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ABOUT THE SOCIETY

MOBILIZATION Society was established in 2003 as a non-profit professional society aimed at sensitizing and mobilizing development partners and community for sustainable development. The Society, during these ensuing years has successfully mobilized researchers, academicians, planners, grass root mobilizers and student and created conducive intellectual atmosphere for introspective deliberations and conducted National seminars/ workshop to address the emerging problems experienced by the agrarian mass. Presently the Society has more than 1700 Life Members. The recognition of the Society in the efforts for strengthening the forum for scientific communication is growing among the related professionals and concerned agricultural stakeholders rapidly. The Society works on following objectives-

1. To document the on-farm and adaptive research experiences in multi- disciplinary agri-bio sciences and extension education.
2. To offer a platform for sharing the empirical experiences of development professionals, community mobilizers, academicians, multi-sectoral researchers, students etc. for the benefit of ultimate users.
3. To facilitate close and reciprocal linkage among the institutions for sustainable rural development.
4. Promoting potential and practicing entrepreneurs.
5. To disseminate the documented knowledge to the global partners through approach abstracting and indexing.

ABOUT THE JOURNAL

Journal of Community Mobilization and Sustainable Development (print ISSN 2230 – 9047; online ISSN 2231 – 6736) is published by Society for Community Mobilization for Sustainable Development twice a year. The Journal of Community Mobilization and Sustainable Development has NAAS rating 5.67 and Journal ID J158. The Journal of Community Mobilization and Sustainable Development, is also available on our website www.mobilization.co.in and it has been registered with www.indianjournal.com for national and global abstracting and indexing. MOBILIZATION envisages reorienting the young professionals and researches for imbibing the values of community participation in research, training and extension efforts.

The aim and scope of the journal are:

1. Sharing the relevant experiences and issues related to agriculture and allied fields at the grass root level and global forum to create the necessary academic and development climate.
2. Sensitizing the different stakeholders about the knowledge and innovation management system in pluralistic agri-rural environment.
3. Developing network among the related partners for convergence of their efforts for sustainable academic development of extension education discipline.

Editorial

Millets, a group of small-seeded grasses that are highly nutritious with a low glycemic index, have been of national importance in India. History of millets in India begins before the Indian Bronze Age (4,500 BC), as evidenced by the identification of foxtail millet (*Priyangava*), Barnyard millet (*Aanava*), and black finger millet (*Shyaamaka*) in some of the oldest *Yajurveda* texts. Millets were eventually abandoned from Indian agriculture as 'orphan crops' because they were considered inferior to rice or wheat and unfit for a more affluent palate. India still stands in the topmost position in millet production globally, but its output has declined from 40% of the grain production share to just 10%. In recent years, efforts to boost farmer incomes, combat climate change, and enhance food security through a sustainable production system have placed a fresh emphasis on millet promotion in India. Major campaigns to promote millet began in 2018 with the 'rebranding' of millet from their classification as 'coarse cereals' to 'Nutri-Cereals' in light of its "high nutritive value" and "anti-diabetic properties." Subsequently, the government has merged INSIMP (Initiative for Nutritional Security through Intensive Millet Promotion, 2011-14) under RKVY (Rashtriya Krishi Vikas Yojana) with the National Food Security Mission (NFSM) and observed 2018 as the National Year of Millets to promote the millet production and consumption. In 2021, Pradhan Mantri Poshan Shakti Nirman (PM POSHAN)- the revamped mid-day meal programme included millets in the mid-day meal menu. A considerable increase in the minimum support price (MSP) and inclusion in PDS was also approved to promote the production of millets. When the UNGA agreed to India's proposal and designated 2023 as IYM (International Year of Millets) to raise awareness of these grains, the promotion of millet for food basket and production in India gathered steam. By raising knowledge of the advantages of millets for the 3Cs (cultivator, consumer, and climate), our nation hopes to turn IYM 2023 into a "people's movement" and establish itself as the "global hub for millets."

I am pleased to present the most recent issues of the MOBILISATION journal (January–April 2023) to our devoted readers. I trust that the compilation of strategic and practical research findings in this issue will make for an engaging academic reading experience. The current issue addresses a broad range of subjects from numerous angles. A couple of them involve the Status of *Green Economy*, Quality evaluation of pearl millet blended cake, Biofortified pearl millet production, Ecosystem analysis of Farmer Producer Organisation (FPO) and entrepreneurial behaviour, Integrated farming systems, Knowledge dissemination and Information processing, Nutrient management aspects, Genetic studies on crop improvement, Co-management in common property resources, Impact studies of various development programmes, research on ICT applications for agriculture and animal husbandry, and climate-smart agriculture.

I acknowledge a great deal of hard work and dedication of Drs. Souvik Ghosh, S. K. Dubey, R. Roy Burman, Nishi Sharma, S.R.K. Singh, Reshma Gills, Sudipta Paul, Sujit Sarkar and Amit K Goswami of the editorial team for the fruition of the current issue of the journal. My sincere gratitude is extended to Drs. Subhashree Sahu and Hema Baliwada for their steadfast guidance and support in forming this journal issue as online editors. Above all, I want to thank our esteemed authors and readers for their scientific contributions, academic support and encouragement, making our journal stand out among other scientific journals.

J.P. Sharma
Chief Editor

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Review Article

Status of Green Economy in India: A Review

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ABSTRACT

India is the second most populous democracy in the world and the seventh largest country in terms of area, with over 1.4 billion inhabitants. India has been one of the major economies with the fastest growth rates since accepting Liberalization, Privatization and Globalization programme in 1991. However, there are numerous environmental difficulties and problems in India. As a result, it is necessary to use an alternate development model known as the green economy. In order to achieve sustainability in the inclusive growth and development of the different areas of countries throughout the world, the notion of the "green economy" has been addressed in recent years. Green economy is simply defined as growth and development programme which is low carbon, resource efficient and social inclusive. India had adopted the strategy of green economy, but there is need to improve the health sector and provision for health in government budget. There are also some barriers to the path of the green economy in India

Keywords: Democracy, Environmental, Green economy, Health, Sustainability

INTRODUCTION

Traditional macroeconomic measures such as GDP reflect a nation's total economic situation, but they do not adequately take into account the costs and benefits of social and environmental factors. The achievement of sustainable decision-making is equally challenging. As a result, the Green Economy is a novel strategy that emerged from the Rio+20 summit in 2012, which was held to mark the 20th anniversary of the first Rio Earth Summit in 1992 (UNEP, 2011). The conference's focus was on the green economy in relation to sustainable development and the reduction of poverty. The UNEP considers a "green economy" as the economy that leads to the improvement of human well-being and social justice and which does not have any ecological downsides. In its simplest expression, a green economy is one that is low carbon, resource efficient and socially inclusive (Diyar *et al.*, 2014).

The Green Economy's goals are green investments which mean investing in activities that are concentrated on initiatives or businesses dedicated to protecting the environment (International Chamber of Commerce, 2012). Public investments in renewable energy sources including solar, wind, hydropower and geothermal are a focus of the green economy. Such a system of economics favours the production and consumption of natural and organic foods. The economy leads to a decrease in ecological risks and scarcities and pursues sustainable development without harming the environment (Stjepanovic, 2017; Smaliukiene and Monni, 2019). At ground level, every person can follow practices of a green economy like porganic farming, kitchen gardening, setting up plant-based homes, solar energy, using a bicycle as a means of transportation, electric vehicle and gasoline/electric hybrids (Vidyapeeth, 2020).

A green economy is one of the ways to achieve sustainability. There are historical links between a green economy and sustainable development. In 1972, concept of sustainable development received its first

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major international recognition in UN Conference on the Human Environment held at Stockholm, Sweden; which lead to the creation of the United Nations Environment Programme. As per the classical definition of sustainable development given by Brundtland Commission in 1987, it is the way of development that fulfills the present needs without affecting the needs of future generation. World summit on Sustainable development was held in 2002 at Johannesburg, South Africa, which focused on sustainable consumption and production, renewable energy production, water conservation and sanitation. United Nations Conference on Sustainable Development also known as Earth summit (Rio+20), held in 2012 with main theme as green economy in context of sustainable development and poverty eradication. United Nations Summit on Sustainable Development was held in 2015 at New York, 17 sustainable development goals were adopted by United Nations. Agenda 2030 was also adopted in this conference to take actions to end poverty, protect the planet and ensure that by 2030, all the persons on planet live with prosperity. In 2022, at Sweden, Stockholm 2022 conference for proper implementation and evaluation of Sustainable Development Goals.

There are three components of green economy - green buildings, green finance and social inclusivity. A green economy follows a more sustainable route by allocating a larger portion of its GDP to sustainable agriculture, waste management, forestry, clean transportation, clean energy and green buildings. The creation of new export markets, such as new markets for bio-fuels and renewable energy technology like solar panels and wind turbines, helps to maintain existing market share and improves energy security are among the economic advantages of the green economy.

1. Why Green Economy?

- Various factors that contribute to global warming include carbon emissions, gas emissions, and greenhouse gas emissions. A significant source of global greenhouse gas emissions is the electricity sector. 25.00 per cent of the world's greenhouse gas emissions come from the electricity sector.
- The industrial sector ranked second in the world for greenhouse gas emissions. It was responsible for 21.00 per cent of global greenhouse gas emissions.
- The sector of transportation accounts for 14.00 per cent of the rising gas emissions. Coal, petroleum, and other fossil fuels are used to power a variety of vehicles. 85.00 per cent of vehicles run on gasoline and diesel.
- The burning of fossil fuels inside of structures also raises gas emissions. The onsite energy generation process emits noxious gases that are harmful for both flora and fauna even though it accounts for 6.00 per cent of gas emissions.
- By 2021, carbon emissions had increased to 36.44 billion metric tonnes from 23 billion metric tonnes in 2002. Modernization and industrialization are the causes of the rising carbon emission (Kaushik, 2021).
- Improper sanitation: More than 60.00 per cent of the country's GDP is being lost due to public health and environmental costs due to unsafe sanitation. 75 per cent of all surface water across India is being contaminated due to the discharge of untreated municipal waste water (Vadyapeeth, 2020).
- The urban population in India which stands at 377 million is expected to grow up to 404 million by 2050. In India, 65 per cent of land is degraded in some way like nature or size (World Urbanisation Prospects, 2014).

2. Principles of Green Economy:

There are 9 key Principles of the green economy

2.1 The Sustainable Principle

- Dependency on a healthy environment and well being for all.
- Addresses all three dimensions (environmental, social and economic) and develops integrated policy mixes.

2.2 The Justice Principle

- Promotes gender equality and recognizes knowledge, skills, experience and contribution of each individual.
- Respects indigenous peoples' rights to lands, territories and resources.

2.3 The Dignity Principle

- Poverty Alleviation, Food Security, Self-Empowerment and Education.

2.4 The Healthy Planet Principle

- Reducing pollution, Safeguarding ecosystems, Biodiversity integrity.
- Restoration of balance between ecological and social relations.
- Efficient use of natural resources without compromising future prospects.

2.5 The Inclusion Principle

- Supports good governance at all levels from local to global.
- Empowers citizens and promotes full and effective voluntary participation at all levels.

2.6 The Good Governance and Accountability Principle

- Achieves transparency.
- Promotes international cooperation and defines international liability.

2.7 The Resilience Principle

- Builds on local skills and capacities.
- Supports sustainable and local livelihood.

2.8 The Efficiency and Sufficiency Principle

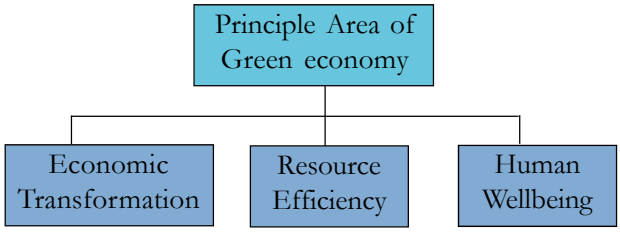
- Supports life-cycle management and strives for zero emission, zero waste, resource efficiency and optimal water use.
- Prioritizes renewable energy and renewable resources.

2.9 The Generations Principle

- Inter-generational and Intra-generational fairness.

3. Analysis of Green Economy in India

This paper identifies the three main components of a green economy, their essential indicators, and the main difficulties in creating a framework for green economy measurements. The UNEP provided a metrics framework for a green economy that included three main areas and the number of indicators found within each of these areas.



3.1 Indicators for economic transformation: Transforming the current economic growth model is at the core of a green economy. Investments in high emission, highly polluting, waste-producing, resource-intensive and ecosystem-damaging activities are often what drive growth. A change in investment toward low-carbon, clean energy, waste-reduction, resource-efficient, and ecosystem-enhancing activities is necessary for a green economy. The major indications of economic transformation thus include the change in investment over time, the ensuing expansion of goods and services that are environmentally friendly or enhance the environment, and related employment.

3.1.1 Total renewable electricity generation: World is running through energy therefore there is continuous use of natural resources like coal, gas, oil, timber *etc.*, but this conventional form of energy generation is harmful for environment and ecosystem of the country. Therefore, there is need to produce clean or healthy energy for the world to develop sustainably. Figure 1 reveals the data about year-wise total renewable energy generation and per capita renewable energy generation in India during the period 2000-2021. In year 2000-01, the total energy generation was 77 billion kWh which increased to 135 billion kWh in 2010-11 and further increased to 324 billion kWh in 2020-21 due to technological and industrial development in India. Whereas, per capita renewable energy generation was 76 kWh in 2000-01 which increased to 115 kWh in the year 2010-11 and further increased to double in next decade *i.e.,* 231 kWh.

Table 1 represents the growth rate and variation in total renewable energy generation and per capita renewable energy generation in India for the period 2000-2021. Compound annual growth rate (CAGR) for total renewable energy generation was 8.00 per cent and the respective coefficient of variation (C.V.) was 45.58 per cent for the period 2000-21. However, the Indian population was growing annually at the rate

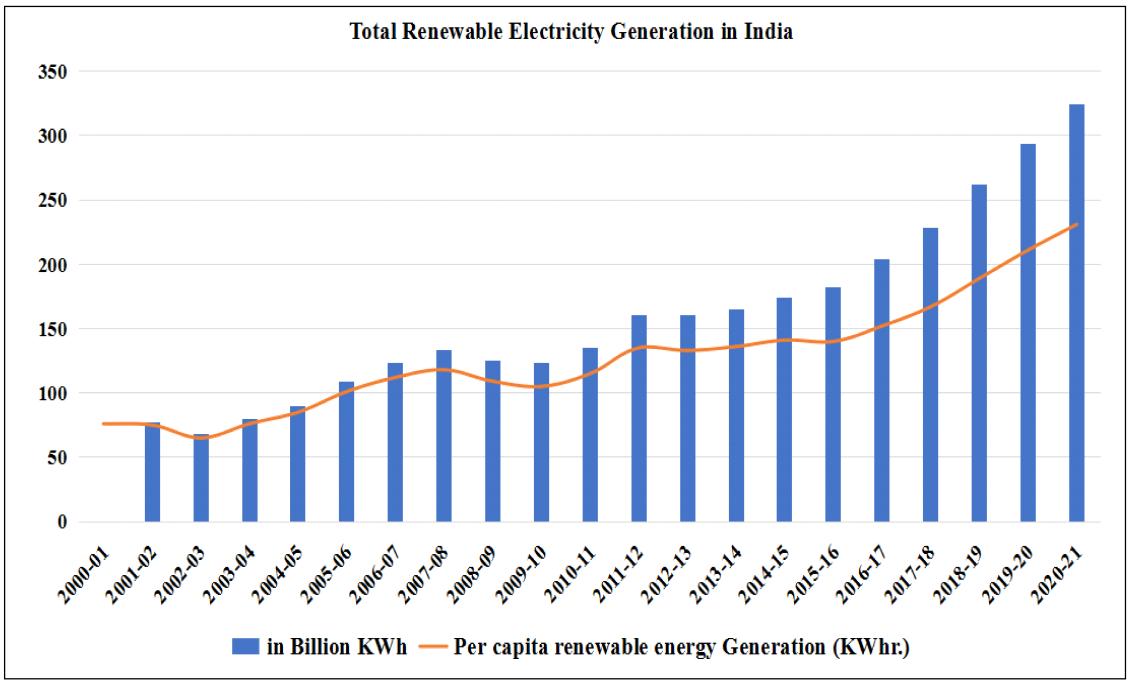


Figure 1: Renewable electricity generation in India
Source: http://www.eia.gov., Ministry of New and Renewable Energy: https://mnre.gov.in and https://population.un.org/wpp/

2.00 per cent compound growth rate and coefficient of variation for per capita renewable energy generation in India during the period 2000-21was found 6.00 per cent per annum and 34.77 per cent per annum respectively.

3.1.1.1 Status of renewable energy in India: India is the third largest consumer of electricity and third largest producer of renewable energy after China and USA. India has committed for a goal of 450 GW renewable capacity by 2030. Figure 2 shows the total installed capacity in India. According to the Central Electricity Authority (CEA), the total non-fossil fuel installed energy capacity in India, as of May 2022, was 1,66,729 megawatts (MW) or 41.40 per cent of India's total installed capacity. Within this, solar energy has the highest share at 14.10 per cent followed by hydro at 11.60 per cent and wind at 10.10 per cent. Waste to energy contributes the least to renewable energy at just 0.1 per cent of the total installed capacity in India. Renewables, including the hydropower but excluding nuclear energy, comprise 39.6 per cent of India's total installed capacity.

3.1.1.2 Renewable energy country attractiveness index: The Renewable Energy Country Attractiveness Index (RECAI) ranks the world's top 40 markets on the attractiveness of their renewable energy investment and deployment opportunities. Rankings reflects market assessment of market attractiveness and global market trends. Table 2 shows India's rank in Renewable Energy Country Attractiveness Index (RECAI) in the world. Overall, India stood in third position with a score of 66.2. Whereas, in the case of energy from solar photovoltaic and solar power plants, India stood at first and fourth, respectively.

For hydroelectricity, India's rank in RECAI was third, for onshore wind power was 10th, for offshore

Table 1: Growth rate and variation for renewable electricity generation in India

Time Period: 2000-2021	Total renewable electricity generation in India	Indian population	Per capita renewable electricity generation
CAGR (%)	8.00	2.00	6.00
C.V. (%)	45.58	11.00	34.77

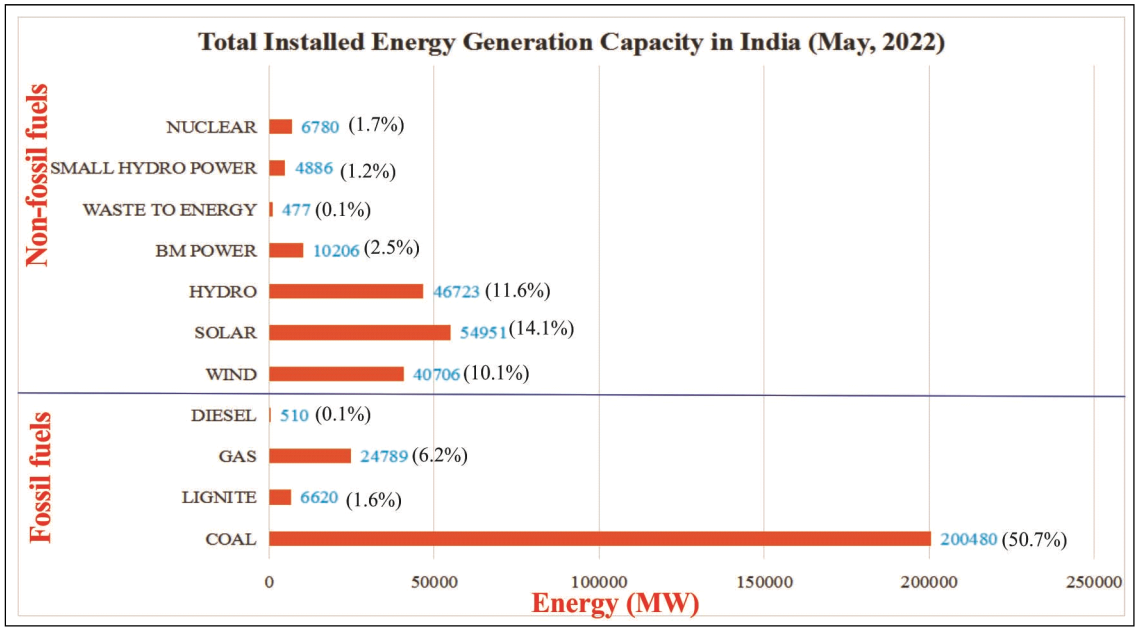


Figure 2: Total installed energy generation capacity in India
Source: powermin.gov.in; as on May 2022

Table 2: India's rank in renewable energy country attractiveness index

Technology	Rank of India in world	RECAI Score
Overall	3*	66.2*
Solar P.V.	1	62.7
Solar Power Plant	4	09.2
Hydroelectricity	3	46.4
Onshore wind power	10	47.4
Offshore wind power	6	54.2
Biofuels	29	28.6
Geothermal Power	16	23.2

***** USA (70.7) and China (68.7)
Source: https://www.ibef.org/industry/renewable-energy-presentation

wind power was sixth. However, for geothermal and bio-fuels energy, India's rank in RECAI was 16th and 29th, respectively. This shows India's excellent efforts towards renewable energy.

3.1.2 Adjusted saving : Natural resource depletion: Adjusted saving is an accounting measure of natural resource depletion. Natural resource depletion is the sum of net forest depletion, energy depletion, and mineral depletion. Net forest depletion is unit resource rents times the excess of round wood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime. It covers coal, crude oil and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime. It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.

- **Gross national income** = (Consumption + Investment) + Government expenditure + (export-import)
- Adjusted saving is concept which involves in accounting of natural resources depletion.
- Measurement of adjusted net saving (ANS) is based on standard national accounting concepts. Adjusted net saving is obtained using the following identity:

Percentage of natural resource depletion in India for the period 2000-21 is presented in the Table 3. In 2000, natural resources deplete at 2.83 per cent of GNI, after which the rate of depletion grew progressively until 2008. After 2008 the natural resources deplete with decreasing rate continuously up to year 2021. Increased public expenditure towards conservation of natural resources, and various initiatives taken by the government like National Wetland Conservation Programme, Mangrove for Future, Waste management under Swach Bharat Abhiyan, *etc.* (Sharma, 2018). Other sources of energy also discovered like monazite sand

Table 3: Natural resources depletion

Year	% of GNI	Net annual per centage change (%)
2000-01	2.83	0.00
2001-02	2.72	-0.11
2002-03	2.69	-0.03
2003-04	2.73	0.04
2004-05	2.86	0.13
2005-06	3.02	0.16
2006-07	3.62	0.60
2007-08	4.04	0.42
2008-09	5.55	1.51
2009-10	3.01	-2.54
2010-11	4.19	1.81
2011-12	4.26	0.07
2012-13	3.23	-1.03
2013-14	3.14	-0.09
2014-15	2.11	-1.03
2015-16	1.58	-0.53
2016-17	1.09	-0.49
2017-18	1.00	-0.09
2018-19	0.99	-0.01
2019-20	0.98	-0.01
2020-21	0.98	0
C.G.R (%)	2.50	
Mean	2.68	
C.V. (%)	48	

Source: The changing wealth of Nations: Measuring sustainable development in the new millennium-2011

in nuclear fuels on the coast of Kerala which is replacement of thorium and uranium. As well as large investment in renewable energy resources (Kumar and Vashisht, 2018).

Positive annual percentage changes indicate greater exploitation of resources by citizens, and vice versa. Negative annual percentage changes indicating improved resource condition imply less resource depletion in the corresponding years. The overall picture of the replenishment of natural resources shows a compound growth rate of 2.50 per cent. The average percentage of GNI lost due to the depletion of natural resources has been 2.09. The coefficient of variation for natural resources depletion for the period 2000-21 was found 48 per cent.

3.2 Indicators for resource efficiency: The main indicators in this field relate to the use of resources such as materials, energy, water and land as well as to ecosystem changes, waste production, and emissions of harmful compounds from economic activity.

3.2.1 Energy use: Energy use refers to use of primary energy before transformation to other end-use fuels. Primary energy consists of unconverted or original fuels. Example: Oil, natural gas, coal, uranium, blowing wind, flowing water, biomass, solar energy. Secondary energy includes resources that have converted or stored. Example: Gasoline, liquid fuel oil, bio-fuels, electricity, hydrogen and heat. Energy use in Kilogram of oil equivalent, abbreviated as kgoe, is a normalized unit of energy. It is equivalent to the approximate amount of energy that can be extracted from one kilogram of crude oil. 1 kg of oil equivalent is equal to 41868 kilojoules.

Figure 3 revealed the data about total primary energy demands in India during 2000-2020. Coal accounted for 44 per cent of India's primary energy needs in 2020, up from 33 per cent in 2000. The demand for oil has stayed constant at 25 per cent between 2000 and 2020 despite rising urbanization and household purchasing power, although there has been a significant rise in oil consumption in absolute terms. The percentage of natural gas, a fossil fuel that burns reasonably cleanly, climbed from 5 per cent in 2000 to 8 per cent in 2010, but declined to 6 per cent by 2020. This fuel is referred to as the transition fuel in India's ambitions to move away from coal. Through the Ujjawala Yojana, the national government's campaign for cleaner cooking fuels, households in India have begun switching to Liquefied Petroleum Gas (LPG) for their cooking needs. Due to this, the percentage of conventional biomass as an energy source has almost decreased in half, from 26 per cent in 2000 to 13 per cent in 2020.

Table 4 shows the data about per capita energy use (kg of Oil Equivalent) in India. In 2000, annual per capita energy use was 438kg, then after the 2001 gradually rate of per capita energy use has been growing up to year 2021 *i.e.,* 698 kg per capita.

The average amount of energy per person in India is 578 kg, and the compound annual growth of energy

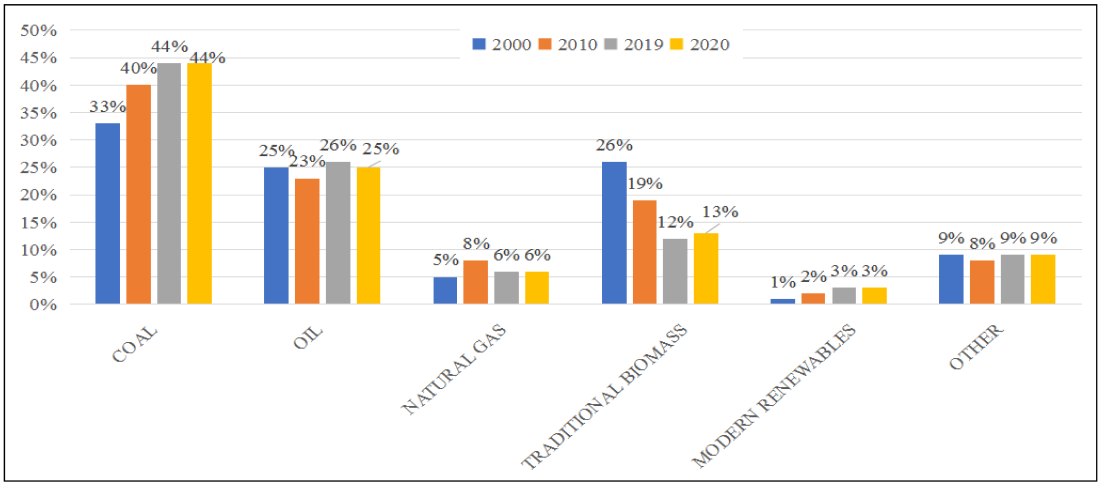


Figure 3: Total primary energy demands in India 2000-2020

Table 4: Energy use in India for the time period 2000-21

Year	kg of oil equivalent per capita	Annual per centage change (%)
2000-01	438	0.00
2001-02	438	0.00
2002-03	444	1.00
2003-04	448	1.00
2004-05	466	4.00
2005-06	479	3.00
2006-07	498	4.00
2007-08	521	5.00
2008-09	538	3.00
2009-10	585	9.00
2010-11	599	2.00
2011-12	616	3.00
2012-13	637	3.00
2013-14	643	1.00
2014-15	661	3.00
2015-16	679	3.00
2016-17	682	0.40
2017-18	687	0.70
2018-19	690	0.40
2019-20	691	0.01
2020-21	698	1.00
C.G.R (%)	3.45	
Mean	578	
C.V. (%)	16.67	

Source: IEA Statistics © OECD/IEA 2014 http://www.iea.org/stats/index.asp, subject to https://www.iea.org/t&c/termsandconditions/

availability over the study period was positive 3.45 per cent. 16.67 per cent coefficient of variation was also observed mainly during the period 2000-21.

3.2.2 Agricultural material export: Analysis of the agricultural sector's performance is a key indicator for achieving green growth and green economy goals. More the agricultural export means more number of resources invested in agriculture and agriculture is sink for pollution, hence export share of agriculture is used as an indicator towards green economy. Investment in agriculture leads to less technology interventions. Also Agriculture sector contributes to bio-fuel economy through bio-diesel - new trade opportunity (Kamble and Ovhal, 2016).

Table 5 releases the data about Agricultural Material Export by India. A total of 6.92 percent of all exports of goods were made in 2000. Its percentage share has been rising steadily at a rate of 5.35 over the period 2000-21. Agricultural material export's per cent share increasing continuously before 2012 but global as well as India's exports saw a decline after 2012 which UN termed as anaemic growth 2012-2014, then by a downturn (2015 and 2016) and then finally by a strong rebound (2017 and 2018) (UNCTAD, 2019). The rebound of 2017 was also largely unanticipated, and more so the strong increase in trade for 2018 as last year was characterized by increasing global uncertainty (UNCTAD, 2019). During 2018-19 and 2019-20, agricultural material export decreases due to covid pandemic.

Table 5: Agricultural material export by India

Year	% share of agricultural material in total export
2000-01	6.92
2001-02	6.54
2002-03	6.23
2003-04	7.35
2004-05	8.72
2005-06	8.89
2006-07	9.13
2007-08	8.53
2008-09	9.21
2009-10	9.75
2010-11	12.28
2011-12	10.01
2012-13	11.62
2013-14	12.25
2014-15	12.59
2015-16	13.10
2016-17	13.71
2017-18	13.77
2018-19	11.67
2019-20	11.21
2020-21	14.14
C.G.R (%)	4.50
C.V. (%)	22.00

Source: https://tradingeconomics.com/india/agricultural-raw-materials-exports-percent-of-merchandise-exports-wb-data.html, APEDA, Ministry of commerce, Govt. of India

3.3 Indicators for human well being: A green economy can advance society and improve people's quality of life in two ways: first, by rerouting money toward green products and services, and second, by rerouting capital toward the development of social and human capital. Two indicators are selected for human well being : Life expectancy at birth and total expenditure on health (public + private).

3.3.1 Life expectancy at birth: The life expectancy at birth is a good indicator of a population's mortality rate. It is the typical lifespan of a person. Indicators of life expectancy at birth are crucial for determining the true effects of progress on the quality of human life in the various nations. Expected total life of Indian people in response to implementation of green development model for inclusive and sustainable development of Indian economy is presented in Table 6.

Through the green and sustainable development of the surrounding region of human society, long and healthy lives can be attained. Hong Kong (87.8), Japan (84.6), Switzerland (83.8), Singapore (83.6) and Spain have the highest life expectancy (83.3).

Indians' average life expectancy was 62 in 2000, but it has been steadily rising during the time period 2020–21. The life expectancy compound growth rate throughout this study period is quite low *i.e.,* 0.49 per cent but favourable. The coefficient of variance was also found 3.35 percent, which is extremely normal. Indians live an average of 65.76 years during 2000-21.

Table 6: Life expectancy at birth of India

Year	Total age (years)	Annual percentage change (%)
2000-01	62	0.00
2001-02	63	1.61
2002-03	63	0.00
2003-04	63	0.00
2004-05	64	1.58
2005-06	64	0.00
2006-07	64	0.00
2007-08	65	1.56
2008-09	65	0.00
2009-10	65	0.00
2010-11	66	1.53
2011-12	66	0.00
2012-13	66	0.00
2013-14	66	0.00
2014-15	67	1.51
2015-16	67	0.00
2016-17	68	1.49
2017-18	69	1.47
2018-19	69	0.00
2019-20	69	0.00
2020-21	70	1.45
C.G.R (%)	0.49	
Mean	65.76	
C.V. (%)	3.35	

Source: https://www.macrotrends.net/countries/IND/india/life-expectancy

3.3.2 Total health expenditure (Public + Private): The efficiency of a worker's labour ultimately depends on how physically fit and healthy they are, as results will indicate that both micro and macro levels of output will suffer if they are not in good physical and mental health. Health of the workforce has a more substantial association with industrial output level, income level, worker's quality of life and ultimately, overall growth has been influenced by the health of the nation. Chronological total health expenditure (Public + Private) on Indian citizen is provided in Table 7.

In 2000-01, government extended 4.31 per cent of GDP in health sector which decreased to 3.82 per cent in year 2010-11and further decreased to 3.45 per cent in the year 2020-21. The compound growth rate for health expenditure during the period 2000-21 was found negative *i.e.,* -0.37 per cent per annum. Average total health expenditure (public + private) for the period 2000-21 was 3.88 per cent of GDP. However, health expenditure in absolute terms was continuously increasing during the whole study period.

Table 7: Total health expenditure (Public + Private)

Year	% share in GDP	Health expenditure (million U.S. Dollar)
2000-01	4.31	21.29
2001-02	4.55	23.83
2002-03	4.45	27.52
2003-04	4.35	31.39
2004-05	4.56	38.04
2005-06	4.31	40.91
2006-07	4.09	50.66
2007-08	3.94	48.23
2008-09	3.99	54.48
2009-10	4.05	69.19
2010-11	3.82	69.64
2011-12	3.83	70.00
2012-13	3.81	70.74
2013-14	3.72	78.25
2014-15	3.97	80.95
2015-16	3.67	84.19
2016-17	2.94	77.95
2017-18	2.95	79.74
2018-19	3.01	85.23
2019-20	3.81	101.64
2020-21	3.45	109.64
C.G.R (%)	-0.37	
Mean	3.88	
C.V. (%)	12.50	

Source: https://data.worldbank.org/indicato=IN, Ministry of Health and Family Welfare, Govt. of India

4. India's Initiatives Towards Green Economy

- Between 2015 and now, India's efforts towards advancing its transition to clean energy and mobility include its determined contribution to install 500 GW of renewable energy capacity by 2030.
- The FAME II (Faster Adoption and Manufacturing of Electric and Hybrid Vehicle in India) scheme is one such measure aimed at promoting the shift from petrol/diesel-based private vehicles to electric vehicles and involves a subsidy component to the buyers of the electric vehicle.
- National Electricity Plan 2018 includes a timeline of retiring coal power plants older than 25 years in two phases, along with plans to reduce around 48 GW of coal capacity between 2017 and 2027.
- In May 2018, National Wind-Solar Hybrid Policy to promote large grid-connected wind-solar photovoltaic (PV) hybrid systems. The policy aims at promoting new and innovative technologies and methods for combining wind and solar power.
- Measures to push renewables, which include increasing government allocation for Production Linked Incentive (PLI) schemes to boost the manufacturing of high-efficiency solar modules, have added to India's efforts for cleaner fuel.
- In June 2021, a global initiative to accelerate clean energy innovation among countries called Mission Innovation Clean Tech Exchange was also launched.
- Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) to support the installation of off-grid solar pumps in rural areas and reduce dependence on the grid in grid-connected areas.
- SAUBHAGYA (Pradhan Mantri Sahaj Bijli Har Ghar Yojna) scheme to provide electricity to Indian households.

- Solar Charkha Mission (employment generation for nearly one lakh people through solar charkha clusters in rural areas).
- National Solar Mission and Renewable purchase obligation (RPO) - the mechanism by which distribution companies are obligated to purchase a certain percentage of power from renewable energy sources.
- Agro-photovoltaic system designed and developed at Central Arid Zone Research Institute, Jodhpur through which will help in generation of electricity, cultivation of crops in interspace area and harvesting rainwater from top surface of PV-module.

5. Some key Barriers to Green Economy in India

- Perception among businesses and policy makers that environmental protection comes at the cost of economic growth and development.
- Financial markets for green investments are at a nascent stage - direct funding towards green and responsible investments are inadequate.
- Green technology - thought of as unreliable and not cost-competitive.
- Greening the economy - not fully recognized as a tool to achieve social prosperity and environmental sustainability.
- Production with green economy practices may not be sufficient for growing population.
- India's dependence in imports for solar energy equipment have been major roadblocks in India's transition to clean energy.

CONCLUSION

Along with reducing wasteful consumption across the economy, green economy also lowers energy use per unit of production and carbon emissions per unit of GDP. Indicators from principal area of green economy with reference to India reveals that indicators like renewable energy, energy use, export of agricultural materials by India, improvements in life expectancy at birth show positive trend while expenditure on health by government shows negative growth rate. India had adopted the strategy of green economy, but there is need to improve the health sector and provision for health in government budget. India has committed to a goal of generating 450 GW renewable capacity by 2030. Therefore, there is need to addition of 20 GW energy per year to total stock to reach the target. There are some policies and programme barriers of green economy in India. The green economy has economical and developmental aspects as well as environmental concerns.

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Effectiveness of Cash Transfer Under the PM-Kisan Scheme of Government of India in Benefitting the Small and Marginal Farmers by Providing Income Support

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ABSTRACT

Among all societal ills that exist in the world, poverty is the most pervasive. Most low- and middle-income countries depend on agriculture as their primary source of income, making them subject to a variety of risks that make it difficult for them to continue their livelihood over the long term. With risks including crop failure, natural disasters, disease, accidents, and job loss, poor and near-poor households in low- and middle-income countries find it challenging, if not impossible, to raise and maintain their standard of living over time. For more than 50 years, cash transfers have been a crucial part of reducing poverty in developed nations, but until the past ten years, poorer nations were thought to be too expensive or unable to execute them. Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) is a central sector scheme run by the Ministry of Agriculture and Farmer's Welfare (MoAFW) where all farmer households receive a direct annual cash transfer of Rs. 6,000, divided into three equal instalments of Rs. 2000 each. An ex post facto research design was used in the study. The present paper presents data gathered in a the Indo-gangetic belts of Uttar Pradesh and Bihar. The 120 respondents, 60 each from two states comprising four districts i.e. Bahraich, Bulandshahr, Bhojpur and Muzaffarpur were selected using stratified disproportionate simple random sampling of small and marginal farmers for the study. The majority of respondents in Uttar Pradesh, or 63.33 per cent, felt that the PM-KISAN scheme was only moderately effective in addressing their needs, while 21.67 per cent of respondents believed it to be highly effective. In the instance of Bihar, almost 50 per cent of respondents, or half, thought that the PM-KISAN programme was medium successful in terms of the benefits they received to meet their needs, while 25 per cent of respondents thought that the plan is highly effective.

Keywords: Benefitting, Cash transfer, Effectiveness, Government of India, Income support, PM-kisan scheme, Small and marginal farmers

INTRODUCTION

Poverty is the most prevalent among all social evils existing across the countries. Owing to the fact that most of the low and middle income countries depend on their primary sector *i.e.,* agriculture for livelihood, they are vulnerable to a range of risks which makes it difficult for them to sustain their livelihood in long term. Poor and near-poor households in low- and middle-income nations suffer a variety of risks (such as crop failure, natural disaster, disease, accident, and job loss), making it difficult, if not impossible, to improve and preserve their level of living over time. There is a growing body of data that the impoverished are rarely able to protect themselves against such shocks.

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As a result, they deal with shocks by selling productive assets, withdrawing children from school, and lowering nutritional intake. This vulnerability impacts both the non-poor, who are at risk of dropping below the poverty line, and the impoverished, who are at risk of sinking deeper into deprivation and persistent poverty. Cash transfers, have played a vital role in alleviating poverty in developed countries for more than 50 years, but they were regarded to be exorbitant or impossible to implement in poorer countries until the last decade (Bryant, 2009). A mix of policies can be economical, allowing for selective selection of the portfolio most likely to provide a reliable consumption floor for the most vulnerable rural residents. Fertilizer subsidies and social transfers, they found, are complementing mechanisms for reducing hunger vulnerability in impoverished agrarian countries (Ellis and Maliro 2013).

Many countries have got the idea to transfer social benefits to its people with the aim to reduce inequalities, poverty, corruption and facilitate better livelihood standards. Informal labour income and self-employment income sectors in Brazil reduced income inequality (Scorzafave and Lima, 2010). Social transfer schemes were found to have a beneficial but limited impact on equality. In India, currently there are 313 schemes under 53 ministries using the mechanism of DBT. Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) under the Ministry of Agriculture and Farmer's Welfare (MoAFW) is a Central sector scheme implemented by Government of India. A direct annual cash transfer of Rs. 6,000 in three equal installments of Rs. 2000 each is given to all landholding farmer families (SMFs) for every four month period.

MATERIALS AND METHODS

Multistage sampling has been used in this study to identify the respondents. The present paper presents data gathered in the Indo-gangetic plains of Uttar Pradesh (U.P) and Bihar chosen purposively, since these two states contribute to 30% of the total small and marginal land holdings in India and 75.2% of the total small and marginal land holdings in the IGP belt (Agricultural Census 2015-16). In the second stage, four districts were selected through simple random sampling, viz. Bahraich, Bulandshahr, Bhojpur and Muzaffarpur of U.P and Bihar respectively. In the third stage, simple random sampling was used to select two gram panchayats from each district viz. Kataha and Ghasipur of Bahraich, Chhapna and Machad of Bulandshahr, Dhandiha and Bakri of Bhojpur, Gavasara and Mohammadpur-Khaje of Muzaffarpur. In the final stage, a sampling frame of the beneficiaries of PM-KISAN was prepared and 15 respondents from each gram panchayat were selected using stratified disproportionate simple random sampling of small and marginal farmers for the study. Thus, 120 respondents were surveyed through face-to-face interviews. The effectiveness of the PM-KISAN scheme was measured by effectiveness index which was be developed for this purpose which consisted of the following four dimensions:

i) *Utility of the fund:* It refers to the degree to which the fund is purposeful in meeting the basic amenities of the farmer.

ii) *Input utilization behaviour:* It refers to the degree to which the fund is perceived beneficial to the respondents' extent of utilization of various inputs required for farming.

iii) *Coping Capability:* It was operationalized as the extent to which the respondents were able to manage adverse conditions, risks, pressures *etc.,* that are involved in farming.

iv) *Level of satisfaction:* It is defined as the degree to which the respondents' perceived contentment in terms of timeliness, sufficiency, procedures and grievance re-dressal mechanism.

The selection criteria should serve as a reference for whether or not to include an indicator in the overall composite index. It should be as specific as possible, describing the phenomena being monitored, such as input, output, or process. The dimensions in this study were discovered by a review of relevant literature and expert opinion, and the indicators chosen under each dimension were tested for relevance with thirty three experts. The mean relevancy score of each statement was calculated and the statements with mean relevancy score greater than 2.2 was included in the final interview schedule.

$$\text{Mean relevancy score} = \frac{(Most\ relevant\ *3)+(Relevant\ *2)+(Not\ relevant\ *1)}{Number\ \ of\ Judges}$$

Weightage: The effectiveness of the scheme is operationalized to the extent the PM-KISAN scheme

is able to meet the desired results of augmenting agricultural production and benefitting the small and marginal farmers in reducing their vulnerability by providing income support. The dimensions and indicators were sent to experts of concern field for relevancy test and to provide weight. The mean weight was calculated and used for final measurement.

$$\text{The Individual Effectiveness Index (E)} = \frac{(E1\times W1+ E2\times W2+ E3\times W3+ E4\times W4+ E5\times W5)}{(W1+ W2+ W3+ W4+ W5)}$$

Where, E1= Score obtained on Input utilization behaviour; E2= Score obtained on Utility of the fund; E3= Score obtained on Level of satisfaction of beneficiary; E4= Score obtained on Coping Capability; W1= Weightage given by judges for Utility of the fund; W2= Weightage given by judges for Input utilization behaviour; W3= Weightage given by judges for Coping Capability; W4= Weightage given by judges for Level of satisfaction.

RESULTS AND DISCUSSION

Results of the study are presented and discussed under the broadheads; Utility of the fund, Input utilization behaviour, Coping Capability, Level of satisfaction.

Table 1 revealed that 57.5 per cent of the respondents agreed with the statement that fund is utilized in investment in agriculture followed by 37.5 per cent undecided with it and 5 per cent were disagreed with it. Regarding repayments of debts showed that 40.83 per cent of respondents undecided with this while 36.67 per cent disagreed with it, and 22.5 per cent were agreed with it. In case of household consumption of basic goods 41.67 per cent of respondents disagreed with it followed by 37.5 per cent of respondents undecided with it, and 20.83 per cent were agreed about it. Regarding education of children, 55.83 per cent of respondents agreed with it followed by 33.34 per cent of respondents undecided with it, and 10.83 per cent were disagreed with it. Regarding expenditure on food consumption, 64.17 per cent of respondents agreed with it followed by 25 per cent of respondents undecided with it, and 10.83 per cent were disagreed with it. Regarding expenditure on medicines and health check-up, 64.17 per cent of respondents agreed with it followed by 27.5 per cent of respondents undecided with it, and 8.33 per cent were disagreed with it. Regarding expenditure on social and religious ceremonies, 40.83 per cent of respondents undecided with it followed by 35 per cent of respondents disagreed with it, and 24.17 per cent were agreed with it.

Table 2 revealed that in Uttar Pradesh 40 per cent of respondents perceived that they had a medium level of utility of the fund using the PM-KISAN scheme benefits, while 38.33 per cent said they had a high level of utility of the fund. Only 21.67 per cent of respondents said this scheme provided them with low level of utility of the fund. Similarly, in Bihar the findings revealed that 41.67 per cent of respondents perceived that they had a medium level of utility of the fund using the PM-KISAN scheme benefits, while 31.66 per

Table 2: State-wise categorization of beneficiaries based on Utility of the fund (n=120)

Category	Uttar Pradesh Frequency (%) (n=60)	Bihar Frequency (%) (n=60)
Low (<59.099)	13 (21.67)	19 (31.66)
Medium (59.099-71.022)	24 (40)	25 (41.67)
High (>71.022)	23 (38.33)	16 (26.67)
Total	60	60

Table 1: Distribution of beneficiaries on the basis of Utility of the fund (n=120)

Statements	A *f(%)*	UD *f(%)*	DA *f(%)*	Mean ±S.D.
Investment in Agriculture.	69(57.5)	45(37.5)	6(5)	2.525 ± 0.594
Repayments of debts.	27(22.5)	49(40.83)	44(36.67)	1.858 ± 0.759
Household consumption of basic goods.	25(20.83)	45(37.5)	50(41.67)	1.792 ± 0.766
Education of children.	67(55.83)	40(33.34)	13(10.83)	2.450 ± 0.684
Expenditure on food consumption.	77(64.17)	30(25)	13(10.83)	2.533 ± 0.685
Expenditure on medicines and health check-up.	77(64.17)	33(27.5)	10(8.33)	2.558 ± 0.646
Expenditure on social and religious ceremonies.	29(24.17)	49(40.83)	42(35)	1.892 ± 0.765

cent said they had a low level of utility of the fund. About 26.67 per cent of respondents said this scheme provided them with medium level of utility of the fund.

Table 3 revealed that 62.5 per cent of the respondents agreed with the statement that fund is utilized for use of new HYV followed by 37.5 per cent were undecided with it. Regarding sowing at appropriate timing showed that 65 per cent of respondents agreed with this while 35 per cent undecided with it. In case of seed treatment 45 per cent of respondents undecided with it followed by 35 per cent of respondents agreed with it, and 20 per cent were disagreed about it. Regarding use of herbicides, 50 per cent of respondents agreed with it followed by 40.83 per cent of respondents undecided with it, and 9.17 per cent were disagreed with it. Regarding plant protection measures at appropriate timing, 47.5 per cent of respondents agreed with it followed by 44.17 per cent of respondents undecided with it, and 8.33 per cent were disagreed with it. Regarding processing and storage, 45 per cent of respondents disagreed with it followed by 43.33 per cent of respondents undecided with it, and 11.67 per cent were agreed with it. Regarding access to mechanization in agriculture, 45.83 per cent of respondents undecided with it followed by 40 per cent of respondents agreed with it, and 14.17 per cent were agreed with it.

Table 4 revealed that in Uttar Pradesh more than half *i.e.*, 55 per cent of respondents perceived that they had a medium level of input utilization behaviour using the PM-KISAN scheme benefits, while 26.67 per cent said they had a high level of input utilization behaviour. Only 18.33 per cent of respondents said this scheme provided them with low level of input utilization behaviour. Similarly, in Bihar the findings revealed that 56.67 per cent *i.e.*, more than half of the respondents perceived that they had a medium level of input utilization behaviour using the PM-KISAN scheme benefits, while 23.33 per cent said they had a low level of input utilization behaviour. About 20 per cent of respondents said this scheme provided them with high level of input utilization behaviour using the fund.

Table 4: State-wise categorization of beneficiaries based on Input utilization behaviour (n=120)

Category	Uttar Pradesh Frequency (%) (n=60)	Bihar Frequency (%) (n=60)
Low (<53.620)	11 (18.33)	14 (23.33)
Medium (53.620-62.971)	33 (55)	34 (56.67)
High (>62.971)	16 (26.67)	12 (20)
Total	60	60

Table 5 revealed that 50 per cent of the respondents were undecided with the statement that fund has ability to endure the vagaries of weather, followed by 25 per cent each in agreed and disagreed with it. Regarding ability to withstand the risk from adoption of new technology showed that 58.33 per cent of respondents agreed with this while 28.33 per cent undecided with it, and 13.34 per cent were disagreed with it. Regarding ability to withstand the risk from pest infestation and disease incidence, 44.17 per cent of respondents agreed with it followed by 36.67 per cent of respondents undecided with it, and 19.16 per cent were disagreed with it. Regarding ability to tolerate the uncertainty in returns, 40.83 per cent of respondents undecided with it followed by 35.84 per cent of respondents disagreed with it, and 23.33 per cent were agreed with it.

Table 3: Distribution of beneficiaries on the basis of Input utilization behaviour (n=120)

Statements	A *f(%)*	UD *f(%)*	DA *f(%)*	Mean ±S.D.
Use of new HYV.	75(62.5)	45(37.5)	0(0)	2.625±0.486
Sowing at appropriate timing.	78(65)	42(35)	0(0)	2.650±0.479
Seed treatment practices has increased	42(35)	54(45)	24(20)	2.150±0.729
Use of herbicides has increased	60(50)	49(40.83)	11(9.17)	1.408±0.655
Plant protection measures has been done at appropriate timing.	57(47.5)	53(44.17)	10(8.33)	2.392±0.639
Processing and storage activities has increased	14(11.67)	52(43.33)	54(45)	1.667±0.678
Access to mechanization in agriculture has been improved.	48(40)	55(45.83)	17(14.17)	2.258±0.692

Table 5: Distribution of beneficiaries on the basis of Coping Capability (n=120)

Statements	A *f(%)*	UD *f(%)*	DA *f(%)*	Mean ±S.D.
Ability to endure the vagaries of weather has increased.	30(25)	60(50)	30(25)	2± 0.710
Ability to withstand the risk from adoption of new technology has increased.	70(58.33)	34(28.33)	16(13.34)	2.45± 0.720
Ability to withstand the risk from pest infestation & disease incidence has increased.	53(44.17)	44(36.67)	23(19.16)	2.25± 0.759
Ability to tolerate the uncertainty in returns has increased.	28(23.33)	49(40.83)	43(35.84)	1.875± 0.762
Ability to bear the fluctuations in market price has increased.	35(29.17)	54(45)	31(25.83)	2.034± 0.744
Ability to withstand burden from repayment of debts has increased.	47(39.17)	50(41.67)	23(19.16)	2.2± 0.740

Regarding ability to bear the fluctuations in market price, 45 per cent of respondents undecided with it followed by 29.17 per cent of respondents agreed with it, and 25.83 per cent were disagreed with it. Regarding ability to withstand burden from repayment of debts, 41.67 per cent of respondents undecided with it followed by 39.17 per cent of respondents agreed with it, and 19.16 per cent were disagreed with it.

Table 6 revealed that in Uttar Pradesh 46.67 per cent of respondents perceived that they had a medium level of coping capability using the PM-KISAN scheme benefits, while 35 per cent said they had a high level of coping capability. Only 18.33 per cent of respondents said this scheme provided them with low level of coping capability. Similarly, in Bihar the findings revealed that about half of respondents i.e. 51.67 per cent perceived that they had a medium level of coping capability using the PM-KISAN scheme benefits, while 28.33 per cent said they had a high level of coping capability. About 20 per cent of respondents said this scheme provided them with low level of coping capability using the fund.

Table 6: State-wise categorization of beneficiaries based on Coping Capability (n=120)

Category	Uttar Pradesh Frequency (%) (n=60)	Bihar Frequency (%) (n=60)
Low (<53.620)	11 (18.33)	12 (20)
Medium (53.620-62.971)	28 (46.67)	31 (51.67)
High (>62.971)	21 (35)	17 (28.33)
Total	60	60

Table 7 revealed that 51.66 per cent of the respondents disagreed with the statement that financial support provided is adequate followed by 39.17 per cent undecided with it and 9.17 per cent were agreed with it. Regarding the statement financial support is timely showed that 39.17 per cent of respondents each were agreed and undecided with this while 21.67 per cent disagreed with it. In case of procedures for

Table 7: Distribution of beneficiaries on the basis of Level of satisfaction (n=120)

Statements	A *f(%)*	UD *f(%)*	DA *f(%)*	Mean ±S.D.
Financial support provided is adequate.	11(9.17)	47(39.17)	62(51.66)	1.575±0.657
Financial support is timely.	47(39.17)	47(39.17)	26(21.67)	2.175±0.763
Procedures for obtaining the credit support were convenient.	38(31.67)	53(44.17)	29(24.16)	2.075±0.747
Investment support provided can be accessed easily.	73(60.83)	47(39.17)	0(0)	2.608±0.490
Grievance redressal mechanism is lucid.	62(51.67)	45(37.5)	13(10.83)	2.408±0.680
No nepotism or bias towards the beneficiaries at any level while availing services.	66(55)	42(35)	12(10)	2.450±0.672
Distress levels due to restricted movements during lockdown period of Covid-19 were reduced.	24(20)	58(48.33)	38(31.67)	1.883±0.712

Table 8: State-wise categorization of beneficiaries based on Level of satisfaction (n=120)

Category	Uttar Pradesh Frequency (%) (n=60)	Bihar Frequency (%) (n=60)
Low (<55.871)	25 (41.67)	23 (38.33)
Medium (55.871-65.574)	23 (38.33)	18 (30)
High (>65.574)	12 (20)	19 (31.67)
Total	60	60

Table 9: Distribution and categorization of the beneficiaries based on Effectiveness Index (n=120)

Category	Frequency	Percentage	Frequency	Percentage
Low (<14.346)	9	15	15	25
Medium (14.346-15.697)	38	63.33	30	50
High (>15.697)	13	21.67	15	25
Total	60	100	60	100

obtaining the credit support were convenient 44.17 per cent of respondents undecided with it followed by 31.67 per cent of respondents agreed with it, and 24.16 per cent were disagreed about it. Regarding investment support provided can be accessed easily, 60.83 per cent of respondents agreed with it and 39.17 per cent of respondents undecided with it. Regarding grievance redressal mechanism is lucid, 51.67 per cent of respondents agreed with it followed by 37.5 per cent of respondents undecided with it, and 10.83 per cent were disagreed with it. Regarding the statement no nepotism or bias towards the beneficiaries at any level while availing services, 55 per cent of respondents agreed with it followed by 35 per cent of respondents undecided with it, and 10 per cent were disagreed with it. Regarding distress levels due to restricted movements during lockdown period of Covid-19 were reduced, 48.33 per cent of respondents undecided with it followed by 31.67 per cent of respondents disagreed with it, and 20 per cent were agreed with it.

Table 8 revealed that in Uttar Pradesh 41.67 per cent of respondents perceived that they had a low level of satisfaction from the PM-KISAN scheme, while 38.33 per cent said they had a medium level of satisfaction. Only 20 per cent of respondents said this scheme provided them with high level of coping capability. Similarly, in Bihar the findings revealed that 38.33 per cent perceived that they had low level of satisfaction from the PM-KISAN scheme, while 31.67 per cent said they had a high level of satisfaction. About 30 per cent of respondents said this scheme provided them with medium level of satisfaction.

CONCLUSION

The overall effectiveness index of model was worked out by taking into all the four dimensions of effectiveness, viz.(i) Utility of the fund (ii) Input utilization behaviour (iii) Coping Capability (iv) Level of satisfaction. The respondents were classified into three categories from low to high effectiveness index score on the basis of cumulative cube root frequency method. Table 9 revealed that in Uttar Pradesh 63.33 per cent, *i.e.*, almost two third of respondents perceived that the PM-KISAN scheme was medium effective with the benefits received under the scheme for meeting their needs, followed by 21.67 per cent of respondents had found that the scheme is highly effective. There were 15 per cent of respondents believed that it was low effective to meet their needs. In case of Bihar about 50 per cent, *i.e.*, half of respondents perceived that the PM-KISAN scheme was medium effective with the benefits received under the scheme for meeting their needs, followed by 25 per cent of respondents had found that the scheme is highly effective. Also 25 per cent of respondents believed that it was low effective to meet their needs. On classifying the beneficiaries on the basis of the four dimensions individually, it was found that dimensions like Utility of the Fund, Input Utilization Behaviour, and Coping Capabilities followed a normal distribution curve with the maximum number of beneficiaries in the middle category *i.e.*, 40 per cent, 55 per cent and 46.67 per cent in the dimensions of Utility of the Fund, Input Utilization Behaviour, and Coping Capabilities, respectively in the case of Uttar Pradesh. However, the beneficiaries of Bihar were slightly edged over Uttar Pradesh with 41.67 per cent, 56.67 per cent and 51.67 per cent in the three dimensions mentioned, respectively. In the case of Level of Satisfaction dimension, it was found that most of the beneficiaries from Bihar and Uttar Pradesh were in the low category of their satisfaction; with beneficiaries from Uttar Pradesh slightly more in this category than the beneficiaries from Bihar. The result are in line with study of Meera et al. (2004) which found that nearly three fourth of

respondent (73%) expressed medium level of personal effectiveness of *Gyandoot*. The result are in line with study of Narain *et al.* (2014) who revealed that a majority (43.33%) of trained farmers (with input supply) were observed under medium productivity level (10-20 q/ha) followed by (40.00%) under higher productivity (> 20 q/ha) and (16.67%) under lower productivity level under NFSM scheme. The study is in contrast with the study of Sanjitkumar (2015) who found that the majority (43.86%) of the recipient households benefited from the programme by increasing their annual net income assets and savings, according to the report. Poverty was reduced among the beneficiaries' homes, and women's social empowerment increased dramatically. Cash transfers, according to Ghosh (2011), cannot and should not replace, but rather augment, public supply of vital commodities and services. To put it another way, cash transfers are desirable and can play a beneficial redistributive function when combined with other public spending on vital goods and services that all residents, especially the impoverished, deserve. This suggests that the farmers were not satisfied with the scheme as they faced constraints in getting themselves registered, facing nepotism issues and lack of proper grievance redressal mechanism.

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Integrated Farming Systems (IFS): A Comparative Status in Punjab, India and Northern Part of Bangladesh

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ABSTRACT

This research approach was attempted to compare the status of integrated farming systems in Punjab state in India and the Rangpur division of Bangladesh. Data were acquired using the personal interview approach and focus group discussions through a pre-tested semi-structured questionnaire. The study's location and participants were chosen using a purposive sampling technique. In Punjab, 75 per cent of respondents reported cultivating paddy during the *Kharif* season, compared to 70 per cent in Bangladesh. In the Rabi season, most respondents (87.5%) reported growing wheat in Punjab, while 85 per cent of farmers in Bangladesh were growing vegetables. In the Punjab and Bangladesh parts, the sampled respondents' gross cropped areas were 10.52 hectares and 4.40 hectares per farm, respectively. The major crops grown in Bangladesh were paddy, vegetables, wheat, and fruits, while in Punjab, were wheat, paddy, vegetables and basmati. There was zero cultivation of basmati rice and cotton in the study area of Bangladesh. In Punjab, the dominant cropping pattern is rice-wheat (65.2%), while the leading cropping pattern in Bangladesh is rice-vegetables + wheat (64.54%). In Punjab and Bangladesh, the cropping intensity was observed 206 and 230 per cent, respectively. Punjab had an average of 3.33 cows and 5.11 buffaloes per farm, while Bangladesh had an average of 4.67 cows per farm that was used for dairy production. In the Punjab region, each sample farm had an average of 16.12 chicken birds, compared to 9.11 on the Bangladesh side. In comparison to Bangladeshi farmers, who had an average of 5.00 goats per sample farm, Punjabi farmers had an average of 6.55 goats per farm. In Punjab, each sample farm had an average of 0.50 acres dedicated to fisheries, compared to 0.34 acres in Bangladesh. The mushroom had an average of 400 s. ft area in Punjab and 225 s. ft. in Bangladesh. Each sample farm kept bees in an average of 14 boxes in Punjab and 04 boxes in Bangladesh. The majority of respondents (55.0%) farmed with Crops + Dairy model in Punjab, and a maximum of 42.50 per cent of Bangladeshi farmers used the Crops + Fisheries model.

Keywords: Comparative analysis, IFS status, IFS components, Punjab, Bangladesh

INTRODUCTION

India is situated in South Asia, bounded by the Indian Ocean in the south, the Bay of Bengal in the south-east, and the Arabian Sea in the south-west. It shares land borders with Pakistan in the west; China, Nepal and Bhutan to the north; and Bangladesh, Myanmar to the east (GOI, 2015). The climate of India is tropical, sub-tropical, and mountainous (India Climate and Geography | Working Abroad, 2019). Agriculture is demographically the broadest economic sector and plays a significant role in India's overall socio-economic fabric (Economy of India, 2022). India ranks first globally with the highest net cropped area, followed by the US and China, and second worldwide in farm outputs (GOI, 2020). Whereas Bangladesh is also a South Asian country, with three sides bordered by India and connecting the Bay of Bengal in the south. The climate of Bangladesh is sub-tropical (Bangladesh, 2022). Agriculture remains the most important sector

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of Bangladesh's economy, where 48 percent of the population is directly employed in agriculture, and 70 percent depend on agriculture for their livelihood (Agricultural Diary, 2021).

Punjab is a state in northern India whose economy has been primarily agriculture-based since the Green Revolution (GOP, 2018). Being referred to as India's breadbasket, Punjab produces over 17 per cent of the nation's wheat (second highest among Indian states and union territories only behind Uttar Pradesh, which produces more than 30 per cent of the country's supply), about 12 per cent of its rice, and about 10 per cent of its milk (Jayan, 2018; Know Punjab, 2020). On the other hand, Rangpur is the northernmost division of Bangladesh and has an area of 16320.26 sq km. (Mondal, 2012). Since it is primarily plain land with ideal environmental conditions and fertile soil features, this northern area of Bangladesh has been playing a very vital role in agricultural output for the entire nation (Sheikh *et al.,* 2022). This region has the highest cropping intensity (244%), whereas the national cropping intensity is 216 per cent (DC Office, 2022). India has 63 per cent agricultural land and Bangladesh has 61 per cent agricultural land (Pocket Book of Agricultural Statistics, 2019; Agricultural Dairy, 2021).

Agricultural growth has been slowing in recent years amid India's rapid economic growth. According to India's Economic Survey, food grain production grew at a slower rate of 1.2 per cent between 1990 and 2007, lagging behind population growth of 1.9 per cent. India's population is expected to reach 1370 million by 2030 and 1600 million by 2050 (Manjunatha *et al.,* 2014). We'll need to grow 289 and 349 mt. of food grains during the two periods to satisfy demand. According to the country's current scenario, the area under cultivation is declining, with more than 20 per cent of current cultivable land being converted for non-agricultural purposes by 2030 (Gill *et al.,* 2005). In India, operational farm holdings decrease, with over 85 million out of 105 million is less than one hectare. Due to the country's ever-increasing population and declining per capita land supply, there is virtually no space for horizontal expansion of agriculture. Vertical extension is only possible by integrating farming components that need less space and time while also providing fair returns to farm families (Manjunatha *et al.,* 2014).

Bangladesh is small but one of the most populous countries globally, having 1116 peoples per square kilometer (Agricultural Dairy, 2021). About 75 per cent of people live in rural areas, around 50 per cent of them are counted as poor. According to 'SDGs: Bangladesh Progress Report-2018' the country's poverty rate is 21.8 per cent. Feeding a vast population is really a big challenge for Bangladesh. Although it has gained self-sufficiency in food grain for the past few years, there are still ups and downs in production and particularly deficient in nutritional security aspects. The majority of rural people in Bangladesh depend on agriculture for their livelihood expenditures. Agriculture contributes 13.6 per cent of GDP in the country's economy and accounts for 47 per cent of the total labor force (Agricultural Diary, 2021). Thus, to eliminate poverty and ensure nutritional security, special attention and innovations are necessary to make agriculture industries more viable and profitable. Diversification and intensification of cropping and farming enterprises can increase the yield of food grains and other agricultural commodities to a significant level.

Integrated Farming Systems (IFS) are becoming more essential for sound management of farm resources to increase farm productivity, reduce environmental degradation, improving the quality of life of resource-poor farmers, and ensuring sustainability. A holistic approach is the need of the hour to maintain a positive growth rate in agriculture in developing countries like India and Bangladesh. The farmers in both places practice integrated farming techniques. However, it is exceedingly challenging to find cross-country comparative studies and examples of IFS activities. The current study is therefore carried out to assess the comparative status of integrated farming systems in Punjab, India and the northern region of Bangladesh in light of the aforementioned factors.

MATERIALS AND METHODS

The present study was conducted in two districts of Punjab State, India and two districts of Northern part (Rangpur division) of Bangladesh during January 2021. Purposive sample technique was followed to select the locale of the study. Due to active IFS programs by Punjab Agricultural University in Patiala and Amritsar districts, as well as the availability of a significant number

of respondents for data collection, those areas were chosen from the Punjab portion. In Punjab, the researcher visited the Krishi Vigyan Kendra (KVK) in each district (Patiala and Amritsar) and collected a list of farmers practicing integrated farming. From the list, 55 farmers were randomly selected and personally interviewed through a semi-structured questionnaire in each district which constituted a total of 110 respondents in Punjab part. Similarly, Rangpur and Kurigram districts were purposively selected as those districts had Integrated Farming System Components (IMFC) projects at Upazilla (Sub-districts) level. Two Uapazilas from each district were selected and a list of IFS farmers was collected from the office of Upazilla Agriculture Office, Department of Agricultural Extension (DAE) in Bangladesh side and 110 farmers were approached personally for data collection. A total of 220 farmers was the sample size of the study. The investigation was carried out on different components of integrated farming systems i.e. crops grown by the farmers and area coverage, size and share of dairy farming, fisheries, mushroom, bee-keeping and goatary, horticulture.

Secondary sources were also investigated for the study, including government papers, academic journals, and online archives. These were used as supporting materials and evidence for the discussion throughout the study.

Tools for data collection: A research instrument (interview schedule) was prepared as per the study's objectives to collect the data from the respondents. The interview schedule was pretested with 15 farmers from Punjab and 15 farmers from Bangladesh in non-sample areas. The research instrument was modified to remove existing discrepancies and make it more understandable by the respondents based on the information gathered. Expert consultation was also made with academicians, extensionists and scientific personnel for the finalization of the interview schedule. The data were collected personally by the researchers by visiting the study area (both Punjab and Bangladesh) and face to face interviews with the respondents. Besides personal interviews, two focus group discussions (FGDs) were conducted together with farmers and experts' members. Each FGD consists of 10 IFS farmers and 10 expert members from research and extension departments to identify the problems regarding integrated farming systems. In this current study, 1 (one) FGD was conducted in the Bangladesh part and 1 (one) FGD in the Punjab part.

Data analysis: To determine the frequency, percentage (%), and average values of various demographic parameters of farmers in the research areas, simple descriptive analysis was performed.

RESULTS AND DISCUSSION

Tables 1 and 2 display the socio-personal traits of the farmers in this study. In both India and Bangladesh, middle-aged people make up the majority of farmers. Among 110 Punjab (India) participants, 49.09% had completed education up to the secondary level. Similarly, in Bangladesh, among the same participants, 47.27 per cent had competed for a similar qualification. Small families made up the majority of families in Punjab (45.45%), whilst middle-sized families are more typical in Rangpur (63.63%). There were no landless farmers in Punjab, and all farmer categories had three times larger farms than those in Bangladesh. Farmers in both Punjab and Rangpur locations had a similar type of farming experience. Extension contacts and mass media exposures are higher in India than in Bangladesh. In Bangladesh, 87.5 per cent of farmers received financing from various sources, compared to 81.82 per cent in India. Compared to the farmers in Rangpur, Punjabi farmers spend more time each day engaged in farming operations. Forty-eight farmers who spend more than 8 hours farming, and the Punjab State has 60 farmers who do so. The farmers of Punjab had more participation in the use of social media than the farmers of the Rangpur division of Bangladesh. The highest 63.64 per cent of respondents fall under the medium use category in Punjab, whereas 41.82 per cent belonged to the low use category in Bangladesh.

During *Kharif* season, 75 per cent of the respondents from Punjab study area were cultivating paddy where in Bangladesh part it was 70 per cent. Table 3 indicated that out of all respondents 52 respondents (43.33%) grow vegetables, 48 respondents (40.00%) grow fodder, 20 respondents (16.67%) grow basmati, 18 respondents (15.00%) grow sugarcane, 15 respondents (12.50%) grow fruits, 12 respondents (10.00%) grow maize and flower in the Punjab part whereas the figures were fruits 44 (36.67%), fodder 40 (33.33%), vegetables 36 (30.00%), maize 30

Table 1: Socio-personal characteristics of respondents

Parameters	Categories	Punjab (n=110)		Bangladesh (n=110)		Overall
		f	%	f	%	(n=220)
Age	Young (up to 30 years)	30	27.27	37	33.36	67 (30.45)
	Middle (31-50 years)	59	53.63	54	49.09	113 (51.36)
	Old (above 50 years)	21	19.09	19	17.27	40 (18.18)
Education	Illiterate	04	03.36	11	10.00	15 (6.81)
	Primary	28	25.45	21	19.09	49 (22.27)
	Secondary	54	49.09	52	47.27	106 (48.18)
	Graduate	15	13.63	23	20.90	38 (17.27)
	Post graduate	09	08.18	03	02.72	12 (5.45)
Family size	Small (up to 4)	50	45.45	35	31.81	85 (38.63)
	Medium (5-8)	40	36.36	70	63.63	110 (50.50)
	Large (> 8)	20	18.18	05	04.54	25 (11.36)

Parameters	Category	Range		Punjab		Bangladesh		
		Punjab	Bangladesh	f	%	f	%	
Farm size	Landless	—	up to 0.02 ha	—	—	06	05.45	06 (02.72)
	Marginal	up to 1.0 ha	0.021-0.20 ha	17	15.45	14	12.72	31 (14.09)
	Small	1.0-2.0 ha	0.21-1.0 ha	27	24.54	65	59.09	92 (41.81)
	Semi-medium	2.0-4.0 ha	—	44	40.00	—	—	44 (20.00)
	Medium	4.0-10.0 ha	1.1-3.0 ha	16	14.54	21	19.09	37 (16.81)
	Large	> 10 ha	> 3 ha	06	05.45	04	03.63	10 (04.54)

Table 2: Other Socio-personal Characteristics

Parameters	Categories	Punjab (n=110)		Bangladesh (n=110)		Overall
		f	%	f	%	(n=220)
Farming experience	5-10 years	26	23.63	35	31.81	61 (27.72)
	11-15 years	32	29.09	31	28.18	63 (28.63)
	16-20 years	25	22.72	26	23.63	51 (23.18)
	Above 20 years	27	24.54	18	16.36	45 (20.45)
Extension contacts	Low (0-9)	10	09.09	25	22.72	35 (15.90)
	Medium (10-18)	67	60.90	62	56.36	129 (58.63)
	High (19-28)	33	30.00	23	20.90	56 (25.45)
Mass media exposure	Low (0-6)	14	12.72	42	38.18	56 (25.45)
	Medium (7-12)	70	63.63	56	50.90	126 (52.28)
	High (>12)	26	23.63	12	10.90	38 (17.27)
Credit received	Yes	90	81.82	96	87.28	186 (84.55)
	No	20	18.18	14	12.72	34 (15.45)
Daily time use	> 8 hrs. /day	60	54.55	48	43.64	108 (49.09)
	6-8 hrs. /day	40	36.36	52	47.27	92 (41.82)
	4-6 hrs. /day	07	06.36	06	05.45	13 (05.90)
	< 4 hrs. /day	03	02.72	04	03.63	07 (03.18)
Use of social media	Low use (0-6)	10	09.09	46	41.82	56 (25.45)
	Medium use (7-12)	70	63.64	42	38.18	112 (50.90)
	High use (13-18)	30	27.27	22	20.00	52 (23.64)

(25.00%), sugarcane 10 (8.33%) in the survey area of Bangladesh. There was zero cultivation of basmati and cotton in Bangladesh part during Kharif season. Data presented in Table 3 also revealed the percentage of Rabi crops grown by the farmers of both locations. It was observed that out of all respondents in Punjab, 105 respondents (87.50%) grow wheat, 75 respondents (62.50%) grow vegetables, 48 respondents (40.00%) grow fodder, 24 respondents (20.00%) grow maize, 15 respondents (12.50%) oilseeds and fruits, 18 respondent (15.00%) grow sugarcane, 6 respondents (5.00%) grow pulses, 8 respondents (6.67%) grow flowers where the respective figures in Bangladesh part were wheat 30 (25.00%), vegetables 102 (85.00%), maize 40 (33.33%), oilseeds 22 (18.33%), fodder 40 (33.33%), fruits 44 (36.67%), flowers 10 (8.33%), pulses 3 (2.50%) and 10 (8.33%). Singh (2014) observed that 85.00 per cent farmers grow paddy and 81.67 per cent grow wheat during Kharif and Rabi season respectively in Punjab. It indicates that cropping in Punjab is mostly dominated by monoculture (Rice-wheat).

Table 3: Season wise major crops grown in Punjab and Bangladesh

Seasonal crops	Punjab		Bangladesh	
	Number	%	Number	%
Kharif season				
Paddy	90	75.00	84	70.00
Basmati	20	16.67	—	—
Maize	12	10.00	30	25.00
Fodder	48	40.00	40	33.33
Cotton	08	06.67	—	—
Vegetables	52	43.33	36	30.00
Fruits	15	12.50	44	36.67
Flower	12	10.00	—	—
Pulses	06	05.00	03	02.50
Oilseed	02	01.67	—	—
Sugarcane	18	15.00	10	08.33
Rabi season				
Wheat	105	87.50	30	25.00
Vegetables	75	62.50	102	85.00
Maize	24	20.00	40	33.33
Oilseeds	15	12.50	22	18.33
Pulses	06	05.00	03	02.50
Fodder	48	40.00	40	33.33
Flowers	08	06.67	10	8.33
Fruits	15	12.50	44	36.67
Sugarcane	18	15.00	10	08.33

*Multiple response

The Cropping pattern deals with the crops grown by sampled households in an agricultural year. The major cropping patterns followed by the sampled farmers in Punjab and in Bangladesh part is shown in Table 4. The Table depicted that the gross cropped area among the sampled respondents was 10.52 hectares and 4.40 hectares per farm in Punjab and Bangladesh part respectively. Data enumerated in Table 4 also indicated that the major crops i.e. wheat, paddy, vegetables and basmati were cultivated on 3.50, 2.55, 1.52 and 0.81 hectares of land per farm in Punjab whereas the major crops grown in Bangladesh were paddy, vegetables, wheat and fruits having area coverage of 1.21, 0.98, 0.65 and 0.35 hectares per farm respectively. In Punjab, the respective share of wheat, paddy, vegetables and basmati among the gross cropped area was 33.27 per cent, 25.24 per cent, 14.45 per cent and 7.69 per cent where it was 27.50 per cent, 22.27 per cent, 14.77 per cent and 7.95 for the paddy, vegetables, wheat and fruits crops respectively in Bangladesh part. Although paddy was the main crop in Bangladesh part but there was zero cultivation of basmati rice and cotton in the study area. Rice-wheat (including basmati) pattern in Punjab occupied the lion share (65.20%) whereas paddy-vegetables-wheat constituted almost equal share (64.54%) in Bangladesh part. The cropping intensity was observed 206 and 230 per cent in Punjab and Bangladesh part, respectively.

Table 5 represents the average size of livestock components per farm in both locations. There were two types of dairy farming in the dairy component in Punjab viz. Cow and Buffalo. Average 3.33 Cows and 5.11 Buffaloes per farms having 44.76 per cent and 55.24 per cent share found in Punjab study location. In Bangladesh, only cows constituted 100 per cent share having an average of 4.67 cows per farm under dairy farming. The average number of poultry birds in Punjab was 16.12 per sample farm, whereas it was 9.11 birds/farm on the Bangladesh side. The Punjab farmers had an average of 6.55 goats per sample farm, and Bangladesh farmers had average of 5.00 goats per sample farm. Singh (2014) found average of 4.83

Table 4: Major cropping pattern on sample farms in both locations, Punjab and Bangladesh

Crops	Punjab			Bangladesh		
	Total area (ha)	Per farm area (ha)	Share (%)	Total area (ha)	Per farm area (ha)	Share (%)
Wheat	420.0	3.50	33.27	78.0	0.65	14.77
Paddy/Rice	306.0	2.55	25.24	145.2	1.21	27.50
Basmoti	97.2	0.81	7.69	—	—	—
Vegetables	182.4	1.52	14.45	117.6	0.98	22.27
Maize	43.2	0.36	3.42	27.6	0.23	5.28
Fodder	72.0	0.60	5.70	38.4	0.32	7.27
Cotton	36.0	0.30	2.85	—	—	—
Sugarcane	19.2	0.16	1.52	7.2	0.06	1.36
Pulses	06.0	0.05	0.48	14.4	0.12	2.27
Oilseed	13.2	0.11	1.04	19.2	0.16	3.64
Flower	21.6	0.18	1.71	18.0	0.15	3.40
Fruits	39.6	0.33	3.13	42.0	0.35	7.95
Other crops	06.0	0.05	0.48	20.4	0.17	3.86
Gross cropped area (ha)	1262.40	10.52	100.00	528.00	4.40	100.00
Cropping intensity (%)		206			230	

Table 5: Average size of dairy, poultry, goatary of the sample farms in both locations

Types of animals	Punjab		Bangladesh	
	Average	Share (%)	Average	Share (%)
Dairy				
Cows, No	3.33	44.76	4.67	100
Buffaloes, No	5.11	55.24	—	—
Poultry birds, No	16.12	100	9.11	100
Goats, No	6.55	100	5.00	100

cows, 3.48 buffaloes and 6.67 poultry birds per farm in Punjab in his study.

Data regarding fisheries, mushrooms, and bee-keeping are furnished in Table 6. Fisheries enterprise comprised an average of 0.50 acre of land per sample farm in Punjab, where it is 0.34 acre in Bangladesh part. In the case of mushroom cultivation, every farm household had an average of 400 s. ft area in Punjab and 225 s. ft. in Bangladesh. For bee-keeping, each sample farm had an average of 14 boxes in Punjab and 04 boxes in the Bangladesh part. Singh (2014) showed in his study that average number of bee boxes was 14.33 on selected farms in Punjab.

The figures enumerated in Table 7 depict the distribution of sampled farmers based on models of integrated farming systems adopted by themselves. Data shows that most of the respondents, e.g., 55.00 per cent farmers had a Crops + Dairy farming system in Punjab location, which was 40.00 per cent in Bangladesh part. Bangladesh's farmers practiced the Crops + Fisheries models maximum of 42.50 per cent, which was 20.83 per cent in Punjab. In the case of the Crops + Goatary + Fisheries model, about 5 per cent more respondents followed this system in Bangladesh (25.00%) than Punjab (20.00%) part. Participation of the respondents in the Crops + Fisheries + Poultry model is almost similar on both sides. Thirty per cent of farmers had engaged in Crops + Mushroom + Bee-keeping system in Punjab, which was only 13.33

Table 6: Average size of fisheries, mushroom and bee-keeping of the sample farms

Types of enterprise	Punjab		Bangladesh	
	Average	Share (%)	Average	Share (%)
Fisheries, acre	0.50	10.27	0.34	17.80
Mushroom, s.ft	400	100	225	100
Bee-keeping (boxes)	14	100	04	100

Table 7: Models of Integrated farming systems adopted by sample households

Integrated Farming System Models	Punjab		Bangladesh	
	Number	Percentage	Number	Percentage
Agriculture (crops) + Diary	66	55.00	48	40.00
Agriculture (crops) + Fisheries	25	20.83	51	42.50
Agriculture (crops) + Goatary + Fisheries	24	20.00	30	25.00
Agriculture (crops) + Fisheries + Poultry	20	16.67	18	15.00
Agriculture (crops) + Mushroom + Bee Keeping	36	30.00	16	13.33
Agriculture (crops) + Horticulture (fruits, flower)	32	26.67	37	30.83

*Multiple response

percent in the Bangladesh study location. Integration of Agriculture + Horticulture (Fruits, Flower), 26.67 per cent of respondents follow from the Punjab study area and 30.83 per cent of the Bangladesh part. The findings accord with the findings from Singh (2014) in the Punjab area. He found 76.67 per cent respondents practicing Crops + Dairy, 16.67 per cent Crops + Fruits, and 11.67 per cent Crops + Bee-keeping.

CONCLUSION

This study has gone some way towards enhancing our understanding of comparative status of integrated farming systems existing in both the locations. The major crops grown in Punjab and Bangladesh parts are almost similar except basmati rice which is absent in Bangladesh part. Paddy is the main crop during *Kharif* season in both Punjab and Bangladesh parts but during Rabi season, most of the Punjab farmers grows wheat where farmers in Bangladesh side grows vegetables. The gross cropped area for the sampled respondents is more than doubled per farm in Punjab than Bangladesh. Buffalo is the major dairy component in Punjab whereas cows constituted cent dairy farming in Bangladesh part. The cropping intensity is observed 30 per cent more in Bangladesh part than the Punjab part. Most of the respondents had Crops + Dairy farming system in Punjab location whereas Bangladesh's farmers practiced Crops+ Fisheries model. Additional studies to understand more completely the key tenets of integrated farming systems are required.

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Welfare Schemes for Fishers of Bargi Reservoir, Madhya Pradesh: Awareness and Access

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ABSTRACT

The study was conducted in 6 fishing villages of the *Bargi* reservoir of Madhya Pradesh. Interviews were conducted with 6 chairpersons of Fisheries Cooperative Societies (FCS), fisheries officials of Madhya Pradesh Fisheries Federation and 180 fishers. To assess the awareness and access of welfare schemes, schemes of Madhya Pradesh Fisheries Federation were listed by the fisheries officials through an interview schedule. After that, awareness about schemes and the extent of schemes availed by the fishers and chairpersons of FCS were explored using semi-structured personal interviews and key informant interviews, respectively. Kruskal-Wallis test was employed to study the differences among fishing villages regarding access to schemes. Later, the source of information dissemination and constraints faced by the fishers in availing schemes were collected using Focus Group Discussions. Constraints were ranked using the Rank Based Quotient (RBQ) method. Fishers perception about the impact of Madhya Pradesh Fisheries Federation interventions was estimated using percentage analysis. The results indicate that most (87%) of the fishers were aware of the schemes, though only 45.13 per cent have availed them. However, all the chairpersons of FCS were knowledgeable and availed of the schemes. Kruskal-Wallis test revealed a highly significant difference in the access to schemes at a 0.05 per cent level of significance among the six sample fishing villages, with Narayanganj followed by Ghagagwari having maximum access to schemes. About 35 per cent of fishers indicated FCS chairpersons as the source of information on schemes, while 25 per cent of fishers directly seek information from fisheries officials, and 18 per cent of fishers depend on FCS meetings as a source of information. About 48 per cent of fishers believed that information about schemes should be disseminated through printed material and 64 per cent favored information dissemination to individual fishers rather than FCS. The major constraints perceived in availing of schemes were favoritism, non-availability of loan on time, delay in the release of money, corruption at a higher level, not being appropriately informed by officials, cumbersome procedures, lack of awareness about schemes, and lack of sufficient assistance.

Keywords: Madhya Pradesh Fisheries federation, Fishers, Reservoir fisheries, Schemes, Information dissemination, Fisheries cooperative societies

INTRODUCTION

India is the 2nd largest fish-producing and 2nd largest aquaculture nation globally with 14.73 MMT (DoF, Ministry of Fisheries, Animal Husbandry & Dairying, India, 2021 and FAO, 2022). Regarding global fish production, India's contribution is 7.58 per cent, 10.43 million tons from the inland sector and 3.72 million metric tons from the marine sector. The sector has shown a growth of 7.53 per cent and provides livelihood to about 28 million fishers and fish farmers (National Fisheries Development Board, 2020).

The topmost states in inland fish production are Andhra Pradesh, West Bengal, Uttar Pradesh, Odisha, and Bihar. Madhya Pradesh ranked 10th in inland fish production even when it has vast and significant water resources in the form of reservoirs, ponds/tanks, rivers, canals, and waterlogged areas with huge but largely underutilized and untapped potential for fish production and livelihood development.

The total inland water bodies of Madhya Pradesh cover over 4.05 lakh hectares area from which water area under reservoirs is 3.38 lakh hectares and area

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under rural ponds and tanks is 0.67 lakh hectares and 17,088 km length of rivers. The total area under fisheries is 3.97 lakh hectares with total fish production of 2.0 lakh tons (DoF, India 2019-20). Fish production from reservoirs was 30,842 tons and fish production of ponds and tanks was 92,820 tons, and fish production from rivers was 15,030 tons (DoF, 2018-19). Madhya Pradesh ranks first among Indian states contributing 14.60 per cent in terms of total area under reservoirs (Sarkar *et al.,* 2017).

As per DoF, India (2020) Madhya Pradesh has about 22,32,822 fish farmers, fish workers, and fishers who are engaged directly or indirectly in fisheries-related activities, of which 1,232,957 were fishermen, and 999,865 were fisherwomen (DoF, India 2020).

The total fish production of Madhya Pradesh has shown an increasing trend over the years. In 2011-12, the total or inland fish production was 0.75 Lakh tonnes, which increased to 2.0 Lakh tonnes in 2019-20 (Handbook on Fisheries Statistics 2018, New Delhi & DoF, 2019-20, Bhopal). This is presented in Table 1.

Table 1: Details of fish and seed production of Madhya Pradesh (Lakh tons)

Year	Fish Production (Lakh tons)	Seed production (million fry)
2011-12	0.75	1500.99
2012-13	0.85	798.01
2013-14	0.96	963.08
2014-15	1.09	1001.88
2015-16	1.15	952.05
2016-17	1.39	1111.33
2017-18	1.43	1117.23
2018-19	1.62	1287.20
2019-20	2.01	1421.99

Source: Handbook on Fisheries Statistics 2020, New Delhi & DoF, 2019-20, Bhopal

It is clear from Table 1, that the state seed production has increased since 2016-17 onwards. It is noteworthy to state that in order to boost the fisheries sector Indian Government created a separate Ministry of Fisheries in 2019. In the year 2020, Pradhan Mantri Matsya Sampada Yojana was launched. PMMSY is an umbrella scheme that has been approved at a total estimated investment of Rs. 20,050 crores with two separate components namely (a) Central Sector Scheme (CS) and (b) Centrally Sponsored Scheme (CSS). The PMMSY is designed to address critical gaps in fish production and productivity, quality, technology, post-harvest infrastructure and management, modernization and strengthening of the value chain, traceability, establishing a robust fisheries management framework and fishers welfare (DoF, India, 2022). The Department of Fisheries approved Fisheries and Aquaculture Infrastructure Development Fund (FIDF), Ministry of Fisheries, Animal Husbandry and Dairying, Ministry of Agriculture and Farmers Welfare (MoA & FW), Government of India. The approval entails an estimated fund size of Rs. 7,522 crores, comprising Rs. 5,266.40 crores to be raised by the Nodal Loaning Entities (NLEs), Rs. 1,316.6 crore beneficiaries' contribution and Rs. 939.48 crore budgetary support from the Government of India (DoF, India, 2022).

Similarly, for the development of fisheries in Madhya Pradesh, a number of schemes/programmes are undertaken by the Department of Fisheries, Madhya Pradesh and Madhya Pradesh Fisheries Federation. These schemes are state government schemes. Madhya Pradesh Fisheries Federation is a state Government organization. It has mandate to increase fish production in large reservoirs (more than 1000 ha), implementation of welfare schemes, regulation of fishing activities and strengthening of fish marketing. Madhya Pradesh Fisheries Federation manages large reservoirs. There are 12 schemes for fishers of large reservoirs. The benefits of these schemes are given to fishers registered with the Madhya Pradesh Fisheries Federation. These registered fishers are from nearby fishing villages which are around the periphery of the reservoir. However not many studies are available with respect to the awareness of these schemes among fishers, how the benefits of these schemes are availed by the fishers and constraints faced by them so these were the objectives of this study.

MATERIALS AND METHODS

Bargi reservoir is among the top five largest reservoirs with a water spread area of 27,296.05 ha. Though the fish production was 94.82 tons in 2019-20, which was less as compared to other large reservoirs of Madhya Pradesh. It was constructed on the river Narmada in year 1990. Bargi reservoir is located in three districts

Jabalpur, Mandla and Seoni. A total of 162 villages in 3 districts i.e., 95 villages of Mandla district, 48 villages of Seoni district and 19 villages of Jabalpur district were affected. However, 82 villages of them were submerged completely. Due to the construction of Bargi reservoir, 5,475 families were displaced. (Human Cost of Bargi Dam Report, 1998; Narmada Valley Development Authority Report, 1997). So in this study, fishers' are the displaced persons during the reservoir construction and, irrespective of their castes, involved in fishing as their primary occupation. (Inland Fisheries Policy, DoF, Madhya Pradesh, 2007).

In this reservoir, 1875 fishers of 41 fishing villages are fisheries dependent. In this study, six villages, two from Jabalpur district and four from Mandla district of Madhya Pradesh, were selected using a multi-stage sampling method as these two districts, Jabalpur and Mandla had highest number of fish landing centers. Subsequently, two fishing villages from the reservoirs head, middle, and tail stretch were randomly selected. Fishing villages Magardha and Durganagar were selected from Jabalpur, and Manadei, Gaghagwari, Patha, and Narayanganj were selected from Mandla. Thirty fishers from each fishing village were selected for the study, thus making a total of 180 fishers. Details are presented in Table 2.

Discussion with officials of Madhya Pradesh Fisheries Federation revealed that there are 12 schemes for fishers of large reservoirs. The benefits of these schemes are given to fishers who are registered with M.P. Fisheries Federation. These registered fishers are from nearby fishing villages which are around the periphery of the reservoir. A semi-structured interview schedule was used to collect information regarding awareness of schemes, the extent of schemes availed, fisheries welfare schemes, awareness among fishers regarding schemes, access to schemes by fishers of fishing villages, extent of availing schemes by fishers, constraints faced in availing of schemes, fishers perceptions about the impact of Madhya Pradesh Fisheries Federation interventions.

RESULTS AND DISCUSSION

There are 12 schemes implemented by the Madhya Pradesh Fisheries Federation for fishers of large reservoir fisheries (Madhya Pradesh Fisheries Federation, 2018). Out of the 12 schemes, 4 are directly related to fishing activities like deferred wages scheme, saving cum relief scheme, fishers training scheme and 80:20 or 50:50 boat-net subsidy scheme for purchase of fishing nets and boats. Other schemes are more general, such as group accident insurance scheme, severe disease treatment grant scheme, nishadraj scholarship scheme, jaldeep scheme, grace scheme, education promotion scheme, meenakshi girl marriage scheme, incentive award scheme, naya savera scheme (Madhya Pradesh Fisheries Federation, 2020). Description about schemes are presented below in Table 3.

It was found that a majority of the fishers (87%) were aware of craft & gear subsidy, accident insurance scheme, saving cum relief scheme, fishers housing scheme, deferred wages scheme, training on netting, net making schemes but not aware of their in-depth content and the remaining 13 per cent of the fishers were unaware of any of the schemes. However, only 10 per cent were aware of all schemes. It was notable that those aware of all the schemes were affiliated with the chairpersons of Fisheries Cooperative Societies or fisheries officials, which could have helped them access such information (Table 4).

Table 4, depicts that about 89.44 per cent of fishers have received accidental insurance coverage, and 66.66

Table 2: Details of the fishing villages sampled in the districts of Jabalpur and Mandla

Districts	Fishing villages	Number of fishers	Number of fishers interviewed	Percentage of fishers interviewed
Jabalpur	Magardha	38	30	78.95
Jabalpur	Durga Nagar	46	30	65.22
Mandla	Manadei	62	30	48.39
Mandla	Ghaghagwari	78	30	38.46
Mandla	Patha	34	30	88.24
Mandla	Narayanganj	31	30	96.77

Table 3: Welfare schemes implemented by Madhya Pradesh Fisheries Federation

Welfare schemes	Description
Deferred wages scheme	Financial assistance of Rs. 8/kg is paid to fisher on his/her total fish catch of the year during fishing ban season of which Rs 4/kg is contributed by the Madhya Pradesh Fisheries Federation and fishers share Rs. 4/kg was taken from their wages rate received per kg. Fishing ban season is from 15-june to 15-august.
Saving Cum Relief Scheme	Financial assistance of Rs 4500 was provided to the BPL and active fishers during the fishing ban season of which Rs. 1500 was contributed by the state govt. and Rs. 1500 by the central govt. i.e., Rs. 3000 and Rs. 1500 are deposited by fishers once a year to Madhya Pradesh Fisheries Federation.
Severe disease treatment grant scheme	For very severe diseases faced by fishers like an organ transplant, major surgery, cancer, and severe diseases like heart or kidney problems and minor accidental surgery, financial assistance up to Rs. 40,000 and Rs. 20,000 respectively is provided by Madhya Pradesh Fisheries Federation.
Nishadraj Scholarship scheme	A sum of Rs. 20,000, and Rs. 10,000 or scholarship according to the actual expenditure is paid every year to the fishers children taking admission on technical courses and non-technical courses respectively.
Meenakshi Girl Marriage Scheme	Financial assistance of Rs. 20,000 is provided to active fishers for the marriage of 2 girl child and also widow remarriage.
Grace scheme	A grant of Rs. 7500 is provided to family members on sudden death of fishers who are registered with Madhya Pradesh Fisheries Federation.
Jaldeep scheme	Health inspection, check-up, vaccination, free medicine & nutritional supplement facilities are provided by the Health Department, Women and Child Development Department and Madhya Pradesh Fisheries Federation.
Fishers training	A provision of two days of training to active fishers is provided under the scheme. Fishers are paid for travel, rental charges and food/ Rs.100 each day. Training is imparted on the mesh size of nets used or fishing techniques.
Education promotion scheme	A promotion grant of Rs. 2000 and Rs.1000 is provided to the students of standard 8th, 10^{th,} and 12th after securing 1st and 2nd division respectively. Rs. 5000 is provided for securing >80% marks to the children of fishers.
Incentive award scheme	Top cooperative societies and fishers in terms of fish production are awarded Rs. 8000- Rs. 50,000, and Rs. 5000- Rs. 30000 respectively.
80:20 boat-net subsidy scheme	Fishers are provided with an 80% subsidy by M.P. Fisheries Federation. Fishers fishing for 100 days or more and 150 days or more annually are subsidized Rs. 6400 and Rs. 9600 respectively on boat-net purchase by M.P. Fisheries Federation. Also, for the purchase of 1 boat, a subsidy is provided once every 5 year to each cooperative society. For purchase of 12 feet boat Rs. 6400, for 15 feet boat Rs. 8000 and for 18 feet boat, Rs. 9600 is subsidized by M.P. Fisheries Federation.
Naya Savera Scheme	The scheme is implemented for unorganized labourers. Under the scheme following facilities are provided to active fishers of reservoirs under M.P. Fisheries Federation. • Instrument subsidy scheme for progressive business • Electricity bill lapse scheme • Funeral assistance scheme • Education promotion scheme • Employment-oriented training scheme • Accidental insurance scheme and grace assistance • Free treatment delivery assistance scheme

per cent of fishers were taking advantage of saving-cum-relief scheme. Another 43.88 per cent of fishers received craft and gear subsidies. Around 30.55 per cent of fishers were granted money for house construction under PM/CM *Aawas Yojana* facilitated by Madhya Pradesh Fisheries Federation. Nearly 3.88 per cent of fishers accessed to other schemes such as *Ujjawala* Scheme (LPG gas)/*Meenakshi* Marriage Scheme. All the fishers have access to deferred wages, and only 13.33 per cent of fishers were provided training on fish harvesting and net making within the last five years. The Kruskal-Wallis t-test revealed that

Table 4: Welfare schemes availed by the fishers

Welfare schemes	Frequency	Percentage
Craft & gear subsidy	79	43.88
Accident insurance scheme	161	89.44
Saving cum relief scheme	120	66.66
Fishers housing scheme	55	30.55
Other scheme /state packages	7	3.88
Deferred wages scheme	180	100
Training on netting, net making	24	13.33
Average		49.67

the p-value for access to schemes is .000, from which it can be inferred that there is a highly significant difference in the access to schemes at 0.01% significance level among the six fishing villages of *Bargi* reservoir. Access can be defined as the opportunity to make use of a resource (March *et al.,* 1999). The maximum access to schemes was to the fishers of Narayanganj with a mean rank of 114.43 followed by Gaghagwari with a mean rank of 112. The reasons for maximum access to schemes were due to more active fishers and proper functioning of Fisheries Cooperative Societies in these villages and direct contact with Madhya Pradesh Fisheries Federation officials (Table 5).

Moreover, after falling into the criteria of availing schemes, some fishers were not benefitted. The "saving-cum-relief scheme" has almost fewer beneficiaries, even though all the respondents desire to avail the benefit. Most of the fishers cannot even submit Rs. 1500 for availing Rs. 4500 in the close/ban season under the scheme, which was perceived as a restricting factor in availing this scheme.

Fishers of all the six villages were of the predominant view that either chairperson of Fisheries Cooperative Societies (FCS) did not adequately inform them or fisheries officials of the Madhya Pradesh Fisheries Federation about the details of existing and newly introduced schemes or subsidies. The Madhya Pradesh Fisheries Federation has taken a few measures to disseminate information on fisheries schemes by distributing booklets and pamphlets containing information on schemes to FCS chairpersons. However, the fishers stated that the information shared through these media was inadequate, inappropriately communicated by the chairpersons, and often merely impractical to help an average number of fishers understand the procedure for availing the schemes.

Table 5: Kruskal-Wallis t-test for difference in access to schemes by fishers of fishing villages

Fishing villages	n=180	Mean rank	Significance (p) value	Decision
Magardha	30	66.98	.000	H_0
Durganagar	30	97.13		Rejected
Gaghagwari	30	112.00		
Manadei	30	69.43		
Narayanganj	30	114.43		
Patha	30	86.18		

It was marked that many of these information dissemination activities were not consistently followed each year. For example, the booklet's distribution with necessary information on all welfare schemes was recognized by the fishers of villages/ fisheries cooperative societies like Gaghagwari, Narayanganj, Magardha, and Patha. However, the fishers from Manadei and Durga Nagar were unaware of such information dissemination activities. These booklets provided only the schemes titles and features without providing any information on the procedure to avail them. The Madhya Pradesh Fisheries Federation relies mainly on the FCS to inform fishers about newly introduced schemes and hands out pamphlets or information booklets to FCS chairpersons. About 35 per cent of the fishers stated that their source of schemes was FCS chairpersons, and 25 per cent directly depend on fisheries officials of the Madhya Pradesh Fisheries Federation for information on schemes (Figure 1). Detailed interviews revealed this dissemination strategy to be problematic.

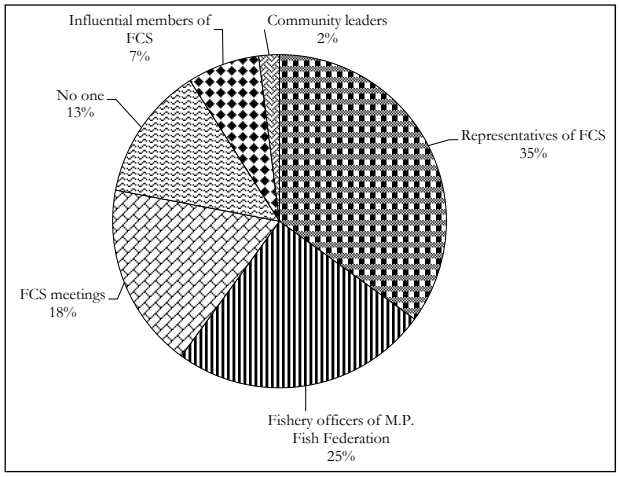

Figure 1: Source of information on welfare schemes

The quality of relations between FCS chairpersons and their members appears to play an essential role in disseminating information. The relationship between the chairpersons and fishers seems to be quite worthy though the fishers complained that the Madhya Pradesh Fisheries Federation officials implement favouritism in disseminating information and selecting names of fishers for availing schemes.

The information dissemination efforts seem to have provided fishers with a general idea about schemes; they were uninformed about these schemes' content, namely the eligibility criteria, documents required, where to avail of them, possibilities for compensation, etc. There was also a marked noticeable social divide between those aware of the schemes and those who were not. Fishers with certain levels of education and social standing in the village knew more about the schemes than those lower in the hierarchy. The former were the ones who avail the schemes as well (Figure 2). Fishers stated that by the time information about a new scheme trickled down to the average number of FCS members from these information intermediaries (FCS chairpersons or influential members), either the deadlines for submitting applications of the scheme had passed or the number of allotment of beneficiaries for that financial year had reached its limit.

Fishers were aware of the fact that some of them were better informed about schemes than others, and they stated that in future attempts at information dissemination, the information should be made available in a printed form that they could keep and refer to, rather than having to rely on other community members to inform them. In some FCS, the Madhya Pradesh Fisheries Federation distributed a limited number of booklets with information on existing and newly introduced schemes and subsidies, which did not get passed on further. Some FCS chairpersons had lost it, and no replacement copies were available. At the same time, the remaining chairpersons did not pass the information due to their irresponsible attitude. About 48% preferred printed media for information dissemination, and around 64% were unwilling to rely on their local FCS chairpersons to get information on the schemes and desired it passed on to them personally (Figure 3).

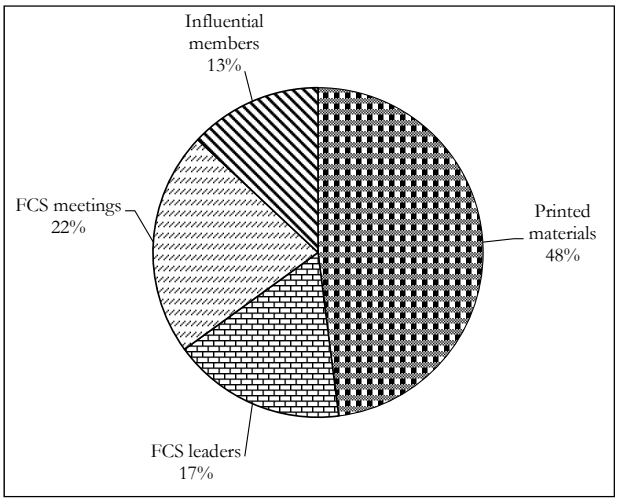

Figure 2: Responses from fishers on how to disseminate schemes information

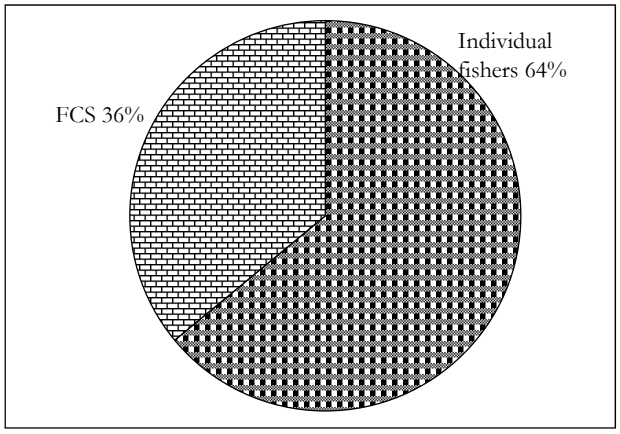

Figure 3: Responses from fishers on whom to disseminate schemes information

Table 6, depicts constraints faced in availing of schemes by fishers. The major constraints perceived by fishers in availing of schemes were Favouritism which ranked first, Non-availability of loan on time ranked second, delay in the release of money ranked third, not appropriately informed by officials ranked fourth, cumbersome procedures ranked fifth, and lack of sufficient assistance was ranked last among all

Table 6: Constraints faced in availing of schemes

S.No.	Constraints	Rank
1.	Favouritism	1
2.	Non-availability of loan on time	2
3.	Delay in release of money	3
4.	Not informed properly by officials	4
5.	Cumbersome procedures	5
6.	Lack of sufficient assistance	6

constraints. The study by Krishnan 2015 also reported inadequate financial support as one of the constraints faced by leaders of Fisheries Cooperative Societies of Malappuram district, Kerala.

The cumbersome legal procedures associated with procurement of schemes lead to loss of fishing time and hence income. For instance, a scheme like the *"Meenakshi* girl marriage scheme" and "Housing scheme" requires a letter of recommendation from the local elected political chairperson and a plan of the proposed marriage or house and land in the name of the fisher. These requirements were challenging to meet, especially for illiterate fishers, as they required a series of steps via online mode. The process of getting the letter of recommendation often requires having some personal connection with the political chairperson. Often fishers do not have proper legal documents for making land claims as all of them lost their land during the reservoir construction. Some fishers own illegally captured land in the periphery of reservoir areas. Lack of coordination between government agencies was another problem fishers perceived. The fishers stated that they did not get the housing schemes loan benefits because the banks have not yet disbursed the money to the landless fishers approved by the Madhya Pradesh Fisheries Federation who are registered members of Fisheries Cooperative Societies.

For a fisher to avail scheme, they must be a registered member of an FCS. One village can have only one FCS. In a heterogeneous fishing village dominated by one particular caste, the dominant caste monopolizes the FCS, and other caste members find it difficult to obtain membership. Moreover, fishers found obtaining documents of proof, identity cards, registration certificates of fishing crafts, and FCS membership (all required to access schemes) as unsatisfying and time-consuming. Fishers also noted that the lack of fishers' involvement in designing the schemes significantly affects its success. The designing of schemes follows a top-down approach where the authorities play a central role. The fishers stated that reservoir fishing was not profitable anymore, and outward migration to pursue other jobs was more rewarding. It suggests fishers' participation in the planning, designing, and disseminating schemes and accountability and transparency concerns.

The other more critical factors in determining whether schemes will be availed by fishers or not, even after having awareness about the same, include the degree of government formalities attached to the schemes (legal documents, letters from government officials, etc.), political interference, Scheduled Caste/ Scheduled Tribes in the heterogeneous fishing village, and seasonal migration (in ban season) of fishers for labour. There seems to be a necessity for the appropriate dissemination of practical information, including the sequence of protocols in availing schemes for fishers'. There emerges a possibility of introducing new schemes by modifying the existing schemes that would support the socio-economic status of fishers.

Table 7 depicts fishers' perceptions about the impact of Madhya Pradesh Fisheries Federation interventions. All the fishers perceive that fish caught from the reservoir is decreasing over the years, it was confirmed from the annual fish production data of Bargi reservoir from 2017, that fish production has decreased (Madhya Pradesh Fisheries Federation, 2020).

About 79.44 per cent of fishers get less income from fishing. Nearby 65 per cent of fishers agreed that their cost of fishing increased over the years, around 80.55 felt that assistance from Madhya Pradesh Fisheries Federation has not contributed to an increase in income, and about 46.11 per cent perceived that fishing knowledge has not increased due to Madhya Pradesh Fisheries Federation interventions, 56.66 per cent agreed that cage culture in the reservoir would result in increased fish production and income, 55 per cent established that they can get a higher catch and income if fish independent of the FCS, only 5.5 per cent find fish seed stocking in the reservoir is useful, 52.22 per cent agreed that Madhya Pradesh Fisheries Federation support had benefited only a few fishers.

Singh and Sharma (2017) studied livelihood impact assessment of fisheries development programs in Chhattisgarh. They revealed that there had been a positive change in all livelihood capitals due to fisheries development programs. Gautam *et al.* (2017) assessed the empowerment status of fish farmers after the intervention of the Fish Farmers Development Agency in Uttar Pradesh. It was noted that the fish farmers benefited moderately in terms of their knowledge, skills, social status, and economic well-being with

Table 7: Fishers perception about impact of Madhya Pradesh Fisheries Federation interventions

Perceptions	Agree (%)	Disagree (%)	Not sure (%)
Fish caught from the reservoir is decreasing over the years	100	-	-
Getting less and less income from fishing	79.44	11.12	9.44
The cost of fishing is increasing over the years	65.00	16.11	19.44
Fisheries Cooperative Society is truly a democratic organization, and all of us feel like equal partners	63.33	25.00	11.66
Cage culture in the reservoir will result in increased fish production and income	56.66	15.00	28.33
Can get a higher catch and income if fish independent of the Fisheries Cooperative Society	55.00	15.00	30.00
Madhya Pradesh Fisheries Federation support has benefited but only a few fishers, not all of us.	52.22	17.22	30.55
Fish production is going to increase in the future	37.77	23.33	38.88
The knowledge about fishing and fisheries has increased due to M.P. Fisheries Federation interventions	23.33	46.11	30.55
Stocking of fish seed in the reservoir is of use	5.50	83.33	16.66
Assistance from Madhya Pradesh Fisheries Federation has contributed to an increase in income	1.66	80.55	17.77

FFDA's support. They also reported improvement in the fish productivity, profitability, and culture area after the intervention of FFDA.

CONCLUSION

This suggests that there is a need to urgently reform the fisheries schemes and ensure their implementation is meaningful to the Bargi reservoir's fishers. A step in this direction is to undertake a complete first-hand investigation of the impact of fisheries schemes on the socio-economic conditions of fishers and fisheries practices over more extended periods. Reservoir fisheries policy should involve schemes that support alternative livelihood, especially during the close/fishing ban season (15 June- 15 August), and provide supplemental livelihood throughout the year for improving the socio-economic condition of fishers, reducing complete dependency on fishing activities, and ensuring sustainable use of depleting resources by reducing fishing effort. Some alternative income-generating programmes should be created to enhance livelihoods for the fisher households.

As a consequence, it can be concluded that it is very critical to consider fishers' interests while designing schemes as enormous fishers will migrate into another occupation, which will emerge as a threat to reservoir fisheries. Lack of access to welfare schemes was one of the major factors that force the fishers to live in extreme poverty leading to the exploitation of fishery resources. Therefore, the designing of schemes need to shift from top-down to welfare-driven and bottom-up approach, which should be fishers-centered and keep in mind the existing & felt needs of fishers. Empowering fishing communities with information and developing a feedback mechanism like social auditing/public hearings to check the availing of schemes and public information display board in the *Gram Panchayats* of the fishing villages by positioning a committee by an authority (preferably cooperative department with chairpersons as members selected by fishers in the committee) over the Madhya Pradesh Fisheries Federation can check on the practice of favoritism and patterns of information dissemination and the number of fishers availed the schemes. These grievances can be resolved and initiatives can be taken under the recently established separate Ministry of Cooperation. The informal nature of the fisheries with various stakeholders, multiple entries, and exit points makes monitoring by the state difficult, as it is a capital and labor-intensive process. Attempts can be made by encouraging the fishing communities to introduce checks in the system and be a part of resource access and resource control, conservation, and proper extraction. The policymakers can start in this direction by acknowledging the serious problems with information dissemination.

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Determinants of Entrepreneurial Behaviour of Women Dairy Farmers by Using one way ANOVA Analysis in Sepahijala District of Tripura

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ABSTRACT

One of the promising industries in India for the growth of entrepreneurship is dairy farming. Global acceptance of entrepreneurship as a powerful instrument for expanding the entrepreneurial base for persons with limited financial means or managerial experience. The study was conducted in Sepahijala district of Tripura and the sample of the research work is 120 women dairy farmers. The objective of the research work was to investigate statistical differences between the entrepreneurial behaviour of women dairy farmers and their profile. One way ANOVA analysis were performed to accomplish the objectives of the study. A one-way ANOVA ("analysis of variance") compares the means of three or more independent groups to determine if there is a statistically significant difference between the corresponding population means. The result indicates that among all independent variables, five variables from significant relationships and these five variables are age, education, land holding, farming experience, and cosmopoliteness.

Keywords: Entrepreneurial behaviour, Farming experience, Dairy farmers, Cosmopoliteness

INTRODUCTION

Dairy farming is a crucial component of rural economy that has the highest potential of generating income and employment through augmenting productivity of milch animals. The present study was conducted to know about the association with profile of dairy farmers and the entrepreneurial behaviour. It is one of the promising sectors for entrepreneurship development in India (Lazar, 2014) Entrepreneurship has been accepted globally as affective tools for widening the entrepreneurial base4 for those who have poor financial resources or managerial background. According to 20th livestock census the total livestock population is 535.78 million (53.6 crore) in the country showing an increase of 4.6 per cent over Livestock Census 2012 and the total livestock population in Tripura is 13.18 Lakh. The total number of cattle in the State is 7.39 Lakh and in the Country is 1934.63 lakh. The Exotic/Crossbred and Indigenous/ Non-descript cattle population in the State is 1.29 Lakh and 6.10 Lakh respectively and in Country is 513.56 Lakh and 1421.06 Lakh respectively. The female cattle population is 6.16 Lakh, increased by 2.25 per cent over previous census (2012) in where 19.04 per cent increased against Crossbred cows than the previous census. Livestock Census is one of the most important economic activities in the rural areas of the State contributing significantly to the state economy. It provides income to household's dependent on agricultural and for many landless households. The department of Animal Husbandry, dairying and fisheries is implementing DEDS for generating self-employment opportunities in the dairy sector, covering activities such as enhancement of milk production, procurement, preservation, transportation, processing and marketing of milk by providing back ended capital subsidy for bankable projects.

MATERIALS AND METHODS

The study was conducted in Sepahijala district of Tripura during the year 2020-2021. The data were taken by a personal interview with the help of a pre-tested

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schedule. Sepahijala district was selected purposively because there is more dairy entrepreneurship. The target respondents were identified using simple random sampling. For this study, 120 women dairy farmers were selected. Descriptive and one-way ANOVA analyses were performed to accomplish the objectives of the study. Use a one-way ANOVA when one categorical independent variable and one quantitative dependent variable were collected. The independent variable should have at least three levels (i.e., at least three different groups or categories). "One-way ANOVA was performed to compare the independent variable with the dependent variable. There was a significant effect of independent variable on dependent variable (that's the result of the hypothesis test). Where we report the F-value, the degrees of freedom, and the p-value". For ANOVA, the null and alternative hypotheses are as follows:

H_0: means across groups do not differ

H_1: means differ between at least two groups

The ANOVA output provides an estimate of how much variation in the dependent variable that can be explained by the independent variable. In the ANOVA table, df column displays the degrees of freedom for the independent variable, Sum sq. column displays the sum of squares between the group means and the overall mean explained by the variable and the Mean Sq. column is the mean of the sum of squares, which is calculated by dividing the sum of squares by the degrees of freedom. The F-value column is the test statistic from the F test (the mean square of each independent variable divided by the mean square of the residuals) and the column is the p-value from the F-statistic. This shows how likely it is that the F-value calculated from the test would have occurred if the null hypothesis of no difference among group means were true. we have three or more groups and we will not know which specific pairs of means are significantly different. After using post hoc test or an a priori comparison test we know which pair of means are significantly different.

RESULTS AND DISCUSSION

In the study, 120 dairy farmers were selected randomly and worked on twenty-three independent variables and one dependent variable. I took five variables in twenty-three variables because these variables had significant relationship. The findings regarding socio-economic variables revealed that majority of respondents belonged to middle age group (47.50%) followed by old age group (30.00%), while (22.50%) were of young age. This may be due to the fact that they had a lot of knowledge of livestock management and they are very dedicated. It was also revealed that majority of women dairy farmers (39.20%) were studied up to the upper primary level followed by (30.80%) primary level, while (22.50%) illiterate and (7.50%) secondary level because of in rural areas educational infrastructure is not good and they do not have income stability or they don't have any financial support. Majority of women dairy farmers (67.50%) had medium (14-35 years) experienced in dairy farming followed by (20.00%) had low (less than 14 years) experienced in dairy farming, while (12.50%) had high (greater than 35 years) experienced in dairy farming. This may be due to they have to associated with it for many years to growth and development for dairy farming. Majority of dairy farmers (49.20%) had small land holding followed by (38.30%) had semi-medium land holding and (12.50%) had marginal land holding. Maximum women dairy farmers (72.50%) had medium category of cosmopoliteness. Whereas (16.70%) were low category of cosmopoliteness and (10.80%) were high category of cosmopoliteness (Table 1).

Table 2 shows that the mean of entrepreneurial behaviour based on the women dairy farmer's age. The mean score 20.85 for middle age women dairy farmers, whereas 17.42 mean score for old age women dairy farmers and 7.00 mean score for young age. So, we may conclude that in between 35-50 years age women mostly engaged in the interests of dairy farming.

Hypothesis testing

$H_{0:}$ There is no significant difference between all age groups mean

$H_{1:}$ There is a significant difference between all age groups mean

The Table 2.1 from the ANOVA output, (ANOVA) is the key table because it shows whether the overall F ratio for the ANOVA is significant. Note that our F ratio (20.689) is significant (p = .000) at the .05 alpha

Table 1: Demographic – frequency analysis

Variable/ Description	No. of respondents	Percentage
Age		
Young (<35 years)	27	22.50
Middle (35-50 years)	57	47.50
Old (>50 years)	36	30.00
Total	120	100
Education		
Illiterate	27	22.50
Primary	37	30.80
Upper primary	47	39.20
Secondary	9	7.50
Higher secondary	0	0
Collage & above	0	0
Total	120	100
Landholding		
Landless (0 ha)	0	0
Marginal (<1 ha)	15	12.50
Small (1-2 ha)	59	49.20
Semi-medium (2-4 ha)	46	38.30
Medium (4-10 ha)	0	0
Large (>10 ha)	0	0
Total	120	100
Experience in dairy farming		
Low (< 14)	24	20.00
Medium (14 to 35)	81	67.50
High (> 35)	15	12.50
Total	120	100
Cosmopoliteness		
Low (< 21)	20	16.70
Medium (21 to 28)	87	72.50
High (> 28)	13	10.80
Total	120	100

Table 2: Mean score of entrepreneurial behaviour and age

Age	Mean
Young (<35 years)	7.00
Middle (35-50 years)	20.85
Old (>50 years)	17.42

level. The 2 and 117 are the two degrees of freedom values (df) for the between groups "effect" and the within-groups "error," respectively. The 20.689 is the obtained F ratio, and the $p < .000$ is the probability of obtaining that F ratio by chance alone. We rejected the null hypothesis that all age groups' means are equal, since $p < \alpha$. We conclude that at least one of the group means is significantly different from the others. we will need to conduct a post hoc follow-up test to determine which means differ from each other.

Figure 1 give us a visual representation of that there was a statistically significant difference between old-medium age group and young-old age group at the $p<0.05$. Post-hoc comparison using Tukey HSD test indicated that the mean scores for young age group (<35 years; X = 99.22), medium age group (35-50 years; X = 98.42), old age group (>50 years; X = 88.58). The mean difference of the old-medium age group is -9.838 and young-old age group is10.639.

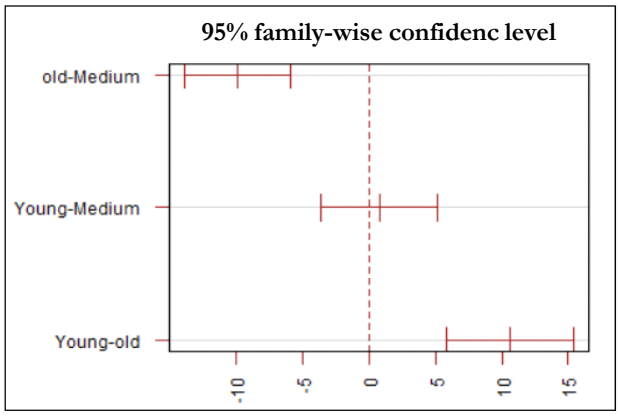

Figure 1: Post-hoc analysis – Entrepreneurial behaviour and age

Table 2.1: One way ANOVA analysis on age and entrepreneurial behaviour of women dairy farmers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2579.989	2	1289.994	20.689	.000
Within Groups	7295.311	117	62.353		
Total	9875.300	119			

Table 3: Mean score of entrepreneurial behaviour and education

Education	Mean
Illiterate	0.22
Primary	0.62
Upper primary	1.17
Secondary	0.30
Higher secondary	0
Collage & above	0

Table 3 revealed that the highest mean score 1.17 for upper primary level studied dairy farmers followed by mean score 0.62 for primary level, mean score 0.30 for secondary level and mean score 0.22 for illiterate women dairy farmers. So, we can conclude that in rural area girls are given early marriages and infrastructure facilities also not good either.

Hypothesis testing

$H_{0:}$ There is no significant difference between all education groups mean

$H_{1:}$ There is a significant difference between all education groups mean

The Table 3.1 revealed that F ratio (5.283) is significant (p = .002) at the .05 alpha level. The 3 and 116 are the two degrees of freedom values (df) for the between groups "effect" and the within-groups "error," respectively. We rejected the null hypothesis that all educational groups' means are equal, since $p < \alpha$. We conclude that at least one of the group means is significantly different from the others. we will need to conduct a post hoc follow-up test to determine which means differ from each other.

Figure 2 give us a visual representation of that there was a statistically significant difference between upper primary-illiterate group and upper primary-primary group at the $p<0.05$. Post-hoc comparison using Tukey HSD test indicated that the mean scores for illiterate dairy farmers group (X = 91.89), primary level

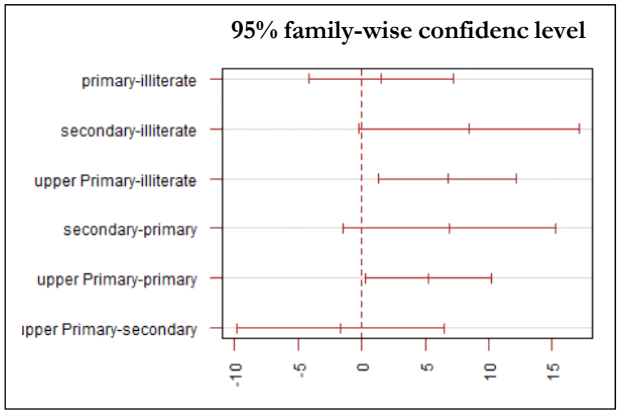

Figure 2: Post-hoc analysis – Entrepreneurial behaviour and educational level

educational group (X = 93.43), upper primary level educational group (X = 98.66) and secondary level educational group (X = 100.33). The mean difference between upper primary-illiterate group is 6.771 and upper primary-primary group is 5.227.

Table 4 revealed that the highest mean score 1.24 for semi-medium (2-4 ha) land holding dairy farmers followed by mean score 0.98 for small (1-2 ha) land holding dairy farmers, and mean score 0.13 for marginal (<1 ha) land holding dairy farmers.

Hypothesis testing:

$H_{0:}$ There is no significant difference between all landholding groups mean

$H_{1:}$ There is a significant difference between all landholding groups mean

Table 4: Mean score of entrepreneurial behaviour and land holding

Landholding	Mean
Landless (0 ha)	**0**
Marginal (<1 ha)	0.13
Small (1-2 ha)	0.98
Semi-medium (2-4 ha)	1.24
Medium (4-10 ha)	0
Large (>10 ha)	0

Table 3.1: One way ANOVA analysis on education and entrepreneurial behaviour of women dairy farmers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1186.999	3	395.666	5.283	.002
Within Groups	8688.301	116	74.899		
Total	9875.300	119			

Table 4.1: One way ANOVA analysis on landholding and entrepreneurial behaviour of women dairy farmers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	583.411	2	291.705	3.673	.028
Within Groups	9291.889	117	79.418		
Total	9875.300	119			

The Table 4.1 revealed that F ratio (3.673) is significant (p = .028) at the .05 alpha level. The 2 and 117 are the two degrees of freedom values (df) for the between groups "effect" and the within-groups "error," respectively. We rejected the null hypothesis that all landholding groups' means are equal, since $p < \alpha$. We conclude that at least one of the group means is significantly different from the others. we will need to conduct a post hoc follow-up test to determine which means differ from each other.

Figure 3 give us a visual representation of that there was a statistically significant difference between (semi-medium and marginal) land holding group, (small and marginal) landholding group and (small and semi-medium) landholding group at the $p<0.05$. Post-hoc comparison using Tukey HSD test indicated that the mean scores for marginal landholding group (X = 90.07), small landholding group (X = 97.05), semi-medium landholding group (X = 95.67). The mean difference between small land holding and marginal land holding group is 6.984.

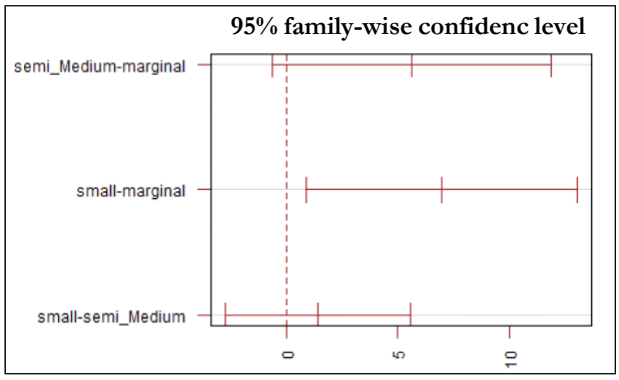

Figure 3: Post-hoc analysis – Entrepreneurial behaviour and land holding

Table 5 shows that the mean score 17.13 for medium experienced in dairy farming, whereas 5.17 mean score for high experienced in dairy farming and 1.98 mean score for low experienced in dairy farming. So, we may conclude that the women had 14-35 years experienced in dairy farming.

Table 5: Mean score of entrepreneurial behaviour and experience in dairy farming

Experience in dairy farming	Mean
Low (< 14)	1.98
Medium (14 to 35)	17.13
High (> 35)	5.175

Hypothesis testing

$H_{0:}$ There is no significant difference between all farming experience groups mean

$H_{1:}$ There is a significant difference between all farming experience groups mean

The Table 5.1 revealed that F ratio (28.031) is significant (p = .000) at the .05 alpha level. The 2 and 117 are the two degrees of freedom values (df) for the between groups "effect" and the within-groups "error," respectively. We rejected the null hypothesis that all landholding groups' means are equal, since $p < \alpha$. We conclude that at least one of the group means is significantly different from the others. we will need to conduct a post hoc follow-up test to determine which means differ from each other.

Figure 4 give us a visual representation of that there was a statistically significant difference between low-

Table 5.1: One way ANOVA analysis on experience in dairy farming and entrepreneurial behaviour of women dairy farmers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3199.009	2	1599.504	28.031	.000
Within Groups	6676.291	117	57.062		
Total	9875.300	119			

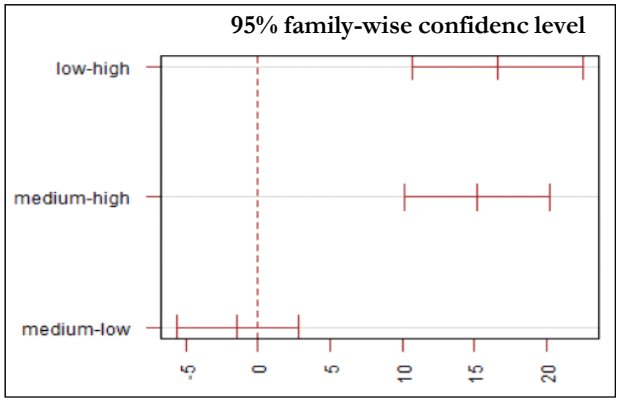

Figure 4: Post-hoc analysis – Entrepreneurial behaviour and experience in dairy farming

high dairy farming experience group and medium-high dairy farming experience group at the p<0.05. Post-hoc comparison using Tukey HSD test indicated that the mean scores for low dairy farming experience group (X = 98.67), medium dairy farming experience group (X = 97.27), high dairy farming experience group (X = 82.07). The mean difference of the low-high dairy farming experience group is 16.600 and medium-high dairy farming experience group is 15.205.

Table 6 revealed that the highest mean score 18.09 for medium category of cosmopoliteness followed by mean score 3.23 for high category of cosmopoliteness, mean score 3.13 for low category of cosmopoliteness.

Table 6: Mean score of entrepreneurial behaviour and cosmopoliteness

Cosmopoliteness	Mean
Low (< 21)	3.13
Medium (21 to 28)	18.09
High (> 28)	3.23

Hypothesis testing

$H_{0:}$ There is no significant difference between all cosmopoliteness groups mean

$H_{1:}$ There is a significant difference between all cosmopoliteness groups mean

The Table 6.1 revealed that F ratio (47.897) is significant (p = .000) at the .05 alpha level. The 2 and 117 are the two degrees of freedom values (df) for the between groups "effect" and the within-groups "error," respectively. We rejected the null hypothesis that all cosmopoliteness groups' means are equal, since $p < \alpha$. We conclude that at least one of the group means is significantly different from the others. we will need to conduct a post hoc follow-up test to determine which means differ from each other.

Figure 5 give us a visual representation of that there was a statistically significant difference between low-high cosmopoliteness group and medium-low cosmopoliteness group at the p<0.05. Post-hoc comparison using Tukey HSD test indicated that the mean scores for young cosmopoliteness group (X = 82.15), medium cosmopoliteness group (X = 98.02), high cosmopoliteness group (X = 100.54). The mean difference of the low-high cosmopoliteness group is -18.388 and medium-low cosmopoliteness group is15.873.

CONCLUSION

While investigating the entrepreneurial behaviour of women dairy farmers twenty-three variables were choosen, the results of this study provide evidence that among all of From the ANOVA the findings showed

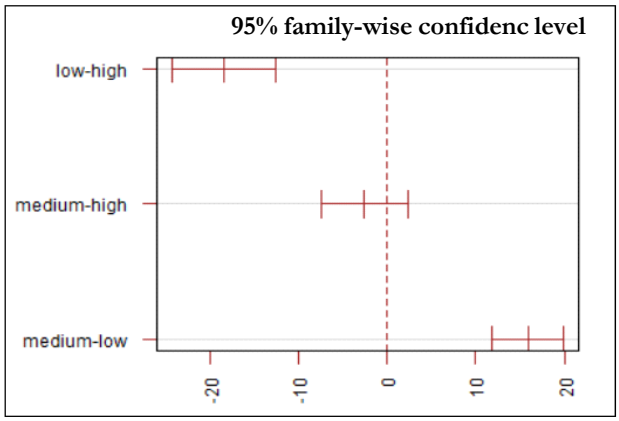

Figure 5: Post-hoc analysis – Entrepreneurial behaviour and cosmopoliteness

Table 6.1: One way ANOVA analysis on cosmopoliteness and entrepreneurial behaviour of women dairy farmers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4445.565	2	2222.783	47.897	.000
Within Groups	5429.735	117	46.408		
Total	9875.300	119			

there was five variables significantly enhances entrepreneurial behaviour variable and these variables are age, education, landholding, experience in dairy farming and cosmopoliteness. Show the results visually using a graph i.e., which mean group is significant. Women dairy farmers age are divided in to three groups from these old-medium age group (p=.000) and young-old age group (p=.000) significantly different. Farmers education level are divided into six groups from these only two groups (upper primary-illiterate group, p=.008 and upper primary-primary group, p=.035) are significantly different. From three different groups of landholdings only one mean group is significantly different i.e., small-marginal land holding group (p=.021). Experience in dairy farming and cosmopoliteness are divided into three different group of theses two groups are significantly different in both groups, these are low-high (p=.000), medium-high (p=.000) dairy farming experience mean group and low-high (p=.000) cosmopoliteness group and medium-low (p=.000) cosmopoliteness group.

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Impact of Recommended Livestock Technologies on Knowledge and Practices of Resource Poor Individuals in Naurangabad, Tarn Taran, Punjab, India

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ABSTRACT

Scheduled caste group occupies more than a quarter of the total population in Punjab, India. This category deprived off in terms of livelihood security, due to non-availability of regular employment. However, these masses have some means of earning in form of livestock, which can be source of income generation when this asset may be intervened with recommended scientific technologies. Taking these points into consideration, it was a thought of interest to mobilize resource poor households (involving both male and female individuals) through conducting skill-oriented vocational trainings, aiming at promulgation of knowledge on recommended technologies in dairy farming and value addition. Under two different training programmes, a total number of 50 individuals (25 individual per training) were trained during the year 2020-21 in District Tarn Taran, Punjab, India and their knowledge gained was being strengthened with livestock inputs such as area-specific mineral mixture, uromin lick, printed literature and scientific magazine in regional language post training. Further, pre and post knowledge and milk quality (milk yield, percentages of fat and solid not fat) assessment were conducted. The findings indicated a positive impact of extension interventions on above-mentioned parameters. Among those, an improvement in knowledge parameter depicts Quantum of Improvement score as 4.2 which is adequately good to abet clean milk production and enhance the quality of milk through practicing scientific methods. Furthermore, a Self-Help Group was established to ensure livelihood security to the resource poor households. Besides, an average increment of 12.60, 0.21 and 0.45 per cent was observed in milk yield, fat and solid not fat parameters, correspondingly. To reiterate, it is stated that self-sufficiency of destitute population can be ensured through recommended livestock technologies.

Keywords: Recommended livestock technologies, Knowledge score, Practices score, Quantum of improvement, Self-help group, Milk quality parameters

INTRODUCTION

In India, among all the socio-economic strata's, scheduled caste category has been considered as the most underprivileged group of people (Ministry of Social Justice and Empowerment, 2012; United Nations in India, 2021). It has been recorded that 16.63 per cent of the total population in India is officially designated as scheduled caste and if it comes to states, the highest percentage (31.94) was reported in Punjab, which is known as a privileged state in terms of resources, since its per capita income (from INR139.78 to INR 153.94 thousand) is increased at the rate of 10 percent from fiscal year 2018 to 2019 (Statista, 2021), while the percentages for population below poverty line and with underemployment have been reported as 8.26 and 8.9, respectively in the years 2017-18 and 2018-19, in that order (Reserve Bank of India, 2021; Ministry of Labour and Employment, 2018-19). Moreover, these resource poor families are dependent on seasonal work in the field of agriculture and have no other means to sustain their livelihood. Additionally, many scheduled caste household's rear livestock at small scale in rural areas of Punjab. Nevertheless, dairy sector

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is also unorganized at rustic settings, due to absence of recommended scientific practices, which deters the goal of optimum nutritional as well as health status of dwellers.

MATERIALS AND METHODS

Selection of subjects: A total number of 50 individuals (25 individual per training) have been endowed with above-mentioned skill-oriented trainings at village Naurangabad, District Tarn Taran Sahib, Punjab by Krishi Vigyan Kendra, Tarn Taran during the year 2020-21. For this purpose, two different skill-oriented vocational trainings entitled "Scientific Dairy Farming for self- employment" and Value addition of dairy produce for self- employment" under the scheme "Strengthening and Development of Higher Agricultural Education in India" Subcomponent Scheduled Caste - Sub Plan (SC-SP)" in District Tarn Taran have been conducted. After execution of these training programmes, improvements in knowledge and practices were recorded and compared the findings with prior to intervention phase.

Interventions undertaken: Under this training course, hands-on experiential learning on scientific dairy farming and value addition of dairy produce was provided to enrolled participants. Elaborately, various techniques *viz.* dairy shed management, per capita fodder availability for milch cattle, disease management in dairy animals was explained. Besides, recommended dairy processing technologies (preparation of paneer, flavored whey drinks and flavored milk etc.) were demonstrated. On the accomplishment of training programmes, completion certificate were issued to the beneficiaries.

Strengthening of scientific knowledge: Apart from these, awareness on livestock inputs such as mineral mixture and Uromin lick was imparted among the trainees. Further, membership of *Vigyanik Pashu Palan* magazine was provided to each participant in order to strengthen their existing skill and knowledge on scientific dairy farming and value added dairy products. Skills on drudgery reduction in dairy farming and dairy processing were transferred to the beneficiaries by making them familiar with dairy mechanization.

Impact assessment of intervention

Appraisal of knowledge: Furthermore, an appraisal of participants with regard to improvement in scientific knowledge and practices was performed through completing a questionnaire (containing a set of ten questions each in dairy farming and value addition segments) by the trainees. For every correct answer, one (1) mark is allotted to test takers and answers denotes as the option "don't know" were marked as wrong answers, thus, zero (0) mark was given for the same. Gain in Knowledge was calculated for obtained mean scores using following formulas:

Gain in knowledge = Score of post test - Score of pre test

Quantum of improvement = Post test score/ Pre-test score

Improvement in livestock production: Efficacy of livestock technologies such as area-specific mineral mixture, uromin lick and Vigyanik Pashu Palan magazine was studied through recording different parameters *viz.* average milk yield, average milk fat and average milk SNF. In addition, parameters on milk production were also observed in form of milk yield, fat and solid not fat (SNF), respectively.

Statistical analysis: The recorded data was subjected to Tukey's test, One-way ANOVA (analysis of variance) to analyze the significant difference ($p<0.05$) between all the parameters recorded throughout the investigation using the software GraphPad Prism (version 5.01).

RESULTS

Table 1 portrays the average increase in gain in knowledge and practices score according to 20 marks in total under knowledge, practices and overall mean scores, respectively. A Self Help Group (SHG) named "SRAN Self Help Group" was formulated and started their value added product based venture. Further, Figure 1 illustrates the quantum of improvement according to pre and post intervention scores, respectively.

Table 2 depicts the effect of supplementation of area-specific mineral mixture and uromin lick on the

Table 1: Knowledge and Practices scores of beneficiaries

Parameters	Mean ± SD		Gain in score
	Pre-test score	Post-test score	
Knowledge	3.7±1.2	16.2±5.5	12.5
Practices	2.9±1.0	11.6±4.1	8.7
Overall Mean ± S. D.	3.3±1.2	13.9±3.8	10.6

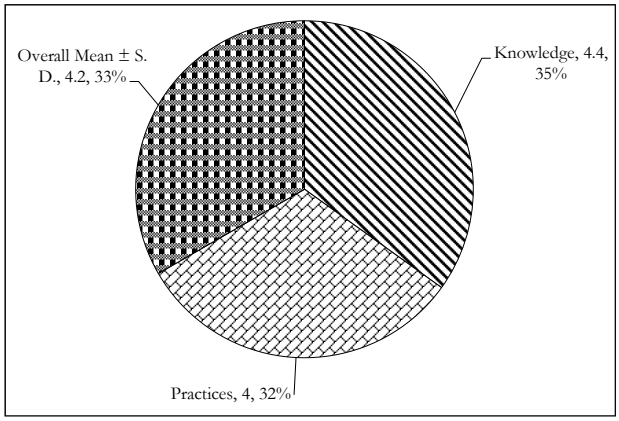

Figure 1: Quantum of Improvement in Knowledge and Practices score after extension intervention

Table 2: Effect of extension interventions related to scientific dairy farming on milk yield

Parameters	Before	After	% increase
Average Milk yield (Lt.)	12.60	14.20	12.60
Average Milk Fat %	4.74	4.78	0.21
Average Milk SNF %	8.88	8.92	0.45

average milk yield, average milk fat and average milk SNF, in that order. In addition, parameters on milk production were also got improved in form of milk yield, fat and solid not fat (SNF), respectively.

Table 3 reveals the effect of supplementation of area specific mineral mixture on reproductive performance of dairy animals, for instance, Onset of First post-partum estrus (days) after calving, Service period (days) and No. of Insemination/Conception.

DISCUSSION

Knowledge gaps with reference to both dairy animal and worker health have been seen, due to lack of effective training strategies. Thus, scientific knowledge

Table 3: Effect of extension interventions related to scientific dairy farming on reproductive performance

Parameters	Before	After	% change
Onset of First post-partum estrus (days) after calving	64.10	49.20	30.28
Service period (days)	87.10	63.10	38.03
No. of Insemination/ Conception	3.78	1.76	114.77

dissemination is mandatory to abridge these gaps (Rowai *et al.,* 2016). As evidenced from above-mentioned data in Table 1 and Figure 1, it is pretty clear that knowledge and practice related aspects of beneficiaries were strengthened through imparting knowledge based on recommended livestock technologies for dairy farming and value addition of dairy produce particularly milk. Similarly, it has been observed that training conducted for value addition has a key role in modifying the perception of participants in terms of their existing food processing knowledge and skills. Moreover, a positive impact on the adoption level of these scientific processing techniques among beneficiaries had been too noted as reliability score of 0.78, which is a remarkable progress for gaining new knowledge in the field of dairy processing technology sector (Roy *et al.,* 2013).

During current study, a self-help group was formed. Similarly, a training programme was conducted for 50 rural women in two different villages of Hisar district, Haryana State. Five days training on scientific dairy farming was scheduled at Choudhary Charan Singh Haryana Agricultural University, Hisar. During this training course, livestock technologies such as mineral mixture was distributed to the beneficiaries. Literature was also provided to the participants which resulted into an efficacious training index of 80.94 per cent. Simultaneously, in case of paneer preparation, knowledge gap was reduced by 87.81 per cent, at post intervention level (Dahiya *et al.,* 2021).

Another intervention was carried out to study the efficacy of multimedia on processing techniques of milk products by Chatterjee *et al.* (2019). During this intervention, the researchers found a significantly positive increase in knowledge parameter of the subjects. Alongside, an organized processing line setup for value added traditional dairy products *viz. ghee*, curd and *paneer* was observed after the training of enrolled participants. Similarly, Hundal *et al.* (2017) stated that skill-oriented vocational training courses have been proven as effective tool for amelioration of rustic dairy farmer with low level of education via improvement in their knowledge regarding scientific dairy farming. Authors conducted an awareness training programme, targeting 138 farmers of Punjab State and recorded an increment of 77.5 per cent under knowledge parameter, after completion of training course.

Bhattu *et al.* (2015) observed that vocational courses on scientific dairy farming organized by Krishi Vigyan Kendras in South-Western districts (Bathinda, Mansa and Sangrur) of Punjab State, have been proven as assets by aiding agricultural income of farmers. Authors reported seven different categories of dairy farmers who started dairying after the commencement of different trainings. Further, it was concluded that 1.9, 4.1, 7.0, 11.5, 16.8 and 24.7 per cent of beneficiaries adopted commercial, large, medium, small, marginal and domestic level dairy farming ventures, respectively.

One of the objectives of imparting vocational trainings by KVK is to impart skills related to different activities of dairying to improve the performance of dairy animals. Data presented in Table 2 depicts changes in dairy management practices of the farmers after attending the training programmes. The role of balanced feeding in successful dairy farming is well established. The present study revealed that 12.6 percent increase in milk yield after acquiring scientific knowledge regarding dairy farming.

Similarly, concept of feeding UMMB licks to lactating cows, was demonstrated during the training programmes, which was not at all used by the farmers before the training. It was observed that though considerable number of trainees (27%) were reluctant to use this technology, 58 percent of them used it sometimes and 15 per cent started using it, regularly. The adoption of UMMB was low, due to the fact that before attending training programme by KVK, Tarn Taran, none of the trainees was aware about the concept of UMMB feeding. Besides, since it contains urea, some of the farmers were hesitant to feed it to their animals with the perception that urea is a poison. Adoption of improved and balanced feeding resulted in fewer occurrences of diseases.

CONCLUSION

Undoubtedly, it can be stated that promulgation of recommended livestock technologies contributed towards livelihood generation and security among resource poor households with milk product quality assurance. Training programmes related to Dairy farming and Value addition will brought a considerable positive impact on the magnitude of perceived knowledge, acquisition of skills and adoption level. Thus, capacity building of scheduled caste individual must be strengthened through creating awareness regarding livestock technologies to sustain their livelihoods.

RESEARCH IMPLICATIONS

Mobilization and capacity building of resource poor farmers via amalgamation of scientific dairy farming and scientific milk value addition techniques at rustic level would exhibit a prolific increase in livestock sector. Moreover, the capacity building will be helpful for consistent management with regard to day-to-day operations of Farmer Producer Organization (FPO) with provision of above trained manpower. Hence, there may be a synergistic effect of skill-oriented scientific dairy farming and milk processing related vocational courses on curbing poverty among SC rural dwellers as well as expected constraints in the success of FPOs.

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Performance Evaluation of On-Farm Water Management Practices for Groundwater Irrigated Wheat Crop

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ABSTRACT

Improving water use efficiency and farm productivity can be among some of the most important options to address the problem of excessive groundwater pumping at the farm level and promote sustainable agriculture practices. This study consists of field experiments conducted at Krishi Vigyan Kendra (KVK-Sonipat, CCS HAU), Sonipat, farm for two years *i.e.*, during *rabi* 2017-18 and *rabi* 2018-19. For this different irrigation methods (Check basin, border flood and micro sprinkler irrigation) and agricultural practices (zero tillage, conventional tillage and laser guided land levelling) were evaluated in terms of yield and water use in wheat crops. Along with that, performance evaluation was conducted in terms of different irrigation efficiencies for different practices. Based on the results of field experiments, micro sprinkler irrigation (T_4) may be preferred in terms of grain and straw yield (45.55 q ha^{-1} and 58.55 q ha^{-1}, respectively), WUE_{grain} (1.27 q $ha^{-1}cm^{-1}$) and relatively higher efficiency of water application (94.49%) and distribution (94.72%). Treatment T_3 (Border irrigation with laser guided land levelling having 0.3% longitudinal slope) followed after T_4 with grain and straw yield (43.70 q ha^{-1} and 55.73 q ha^{-1}, respectively), WUE_{grain} (1.05 q $ha^{-1}cm^{-1}$), water application (87.45%) and distribution (91.76%) efficiency, while T_5 (Farmer's practice) had least preferable results.

Keywords: Groundwater pumping, Irrigation efficiency, WUE, Water saving

INTRODUCTION

Water conservation have become an important issue for irrigated agriculture in arid and semi-arid regions (Van Dam *et al.*, 2006; Jhorar *et al.*, 2009). Irrigated agriculture is the dominant user of fresh water resources, globally contributing to nearly 70 per cent of consumptive use (Gleick, 2014). At world level, about 40% requirement of irrigation water is fulfilled through groundwater. India is the world's largest user of groundwater with more than half of its total irrigated area being served by groundwater (Anonymous, 1998; Shah, 2010 and Dhawan, 2017). However, over exploitation of groundwater is resulting in depletion of aquifers, leading to water level decline across the country (Devineni *et al.*, 2013; Russo *et al.*, 2013 and Fishman *et al.*, 2015). In fact, the rates of water table depletion in India are probably the highest in the world (Aeschbach and Gleeson, 2012). The sustenance of a system thus requires updating of technologies and practices consistently (Jasna *et al.*, 2017).

For a given crop, one of the options to reduce groundwater pumpage is to improve efficiency of on-farm water application. This can be achieved by the selection of suitable irrigation and/or cultural practices. The method of irrigation used at the farm level is broadly classified as surface, subsurface, sprinkler and drip or trickle irrigation. At present, surface method

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of irrigation is the most popular and commonly used method (Rajurkar *et al.*, 2016). Irrigation efficiency of surface irrigation methods in India is reported to be very low (Rosegrant, 1997) as 50 per cent water losses occur due to leakage, seepage and through system inefficiencies (Hamdy *et al.*, 2003; Sivanappan, 1994; Wallace, 2000). Most of the wheat growers in the Indo-Gangetic Plains (IGP) of India apply surface irrigation either through border or check basin methods (Jat *et al.*, 2011). Poor farm design and uneven fields are accountable for nearly 30 percent of water losses (Gill, 1998). An annual irrigation saving of 10 to 12.5 cm was observed in zero tillage wheat sowing as a result of reduction in water evaporation and lower surface soil temperature by crop residue shading effects (Van Donk *et al.*, 2010). Water saving of 14.48 and 16.89 percent with yield increasing by 4.45 and 6.95 percent in maize and wheat crop was observed by using sprinkler as compared to surface irrigation (Acharyna *et al.*, 1993). In another study, when sprinkler and surface irrigated fields were compared to observe evaporation potential, it was found that sprinkler irrigated field had 3-11 per cent lower evaporation potential (Liu and Kang, 2006a, 2006b).

Diminishing groundwater resources and low efficiency of on-farm irrigation application are some major challenges for irrigated agriculture. Therefore, efficient utilization of groundwater for irrigated need special attention. It is essential to efficiently utilize every drop of water in agriculture to obtain higher crop yield to boost economic status of resource poor farmers. Improved irrigation system's efficiency equally saves both water and energy. As the amount of irrigation water is reduced, the required energy, under a particular irrigation practice will also be reduced. Present study was undertaken to evaluate the effect of different irrigation and cultural practices in terms of efficiency of water application and water use efficiency.

MATERIALS AND METHODS

Experimental set up: Field experiments were carried out during *rabi* 2017-18 and 2018-19 for wheat crop (variety HD-2967) at research farm of *Krishi Vigyan Kendra* (KVK) of CCS HAU at Sonipat (latitude: 28° 55' 59.2752″ N, longitude: 77° 3' 11.214″ E), Haryana, India. Source of irrigation was groundwater. Brief description of experimental treatments is given in Table 1.

Similar tillage and land preparation operations were performed in all the four treatments except T_1 where no tillage operation was performed. Different agronomic practices *i.e.* applications of chemical fertilizer, weedicide and other inputs were kept same in all the treatments. In treatment T_4, micro-sprinkler irrigation had spacing of 8 m x 8 m, rated sprinkler head discharge of 8.33 L min^{-1} at an operating pressure of 1.5 kg cm^{-2}. Sprinklers mounted on outermost lateral lines were operated in part circle mode (180°) to avoid flow of irrigation water outside the intended area. In treatment T_5, field was kept as per general practices adopted by farmers on their fields without any land levelling operation. For evaluation of current irrigation practices two blocks namely Rai and Sonipat were selected where majority of the farmers were using ground water as source of irrigation. A total 60 farmers, 30 from each block, covering 60 villages, randomly one from each village was selected in the study. Out of 60 farmers 35,14 and 11 were dividing their 0.4 ha field in one, two and three parts, respectively, for applying irrigation water through electrical submersible tube wells. None of the farmers divided their field in more than three parts for applying irrigation. On the basis of the survey conducted, standard plot size of farmer's practice in this study was considered as one third part of 0.4 ha area.

Schedule for irrigating wheat crops was followed as per recommendations of the package of practices

Table 1: Different treatments for groundwater irrigated wheat crop

Treatment description	Treatment code	Plot size(m x m)
Check basin irrigation with zero tillage	T_1	10 × 40
Border irrigation with conventional tillage	T_2	10 × 40
Border irrigation with laser guided land levelling having 0.3% longitudinal slope	T_3	10 × 40
Micro sprinkler irrigation	T_4	10 × 40
Farmer's practice	T_5	20 × 67

(Anonymous, 2019) of CCS HAU, Hisar. Minimum and maximum temperatures during crop growth season varied from 3.6 to 40.9 °C during 2017-18 and 3.0 to 40.1 °C during 2018-19, respectively (Figure 1). A total of 17 mm (rainy days = 6) and 48 mm (rainy days = 12) rainfall was received during the crop growth period of wheat in 2017-18 and 2018-19, respectively. At harvest random samples (1m length × 1m width plot area) were taken from three locations of each plot to determine yield which was then used to estimate yield per hectare. Both straw and grain yields were recorded separately for different treatments.

Soil characteristics: Basic soil characteristics of the experimental site including soil texture, bulk density, and field capacity were determined using standards practices upto the depth of 120 cm (Table 2). The soil types of the experimental site were loamy sand for depths 0-15, 15-30, and 30-60 cm and sand for depths 60-90 and 90-120 cm. The surface layer showed slightly higher value of field capacity, which may be due to addition of FYM and incorporation of crop residues in the farm area. The bulk density was minimum in upper layer (1.44 g cm^{-3}) and increased towards lower depths and found maximum (1.56 g cm^{-3}) in 90-120 cm depth mainly due to presence of sand.

Table 2: Soil texture, field capacity and bulk density of experimental site

Soil depth (cm)	Soil texture	Field capacity (%)	Bulk density (g cm^{-3})
0-15	Loamy sand	17.02	1.44
15-30	Loamy sand	16.83	1.46
30-60	Loamy sand	16.68	1.50
60-90	Sand	10.04	1.54
90-120	Sand	9.96	1.56

In order to define the infiltration characteristics of the soil, measured infiltration data were fitted to the following form of Kostiakov's infiltration equation (Michael, 2008)

$$I = kt^n \quad \text{... (1)}$$

In which, I is the cumulative depth of water infiltrated in cm for an elapsed time of t minutes. k and n are the fitting coefficients of Kostiakov's equation.

***Irrigation depth*:** Knowing the discharge of the tube well and time required to complete an irrigation, depth of water delivered (d_d) to different plots was estimated as volume of water delivered to the plot divided by the area of the plot. Required net depth of the irrigation was estimated as under:

$$d_n = \frac{(\theta_{fc} - \theta_{bi})}{100} \times \rho_b \times RD \quad \text{... (2)}$$

In which, d_n is the required net depth of the irrigation in cm, θ_{fc} is the moisture content at field capacity in per cent, θ_{bi} is the average moisture content before irrigation in per cent, ρ_b is the bulk density of the soil in g cm^{-3} and RD is root zone depth in cm

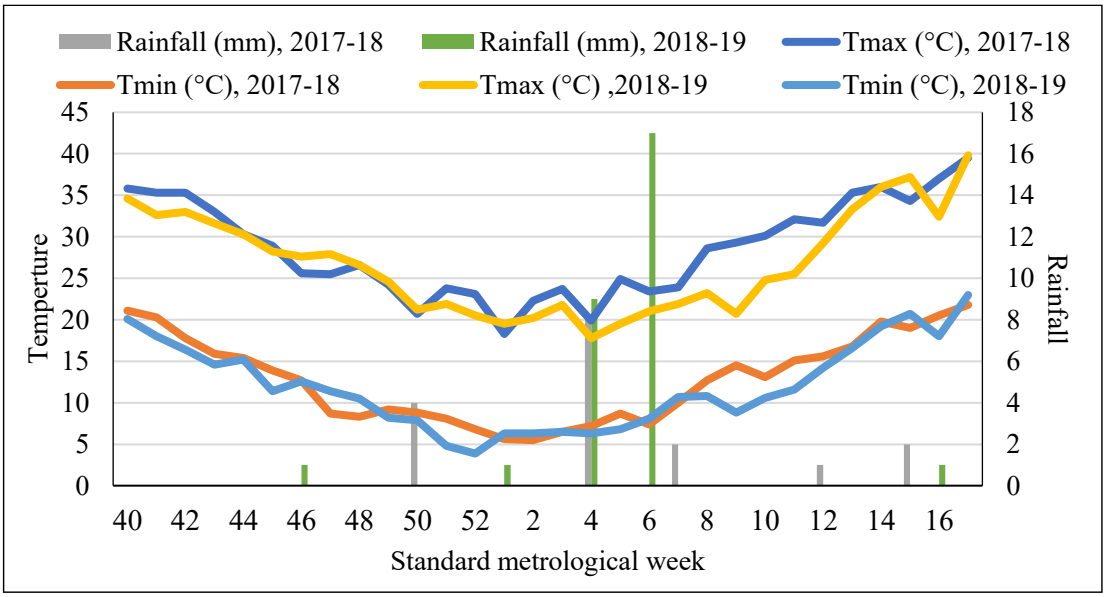

Figure 1: Meteorological parameters during the study period

Table 3: Average required net depth of irrigation during different irrigation events in 2017-18 and 2018-19

Year	Average required net depth of irrigation (cm)						
	Pre sowing irrigation	Ist irrigation	IInd irrigation	IIIrd irrigation	IVth irrigation	Vth irrigation	Mean
2017-18	6.25	6.01	5.54	5.51	5.87	6.04	5.87
2018-19	6.32	6.05	5.71	5.59	5.94	5.98	5.93

which was taken as 90 cm for the wheat crop (Michael, 2008). The average required net depth of irrigation estimated during different years of study is given in Table 3.

Stored depth of the water in the root zone after irrigation was estimated as under:

$$d_s = \frac{(\theta_{ai} - \theta_{bi})}{100} \times \rho_b \times RD \quad \text{... (3)}$$

In which, d_s is the stored depth of the water in the root zone in cm and θ_{ai} is the moisture content in the soil after irrigation in per cent. All other parameters are same as defined in equation (2).

Applied depth of the irrigation in surface irrigation treatments (T_1, T_2, T_3 and T_5) was also calculated using Eq. 1. In order to determine the infiltration opportunity time (t), fields measurements were made on water advance and recession. Advance time is the time taken by the water front, from the time when the inflow stream is introduced into the field, to advance to predefined distance and recession time is the time when water receded from the same distance. In micro sprinkler applied depth was fixed at 6 cm for all the irrigations scheduled. Knowing the nozzle discharge and area of the experimental plot, the time of operation of the micro sprinkler irrigation system was fixed.

Irrigation practice performance parameters: The performance of irrigation practices was evaluated by estimating the water application and water distribution efficiency.

Water application efficiency (E_a, %) was calculated by dividing depth of water stored (d_s) by the applied depth of irrigation (d_a) as under (Michael, 2008),

$$E_a = \frac{d_s}{d_a} \times 100 \quad \text{... (4)}$$

For treatment T_1, T_2, T_3 and T_5, d_a (= I) was estimated by Eq. 1 based on infiltration opportunity time as determined from water advance and recession data. As stated earlier, for treatment T_4 (micro irrigation), d_a was takes as 6 cm.

Water distribution efficiency (E_d, %) or uniformity coefficient was computed as under (Michael, 2008),

$$E_d = \left[1 - \frac{y}{d}\right] \times 100 \quad \text{...(5)}$$

In which y is the average of the absolute numerical deviation in depth of water applied from average depth of water applied during the irrigation in cm and d is the average depth of water applied during irrigation in cm.

Irrigation water use efficiency (WUE) was calculated by dividing the grain yield by the total irrigation depth applied in the treatment. It is given by,

$$\text{WUE} = \frac{\text{Yield (q/ha)}}{\text{Total irrigation depth applied (cm)}} \quad \text{... (6)}$$

RESULTS AND DISCUSSION

The required net depth of irrigation for different irrigation events for wheat crop varied from 5.51 to 6.25 cm with mean depth of 5.87 cm during 2017-18 and 5.59 to 6.32 cm with a mean depth of 5.93 cm during 2018-19. A fixed depth *i.e.,* 6.00 cm was applied in treatment T_4 (micro irrigation) for all the irrigation events during both the years. For other treatments, as per the prevalent practice of surface irrigation, water was applied till the water advance reached the end of the border strip. The mean applied depth of irrigation for different surface irrigation treatments (T_1, T_2, T_3 & T_5) varied from 6.66 to 8.53 cm during 2017-18 and 6.83 to 9.34 cm during 2018-19. The applied irrigation depth among surface irrigation treatments was observed highest for treatment T_5 (Farmers' practice) & lowest for treatment T_3 (Laser land levelling field) during both the years of study. Similar results were

observed by Naresh *et al.*, (2014). Stored depth of irrigation varied among different treatments during both the years of study. No fixed trend was observed in stored depth of irrigation. However, relatively less stored depth was recorded in treatment T_4 (micro irrigation) due to application of fixed depth (6.00 cm) of water during all the irrigation events in both the years of the study period. The mean applied depth based on stream discharge for different surface irrigation treatments (T_1, T_2, T_3 & T_5) varied from 6.88 to 8.96 cm during 2017-18 and 7.06 to 9.82 cm during 2018-19. Among the surface irrigation treatments, maximum applied irrigation depth was observed in treatment T_5 (Farmers' practice) and minimum in treatment T_3 (Laser land levelling field) during both the years of study. Slight difference in the depth of water applied (as estimated based on infiltration opportunity time) and depth of water delivered (as estimated based on inflow stream discharge and cut off time) in surface irrigation treatments was observed. The difference in applied and delivered depth may be attributed to i) conveyance losses in the channel from location of submersible tube well to entry point of water to experimental plot and ii) spatial variability in infiltration characteristics. Required, stored, infiltrated & pumped depth of irrigation, averaged over the two seasons for different treatments is given in Figure 2.

The applied depth, for treatments having surface irrigation, as calculated from the infiltration opportunity time, showed that the applied depth of irrigation was larger than required depth of irrigation at all points in the field. Therefore, it was assumed that whole required net depth of irrigation was stored in the root zone, hence accordingly water application efficiency for these treatments was calculated based on the required depth of irrigation. For treatment T_4 (micro irrigation), the stored depth of irrigation as computed based on moisture observation was used for estimating the water application efficiency. Noting that certain amount of moisture content might have been lost due to evapotranspiration during the period from the day of irrigation to the day of moisture observation, it is expected that actual water application efficiency under treatment T_4 would be slightly higher than the reported values.

Water application efficiency during different irrigation events varied between 66.9 to 97.9 per cent and 61.7 to 97.6 per cent in the years 2017-18 and 2018-19, respectively. Maximum application efficiency was recorded in treatment T_4 (Micro sprinkler irrigation) in both the years. Similarly, it was least for treatment T_5 (Farmer's practice) in both years. Likewise, other researchers observed better results in micro sprinkler irrigation (Rana *et al.*, 2006 and Liu *et al.*, 2013). Water distribution efficiency for different irrigation events varied between 84.2 to 95.1 per cent and 83.6 to 94.4 per cent in the years 2017-18 and 2018-19, respectively. The highest water distribution

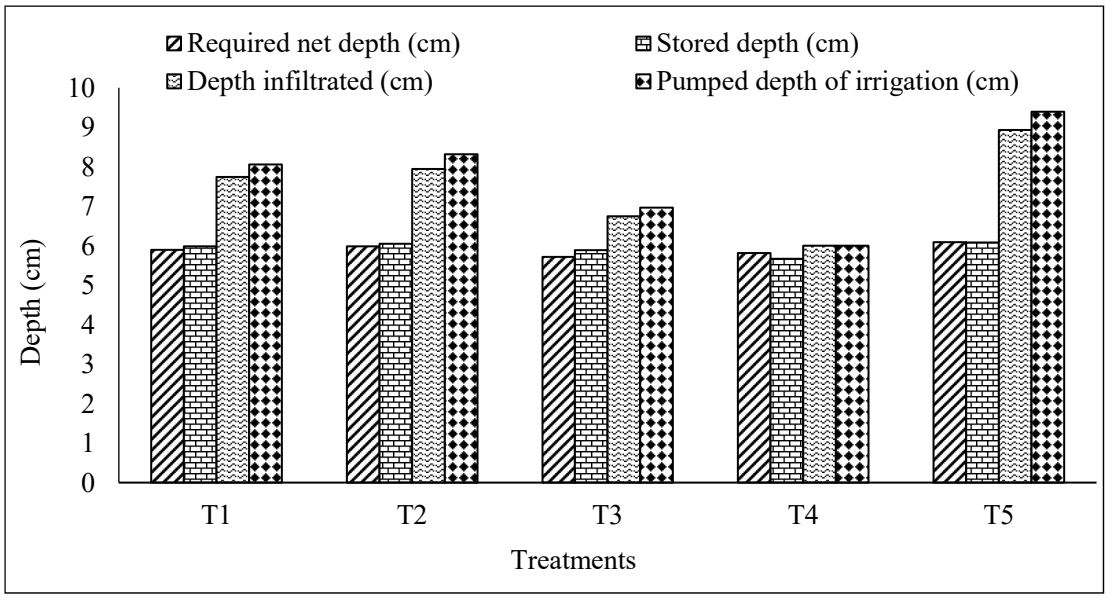

Figure 2: Average required, stored, infiltrated and pumped depth of irrigation for various treatments

efficiency was obtained in treatment T_4 (Micro sprinkler irrigation) in both years. Similarly, it was lowest for T_5 (Farmer's practice) in both years.

Among the surface irrigation, treatment T_3 (Border irrigation with laser guided land levelling having 0.3 per cent longitudinal slope) had better efficiency of water application (87.5%) and distribution efficiency (91.8%). Water application and distribution efficiency averaged over the two seasons for different treatments is also shown in Figure 3.

Yield and water use efficiency: Yield in terms of grain and straw was recorded for different treatments. Irrigation water use efficiency (WUE) for grain was calculated by dividing the respective yield by the total irrigation depth applied. Yield and irrigation water use efficiency (WUE) of grain for different treatments as well as for different irrigation events during different years and CD at 5 % level of significance for the study is given in Table 4.

Grain yield (q ha^{-1}) varied between 37.6 to 45.0 q ha^{-1} and 38.1 to 46.1 q ha^{-1} in the years 2017-18 and 2018-19, respectively. It was highest in treatment T_4 (Micro sprinkler irrigation) in both the years. Similar results were observed by (Liu *et al.*, 2013, Nasseri, 2019 and Sharma *et al.*, 2018). Likewise, it was least in treatment T_5 (Farmer's practice) in both the years. The grain yield among different treatments differed significantly during both the years. Straw yield (q ha^{-1}) ranged between 47.1 to 56.8 q ha^{-1} and 49.5 to 60.4 q ha^{-1} in the years 2017-18 and 2018-19, respectively. It was highest in treatment T_4 (Micro sprinkler irrigation) in both the years. Similarly, it was least in treatment T_5 (Farmer's practice) in both the years. Straw yield also differed significantly among all the treatments during both the years. Total irrigation depth applied (cm) ranged from 36 to 53.8 cm and 36 to 59.0 cm in the years 2017-18 and 2018-19, respectively. It was lowest in treatment T_4 (Micro sprinkler irrigation) in both the

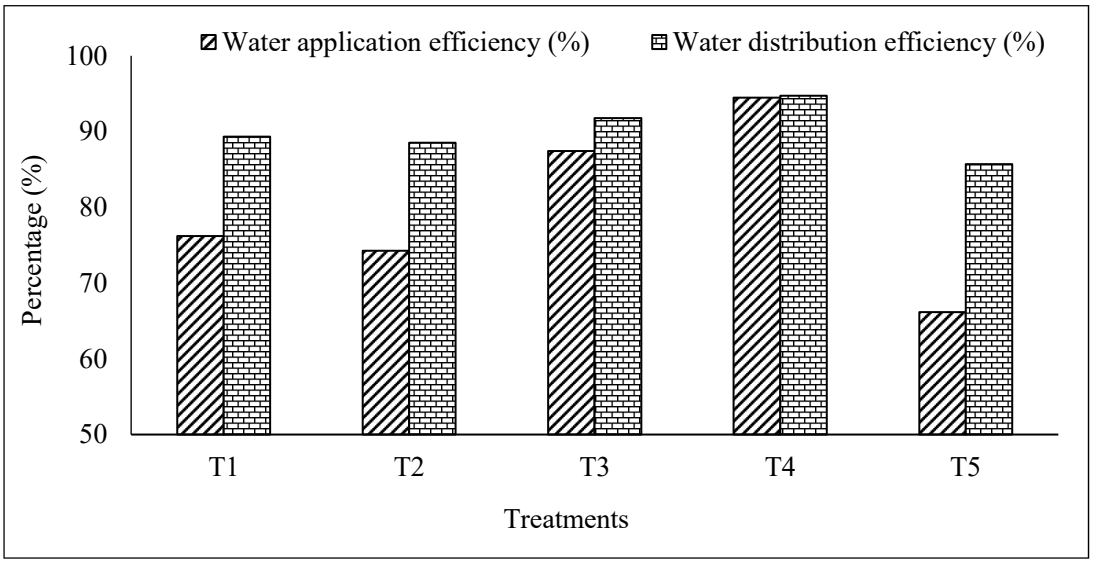

Figure 3: Water application and distribution efficiency for various treatments

Table 4: Yield and water use efficiency (WUE_{Grain}) as affected by various treatments during 2017-18 and 2018-19

Treatment	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		WUE_{Grain} (q ha^{-1} cm^{-1})	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T1	40.71	41.52	50.08	53.15	0.86	0.84
T2	41.45	42.36	51.82	55.07	0.84	0.84
T3	43.21	44.19	54.01	57.45	1.05	1.04
T4	45.04	46.07	56.76	60.35	1.25	1.28
T5	37.64	38.05	47.06	49.46	0.70	0.65
CD ($p< 0.05$)	0.72	0.66	0.89	0.86	0.15	0.14

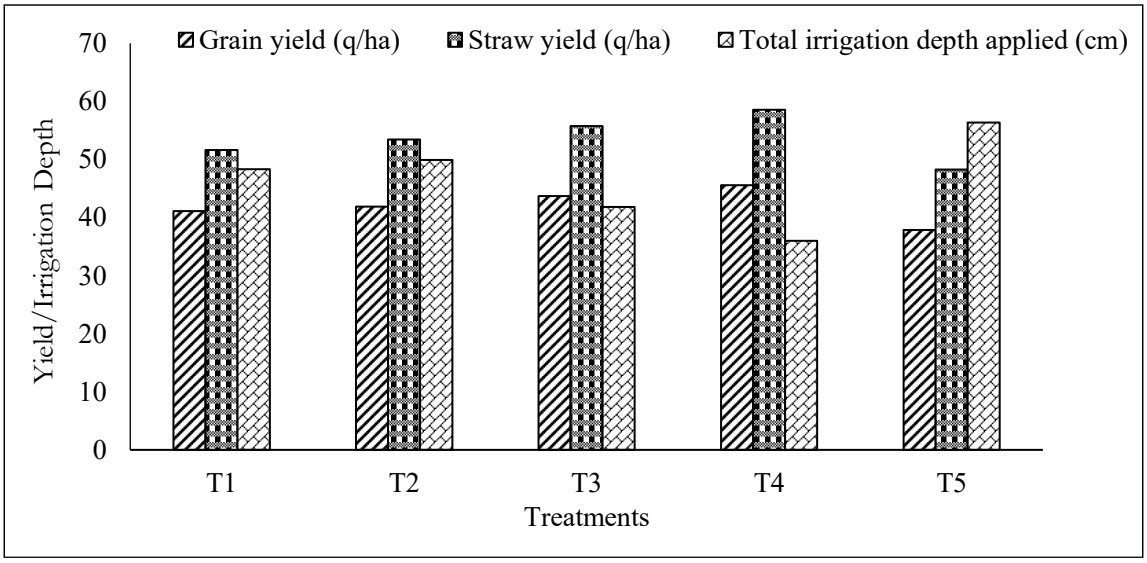

Figure 4: Total irrigation depth applied, grain and straw yield for various treatments

years due to application of recommended fixed depth of irrigation for wheat crop. Similarly, it was highest for treatment T_5 (Farmer's practice) in both the years due to larger plot size non-graded field for same discharge of tube well. Compared to the traditional method of levelling, using laser land levelling farmers could save 21 per cent irrigation water and obtained 6.6, 5.4 and 10.9 per cent higher yield in rice, wheat and sugarcane crop (Naresh *et al.*, 2014). Total irrigation depth applied, grain and straw yield averaged over the two seasons for different treatments is given in Figure 4.

Water use efficiency (WUE) for grain was calculated by dividing the respective yield by the total irrigation depth applied. WUE Grain (q $ha^{-1}cm^{-1}$) varied between 0.7 to 1.25 q ha^{-1} cm^{-1} and 0.65 to 1.28 q ha^{-1} cm^{-1} in the years 2017-18 and 2018-19, respectively. It was maximum in treatment T_4 (Micro sprinkler irrigation) in both the years. Likewise, it was minimum for treatment T_5 (Farmers' practice) in both the years. The water use efficiency differed significantly among all the treatments during both the years except in treatment T_2 in the year 2017-18. Similar outcomes were found by (Rana *et al.*, 2006). Highest grain yield, straw yield and WUE of grain obtained in treatment T_4 (micro sprinkler irrigation) is due to application of recommended irrigation depth and uniform distribution of water over the field. Water use efficiency (WUE) for grain averaged over the two seasons for different treatments is given in Figure 5.

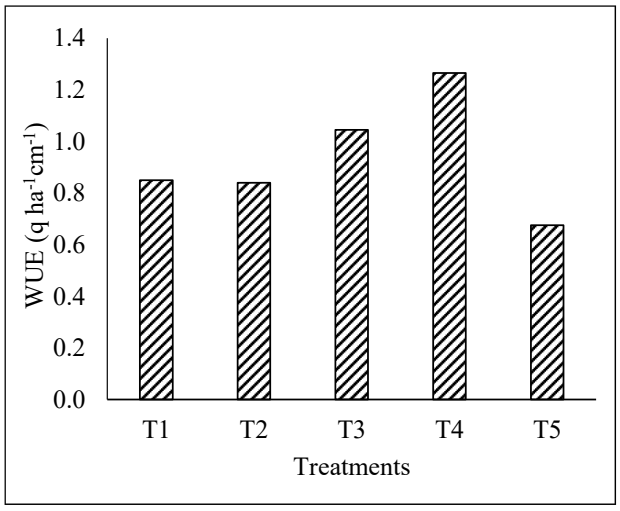

Figure 5: Water use efficiency for grain (WUE_{Grain}) in various treatments

CONCLUSION

- Use of micro sprinkler irrigation in wheat crop resulted into on farm water application of 94.5 per cent as compared to 66.2 per cent under farmers' practice. Even proper grading and sizing of field was found quite effective in raising the water application efficiency from 66.2 per cent under the farmers' practice to 87.5 per cent.
- Relatively good value of water distribution efficiency under all the practices (85.7% under farmers' practice to 94.7 per cent under micro sprinkler) indicates that with suitable control over

duration of irrigation, there is lot of scope for reduced pumpage of groundwater without affecting the crops yields.

- Water use efficiency and crop yield both were found maximum and minimum, respectively, under micro sprinkler irrigation and farmer's practice. Farmers' practice required about 1481 litres of groundwater pumping per kg of wheat grain produced. On the other hand, due to enhanced water application efficiency, improved surface irrigation (properly graded and size field) and micro sprinkler irrigation, respectively, required about 957 and 791 litres of groundwater pumping per kg of wheat grain produced.

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Job Satisfaction of *Anganwadi* Workers: Comparative Study and Impact on Developmental Milestones of Children in Rural and Urban *Anganwadis* of Ludhiana District

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ABSTRACT

Job satisfaction is an overly broad and complex phenomenon. It refers to a worker's satisfaction with his job. It cannot be seen in isolation from other aspects of his life, and it is a widely accepted psychological component of function in any profession. An employee's job satisfaction is related to their positive attitude towards their employment with the organization. Job satisfaction is the overall attitude an individual has toward his/her job (Robbins, 2000). According to psychologists, job satisfaction refers to an amusing or positive emotional state that flows from evaluating one's work experience. An individual's job satisfaction is influenced by factors such as their environment, their co-workers, their salary, their students, etc. An employee's level of job satisfaction refers to how they feel about their job and how they perceive their work environment. But, if an employee is not satisfied with their work and work environment, he or she cannot make a perfect human relationship with others, which can cause social disorder. Pillay (2009) also suggested that the level of job satisfaction can be boosted by multiple factors, including competitive pay, adequate staffing, a pleasant working environment, opportunities for personal and professional growth, a reasonable workload, supervision, recognition, visible progress of patients, positive relationships with co-workers, autonomy on the job, job security, career advancement, and contingent rewards.

Keywords: *Anganwadi*, Comparative study, Developmental milestones, Job Satisfaction, Rural and Urban

INTRODUCTION

The *anganwadi* workers are the women worker and the main employee in executing the ICDS services, who focus their concern to child and the mothers and the most susceptible population of the world (Borgohain and Saikia, 2017). She is the same locality woman, selected by the people, having educational qualification of matric or higher. She not only needs to reach many diverse groups of beneficiaries, but also provide them with different services that include nutrition and health education, non-formal pre-school education, supplemental nutrition, growth monitoring, and family welfare (Sandhyarani and Rao, 2013). *Anganwadi* workers play a variety of roles that require management, education, communication, and counselling skills. A helper is also there in centre that supports the *anganwadi* worker in delivery of the intended services (NIPCCD, 2006).

A teacher who teaches in pre-primary schools, called *anganwadi* workers, also needs job satisfaction since the achievement of ICDS goals depends on the effectiveness of the *anganwadi* workers. It is very much important to know that how much satisfaction they are having in rendering the care to the population (Fredy, 2019). Vijayavardhini and Kumari (2016) suggested that *anganwadi* worker's job satisfaction is very much essential. Job satisfaction is crucial in promoting quality education, since a teacher who is dissatisfied in their profession is not going to impart the necessary skills and knowledge to the students. It refers to workers feeling of satisfaction related on the job, which performs as motivating factors to work. The best way to understand

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job satisfaction is to analyze it as a personal evaluation of work conditions. Generally, the productivity of an organization is dependent on a company's employees, infrastructure, method, and job design.

Children's developmental milestones are defined as the physical and behavioural signs of their progress. Milestones are like guideposts that mark various stages of development, through which every normal child must pass. It included the physical, cognitive, language, social-emotional development of the children. A preschool education is shown to improve children's chances of higher achievement in adulthood by giving them a better start in life (Arya and Vig, 2022). Therefore, a rich environment needs to be provided for children during this period for their growth and development (Manhas and Qadiri, 2010). The *anganwadi* worker plans and conducts activities in the *anganwadi* to stimulate the developmental milestones *viz* physical, motor, social, emotional, language, and cognitive development of children. ICDS aims to develop desirable attitudes, values, and behaviour patterns in children. The center provides informal care, helps children form healthy habits, and promotes mental development among the children Ade *et al.* (2010). As part of pre-school education, children learn not only social skills, but also how to adjust in a school environment as well as how to deal with bullies. Thus, the present study is rigorously with personal information of *anganwadi* workers which are directly or indirectly related to their job satisfaction.

MATERIALS AND METHODS

The present study was conducted in 80 Urban and Rural *anganwadi* centres of Ludhiana district and 400 children selected from these *anganwadi* centres. Sample selection for present study was represented diagrammatically in Figure 1. In the present study following research tools were used.

I. Job satisfaction scale developed by Singh and Sharma (2012) was used to assess job satisfaction of *anaganwadi* workers. The scale was designed to measure the job satisfaction of the employee across two factors viz. job intrinsic and job extrinsic. The test-retest reliability was found to be 0.97 and the construct validity was found to be 0.74.

i) Job-intrinsic (factors inherent in the job) It had two sub factors

(a) Job concrete included statements such as excursion, place of posting and working conditions.

(b) Job-abstract included statements such as cooperation, democratic functioning etc.

ii) Job-extrinsic statements (factors residing outside the job). It had further 3 sub factors.

(a) Psycho-social included statements related to intelligence, social circle etc.

(b) Economic included statements related to salary, allowances etc.

(c) Community growth included statements related to quality of life and national economy

II. Developmental milestones assessment checklist developed by NIPCCD, 2006 was used to assess following four domains of developmental milestones. The checklist included worksheets and activities carried out by the children for each components of the developmental milestone. The following developments were assessed.

1. Physical and Motor Development

a) Gross motor Development

b) Fine motor Development

2. Cognitive Development

3. Language Development

4. Social and Emotional Development

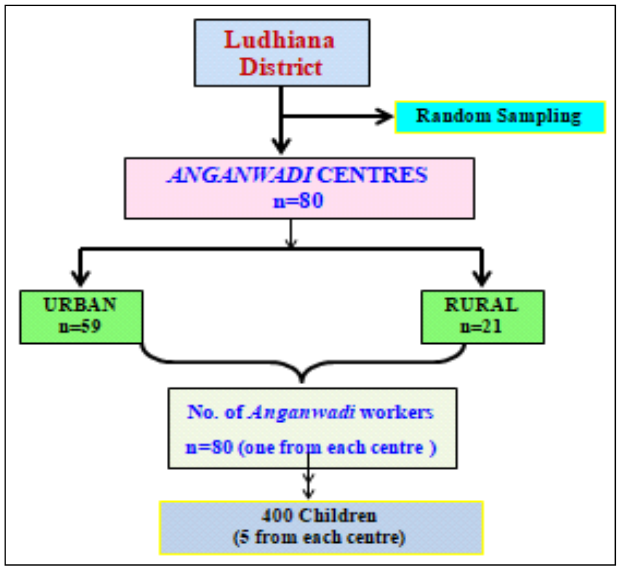

Figure 1: Diagrammatic representation of sample selection for the present study

Measures

Job satisfaction scale: The positive statements carry a weightage of 4,3,2,1 and 0 and the negative ones a weightage of 0,1,2,3 and 4. The total score measured the satisfaction/dissatisfaction of a *anganwadi* worker towards her job. The minimum and maximum range of score is 00 (zero) to 120. These scores were further interpreted as 81-120- high, 41-80- Medium and 0-40- Low.

Developmental milestones checklist: To assess the Developmental milestones Checklist for *anganwadi* children aged 3-6 years, the physical development checklist was used for three performances level i.e. high, average and low. Two scores were given for correct response, one score for incorrect/ incomplete response and zero score was give when the child did not perform the activity even after given three chances.

RESULTS AND DISCUSSION

The Table 1 showed the per cent distribution of *anganwadi* workers regarding their job satisfaction of data regarding urban centres demonstrated that 69.5 per cent of workers at *anganwadis* had average levels of job satisfaction, 18.64 per cent had high levels of job satisfaction, and 11.86 per cent had low levels of job satisfaction. Similarly, rural data showed that 61.9 per cent of the *anganwadi* workers were satisfied with their jobs at an average level, followed by 19.05 per cent who were satisfied at a high level as well as low level. As reported in the study, Vijayavardhini and Kumari (2016) found that the majority of *anganwadi* teachers found a medium level of job satisfaction.

The Table 2 illustrated the job intrinsic factor of job satisfaction and indicated that in urban areas, a most (66.1%) of *anganwadi* workers had an average level, 17 per cent had a high level of job intrinsic factor, and only 13.56 per cent had low level of this factor.

Table 1: Per cent distribution of *anganwadi* workers according to level of job satisfaction

Levels of job satisfaction	Urban (59)		Rural (21)	
	Frequency	Percentage	Frequency	Percentage
High	11	18.64	4	19.05
Average	41	69.5	13	61.9
Low	7	11.86	4	19.05

Table 2: Per cent distribution of *anganwadi* workers according to factor-wise job satisfaction

Factor wise job satisfaction	Urban (59)		Rural (21)	
	Frequency	Percentage	Frequency	Percentage
Job intrinsic				
High	12	20.34	4	19.05
Average	39	66.10	11	52.38
Low	8	13.56	6	28.57
Job extrinsic				
High	17	28.81	3	14.29
Average	38	64.41	15	71.43
Low	4	6.78	3	14.29

However, in rural centres, more than half (52.38%) of *anganwadi* workers were found at a high level, while 28.57 per cent were at low level, and 19.05 per cent were at a high level.

Data relating the job extrinsic factor of the *anganwadi* workers from urban *anganwadi* centres depicted that most of the *anganwadi* workers were at average level (64.41%) with 20.81 per cent at high level and only 6.78 per cent at low level of job extrinsic factor. Similarly data in rural areas showed that majority (71.43%) of *anganwadi* workers had a average level and 14.29% had a high level as well as low level of job intrinsic factor. However, it was noted that the minimum number of *anganwadi* workers showed low job satisfaction because of extrinsic factors as compared to intrinsic factors. This indicated that low job satisfaction was more because of factors like place of posting, working conditions, democratic functioning etc. In both the factors of job satisfaction, most of the *anganwadi* workers were found at an average level.

Furthermore, in Table 3 the data examined the distribution of *anganwadi* workers based on the 'Job concrete' and job abstract sub-factors of job intrinsic. This research determined that in urban *anganwadi* centres, 61.02 per cent of the *anganwadi* workers had an average level of job concrete, followed by 27.12 per cent at a low level and only 11.86 per cent at a high level. Further data related job concrete levels of *anganwadi* workers showed that 47.62 per cent were at an average level followed by low levels 28.57 per cent and 23.81 per cent of workers were at high levels. Therefore, a

Table 3: Per cent distribution of *anganwadi* workers according to intrinsic job satisfaction

Intrinsic job satisfaction	Urban (59)		Rural (21)	
	Frequency	Percentage	Frequency	Percentage
Job Concrete				
High	7	11.86	5	23.81
Average	36	61.02	10	47.62
Low	16	27.12	6	28.57
Job Abstract				
High	17	28.81	5	23.81
Average	27	45.77	8	38.1
Low	15	25.42	8	38.1

majority of the *anganwadi* workers met the job concrete sub-factor of job intrinsic at a standard level, which indicates that they are satisfied with the approach towards their jobs.

The data also examined the distribution of workers in *anganwadi* based on the 'Job Abstract' sub-factor of job intrinsic. The data for urban centres showed that 45.77 per cent of *anganwadi* workers were at average levels, followed by high (28.81%) and only 25.42 per cent at low level. However, data related to rural centres showed that 38.1 per cent were at average as well as low level of job abstract rest of the *anganwadi* workers (23.81%) were at high level. it would be concluded that most of the *anganwadi* workers were found to have an average level of concrete as well as abstract job satisfaction.

Data Table 4 showed regarding their subfactor of job extrinsic viz. psychosocial of *anganwadi* workers in urban centres suggested that 40.68 per cent of the *anganwadi* workers had average level as well as high level of extrinsic job factor and only 18.64 per cent of the *anganwadi* workers were at low level. Whereas, in case of rural *anganwadi* workers 42.86 per cent were at average level followed by low (33.33%) and high (23.81%) in the psychosocial sub-factor of *anganwadi* workers. In the distribution of *anganwadi* workers was examined as per economic sub-factor of extrinsic job satisfaction. In urban *anganwadi* centre most of the *anganwadi* workers had average level (40.68%) while 32.2 per cent at low levels and remaining had (27.12%) at high level. Data pertaining in rural *anganwadi* centres suggested that most (47.62%) of the *anganwadi* workers

Table 4: Per cent distribution of *anganwadi* workers according to extrinsic job satisfaction

Extrinsic job satisfaction	Urban (59)		Rural (21)	
	Frequency	Percentage	Frequency	Percentage
Psycho-social				
High	24	40.68	5	23.81
Average	24	40.68	9	42.86
Low	11	18.64	7	33.33
Economic				
High	16	27.12	4	19.05
Average	24	40.68	7	33.33
Low	19	32.2	10	47.62
Community growth				
High	18	30.51	4	19.05
Average	30	50.85	11	52.38
Low	11	18.64	6	28.57

were at low level followed by average 33.33 per cent and 19.05 per cent of *anganwadi* workers were at high level of economic level of job satisfaction.

The data from urban centres illustrated that half (50.85%) of *anganwadi* workers experienced average level community growth followed by 30.51 per cent at a high level while 18.64 per cent were at a low level of community growth. Similarly, rural centre it was found that half (52.38%) of *anganwadi* workers were at average level with 28.57 per cent were at low level and 19.05 per cent were at high level. Most of the *anganwadi* workers had an average level of psycho-social, economic and community growth factor of extrinsic job satisfaction. However, it was observed that among the three extrinsic factors, maximum no. of *anganwadi* workers were found at a low level of economic factor which indicated that many of the *anganwadi* workers were not satisfied with their salary and allowances.

Table 5 shows the difference in mean scores (±SD) of *anganwadi* workers in urban and rural centres. No significant differences were found in job intrinsic and its sub-factors. Whereas, in the case of job extrinsic factors ($t=2.57$; $p<0.01$) significant differences were observed in psycho-social ($t=2.17$; $p<0.05$), community growth factors ($t=2.30$; $p<0.05$) and overall job satisfaction ($t=2.06$; $p<0.05$). The data for factor-wise

Table 5: Centre-wise difference in mean score (± SD) of job satisfaction of *anganwadi* workers

Domains of job satisfaction	Urban (n_u=59) Mean ± SD	Rural (n_r=21) Mean ± SD	t-value
Job intrinsic	27.28±7.65	25.38±8.90	0.94
Job Concrete	12.32±3.68	12.29±4.11	0.04
Job abstract	14.96±5.47	13.10±5.7	1.33
Job extrinsic	40.08±10.48	33.33±10.49	2.57**
psycho-social	19.05±5.72	15.90±5.61	2.17*
Economic	7.76±3.69	6.48±4.42	1.30
Community growth	13.27±4.03	10.95±3.74	2.30*
Overall	67.37±16.04	58.71±17.80	2.06*

*Significant at 5%, **Significant at 1%

analysis of job extrinsic showed that for 'Psycho-Social' sub-factor from urban centres (19.05±5.72), had maximum numbers of mean scores whereas, minimum mean scores (15.90±5.61) were found in Rural *anganwadi* centres. Whereas, the data regarding 'Community Growth' sub-factor of job extrinsic factor showed that maximum mean scores of the *anganwadi* workers from urban centres (13.27±4.03) and minimum mean scores (10.95±3.74) were found in rural *anganwadi* centres. Furthermore, overall comparative analysis across centre showed that maximum mean scores were found in urban centres (67.37±16.04) whereas, minimum mean scores (58.71±17.80) were found in rural centres.

The data furnished in the Table 6 divulged the overall per cent distribution of *anganwadi* children at different domains and levels of developmental milestones. Data indicated that in terms of gross motor skill, most of the *anganwadi* children were at average level (73.90%) at urban *anganwadi* centres as well as in rural *anganwadi* centres (61.90%). The in-depth analysis of the data from the above table in urban centres elucidated that majority of the (73.9%) of the *anganwadi* children were at average level in fine motor skill followed by high level 19.32 per cent and only 6.78 per cent were found at low level. Furthermore in rural centres illustrated that major proportion (65.71%) of the *anganwadi* children were at average level in fine motor followed 22.86 per cent by high level and remaining 11.43 per cent of the *anganwadi* children had found at

Table 6: Per cent distribution of the *anganwadi* children of different domains and levels of developmental milestones

Domains and levels of developmental milestones	Urban (n_u=295) Frequency	Rural (n_r=105) Frequency
Gross motor skill		
High	69 (23.39)	38(36.19)
Average	218(73.90)	65(61.9)
Low	8(2.17)	2(1.9)
Fine motor skill		
High	57(19.32)	24 (22.86)
Average	218 (73.9)	69 (65.71)
Low	20 (6.78)	12 (11.43)
Cognitive skill		
High	82 (27.8)	20(19.05)
Average	209 (70.85)	80(76.19)
Low	4 (1.35)	5(4.76)
Language skill		
High	131 (44.41)	41(39.05)
Average	164 (55.59)	64(60.95)
Low	0	0
Social and emotional skill		
High	124 (42.03)	40(38.1)
Average	171(57.97)	65(61.9)
Low	0	0

low level. Data regarding in urban centres depicted that around 70 per cent of the *anganwadi* children were at average level in cognitive skill as well as rural *anganwadi* centres. The findings of the present study is in line with the studies of Najineem *et al.* (2002) who indicated that a higher per centage of ICDS children fell under average category in cognitive skill.

The data relating in urban centres found that more than half (55.59%) of the *anganwadi* children were at average level in language skill while 44.41 per cent had high level and none of them were at low level. However, in Rural centres it was noticed that 60.95 per cent of the *anganwadi* children were at average level in language skill and merely 39.05 per cent were at high level. Similar finding Mohanty (2002) also inferred that children having pre-schooling had better language skill and better communication skills than the children having no pre-schooling.

The data illustrated from urban centres the more than half (57.97%) of the *anganwadi* children were at average level in social and emotional skill while 42.03 per cent had high level and none of them were at low level. Furthermore, in rural illustrated that major proportion (61.9%) of the *anganwadi* children were at average level followed by 38.1 per cent were at high level of the *anganwadi* children in social and emotional skill. It was interesting to note that none of the child was found to have low level of social and emotional skill.

Data presented in Table 7 puts-forth difference mean scores (± SD) of developmental milestones of *anaganwadi* children. The data depicted that significant differences in mean scores were found in gross motor ($t=2.53$; $p<0.05$), cognitive skill ($t=2.23$; $p<0.05$) language ($t=3.51$; $p<0.01$), and socio-emotional skills ($t=2.69$; $p<0.05$) of children. Maximum mean score of gross motor skills (11.56±2.86) was found in rural *anganwadi* children. Whereas in cognitive skills maximum mean score found in urban *anganwadi* children (11.94±3.03) rather than rural *anganwadis* (11.19±2.89). Similarly in language and socio-emotional skills, the maximum(11.33±2.34) and (18.08±3.53) and minimum mean score (10.40±2.28) and (17.00±3.57) was observed for the *anganwadi* children from urban centres and rural *anganwadi* centres, respectively.

Table 7: Mean scores difference (±S.D) of the *anganwadi* children at different domains of developmental milestones

Domains of developmental milestones	Urban (n_u =295) Mean ± SD	Rural (n_r=105) Mean ± SD	t-value
Gross motor skill	10.83±2.39	11.56±2.86	2.53*
Fine motor skill	11.83±3.12	11.99±3.44	0.44
Cognitive skill	11.94±3.03	11.19±2.89	2.23*
Language skill	11.33±2.34	10.40±2.28	3.51***
Social-emotional skill	18.08±3.53	17.00±3.57	2.69**

*Significant at 5%; **Significant at 1%

Data contained in the Table 8 examines the correlation between the job satisfaction of the *anganwadi* workers and different domains of developmental milestones of the children. It was clearly evident from the data that fine motor skills of *anganwadi* children were found to be positively correlated with job satisfaction of rural *anaganwadi* workers ($r=0.21$; $p<0.05$). Whereas language skills ($r=0.14$; $p<0.05$) of the children positively correlated with job satisfaction of urban *anaganwadi* workers. However, Social and emotional skills was also found positively ($r=0.15$; $p<0.05$) correlated with job satisfaction of urban *anaganwadi* workers as well as rural workers ($r=0.22$; $p<0.05$).

Table 8: Correlation between job satisfaction of *anganwadi* workers and developmental milestones of the *anganwadi* children

Domains of developmental milestones	Job satisfaction in urban *anaganwadi* workers	Job satisfaction in rural *anaganwadi* workers
Gross motor skills (r)	-0.006	0.01
Fine motor skills (r)	0.04	0.21*
Cognitive skills (r)	0.02	0.10
Language skills (r)	0.14*	0.17
Social and emotional skills (r)	0.15*	0.22*

CONCLUSION

Anganwadi workers' overall job satisfaction was affected by job extrinsic factors such as promotions, work status, and financial stability. However it was observed that two extrinsic factors viz. psychosocial and community growth indicated that many of the *anganwadi* workers were not contented with their growth and opportunities, salary and allowances. For this purpose, it is recommended to provide an appropriate working environment, such as job security, recognition of good work, and freedom to carry out work to the *anganwadi* workers. Therefore, providing basic necessities to *anganwadi* workers will result in a positive attitude towards their jobs that would help in promoting job satisfaction in them.

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Oilseeds and Pulses Cultivation Starter by Demonstrations in District Ferozepur

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ABSTRACT

Punjab Agricultural University Farm Advisory Service Centre, Ferozepur conducted demonstrations on pulses (summer moong varieties SML 668, chickpea varieties PBG 7 and PBG 8) and rapeseed (gobhi sarson variety GSC 7) on farmer's fields in district Ferozepur. Gobhi sarson and chickpea demonstrations were conducted during *rabi* seasons (October to March) of the years 2019-20, 2020-21 and 2021-22 on 41.93 and 5.51 ha area, respectively. Summer moong demonstrations were conducted during *summer* seasons (April to June) of the years 2020, 2021 and 2022 on 8.08 ha area. Punjab Agricultural University recommended varieties of gobhi sarson, chickpea and summer moong in demonstration plots produced 27.8, 15.7 and 13.4 percent more grain yield than check plots having farmer's local cultivation practices. Green chickpea obtained higher net return of Rs. 304353 followed by gobhi sarson and summer moong with net return of Rs. 153737.5 and Rs. 96955.5, respectively. In addition to adding nutrition for nutritional security rapeseed and pulses recorded highest net return as compared to wheat crop.

Keywords: Pulses, Summer moong, Chickpea, Rapeseed, Gobhi sarson, Nutritional security

INTRODUCTION

Oilseeds and pulses are integral part of human diet as a major source of edible oil and protein. Pulses are one of the important food crops globally due to higher protein content (Jakhar and Kumar, 2022). Rapeseed protein contain well balanced amino acid profile, which as a essential amino acids far better than cereals (Thanaseelaan, 2013). Rapeseed alongwith oil contain high-quality protein also, which has many essential amino acids. Worldwide rapeseed oil gives around 1.12 million tons of crude protein (Christoph *et al.,* 2018). There is a dramatic change in rapeseed from traditional type to varieties grown today like GSC 7 a canola quality ('00') hybrid of gobhi sarson. Canola is an international accepted nomenclature for Brassica varieties or hybrids recognized under ISO 5725, Codex Alimentarius, and ISTA as cultivars of rapeseed with < 2% erucic acid in the oil and < 30 μmol of aliphatic glucosinolates in the meal (Mailer, 2016). The oil from canola varieties is healthy oil for human consumption (Rabi, 2022). Despite oilseeds and pulses importance, the area under these crops is less. Farmers cultivate these crops on small area due to low productivity of these crops per unit area. Over a period of time, a number of improved pulses and rapeseed varieties and production technologies have been developed, but full potential of these varieties as well as technologies could not be exploited due to low rate of adoption and low yields (Reddy, 2009; Jakhar and Kumar, 2022). Productivity of these crops per unit area could be increased by adopting improved cultivation practices along with high yielding varieties (Ranawat *et al.,* 2011; Rai *et al.,* 2016). Demonstration were planned and executed with aim to transfer technology at farmer's field to raise yield and income per unit area. Keeping this in view the present study was undertaken to know the effect of demonstrations on farmer's field.

MATERIALS AND METHODS

Punjab Agricultural University (PAU) Farm Advisory Service Centre (FASC), Ferozepur conducted demonstrations on pulses and rapeseed on farmer's

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fields in district Ferozepur. Gobhi sarson demonstrations were conducted as rapeseed. Chickpea (gram) and summer moong demonstrations were conducted as pulses. Chickpea and gobhi sarson demonstrations were conducted during winter (*rabi*) seasons (October to March) of the years 2019-20, 2020-21 and 2021-22. Summer moong demonstrations were conducted during summer seasons (April to June) of the years 2020, 2021 and 2022. FASC, Ferozepur conducted 448, 96 and 30 demonstrations of gobhi sarson, chickpea, and summer moong on 41.93, 5.51 and 8.08 ha area, respectively. PAU recommended variety of gobhi sarson under demonstration was GSC 7 throughout the study period. PAU recommended varieties of chickpea under demonstration were PBG 7 during winter seasons 2019-20 and 2020-21 and PBG 8 during winter season 2021-22. Similarly, PAU recommended variety of summer moong under demonstration was SML 1827 throughout the study period. The demonstrations were evaluated against farmer's local varieties and cultivation practices as check plot. Farmer's local variety means variety purchased from local market from open bags without any assurity of variety and variety name.

RESULTS AND DISCUSSION

Demonstration plots with PAU recommended variety GSC7 of gobhi sarson recorded significantly higher grain yield 22.4, 22.2 and 20.1 q/ha than check plots having grain yield 17.2, 14.8 and 15.6 q/ha during *rabi* 2019-20, 2020-21 and 2021-22 (Table 1). Demonstration plots gave 23.2, 33.3, and 22.3 percent more grain yield than check plots during *rabi* season of 2019-20, 2020-21 and 2021-22, respectively. Higher yield in demonstration plots may be due to adoption of improved variety and cultivation practices. These findings are in accordance with the finding of Dhaka *et al.* (2015); Jha *et al.* (2021) and Gill (2021). Demonsration plots with PAU recommended variety PBG 7 of chickpea gave significantly higher grain yield of 14.7 and15.0 q/ha than check plots having grain yield 12.6 and 12.0 q/ha during the *rabi* 2019-20 and 2020-21, respectively (Table 1). Similarly, during *rabi* 2021-22 demonsration plots with PAU recommended variety PBG 8 of chickpea produced significantly more grain yield of 12.2 q/ha than check plots with grain yield 10.9 q/ha. Demonstration plots yielded 14.3, 20.0 and 10.7 percent more grain yield than check plots during the *rabi* 2019-20, 2020-21 and 2021-22, respectively. This may be due to introduction of improved cultivation practices in demonstration plots which enhanced yield potential of improved varieties. These results are in accordance with the results of Singh *et al.* (2019); Tripathi *et al.* (2019) and Gill (2021). Demonstration plots with PAU recommended variety of summer moong SML 1827 produced significantly higher grain yield 14.6, 14.8 and 15.3 q/ha as compared to check plots with recorded grain yield 12.3, 13.0 and 13.5 q/ha during the summer season of the years 2020, 2021 and 2022, respectively (Table 1). Higher grain yield of summer moong in demonstration plots may be due to improved cultivation practices as compared to farmer's practices. These results are in line with Sangwan *et al.* (2021), Gill (2021) and Jakhar and Kumar (2022). Demonstration plots with PAU recommended varieties of gobhi sarson, chickpea and summer moong recorded significantly higher average grain yield as compared to check plots having farmer's local cultivation practices during the period under study (Table 1). Gobhi sarson, chickpea and summer moong demonstration plots produced 27.8, 15.7 and 13.4 per cent more grain yield than check plots. The more grain yield under demonstration plots with PAU recommended varieties of gobhi sarson, chickpea and

Table 1: Grain yield of demonstrations on gobhi sarson, chickpea and summer moong

Year	Grain yield (q/ha)		p = 0.05
	Demonstration plot	Farmer's practices	
Gobhi sarson			
Rabi 2019-20	22.4	17.2	0.16
Rabi 2020-21	22.2	14.8	0.17
Rabi 2021-22	20.1	15.6	0.17
Average	21.6	15.9	0.19
Chickpea			
Rabi 2019-20	14.7	12.6	0.49
Rabi 2020-21	15.0	12.0	0.19
Rabi 2021-22	12.2	10.9	0.20
Average	14.0	11.8	0.3
Summer moong			
Summer 2020	14.6	12.3	0.15
Summer 2021	14.8	13.0	0.43
Summer 2022	15.3	13.5	0.19
Average	14.9	12.9	0.3

summer moong was mainly due to introduction of improved varieties of these crops which are high yielding, adaptive to region and resistant to diseases like wilt and dry rot in chickpea, yellow mosaic in summer moong and white rust in gobhi sarson along with improved cultivation practices. Adoption of improved cultivation practices enhanced yield potential of improved recommended varieties of gobhi sarson, chickpea and summer moong. Similar type of the findings were obtained by Chaudhary *et al.* (2018); Sangwan *et al.* (2021) and Gill (2021).

An increase in area under rapeseed (gobhi sarson) has recorded in Ferozepur district. The area under gobhi sarson has increased 2.5 times in *rabi* 2021-22 than *rabi* 2019-20 and 2020-21 (Table 2). More demand of rapeseed (gobhi sarson) oil and higher market price of gobhi sarson is the reason for increase in area under gobhi sarson. However, summer moong area in summer 2022 decreased to half of the area in summer 2020 (Table 2). Non availability of irrigation water due to electricity cuts for field prepration (rauni) and irrigations were the reasons for shrinking of area under summer moong.

Table 2: Area (ha) under rapeseed (gobhi sarson) and summer moong in Ferozepur district

Crop	Area (ha)*		
Rapeseed (gobhi sarson)	*Rabi* 2019-20	*Rabi* 2020-21	*Rabi* 2021-22
	394	385	1000
Summer moong	Summer 2020	Summer 2021	Summer 2022
	1000	800	500

*The data regarding gobhi sarson and summer moong in Ferozepur district taken from district headquarter of department of agriculture & farmer welfare, Ferozepur

Average wheat grain yield in Punjab in *rabi* 2019-20 is 50.04 q/ha which was less than average wheat yield (51.18 q/ha) in Ferozepur district (Statistical Abstract, 2020). Cultivation of wheat gave net return of Rs. 69443.1 per hectare (Table 3) which was lower than net returns obtained by cultivation of gobhi sarson and chholiya (chickpea plant bearing green pods also called Chholiya). Gobhi sarson seed (without processing) sold at maximum market price fetches net return of Rs. 107417.5 and processing of seed for oil

Table 3: Economics of wheat, summer moong, ghobi sarson and chickpea

Particulars	Wheat	Summer moong	Gobhi sarson		Chickpea	
			Without processing	With processing	Mature chickpea seed	Green chickpea
Average grain/seed yield (q/ha)*	50.04	14.9	21.6	-	14.0	-
Average green chickpea yield (q/ha)	-	-	-	-	-	160
Average seed oil cake production (q)			-	14.0	-	-
Average oil production (litres)			-	777.6	-	-
Cost of cultivation (Rs/ha)**	31387.5	11442	32982.5	43782.5	15647	15647
Gross return (Rs/ha)***	100830.6	108397.5	140400	197520	73220	320000
Net return (Rs/ha)	69443.1	96955.5	107417.5	153737.5	57573	304353
B:C ratio	2.2	8.5	3.3	3.5	3.7	19.5

*Grain/seed yield of wheat, chickpea, summer moong and gobhi sarson is average grain/seed yield of demonstrations conducted during the period under study.

**Cost involved in cost of cultivation of wheat, chickpea, summer moong and gobhi sarson - seed and seed treatment cost, fertilizers cost, plant protection cost, irrigation cost, human labour hours cost, harvesting cost, tractor hours cost. Post harvesting processing charges (Processing charges for oil and seed oil calke were Rs. 500 per quintal) were also included in gobhi sarson. Interest on variable costs and marketing charges were not included.

***Wheat gross return is calculated by multiplying average wheat grain yield of *rabi* 2019-20 with Minimum Support Price (MSP) Rs 2015 of wheat in rabi 2021-22. Gross return not included returns of by product in wheat. Chickpea gross return included returns of seed yield, green chickpea (local name "Chholiya") (Rs 20 per kg as per market rate). MSP of mature chickpea was Rs 5230 per quintal during 2021-22. MSP of summer moong was Rs 7275 per quintal during 2021-22. Gobhi sarson gross return included returns of seed yield (maximum market price Rs. 6500 per quintal), by product oil (Rs 200 per litre as per market rate) and seed oil cake (Rs 3000 per quintal as per market rate). MSP of sarson was Rs 5050 per quintal during 2021-22.

and seed oil cake provided net return of Rs. 153737.5 which were 35 and 54 per cent higher than net return obtained by wheat cultivation (Table 3). Green chickpea (chholiya) gave net return of Rs. 304353 per hectare which is 77.2 per cent higher than wheat crop (Table 3). Summer moong cultivation produced additional income in off season when fields remain vacant. It gave net return of Rs. 96955.5 per hectare (Table 3). The similar findings were observed by Gill (2021). Due to poor linkage with market, high labour wages, cumbersome processing and less mechanization in oilseeds and pulses cultivation farmers cultivate these crops on small area in spite of high income from these crops (Singh and Bansal, 2020).

CONCLUSION

Demonstration plots with PAU recommended cultivation practices and varieties recorded higher grain yield than farmer's local practices check plots having local varieties cultivated with local cultivation practices. Cultivation of rapeseed and pulses gave higher net return than wheat crop cultivation. Even though cultivation of rapeseed and pulses is economically more beneficial than wheat crop, the area under rapeseed and pulses has not increased due to poor linkage of farmers with market, high labour wages, cumbersome processing and less mechanization.

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Information Processing Behaviour of Farm Women

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ABSTRACT

Information processing behaviour refers to the activities performed by the farm women after acquiring information from the print media. Therefore, the current study was conducted to examine the processing behaviour of farm women regarding household messages in print media. Two hundred farm women from Punjab state who were subscribers of selected newspapers i.e., *'Ajit'* and *'Jagbani'* and farm magazine *'Changi Kheti'* published by Punjab Agricultural University, Ludhiana were selected as the sample for the study. Data were collected through a well-structured and pre-tested interview schedule. A low level of processing behaviour was observed for majority of the respondents. Independent variables i.e., educational level, size of family, participation in various social activities and mass media usage were positively correlated and contributing towards increasing the extent of processing behaviour.

Keywords: Processing behaviour, Farm women, Household messages, Print media

INTRODUCTION

Agriculture is most significant sector of Indian economy. Besides, Punjab is primarily based upon agriculture. The total population of Punjab is 30.73 million out of which about 73 per cent of the population depends directly on agriculture (Anonymous, 2020). Farmers play a very important role in our daily lives as they are fully responsible for the food we eat. But, now women also play an equal role in all farm-related activities as farmers do. Women are not only engaged in household activities but also play a crucial role in farm activities.

As the farmer is the body of agriculture, farm women are the backbone of agriculture. Farm women perform dual duties, both at home and fields. Majority of the farm women actively participate in agricultural and household activities. Besides, farming and household activities, rural/farm women are also involved in other occupations, such as, craftwork, stitching, dyeing & printing, hair dressing, food management etc. Women contribution in today's era is unlimited both at farm and home. To pursue any occupation it is important to have knowledge and information about that sector. In this way, mass media plays an important role in disseminating information to farm women. The mass media today exerts a significant amount of influence. It affects a vast population in a catalytic way, starting with literature and ending with the internet. It functions as a mass mobilizer without regard to literacy. By drawing attention to certain situations, mass media can also advance knowledge and alter people's behaviour (Hassan *et al.*, 2009; Kayode and Adeniran, 2012). Newspapers have additional benefits despite radio and television being the mass media formats with the quickest growth rates: a definite format, a lot of knowledge, and power (Aiyesimoju and Awoniyi, 2012). Newspapers are frequent periodicals with articles that are educational, editorial, critical, and analytical, as well as with ads, special reports, photos, and comics. Newspapers can also consistently and prominently cover particular subjects, and they play a significant role in encouraging readers to adopt new perspectives, expand their awareness of various issues, and gain new knowledge and skills (Khan *et al.*, 2020). Keeping the importance of reading newspapers and magazines in mind the present study was planned to

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assess the processing behaviour of farm women regarding different messages in newspapers and magazine, and to determine the relationship between processing behaviour of women and their socio-personal profile.

MATERIALS AND METHODS

The five agro-climatic zones of Punjab State i.e., the Sub-Mountain Undulating Zone I, Undulating Plain Zone II, Central Plain Zone III, Western Plain Zone IV, and Western Zone V-were the locations of the current study. Two local newspapers, *"Ajit"* and *"Jagbani,"* were chosen for the study because they have the highest distribution in rural areas and feature homebased and agriculture related messages.

The scientific farm publication *"Changi Kheti,"* published by the Punjab Agricultural University, Ludhiana, was specifically chosen because it also features various homebased and agriculture related articles. Following the selection of print media, the Communication Center at the Punjab Agricultural University in Ludhiana provided a list of *"Changi Kheti"* subscribers. Then, from the list, the district with the greatest number of subscribers was chosen from each agroclimatic zone. Two blocks from each of the chosen district were chosen at random. Then, 20 farm women were chosen from each block. Thus, 200 farm women constituted sample for the study.

For this study, messages related to home science, general awareness, and women associated agricultural activities were chosen from the print media. Following selection, a list of all such items that appeared in *"Ajit", "Jagbani"* and *"Changi Kheti"* between October 2020 and January 2021 was prepared by carefully examining each print publication. Previous editions of *"Changi Kheti"* and newspapers were collected from the library and communication centre of the Punjab Agricultural University, Ludhiana, respectively. After that, the messages that were chosen were divided into six categories: food, nutrition and health, clothing selection, construction, maintenance and storage, household management, mother and child care and family relationships, general awareness, homebased agricultural activities.

A pre-tested interview schedule was used to acquire the data. After being collated, the data were statistically examined using frequencies, percentages, weighted arithmetic mean, category interval technique and regression.

RESULTS AND DISCUSSION

The message processing behaviour of respondents of agro-climatic zones has been described under method of processing the message and overall extent of message processing behaviour for the combined print media.

For analysing the message processing behaviour of respondents, the method of processing was differentiated into two categories viz. internal processing of the messages and external processing of the messages. Internal processing means processing of the messages by the respondent internally such as remembering, re-reading, memorizing and internalizing the messages. Whereas, external processing includes underlining the message, clipping, taking pictures and noting down in the dairy.

Table 1: Methods of processing of household messages (n=200)

Method of processing	Zone I	Zone II	Zone III	Zone IV	Zone V	Overall
Internal processing of the message						
Remembering the message	1.82	1.62	1.92	1.67	1.77	1.76
Re-reading the message	1.00	1.07	1.02	1.00	1.05	1.03
Internalizing the message and making it part of daily life	1.90	1.77	1.75	1.70	1.63	1.74
External processing of the message						
Underlining the important points	1.07	1.10	1.17	1.15	1.12	1.12
Clipping/preserving the article	1.17	1.15	1.27	1.15	1.10	1.16
Digitization of the articles	1.80	1.50	1.87	1.50	1.60	1.65
Noting down in the diary	1.12	1.05	1.07	1.05	1.10	1.07

Score range: 1- 3

The perusal of Table 1 shows that on overall basis, remembering the message was utmost preferred method by respondents with mean score 1.76 followed by internalizing the message and making it part of daily life and digitization of articles for processing the messages with mean score 1.74 and 1.65, respectively. However, the minimum chosen method for processing the message was re-reading the message.

Moreover, on analyzing data agro-climatic zone wise, it was concluded that in the category of internal processing of the messages, highest mean score (1.92) was secured by agro-climatic zone III. Whereas, in external processing of the message, digitization of the articles was utmost used method again by the respondents of agro-climatic zone III with 1.87 mean score, followed by agro-climatic zone I (1.80), agro-climatic zone V (1.60), agro-climatic zone II and V with same mean score (1.60) (Table 1).

Thus, it can be concluded that the respondents of agro-climatic zone III used both internal processing (1.75) and external processing method (1.87) with highest mean score among the five agro-climatic zones.

Table 2: Extent of message processing behaviour of farm women (n=200)

Extent of message processing behaviour	Distribution of respondents	
	Frequency	Percentage
Low (1-1.66)	110	55.00
Medium (1.67-2.33)	73	36.50
High (2.34- 3)	17	8.50

The findings are in agreement with Leelavani (2011); Anwar (2016) and Ghanghas *et al.* (2020) that large percentage of respondents preferred remembering the messages. While, the findings of Prasad *et al.* (2009) and Manhas *et al.* (2013) were contradicting with results of the study.

Table 2 depicts that about 55.00 per cent of the respondents were in the low processing behaviour category, followed by 36.50 per cent in medium processing behaviour category. Only a small percentage of respondents (8.50%) were found with high processing behaviour. This is due to the reason that not all processing methods were being preferred by the respondents because methods such as re-reading and memorizing, underlining the important points and noting down in the diary consume lots of time so its been difficult for the respondents to do so.

Table 3 specifies that all independent variables were positively correlated with processing behaviour. These relationships were also resulted as statistically significant at 0.01 level of significance.

It can be inferred from the findings that with the increase in independent variables the processing behaviour of the respondents increases with respect to selected print media. The findings partially supports the findings of Hanumanaikar (2009); Sangama (2014); Singh and Singh (2014); Horakeri (2015); Anwar (2016); Chaitra (2017) and Tanaji (2019).

A perusal of Table 4 indicates that apart from participation in various social activities or events, all

Table 3: Relationship of independent variables with processing behaviour

Variables	Educational Level	Size of family	Participation in various social activities	Mass media usage
Processing behaviour	0.256**	0.263**	0.234**	0.206**

** Significant at the 0.01 level

Table 4: Relative contribution of independent variables to processing behaviour

Independent variables	Regression coefficient	Standard error	't'-value	Significance
Educational Level	0.059	0.017	3.545**	0.000
Size of family	0.121	0.035	3.417**	0.001
Participation in various social activities/ events	0.007	0.013	0.501 ^{NS}	0.617
Mass media usage	0.033	0.013	2.545**	0.012

**Significant at the 0.01 level; NS=Non-significant; $R^2 = 0.278$

other independent variables were perceived to be influencing in regards to processing behaviour of respondents. The absolute per unit contribution regarding educational level, family size and mass media usage was 0.059, 0.121 and 0.033 respectively. Whereas, R^2 value was low i.e., 0.278 which means that there were various other independent variables that could be responsible for variation in processing behaviour. The findings of Leelavani (2011) were contradicting with results of the study.

CONCLUSION

It may be concluded from this study that the processing behaviour of farm women was found to be low. However, Remembering the message was utmost preferred method by the respondents followed by internalizing the message and making it part of daily life and digitization of the articles for processing the messages. Therefore, it is suggested that the communication planners should provide the information in such a manner that the farm women continue to process the maximum.

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Entrepreneurial Behaviour of Chilli Growers in Punjab State

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ABSTRACT

An exploratory study on the entrepreneurial behaviour of chilli growers was conducted in Punjab state. A sample of 30 chilli growers was selected by random sampling from four selected districts with a total sample size of 120. A modified scale based upon assessment scales like Technonet Asia (1981) and Chaudhari (2006) was used to elicit the response of chilli growers on selected entrepreneurial dimensions. The data were collected by personally interviewing the respondents. The findings of the study revealed that the majority of chilli growers possess high-risk orientation, medium achievement motivation, management orientation, and self-confidence, and intermediate decision-making ability, whereas they lacked in the case of other entrepreneurial dimensions like innovativeness, cosmopoliteness, leadership ability. Overall entrepreneurial behavior was computed and it was found that the majority of chilli growers had a medium level of entrepreneurial behavior. One-third of the respondents had low entrepreneurial behavior. Variables such as education, operational land holding, mass media exposure, social participation, annual income, and adoption had a positive and significant relationship with the entrepreneurial behaviour of the chilli growers.

Keywords: Chilli growers, Cosmopoliteness, Entrepreneurial behaviour, Innovativeness, Risk orientation

INTRODUCTION

Entrepreneurs can play an important role in increasing agricultural production and turn contribute to the economic development of the country (Pandeti, 2005). India constitutes a significant portion of horticultural crops to the total agricultural produce. Horticulture is a prominent sector and an important means of diversification for making agriculture more productive through efficient land use, optimal natural resource utilization, and the development of skilled employment for rural populations. The total area under horticultural crops has shown a significant increase from 14.0 million hectares in 1996-97 to 27.50 million hectares in 2020-21. It was observed that the contribution of vegetable crops in horticulture is highest (59-61%) as compared to other crops and India is the second largest producer of vegetables after China (Anonymous, 2021). Chilli (*Capsicum annum* L.) is one of the most important commercial vegetable cum spice crops grown in India (Singh *et al.,* 2020; Reddy *et al.,* 2018). There is great potential to increase the production of this crop in the future if growers are oriented towards entrepreneurship and the adoption of modern technology. All-round development of agriculture is possible only with the effective exploitation of entrepreneurial behaviour skills as well as material resources (Yewatkar, 2019). The twenty-first century is the century of entrepreneurship and every individual can be an agent for innovation and change. Entrepreneurship is regarded as one of the most crucial factors in the economic development of every region of the country (Chaudhary *et al.,* 2017). With the increase in population in our country and the decrease in material resources, it is important to educate the people, especially the farmers and develop their skills to establish their enterprises, generate income and sustain their livelihood. Entrepreneurship is very essential for social development in terms of the social behaviour of human beings. In general, an entrepreneur is someone who starts, organises, manages, and directs the activities of a business unit by integrating production

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factors to produce goods and services. It is now widely accepted that an increase in production, the productivity of farms, farm diversification, innovation and the development of farmers into self-sustaining individuals follow the inculcation of entrepreneurial qualities among farmers (Wankhade *et al.,* 2013). Enterprises play a crucial role in creating new employment and creating new work environments. However, entrepreneurial behaviour can be attributed to the change in knowledge, skills, and attitude of entrepreneurs in the enterprises they have taken up (Kumar and Poonam, 2019).

Entrepreneurial behaviour is the result of an interaction of social, individual, situational, psychological, and experimental factors. Farmers cultivating horticultural crops have higher chances of becoming entrepreneurs, but they are unable to grow significantly as a result of several constraints such as non-availability of seeds at a reasonable price, inadequate infrastructure, poor transportation, poor market linkages and lack of awareness (Kharlukhi and Jha, 2021). An entrepreneur growing chilli crop can produce more by adopting new practices or ideas take a rational decision and coordinate farming operations that would lead to maximum profit. Farmers who decided to take a particular crop/enterprise or use scientific methods to grow crops also exhibit entrepreneurial behaviour (Rao and De, 2001). Progressive farmers cannot be identified as agricultural entrepreneurs but those who are entrepreneurs are essentially progressive farmers (Patil *et al.,* 1999). Therefore, keeping in view the following issues, the present study was conducted to analyse the entrepreneurial behaviour of chilli growers in Punjab.

MATERIALS AND METHODS

The study was conducted during the year 2021-22 in Punjab State. Four districts namely Jalandhar, Sangrur, Patiala and Tarn Taran were selected randomly for the present study. A list of chilli growers was prepared from information available from either the State Horticulture Department or Krishi Vigyan Kendras (KVKs). A total of 30 chilli growers were selected randomly from each district, which comprised 120 respondents. Entrepreneurial behaviour was measured in terms of the extent to which chilli growers have the traits responsible for entrepreneurial behavior. The dimensions for the study have been chosen based on the literature available on entrepreneurial behaviour in vegetables as well as in consultation with scientists and experts. Assessment scales like Technonet Asia (1981) and Chaudhari (2006) were studied and modified in view of selected dimensions. The modified scale was comprised of dimensions like innovativeness, risk orientation, achievement motivation, decision-making ability, cosmopoliteness, self-confidence, leadership ability, and management orientation. Cronbach's alpha coefficient of testing internal consistency was also used to measure the reliability of the scale. The irrelevant statements were excluded from the final scale after discussion with the experts. Validity of the test was established through content validity, indicated by the square root of its reliability. The response was recorded on the three-point continuum. The collected data were classified, tabulated, and analyzed with the help of statistical tools like percentage, mean, standard deviation, and coefficient of correlation.

Entrepreneurial behavior index: It was measured as the percentage of obtained score to the maximum possible score.

$$EBI = \frac{\text{Sum of obtained scores on eight entrepreneurial attributes}}{\text{Maximum obtainable score}} \times 100$$

RESULTS AND DISCUSSION

Socio-personal characteristics of the respondents: The information about various socio-personal characteristics viz., age, education, occupation, operational land holding, annual income, experience of chilli cultivation, mass media exposure, and training exposure of the chilli growers has been furnished in Table 1. Data revealed that half of chilli growers (50.83%) belonged to the age group between 43-59 years while 27.50 per cent of them aged between 26-42 years. About 50.00 per cent of the respondents were educate up to the matric level followed by 28.33 per cent respondents who had education level up to senior secondary level whereas 10 per cent of the respondents were reported to be illiterate and 9.17 per cent of the respondents were graduated. Most (40.83%) of the farmers were medium farmers, holding a land of 10-25 acres. About 30 per cent of the farmers were semi-medium farmers followed by 15.00 per cent fall under the category of large farmers and 2.50 per cent were small farmers. The majority (73.33%) of the

Table 1: Distribution of respondents according to their socio-personal characteristics (n=120)

Characteristics	Categories	Frequency	Percentage	Mean ± S.D.
Age (years)	26-42	33	27.50	46.91±11.10
	43-59	61	50.83	
	60-76	26	21.66	
Education	Illiterate	12	10.00	10.19±3.78
	Primary	4	3.33	
	Matric	59	49.17	
	Senior Secondary	34	28.33	
	Graduate	11	9.17	
Operational land holding (acres)	Marginal (<2.5)	3	2.50	16.92±16.37
	Small (2.5-5.0)	14	11.67	
	Semi-medium (5-10)	36	30.00	
	Medium (10-25)	49	40.83	
	Large (>25)	18	15.00	
Total area under chilli (acres)	1-9	88	73.33	8.20±7.03
	10-18	29	24.17	
	19-27	3	2.50	
Experience in chilli cultivation (years)	2-12	45	37.50	13.91±7.80
	12-21	58	48.33	
	21-31	17	14.17	
Mass media exposure	Low (16-17.71)	17	14.16	22.40±4.69
	Medium (17.71-27.09)	84	70.00	
	High (27.09-34.00)	19	15.83	
Training exposure	Acquired	22	18.33	-

respondents had 1-9 acres area under the chilli crop, while 24.17 per cent of the growers had an area of 10-18 acres and only 2.50 per cent of the growers had an area of 19-27 acres under chilli crop. The study further envisaged that 48.33 per cent of the growers had 12-21 years of experience in chilli cultivation followed by 37.50 per cent and 14.17 per cent who had experience of 2-12 years and 21-31 years respectively. The data revealed that 70.00 per cent of respondents had medium level of mass media exposure for seeking information regarding chilli cultivation followed by 15.83 per cent of the respondents had high level of mass media exposure. About 14.16 per cent of the respondents had low level of mass media exposure for seeking information about chilli cultivation. The mean and standard deviation of mass media exposure was 22.40 and 4.69 respectively. Only 18.33 per cent of them acquired training on vegetable cultivation.

Entrepreneurial attributes of the respondents: The entrepreneurial behaviour of the respondents was analyzed by including the following entrepreneurial attributes from Table 2.

Risk orientation: The findings in Table 2 revealed that more than half (55.83%) of chilli growers had high-risk orientation whereas 28.33 per cent had medium and 15.83 per cent had low-risk orientation respectively. The probable reason could be that chilli growers face high price fluctuations in their chilli crop or unexpected weather conditions in Punjab affect the yield of their crop. This is reflected in the practices followed by chilli growers and it was observed that growers considered chilli cultivation as risk-involving activity and they possess a high-risk orientation with a mean score of 13.46. Successful chilli growers are the one who readily accept to face the risk and adjust with nature's vagaries. It was also found in Table 1 that the

maximum number of chilli growers had an experience of 12-21 years and more experience in farming increased the confidence about the adoption of the new technologies and to gain more income by taking risks.

Innovativeness: It is apparent from Table 2 that the majority (52.50%) of chilli growers were in the low innovativeness category followed by 34.17 per cent and 13.33 per cent belonged to medium and high innovativeness categories. Similar findings were observed by Bhati and Upadhyay (2019). It is an important factor in chilli cultivation, as it indicates the willingness of an individual farmer to know about new things, ideas and new practices related to enterprise and to what extent the farmer is going to apply these things in their field. In discussions with chilli growers, it was found that farmers were reluctant to use new cultivation technologies like protected cultivation and hesitant to go for any innovative technologies or protected environment and they did not try new farming methods unless others had used them successfully. Generally, growers tend to rely on the opinion of their friends/neighbours or fellow farmers before adopting or using any new practices or technologies on their farm. On the contrary, chilli growers who had a high level of innovativeness were more likely to look at chilli cultivation as a profit-making enterprise rather than a subsistence activity. They were generally market-oriented and became aware of the prices and got information about the local or distant market.

Achievement motivation: The results in Table 2 indicated that slightly less than half (48.33%) of the chilli growers had medium achievement motivation,

Table 2: Distribution of respondents based on their entrepreneurial attributes (n=120)

Parameters	Categories	Frequency	Percentage	Mean score
Risk orientation	Low (<10)	19	15.83	13.46
	Medium (10-14)	34	28.33	
	High (>14)	67	55.83	
Innovativeness	Low (<13)	63	52.50	13.08
	Medium (13-17)	41	34.17	
	High (>17)	16	13.33	
Achievement motivation	Low (<8)	23	19.17	9.22
	Medium (8-11)	58	48.33	
	High (>11)	39	32.50	
Cosmopoliteness	Low (<11)	56	46.67	11.23
	Medium (11-14)	43	35.83	
	High (>14)	21	17.50	
Leadership ability	Low (<9)	55	45.83	9.56
	Medium (9-12)	43	35.83	
	High (>12)	22	18.33	
Management Orientation	Low (<20)	46	38.33	22.31
	Medium (20-24)	57	47.50	
	High (>24)	17	14.17	
Self-confidence	Low (<9)	31	25.83	10.15
	Medium (9-12)	56	46.67	
	High (>12)	33	27.50	
Decision-making ability	Less Rational (<10)	24	20.00	10.98
	Intermediate (10-12)	61	50.83	
	Rational (>12)	35	29.17	

while 32.50 per cent and 19.17 per cent of the growers were observed in high and low achievement motivation respectively. This might be due to their desire or need to increase or improve their economic conditions. The probable reason for medium followed by high achievement motivation might be due to their enthusiasm to achieve success in chilli cultivation. Growers would like to try hard in difficult situations even though they know their chances of failure are high. It could be indicated that farmers always try to gain something more and more in their field and thus they put all their efforts into getting the desired outcome. These finding was in line with the findings of Maratha *et al.* (2016).

Cosmopoliteness: It was revealed that the low level (46.67%) of this trait was possessed by chilli growers followed by medium (35.83%) and high level (17.50%) of this attribute. This might be due to their less active participation in extension activities such as agriculture exhibitions, Kisan Mela, etc. It was indicated from Table 1 maximum number of chilli growers had not undertaken any training in vegetable cultivation. They might not have attempted to keep in contact with cosmopolite sources of information. After a discussion with the farmers, they expressed satisfaction with the many things learned from the situations and experiences in their village. Another plausible reason could be that chilli growers generally seek information from fellow farmers. Chilli growers had medium and high levels of cosmopoliteness. This may be due to an increase in mass media exposure, which in turn increases the progressiveness among growers. Mass media contact enhances the ability of farmers to get more information about market prices or recent technologies, which in turn broadens the mental horizons of the growers to accept and adopt the practices.

Leadership ability: It is obvious from the data presented in Table 2 that slightly more than two-fifths (45.83%) of the chilli growers had low level of leadership ability followed by 35.83 per cent had medium and 18.33 per cent had a high level of leadership ability. The chilli growers had low leadership ability as they had less exposure and less accessibility of information from outside of the village. The probable reason could be that chilli growers lacked certain leadership qualities like sufficient knowledge, good supervision, record keeping etc. They expressed that entrepreneurship in vegetable cultivation, especially chilli required a keen sense of the market, exploitation of the opportunities, and willingness to adapt to the environment. The results were in contradiction with the findings of Yewatkar *et al.* (2019) who found that garlic growers had medium leadership ability.

Management orientation: Management orientation consisted of production and market orientation. It was observed from Table 2 that the maximum number (47.50%) of chilli growers had the medium category of management orientation, followed by low (38.33%) and high (14.17%) categories of management orientation respectively. The plausible reason for medium management orientation is that they have to grow the variety that has more market demand and they have obtained information on market prices from neighbours, fellow farmers, or the mass media. After discussion with growers, they stated that it was most important to gain a good knowledge of the market and production technology of chilli before starting their enterprise and tended to produce only those vegetables including their varieties which were found to have consumer acceptance. When these findings are looked at in the context of chilli production activities leads to conclude that it requires efficiently managing the operations related to the cultivation and marketing of the produce. The reason for low management orientation could be that farmers have not received any training and thus lacked skills in areas such as nutrient management and the selection of early and late varieties. The training inculcates the spirit of coordination by sharing experiences among the farmers. Thus, a trained grower could produce more vegetables from the same unit of land by reducing the cost of cultivation and exhibiting more profit. Similar findings were reported by Kolgane *et al.* (2018).

Self-confidence: It was quite clear from Table 2 that nearly half (46.67%) of chilli growers had medium self-confidence whereas 27.50 per cent of chilli growers had high self-confidence and 25.83 per cent of chilli growers had a low level of self-confidence. The probable reason might be that the chilli enterprise is dependent on the natural environment and no growers tend to persist in the face of difficulties or obstacles. Farmers had enough faith to take the right decision at the right time in case of adopting or trying any new practices in chilli cultivation. They were confident in

adjusting to any adverse condition without any hesitation. These findings are in accordance with those of Shanker *et al.* (2019).

Decision-making ability: Table 2 indicated that the maximum number (50.83%) of chilli growers belong to the intermediate category, followed by 29.17 per cent and 20.00 per cent of the growers belong to rational and less rational categories. Similar findings were reported by Pongener and Jha (2021). One possible reason is that farming decision-making, particularly in Indian conditions, is extremely difficult due to constantly changing agro-climatic conditions and a lack of a stable price policy. Another reason might be their experience in the cultivation of chilli, which helped them to make the right decision at the right time and the right place. It was also observed that chilli growers decide the variety or area under those varieties put under cultivation based on the market demand and experience with new varieties. Sometimes growers make quick decisions about plant protection measures based on careful observation. On the contrary, those who had less rational decision-making ability had taken their decisions under peer pressure regarding the use of inputs and quantity of fertilizers, etc.

Entrepreneurial behaviour of chilli growers: The scores obtained by an individual farmer on all eight attributes of entrepreneurial behaviour were pooled and referred to the entrepreneurial behaviour score of that individual. Thus entrepreneurial behaviour is the composite measure of eight components such as risk-taking, innovativeness, cosmopoliteness, decision-making ability, self-confidence, leadership ability, and management orientation. Based on summing up the scores of all the eight components of the entrepreneurial behaviour of chilli growers they were categorized into three categories namely low, medium and high entrepreneurial behaviour, and presented in Table 3 and Figure 1. The most of the chilli growers had a medium level (46.67%) of entrepreneurial behaviour followed by 34.17 per cent of growers who had a low level whereas 19.17 per cent of the growers belong to high entrepreneurial behaviour category. Among the sample of growers, the mean score of entrepreneurial behaviour was 64.88. The measure of standard deviation was 7.71 indicating lower dispersion in the score. The analysis of overall entrepreneurial behaviour revealed the situation where a large majority of the farmers are medium in their entrepreneurial ability. The reason could be that, despite high price fluctuations in chilli, and uncertain climatic conditions affecting the yield and quality of the crop, farmers sustain cultivating chilli on their fields. It can be interpreted that these farmers were having medium to high levels of realistic estimation for progressive and prosperous chilli cultivation at their farms. Farmers could take the right decision at the right time which is a very important attribute in entrepreneurial behaviour for the success of an enterprise. The other aspect of medium entrepreneurial behaviour was good management orientation concerning production and marketing. This indicates that given the right conditions, many of them will be able to turn chilli cultivation into chilli enterprise. Similar findings were reported by Jamir and Jha (2020) possessed a medium level of entrepreneurial behaviour concerning the cultivation of chilli.

Correlational analysis was carried out to find out whether the selected attributes had any association with the entrepreneurial behaviour of chilli growers. The

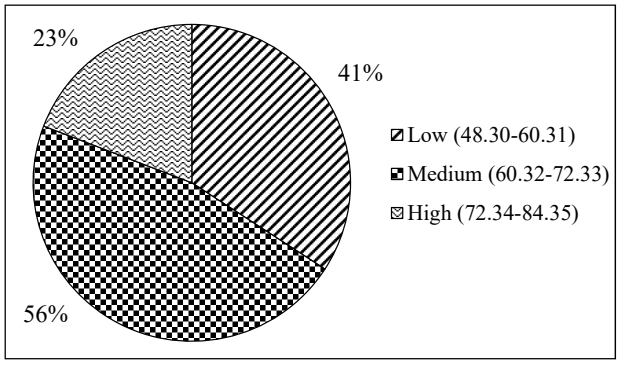

Figure 1: Overall entrepreneurial behaviour of chilli growers

Table 3: Distribution of chilli growers based on their overall entrepreneurial behaviour (n = 120)

Entrepreneurial behaviour index	Frequency	Percentage	Mean±S.D.
Low (48.30-60.31)	41	34.17	
Medium (60.32-72.33)	56	46.67	64.88±7.71
High (72.34-84.35)	23	19.17	

Table 4: Association between independent variables and entrepreneurial behaviour of the respondents

Independent variables	Correlation coefficient (r)
Age	-0.037^{NS}
Education	0.381**
Operational land holding	0.331**
Area under chilli crop	0.012^{NS}
Experience in chilli cultivation	0.027^{NS}
Annual income	0.206*
Mass media exposure	0.232*
Social participation	0.358**
Training exposure	0.113^{NS}
Adoption	0.219*

* Significant at 0.05 level; **Significant at 0.01 level; NS = Non-significant

data in Table 4 revealed that education, operational land holding, and social participation had a positive and significant relationship with entrepreneurial behaviour at 0.01 level of probability. Mass media exposure, annual income and adoption had a positive and significant relationship with entrepreneurial behaviour at a 0.05 level of probability. The negative value of the variable age (-0.037*) was indicating the negative effect of age on entrepreneurial behaviour. Similar findings were observed by Boruah *et al.* (2015). Hence, the null hypothesis was rejected for these attributes and concluded that these attributes were correlated with entrepreneurial behaviour. It was evident from Table 4 that the predictor variable age had a negative association with the entrepreneurial behaviour of chilli growers however experience in chilli cultivation, the area under chilli crop, and training exposure was non-significantly related to the entrepreneurial behaviour of chilli growers.

CONCLUSION

Entrepreneurial competencies are becoming increasingly important for farmers due to external and internal changes toagrarianecosystem. Vegetable cultivation allows frequent cash flow, increased precision farming and improved decision-making ability thus necessitating possessing entrepreneurial traits. The study concluded that the majority of chilli growers had a medium level of entrepreneurial behavior. Chilli growers had high-risk orientation, and medium achievement motivation and the maximum number of chilli growers belong to the intermediate category of decision-making. The future progress of farming in the country depends on the entrepreneurial behaviour of farmers. This study suggests imparting necessary knowledge and skills in the deficient areas of entrepreneurial behavior like leadership ability, innovativeness, cosmopoliteness, management orientation, etc. Communication is central to enhancing these attributes of entrepreneurial behavior. Strong liasioning with farmers, intensive training programs, and field visits may help to augment entrepreneurship in farmers and the socio-economic upliftment of chilli growers.

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Perception, Attitude and Knowledge of Farmers towards Agri-drones: Case Study on Influence of *Mann Ki Baat* Program

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ABSTRACT

In the recent years, ICTs has proved to be highly beneficial for the farmers in getting easy access to the customized agricultural information and therefore, have a potential to influence smart agriculture. The Honourable Prime Minister through his *Mann Ki Baat* program has given a vision of quantum jumps in the economy, which will be driven by 'new-age technologies'. Out of 99 episodes on *Mann Ki Baat* broadcasted so far, 7 had major emphasis on the farming sector and farmers welfare. In the 95th episode (aired on November 27, 2022), he highlighted the roles of drones in agriculture. The present study was designed to know the overall perception, attitude, and knowledge level of farmers with respect to different aspects of Agri-drones, who have actively participated in *Mann Ki Baat* program. Primary data was collected and analysed from 1398 farmers, who participated in *Mann Ki Baat* program under the aegis of 77 Krishi Vigyan Kendras (KVKs), chosen randomly across the country. We learned that a majority of the farmers have participated in the program and perceived that drones were useful for agricultural operations and such farmers had favourable attitude towards Agri-drones. However, a significant number of farmers expressed difficulty in understanding the drones' technology. Most farmers exhibited knowledge about Agri-drones to a moderate scale and have medium to high level of knowledge, which clearly indicates that *Mann Ki Baat* program has influenced and enriched farmers with respect to the knowledge related to Agri- Drones. The socio-economic characteristics of farmers were found to have significant and positive relationship with the knowledge level. The insights gained from this present study may help policy makers and researchers in effective planning and execution of programmes on adaptive capacity development of farmers, making them more aware and knowledgeable to strengthen the adoption of drone technology in agriculture.

Keywords: Agri-drones, Mann ki Baat, Perception, Knowledge level

INTRODUCTION

In the recent years, Information and Communication Technology (ICT) has proved to be highly beneficial for the farmers and helped them in getting easy access to customized information regarding improved varieties, cropping pattern, use of high-yielding seeds, fertilizer application, pest management, marketing, entrepreneurship, etc. ICT can have a leading role in the dissemination of right information to needful farmers at right time. ICT services provide critical access to the knowledge, information, and technology that farmers require to improve their productivity and thus, enhance their livelihood and quality of lives (Nandeesha, 2016). Advancement in ICTs has given boost to smart farming, which harness modern technologies in precision agriculture like big data, cloud and Internet of Things (IoT) for effective and efficient tracking, monitoring, automation and analysis of agricultural operations.

Hon'ble Prime Minister, with his *Mann Ki Baat*, motivated the farming community and other stakeholders to drive innovations in the sector. In the *Mann Ki Baat* 95th episode aired on November 27, 2022, Prime Minister of India highlighted the roles of drones in agriculture and informed that India is moving fast in the field of drones. He elucidated, how with the

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help of Drone Technology, delicious Kinnauri apples of Himachal are reaching people more quickly, timely with reduced wastage and expenditure of our farming communities. Driven by the Prime Minister's vision of making India a global drone hub by 2030, the Government has taken major initiatives over the last year to encourage the adoption of drones in the country. The Drone Rules 2021, built on a premise of trust, has brought ease-of-doing business for drone manufacturers, service providers, and pilots. Production Linked Incentive (PLI) scheme for drone and component manufacturing, coupled with the Government's push for *Atmanirbhar Bharat*, has encouraged an indigenous manufacturing base to come up in this strategic sector. These measures have led to a 35 per cent increase in the number of drone startups in the country in the last year itself (Mehta, 2022).

Agriculture has undergone a fourth transformation (Farming 4.0) in recent years as ICT has been integrated into conventional farming practices (Sundmaeker *et al.*, 2016). Unmanned Aerial Vehicles (UAVs) popularly known as Drones, Remote Sensing, Internet of Things (IoT), Machine Learning (ML), Artificial Intelligence (AI), Big Data Analytics (BDA) etc. have the potential to usher a new era in agricultural practices (Walter *et al.*, 2017; Wolfert *et al.*, 2017). Drones are being used in precision agriculture, photogrammetry and remote sensing in developed countries (Everaerts, 2008; Zhang *et al.*, 2012; Colomina and Molina, 2014; Natu and Kulkarni, 2016). India has an opportunity to realize approximately INR 1.8 lakh crore worth of domestic manufacturing potential by 2030 through focused implementation of drone indigenization projects across defence, commercial and homeland security sectors (EY and FICCI, 2022). One of the largest deployments of drones in the country has been initiated as a part of the SVAMITVA scheme in which drones are being used for mapping the land parcels of 6.6 lakh villages across India to create accurate digitized property records. Today, more than 2 lakh villages have already been surveyed using drones, making this a globally unprecedented use of drone technology for rural development. The use of drones in agriculture is also picking up pace. Kisan drones are being used for the effective spraying of pesticides and nutrients over farms, thereby reducing time, improving efficiency, and enhancing safety. Drones with advanced sensors are also being used to digitize farms for crop health analysis, land usage planning, transparent & quick settlement of insurance claims, and many more. It is very fast and it could reduce the work load of a farmer *Mann ki Baat* episodes have brought much needed traction in driving innovations and sustainable practices at KVK as well as farmers' level. Therefore, it has been attempted to explore, how *Mann ki Baat* programme has influenced farmers with respect to their perception, level of motivation, awareness generated, interest created and knowledge gain regarding Agri-drones.

CONCEPTUAL FRAMEWORK

The process of the farmers learning and its sharing with respect to different aspects of Agri drones among the peers can be attributed to various communication theories, which in turn contribute to perception, attitude, and knowledge level of farmers, The combination of the theories is used to demonstrate effect of *Mann ki Baat* program on perception, attitude, and knowledge level of farmers (Figure 1). The diffusion of innovation theory (Rogers, 2010) explains how new ideas, products, or services spread through a social system. Theory of change shows farmers readiness to change in their status in the adoption behaviour. According to the Unified Theory of Acceptance and Use of Technology (UTAUT, 2003), the actual use of technology is determined by behavioural intention. The perceived likelihood of adopting the technology information is dependent on the direct effect of four key constructs, namely performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy refers to the degree to which farmers believe that using Agri drones will help them improve their agricultural practices and increase their productivity. Effort expectancy refers to the ease of using technology and the perceived ease in learning to use it. Social influence refers to the impact of external factors, such as the opinions of family, friends, or other farmers, on a farmer's intention to use the technology. Facilitating conditions refer to the availability of necessary resources, such as access to Agri-drones and data interpretation support system, to use the technology effectively (Venkatesh *et al.*, 2003).

In the context of Agri-drones that was emphasized in *Mann Ki Baat*, social learning can occur through interactions with peers, extension workers, or through

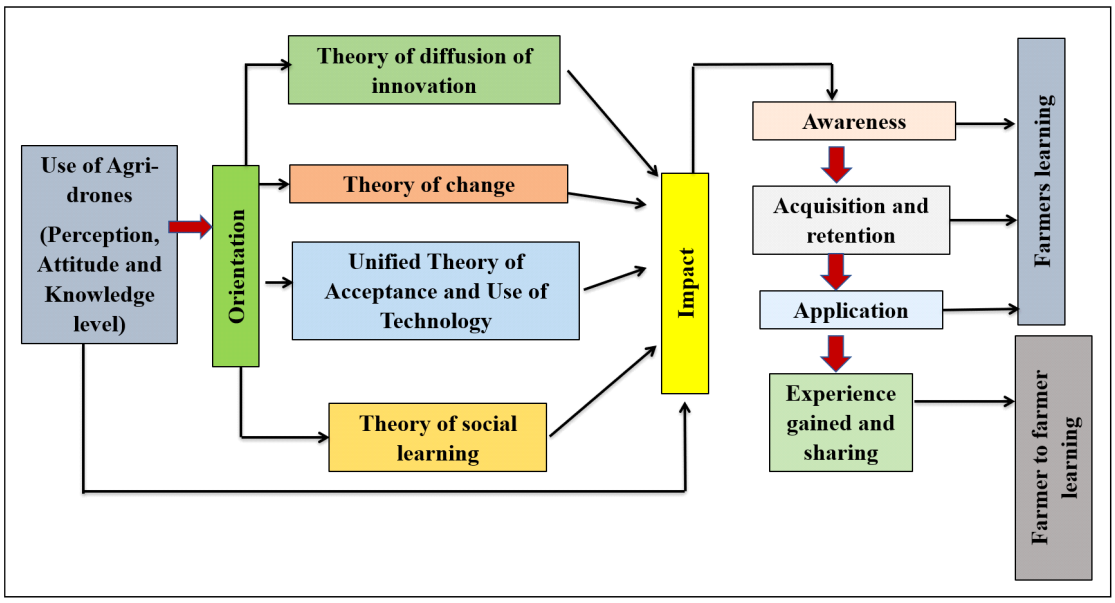

Figure 1: Conceptual framework developed for the study

online platforms (Bandura 1977). By creating opportunities for social learning, service providers can help farmers to develop the skills and knowledge needed to adopt and use these services effectively.

MATERIALS AND METHODS

Data: Primary data were collected by administering a well-structured and pre-tested interview schedule to the key informants (farmers), who listened *Mann Ki Baat* messages. Information were collected on demographic characteristics of the respondent farmers, farm specific characteristics, including ancillary activities; farmers' source of obtaining information on *Mann Ki Baat* initiatives; perception, attitude, and knowledge level of farmers, with respect to different aspects of Agri-drones.

Sampling frame: The study was carried out in 77 districts in India, spanning across selected 29 states/ union territories of the country. The study area thus covered all the agro-climatic zones of India, as by specified Planning Commission (1982) and all the geographical regions. The districts for the study were selected based on number of '*Mann Ki Baat*' events organized by respective KVKs of these districts both 'on-campus' and 'off-campus'. A list of the farmers who had participated in the '*Mann Ki Baat*' programmes were prepared. Table 1 shows the detail sampling plan covering 77 KVKs, selected randomly, representing all ATARIs; a minimum of 30 farmers were selected randomly from each of the district to make the final sampling size of 2310 farmers. As the sample included farmers from KVKs from all ATARI zones, all states were represented in the sample. Given the above sampling plan and availability of farmers during the survey period and after data cleaning and smoothing, the final data set comprised information for 1398 farmers.

Analytical framework: Data were gathered in person using pre-tested questionnaire and voice/video recording of the *Mann Ki Baat* program (in case the sampled respondents has not participated in *Mann Ki Baat* program earlier*)*. Out of total data of 2310 farmers, data pertinent to 1398 farmers was found fit for statistical analysis. Descriptive statistics, in the form of means and proportions, were used to analyze farmers demographic features, their perceptions regarding Agri-drones. The perceptions of farmers with respect to usefulness of drones, opinion on Agri-drones, conviction, trickledown effect on Agri-drones and response of family members/fellow farmers along with the extent of shift of farmers for adopting Agri-drones were captured through series of closed ended questions with three choices (*Yes, No* and *Do not know*). The attitude of farmers towards Agri-drones was measured with five-point rating of narrative statements based on Agri-drone usage, application,

Table 1: Distribution of respondents from selected KVKs of ATARIs

Krishi Vigyan Kendras	No. of KVKs	No. of KVKs selected for data collection	No. of farmers selected
ATARI, Zone I, Ludhiana–72 KVKs			
Himachal Pradesh	13	2	300
Jammu and Kashmir	20	2	
Ladakh (UT)	04	1	
Punjab	22	3	
Uttarakhand	13	2	
ATARI, Zone II, Jodhpur–66 KVKs			
Delhi	01	1	210
Haryana	18	2	
Rajasthan	47	4	
ATARI, Zone III, Kanpur–89 KVKs			
Uttar Pradesh	89	4	120
ATARI, Zone IV, Patna–68 KVKs			
Bihar	44	4	210
Jharkhand	24	3	
ATARI, Zone V, Kolkata–59 KVKs			
A & N Islands	03	1	210
Odisha	33	3	
West Bengal	23	3	
ATARI, Zone VI, Guwahati–47 KVKs			
Assam	26	3	180
Arunachal Pradesh	17	2	
Sikkim	04	1	
ATARI, Zone VII, Barapani–43 KVKs			
Manipur	09	1	180
Meghalaya	07	1	
Mizoram	08	1	
Nagaland	11	2	
Tripura	08	1	
ATARI, Zone VIII, Pune–82 KVKs			
Maharashtra	50	4	240
Gujarat	30	3	
Goa	02	1	
ATARI, Zone IX, Jabalpur–82 KVKs			
Chhattisgarh	28	3	210
Madhya Pradesh	54	4	
ATARI, Zone X, Hyderabad–75 KVKs			
Tamil Nadu	32	3	270
Puducherry	03	1	
Andhra Pradesh	24	3	
Telangana	16	2	
ATARI, Zone XI, Bengaluru–48 KVKs			
Karnataka	33	3	180
Kerala	14	2	
Lakshadweep	01	1	
Total	731	77	2310

benefits and risk involved. All statements were measured on five-point rating scale with positive statements as (strongly agree=5, agree=4, undecided=3, disagree=2 and strongly disagree=1). The weighted mean score of every statement was calculated to finally rank the statements and draw inferences. A knowledge test was also executed to check the knowledge level of respondents towards Agri-drones. The questions were based on diverse aspects of Agri-drones, viz. use of Agri-drones for pesticide/insecticide spray on farms, their usage in precision agriculture, safety measures for farmers, time involvement in drone led spraying, ability of drones to monitor crop growth, several Agri-drone startups, New Drone Policy, 2021 and Government support and schemes. The respondents, then categorised on low, medium, and high categories of knowledge based on mean and standard deviation, to draw inferences. Lastly, relationship of socio-economic characteristics of farmers with their knowledge level was revealed based on Pearson correlation and regression analysis.

RESULTS AND DISCUSSION

Demographic and socio-economic characteristics of farmers: It is evident from Table 2 that majority of the farmers (94.10%) were of middle age group (24 to 67 years). With respect to gender, majority of the farmers (91.50%) were males. In terms of economic status, majority of the farmers (71.80%) were above poverty line (APL). Regarding education level, majority of the farmers (41.70%) were educated up to High school; however, 28.23% of farmers had Degree/Diploma followed intermediate level of education (23.24%). It was found that majority of the farmers (72.70%) were marginal (<2.5 acres of land) followed by small farmers (2.51-5 acres of land). Most of the farmers (40.99%) have annual income of Rs.1.0 to 2.0 Lakh, followed by 39.20 per cent of farmers having annual income of more than Rs.2.0 Lakh. Overall, the data indicates that majority of the farmers were males of middle age group, who were marginal farmers.

Farmers Participation in Mann ki Baat Program: It is evident from Figure 2 that farmers got information about *Mann Ki Baat* program from multiple sources simultaneously. On analysis of data, it was revealed that KVKs were the prime source of information

Table 2: Demographic and socio-economic characteristics of farmers (n=1398)

Characteristics	Frequency	Percentage
Age		
Young (< 24 years)	35	2.5
Middle aged (24 to 67 years)	1316	94.1
Older (> 67.7 years)	47	3.4
Gender		
Male	1279	91.5
Female	119	8.5
Economic Status		
Above Poverty Line	1004	71.8
Below Poverty Line	394	28.2
Education level		
Non-formal Education	19	1.43
High school or less	658	47.1
Intermediate	324	23.24
Degree/Diploma	397	28.23
Total land (hectare)		
Land less	3	0.2
Marginal (<2.5 acres)	1016	72.7
Small (2.51-5 acres)	247	17.7
Medium (5.01-10 acres)	85	6.1
Big farmers (>10 acres)	47	3.4
Annual income (Lakhs)		
< Rs. 1.0 Lakh	277	19.81
Rs.1.0 to 2.0 Lakh	573	40.99
> Rs.2.0 Lakh	548	39.20

(87.14%) followed by peer communication of farmer to farmer (51.57%), FPOs (18.02%), State Departments (16.73%) and ATMA (10.94%). Gram panchayats, SAUs, input dealers, NGOs and SHGs also played role in creating awareness about *Mann Ki Baat* program. Analysis of extent of participation indicated that majority of the farmers (94.63%) actively participated (listened) *Mann Ki Baat* program with varied place of participation. Out of total farmers who participated in the program, 51 per cent of farmers participated from respective KVKs followed by 49 per cent of farmers, who participated from their respective homes.

Farmers perception towards agri drones after listening Mann ki Baat program: As majority of the farmers actively participated (listen) *Mann Ki Baat* program it is pertinent to know their perception regarding content of *Mann Ki Baat* program with special reference to Agri-drones. Perception of farmers was captured under three heads: usefulness of drones, opinions (price, availability, ease of understanding and usefulness), conviction level, trickle down of information, family members/fellow farmers response and extent of shift (Figure 3&4).

Attitude towards usefulness of drones: It is evident from Figure 5 that majority of farmers (97.60%) perceived the drones are overall useful for agricultural operations. Perception of farmers with respect to Agri-drones was also measured using Weighted Mean Score

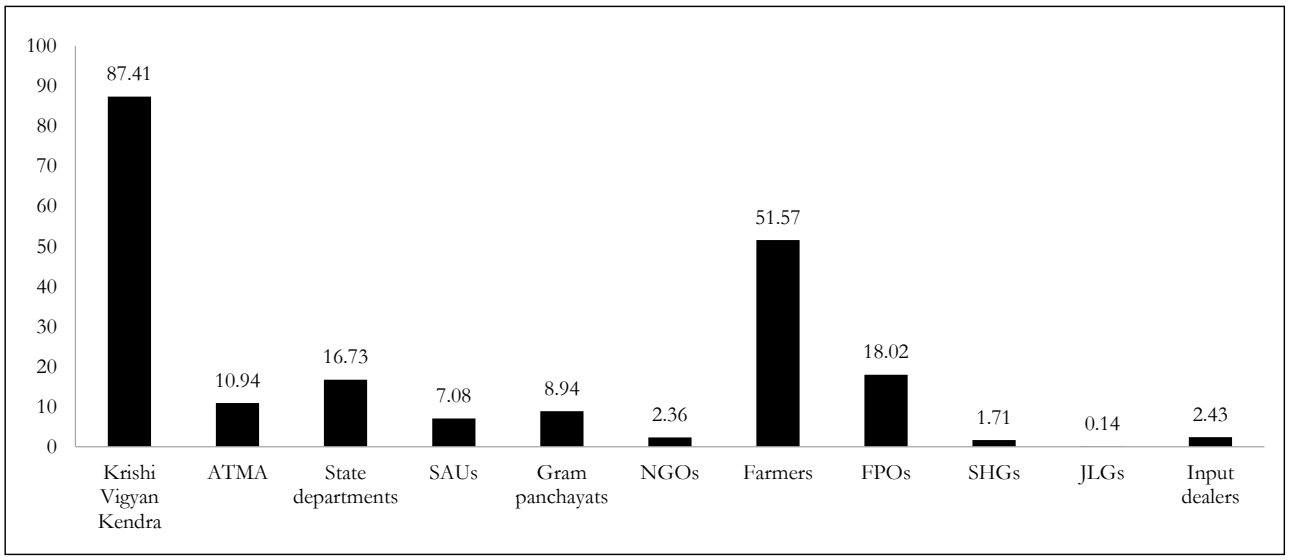

Figure 2: Farmers categorization based on Sources of information about *Mann Ki Baat*

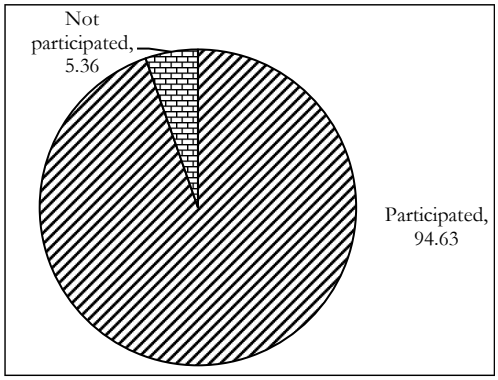

Figure 3: Farmers categorization-based participated and not participated

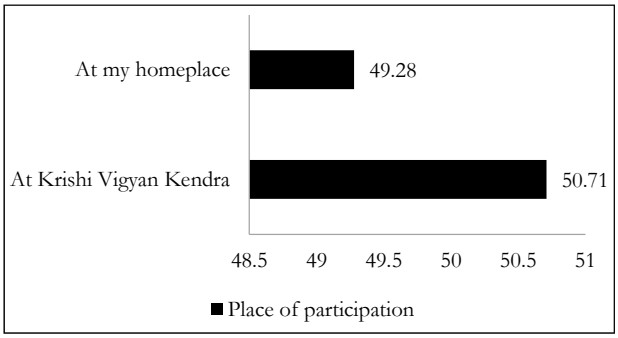

Figure 4: Farmers categorization based on place of on participation

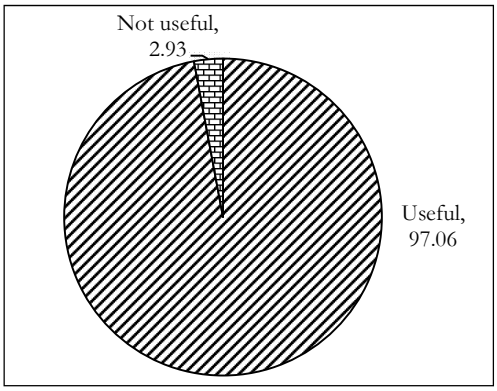

Figure 5: Farmers categorization based on Attitude towards usefulness of drones

(WMS) and it was revealed (Table 3) that farmers gave first rank to the fact that drones are highly beneficial technology for increasing input efficiency, followed by its immense use in monitoring of crop and cattle, highly effective in assessment of crop losses, ability to reduce the cost of pesticides use and promotion of drone creating the jobs for youth in villages. The negative statements with respect to Agri-drones were ranked lower by the farmers viz., the fact that drones will be difficult for farmers to handle was ranked sixth followed by the statement drones are not affordable for small farmer and use of drone is risky, with rank seventh and eighth, respectively. Overall farmers perceived that drones are highly beneficial technology in agriculture.

Opinion on Agri-drones: It is evident from Figure 6(a-d) that majority of farmers (71.31%) believes that the price of drone is very high, which are generally not affordable by farmers.

Conviction and trickle down on agri drones: It is evident from Figure 7 that majority of the farmers (92.56%) are convinced about the overall usefulness of Agri-Drones in precision farming after listening to *Mann Ki Baat*. In addition to this majority of farmers (74.35%) share information learnt from the episodes with others farmers also (Figure 8).

Response of family members/fellow farmers and extent of shift: It is evident from Figure 9 that majority of farmers (70.95%) got positive response from family members/ fellow farmers towards Agri-Drone Technology. However, a significant proportion of farmers (23.60%) got positive response from family members/fellow farmers towards Agri-Drone Technology. Figure 10 reveals that 28.68 per cent of

Table 3: Perception of students based on Weighted Mean Score (WMS) with respect to Agri drones (n=1398)

S.No.	Attributes	WMS	Rank
1.	It is highly beneficial technology for increasing input efficiency	4.37	I
2.	It is of immense use in monitoring of crop and cattle	3.99	II
3.	It is highly effective in assessment of crop losses	3.31	III
4.	It will reduce the cost on pesticides	3.27	IV
5.	Promotion of drone will lead to creation of jobs for youth in villages	3.24	V
6.	It will be difficult for farmers to handle drone	2.19	VI
7.	It is not affordable for small farmers	1.73	VII
8.	Use of drone is risky	1.20	VIII

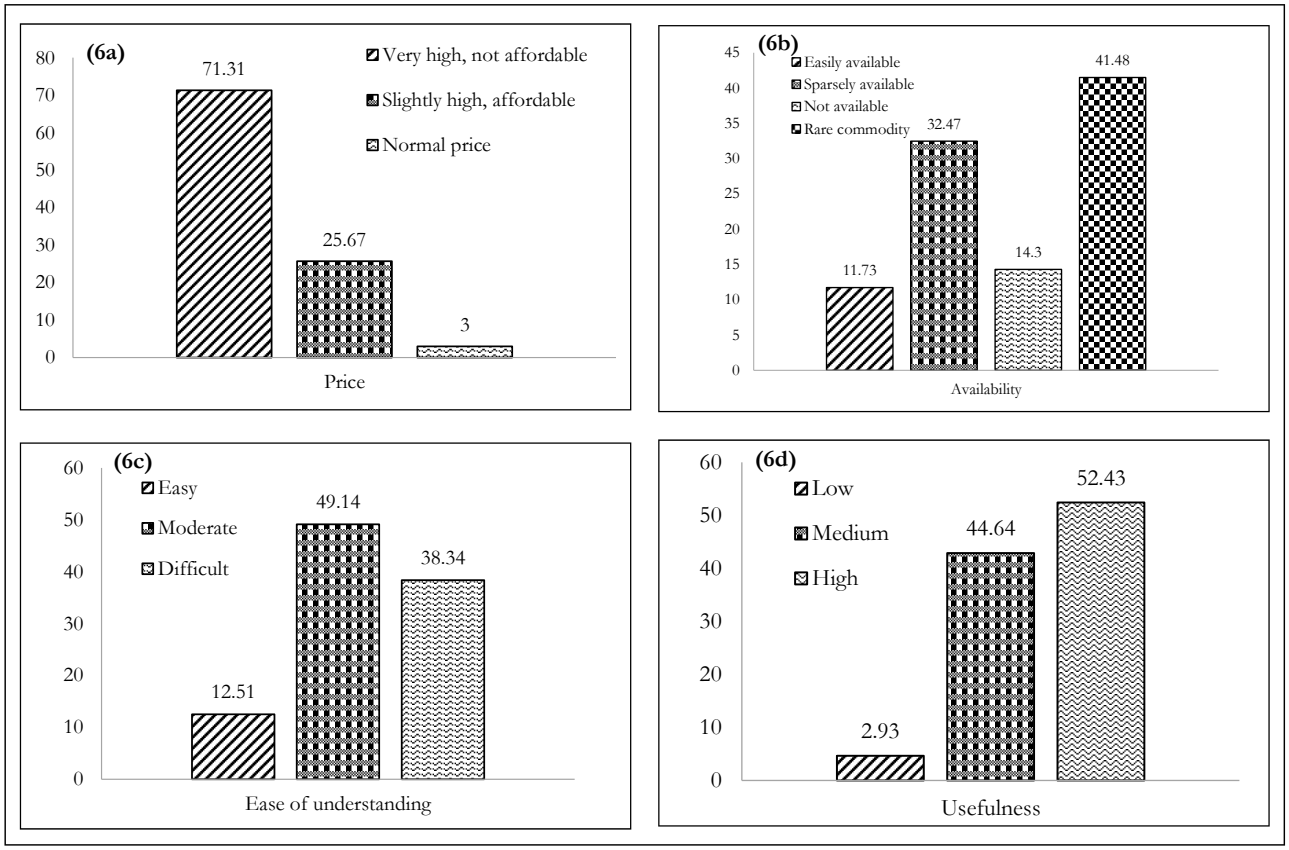

Figure 6a: Farmers categorization-based on Opinions with respect to Agri-Drones; Figure 6 (b) indicates that most of the farmers (41.48%) believes that drones are rare commodity followed by 32.47% of farmers who believes that drones are sparsely available; Figure 6 (c) indicates that most of the farmers (49.14%) believes that ease of understanding the drone's technology is moderate followed by 38.34% of farmers, who believe that drones technology is difficult to understand. It is pertinent to note from Figure 6 (d) which shows majority of farmers (97.60%) perceived that drones are overall useful for agricultural operations.

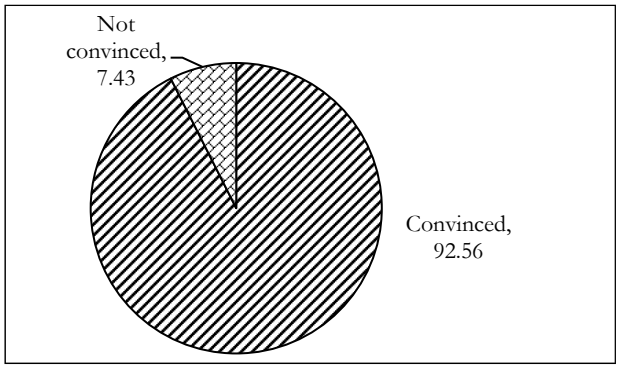

Figure 7: Farmers categorization-based on Conviction on Trickle down

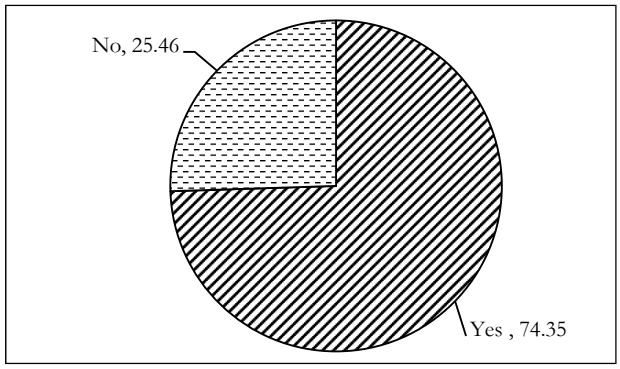

Figure 8: Farmers categorization based on Conviction on Trickle down

farmers showed more than fifty percent chance to adopt Agri-Drones for their farms if opportunity is provided, after listening to *Mann Ki Baat*, followed by 32.26 per cent of farmers who showed 26-50 per cent chance to adopt Agri-Drones for their farms if opportunity is provided. A significant proportion of farmers (31.04%) showed less than 25 per cent chance to adopt Agri-Drones for their farms if opportunity is provided; however, only 8.01% farmers showed no interest to adopt Agri-Drones for their farms.

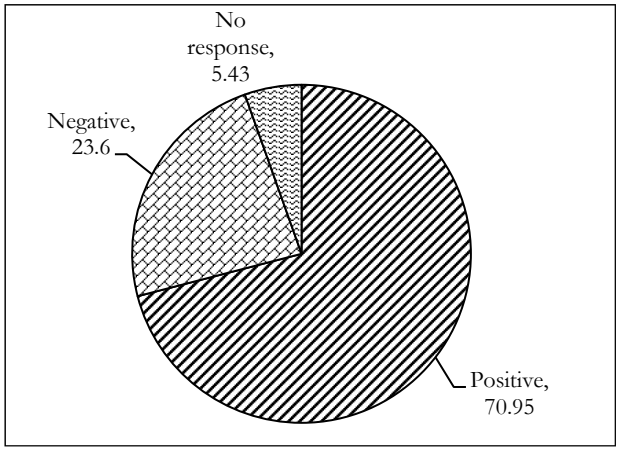

Figure 9: Farmers categorization based on Response of family members/fellow farmers

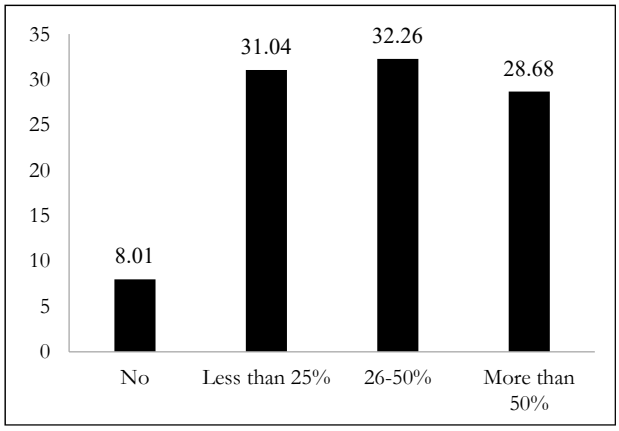

Figure 10: Farmers categorization based on Extent of shift

Farmers' gain in knowledge level with respect to Agri-Drones after listening Mann ki Baat Program: A knowledge test was executed to check the knowledge level of respondents towards Agri-Drones. The questions were based on diverse aspects of Agri-Drones, viz. use of Agri-Drones for pesticide/ insecticide spray on farms, their usage in precision agriculture, safety measures for farmers, time involvement in drone led spraying, ability of drones to monitor crop growth, several Agri-Drone startups, and New Drone Policy, 2021. When we categorised the knowledge of farmers on low, medium, and high categories (Table 4) based on mean and standard deviation, we found that majority of farmers (52.40%) had medium level of knowledge, followed by high level of knowledge (38.10%). Overall, it can be concluded that 90.50% of farmers have medium to high level of knowledge, which clearly indicates that *Mann ki Baat* program has influenced and enriched farmers with respect to the knowledge related to Agri-Drones.

Table 4: Farmers categorization based on Knowledge level

Knowledge level	Percentage
Low	9.6
Medium	52.4
High	38.1

In addition to the knowledge level of respondents towards usage of Agri-drones, knowledge of respondents with respect to Government support and schemes was also tested. Table 5 indicates that majority of farmers (59.44%) were aware about the financial assistance (40% up to a maximum of Rs. 4.00 lakhs) being provided by government for purchase of drones by Custom Hiring Centers under Cooperative Society of Farmers, FPOs/ and Rural entrepreneurs. It is also evident from Table 5 that majority of farmers (57.08%) were aware about the fact that Agriculture graduates who are establishing Custom Hiring Centers are eligible to receive financial assistance @ 50% of the cost of drone up to a maximum of Rs.5.00 lakhs per drone.

Table 5: Farmers categorization based on Government support

Government support	Yes		No	
Statements	Freq.	%	Freq.	%
Do you know that in order to make available drone services to farmers on rental basis, financial assistance @ 40% up to a maximum of Rs. 4.00 lakhs are provided for purchase of drones by Custom Hiring Centers under Cooperative Society of Farmers, FPOs/ and Rural entrepreneurs.	831	59.44	567	40.55
Agriculture graduates establishing Custom Hiring Centers are eligible to receive financial assistance @ 50% of the cost of drone up to a maximum of Rs.5.00 lakhs per drone.	798	57.08	600	42.91
If Yes, are you willing to take benefit of this service?	955	68.31	443	31.69

Table 6: Correlation between socio-economic characteristics of farmers with Knowledge level

Independent variables	Pearson correlation	Sig. (2-tailed)
Gender	0.142**	.000
Age	0.056*	.037
Category	0.023	.387
Economic status	0.201**	.000
Education	0.162**	.000
Family size	0.054*	.045
Total land holding	0.124**	.000
Annual income	0.094**	.000
Place of contact	0.198**	.000
Source of information	0.180**	.000
Mass media	0.232**	.000
Attitude	0.234**	.000

Overall, majority of farmers (68.01%) are willing to take benefit of these supports being provided by Government.

Relationship of socio-economic characteristics of farmers with knowledge level: It is evident from Table 6 that p value for the variables gender, economic status, education, total land holding, annual income, place of contact, source of information, mass media exposure and attitude has a significant positive relationship with knowledge level at 1% level of significance ($p<0.01$). Table 6 also indicates that the variables like age and family size also have a significant positive relationship with knowledge level at 5% level of significance ($p<0.05$). Overall, all socio-economic characteristics of farmers have significant positive relationship with knowledge level except one variable that is category.

CONCLUSION

Drones have shown potential to transform Indian agriculture into smart agriculture. With the further advancement of information communication technologies (ICTs) in the future, the production and usage of drones is expected to become economical and easier, respectively. Evidences suggest that the modern Indian youth are not attracted towards agriculture due to hard work, drudgery and uncertainty involved in it. Introducing Agri-drones can encourage the youth towards agriculture since drones provide real time and high-quality data with respect to aerial imagery of agricultural areas, localizing weeds and diseases, determining soil properties, detecting vegetation differences and the production of an accurate elevation models. This study has tried to explore the perception of farming community towards Hon'ble Prime Minister's program on *Mann Ki Baat* with special reference to Agri-drones. Farmers' perception was captured with respect to usefulness of drones, opinion on Agri-drones, conviction, trickledown effect on Agri-drones and response of family members/fellow farmers along with the extent of shift of farmers for adopting Agri-drones. In addition to this, the present study has explored the demographic and socio-economic characteristics of farmers along with the level of participation of farmers in *Mann Ki Baat* Program. Gain in knowledge of farmers on Agri-drones after listening the *Mann ki Baat* program was assessed and contextualized with their socio-economic attributes.

In conclusion, it is pertinent to note that majority of farmers have perceived that drones are overall useful for agricultural operations; however, farmers have ranked and believed that this technology is difficult in understanding (moderate scale). Also, a significant proportion of farmers has showed chance (<25%) to adopt the Agri-Drones for their farms if opportunity is provided. Policy makers and researchers may consider in organizing capacity building (awareness, training and demonstrations) programmes to enhance ease of understanding the Drone technology. In addition, policy makers and researchers may establish coherence in their planning and programmes so that, majority of farmers can move up from medium level of knowledge to high level of knowledge with respect to applying the usage of Agri drones. Additionally, concerted efforts on awareness program is need of the hour to purse and motivate the farmers for adopting Agri-drone with integral support from and access to institutional resources (policy, and finances. Such measures may considerably help in mobilizing farming community to achieve India's vision of becoming a Drone hub by 2030.

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Ethical statement: In this study data has been taken from the *Mann Ki Baat* participating farmers on the basis of informed consent.

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Estimation of Socio-ecological Compliances and Conflicts in Terms of Yield, Income and Livelihood in Selected Farm Enterprises of West Bengal

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ABSTRACT

The sociology of agriculture has now built up a strong kinship with ecology of agriculture; and in between there have been income, productivity and livelihood for myriad of farmers with marginal land and fragile income. It is nearly difficult to drive the apparently conflicting issues of income, ecology, productivity and livelihood to form an organic orchestration of what we call sustainable agriculture. Here, 105 respondents were identified from five villages viz. Chakbirohi, Kantabelia, Ghoragacha, Mitrapur, Kastodanga, from Haringhata block of Nadia district by following both random and non-random sampling method as per convenience and wherein applicable. Their responses were collected using pre-tested interview schedule. A set of criterion variables (dependent) have been elucidated with the help of a set of 22 exogenous variables, the following variables have been found to exert dominant impact on the criterion variables and merit to be included while declining micro-level policy for a resilient agricultural and social development. The dominant factors as extracted based on factor leading and Eigen values have got also extreme strategic importance. The ANN has gone further in highlighting the marker variables and can be applied in similar research locale across the terrains.

Keywords: Ecology, Income, Productivity, Reconciliation, Resilience, Wage

INTRODUCTION

The agricultural production needs to be increased 60 per cent over the present one by 2050 to feed the human population of this planet. For India the target is 450 million tons by 2050. This is a humongous task (Gahukar, 2011). This mammoth escalation of targeted food production has to be carried out with the constraints and barrier created by climate change, erosion of soil, bio-diversity, ecological disruption due to mindless anthropogenic action and wrong planning (Dupdal *et al.,* 2021). It is obvious that enhancing food productivity, there could be more disruption and stress on soil, water and bio-diversity. Wherein restoration and retention, ecological resilience will move in resonance and complementary manner (Acharya *et al.,* 2022). The present study envisages as how to and whether the following factors *viz.* productivity, income, livelihood and ecological resilience can be optimally integrated on a mutually agreed upon platform of an operating agro-ecosystem.

West Bengal is growing fast through a process spectacular transformation in its rural life process. For the last couple of decades West Bengal kept on experiencing a change in agricultural growth at the rate of 4 per cent approx. Modernizing agriculture keeps replacing the domination of field crops with the emergence of commercial crops, fishery and livestock enterprises (Pandey *et al.,* 2014). All these are happening to generate more livelihood, more income and assured higher food security. The indication of diminishing productivity, reducing livelihood and income redundancy are becoming prominent and alarming (Pradhan *et al*., 2021). So, a diverse farming system by replacing prototype agriculture is not only be agricultural

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reality but also an ecological necessity to sustain all kinds of micro, meso and mega life forms (Paramesh *et al.,* 2022).

A systems perspective provides a logical framework for managing changes in social-ecological systems. Any sustainable solution to a resource issue must be compatible with current social and ecological conditions and their likely future changes (De Fries *et al.,* 2016). The more rapidly the world changes, the less likely that rigid management approaches will be successful. By considering the system properties presented above, however, we can develop resilience-based approaches that substantially reduce the risk of undesirable social-ecological outcomes and increase the likelihood of making good use of unforeseen opportunities (Acharya *et al.,* 2019). This requires managing for general system properties rather than for narrowly defined production goals (Bhan and Behera, 2014; Khatri-Chhetri *et al.,* 2016).

The present study was undertaken to delineate a general understanding of yield and income of selected enterprises viz. Fish, rice and vegetables for the research locale and then to examine the interactions and impact of these two predicted characters viz. yield and income in terms of a score of socio-economic and ecological predictors. The study was intended to isolate the point of optimization or a common platform for landing wherein yield and income will be behaving in a mutual incremental way to reach a threshold and lastly to generate a micro sociological policy implication based on the empirical study.

MATERIALS AND METHODS

The present study was conducted in new alluvial zone of West Bengal. Five villages from Haringhata block of Nadia district were selected purposively from the new alluvial zone. The selected five villages are Ghoragacha, Kantabelia, Kashtodanga, Chak Birohi and Mitrapur. After that, total 105 farmers were interviewed from the five villages following a non-random snowball sampling method using personal interview schedules. More numbers of respondents were not available for interview due to COVID-19 pandemic situation. Respondents were engaged in both agricultural and allied activities. Before taking up actual fieldwork, a pilot study was conducted to understand the area, its people, institution, communication, and social system, and the knowledge, perception, and attitude of the people. The study was conducted during the period between the years 2020 and 2022. The structured questionnaire used in the present study consists of both open and closed questions consisting of two sets of variables i.e., (i) independent variables (x_1-x_{29}) and (ii) dependent variable (y_1-y_6). The independent variables are age of the respondent (x_1), education (x_2), family size (x_3), training and capacity building (x_4), family education score (x_5), holding size (x_6), homestead (x_7), no. of land fragments (x_8), cultivable land area (x_9), cropping intensity (x_{10}), annual income (x_{11}), yield (x_{12}), social participation (x_{13}), constraint participation (x_{14}), suggestions for improvement (x_{15}), communication through mobile (x_{16}), no. of fragments (x_{17}), no. of stakeholders in different practices (x_{18}), total production (x_{19}) family expenditure (x_{20}), energy consumption (x_{21}) and nutrition and health status (x_{22}). Family farm income(y_1) and productivity (y_2), were collected using a pre-tested structured interview schedule, and the associations between the twenty-two independent variables were examined using quantitative approaches such as coefficient of correlation, stepwise regression, path analysis and canonical covariate analysis (CCA) analysis with the help of IBM SPSS v26.0 (Acharya *et al.,* 2020).

RESULTS AND DISCUSSION

Table 1 presents the multiple co-efficient of correlation between family farm income (y_1), productivity (y_2) and selected socio-ecological variables. Holding size (x_6) has been found to exert significant and positive influence on family farm income (y_1). It is quite obvious that the bigger is the holding size, the higher has been the family farm income (Birthal *et al.,* 2014). Homestead land cultivable area (x_7) have also exerted positive and significant influence in augmenting income from family farm. So, it has been obvious that land resources are still the strongest determinant in ushering family farm income (y_1). In an enterprising agriculture, ability to invest is one of the determinants which can make farm management and production proficient and profitable (Chand *et al.,* 2015). Other source of income of a family farm extends immense support to enhance investment ability, risk bearing capacity and thus helps farming a better farm income. Communication through mobile (x_{16}) and energy consumption (x_{21}) however have recorded negative and significant influence on Family

Table 1: Multiple co-efficient of correlation of migration attributes and selected socio-ecological variables (x_1 to x_{11})

Independent Variables	'r' Value	
	Family farm income (y_1)	Productivity (y_2)
Age (x_1)	0.149^{NS}	-0.075^{NS}
Education (x_2)	0.152^{NS}	-0.029^{NS}
Family members (x_3)	0.125^{NS}	-0.155^{NS}
Training and capacity building (x_4)	-0.029^{NS}	0.316**
Family education score (x_5)	0.115^{NS}	0.110^{NS}
Holding size (x_6)	0.438**	-0.162^{NS}
Homestead land (x_7)	0.256**	0.113^{NS}
No. of fragments (x_8)	0.134^{NS}	-0.031^{NS}
Cultivable land area (x_9)	0.205*	0.059^{NS}
Cropping intensity (x_{10})	-0.002^{NS}	-0.021^{NS}
Annual Income (x_{11})	0.268**	-0.165^{NS}
Yield (x_{12})	0.016^{NS}	0.637**
Social participation (x_{13})	0.055^{NS}	0.042^{NS}
Constraint perception (x_{14})	0.015^{NS}	-0.094^{NS}
Suggestions for improvement (x_{15})	0.153^{NS}	-0.129^{NS}
Communication through mobile (x_{16})	-0.208*	0.155^{NS}
No. of fragments (x_{17})	0.250**	-0.105^{NS}
No. of stakeholder in different practices (x_{18})	0.272**	-0.259**
Total Production (x_{19})	0.128^{NS}	-0.072^{NS}
Family expenditure (x_{20})	-0.130^{NS}	-0.146^{NS}
Energy consumption (x_{21})	-0.271**	0.147^{NS}
Nutrition and Health Status (x_{22})	0.180^{NS}	-0.012^{NS}

***Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level, ^{NS} Not significant*

Farm Income while ecological level of energy consumption has contributed positive change in Family Farm Income, Mobile telephonic could not record any impressive effect on improving Farm Income. On the other hand, no. of fragments (x_{17}) and no. of stakeholder in different practices (x_8) have positively influenced. To improve the family farm income (y_1) small fragment of land here have been found to have higher proficiency in generalizing Family Farm Income and the more number of stakeholders involved in farm production process have also exerted positive influence on Family Farm Income. More no. of fragments of land being managed under single ownership, offers better opportunity for diversification with different crops and enterprises by minimizing the risk involved with monolithic enterprise (Siva and Gupta, 2019).

Training and Capacity Building (x_4) has recorded positive and significant correlation with productivity (y_2). This indicates that intensive training has been instrumental in improving the productivity (y_2) of farm. Yield of crops (x_{12}) has collectively contributed to the overall productivity (y_2) of farm and the relation is obvious. When there is more no. of stakeholders in different practices (x_{18}), the productivity has gone up naturally (Ghatak and Roy, 2007).

In Table 2, it has been found that holding size (x_6) has retained in the last stage to contribute 19 per cent variant in the consequent variable family farm income (y_1). The present study elevated that holding size (x_6) has come out strong functional determinant of family farm income (y_1). When holding size goes higher, the productivity will be increased and diverse. Hence, income and wage will go up (Zhang *et al.,* 2019).

Table 2: Stepwise regression analysis between family farm income (y_1) & selected socio-ecological variables (x_1 to x_{22})

Variables	Reg. Coef. B	S.E. B	Beta	t Value
Holding size (x_6)	49963.384	10217.042	0.436	4.890

R square: 19.00 %, The standard error of the estimate: 0.0974703

Table 3: Decomposition of family farm income (y_1) into selected socio-ecological variables (x_1 to x_{22})

Variables	TE	DE	IE	HIE
Age (x_1)	0.149	0.088	0.061	0.181 (x_6)
Education (x_2)	0.152	0.103	0.049	0.116 (x_6)
Family members (x_3)	0.125	-0.495	0.620	0.308 (x_6)
Training and capacity building (x_4)	-0.029	0.012	-0.041	0.07 (x_3)
Family education score (x_5)	0.115	0.002	0.113	0.055 (x_{19})
Holding size (x_6)	0.438	0.570	-0.132	-0.268 (x_3)
Homestead land (x_7)	0.256	-0.120	0.376	0.263 (x_6)
No. of fragments (x_8)	0.134	-0.097	0.231	0.23 (x_6)
Cultivable land area (x_9)	0.205	0.050	0.155	0.323 (x_6)
Cropping intensity (x_{10})	-0.002	0.088	-0.090	-0.092 (x_6)
Annual Income (x_{11})	0.268	0.201	0.067	0.267 (x_6)
Yield (x_{12})	0.016	0.013	0.003	-0.044 (x_{21})
Social participation (x_{13})	0.055	0.002	0.053	0.042 (x_3)
Constraint perception (x_{14})	0.015	-0.056	0.071	0.042 (x_{22})
Suggestions for improvement (x_{15})	0.153	0.177	-0.024	-0.073 (x_3)
Communication through mobile (x_{16})	-0.208	-0.092	-0.116	-0.181 (x_6)
No. of fragments (x_{17})	0.250	-0.139	0.389	0.336 (x_6)
No. of stakeholder in different practices (x_{18})	0.272	-0.137	0.409	0.316 (x_6)
Total Production (x_{19})	0.128	0.227	-0.099	-0.097 (x_3)
Family expenditure (x_{20})	-0.130	-0.168	0.038	0.051 (x_6)
Energy consumption (x_{21})	-0.271	-0.227	-0.044	0.160 (x_6)
Nutrition and Health Status (x_{22})	0.180	0.276	-0.096	-0.395 (x_3)

Total Effect= TE, Direct Effect= DE, Indirect Effect= IE, Highest Indirect Effect = HIE, Residual effect: 0.62707

Total effect of exogenous variable (x_1 to x_{22}) decomposed into direct, indirect and residual effect on family farm income (y_1).

Table 3 presents the path analysis in which the total effect (r) of exogenous variables (x_1 to x_{22}) have been decomposed due to direct, indirect and residual effect on family farm income (y_1). Holding size has (x_6) been recorded the highest substantive effect on family farm income (y_1). So, it is clear that the holding size as resource endowment owned by the farmer has become the strong determinant to improve the farm income (Ghafoor *et al.,* 2010). It is further to infer that even today farm income is very much scale sensitive and goes better for the bigger size. The indirect effect, however, has been executed by the no. of stakeholders. The connectivity and interaction by a farmer with multi stakeholder entities have contributed positively to make farmer successful enterprise. The variable Holding size (x_6) has routed the highest indirect effect of as many as 13 exogenous variables to ultimately characterized the behavior and performance the consequent variable i.e., family farm income (Wang *et al.,* 2016).

The residual effect being 62.7 per cent, it is to imply that 62.7 per cent of the variant in family farm income (y_1) could not be explained with the combination of the 22 exogenous variables.

In Table 4, it has been found that 3 causal variables i.e., yield (x_{12}), training and capacity building (x_4) and cropping intensity (x_{10}) have retained in the last stage to contribute 28.10 per cent variant in the consequent variable productivity (y_2), (Acharya *et al.,* 2022). The present study elevated that these three variables have come out strong functional determinant of productivity (y_2). Yield of a single crop is the strongest determinant of productivity (De wit *et al.,* 2011). Training enhances capacity building in an individual and helps improve productive performance. Similarly, cropping intensity directly impacts on productivity by making every factor production perfectly orchestrating in any farming system (Ulimwengu and Badiane, 2010).

Table 5 presents the path analysis in which the total effect (r) of exogenous variables (x_1 to x_{22}) have been decomposed due to direct, indirect and residual effect on productivity (y_2). The variable yield of crops (x_{12}) has contributed the highest direct effect on the productivity (y_2), and this is for an obvious reason that when yield of individual crops increases, the productivity, of the farm as a whole improves (Awate and Todkari, 2012). The annual income (x_{11}) as exerted

Table 4: Stepwise regression analysis between productivity (y_2) and selected socio-ecological variables (x_1 to x_{22})

Variables	Reg. Coef. B	S.E. B	Beta	t Value
Yield (x_{12})	0.856	0.101	0.626	8.505
Training and capacity building (x_4)	899.126	257.177	0.262	3.496
Cropping intensity (x_{10})	-38.929	15.808	-0.185	-2.463

R square: 28.10 %, The standard error of the estimate: 0.1590416

Table 5: Decomposition of productivity (y_2) into selected socio-ecological variables (x_1 -x_{22})

Variables	TE	DE	IE	HIE
Age (x_1)	-0.075	-0.011	-0.064	-0.081 (x_6)
Education (x_2)	-0.029	-0.070	0.041	0.051 (x_6)
Family members (x_3)	-0.155	-0.097	-0.058	-0.138 (x_6)
Training and capacity building (x_4)	0.316	0.217	0.099	0.095 (x_{12})
Family education score (x_5)	0.110	0.015	0.095	0.039 (x_7)
Holding size (x_6)	-0.162	-0.254	0.092	0.089 (x_7)
Homestead land (x_7)	0.113	0.191	-0.078	-0.118 (x_6)
No. of fragments (x_8)	-0.031	0.052	-0.083	-0.103 (x_6)
Cultivable land area (x_9)	0.059	-0.012	0.071	-0.144 (x_6)
Cropping intensity (x_{10})	-0.021	-0.184	0.163	0.091 (x_{12})
Annual Income (x_{11})	-0.165	0.121	-0.286	-0.119 (x_6)
Yield (x_{12})	0.637	0.582	0.055	0.036 (x_4)
Social participation (x_{13})	0.042	-0.017	0.059	0.098 (x_{12})
Constraint perception (x_{14})	-0.094	-0.109	0.015	0.028 (x_{12})
Suggestions for improvement (x_{15})	-0.129	-0.140	0.011	0.049 (x_7)
Communication through mobile (x_{16})	0.155	-0.021	0.176	0.088 (x_{12})
No. of fragments (x_{17})	-0.105	0.130	-0.235	-0.15 (x_6)
No. of stakeholder in different practices (x_{18})	-0.259	-0.093	-0.166	-0.141 (x_6)
Total Production (x_{19})	-0.072	-0.132	0.060	0.048 (x_7)
Family expenditure (x_{20})	-0.146	-0.037	-0.109	-0.118 (x_{12})
Energy consumption (x_{21})	0.147	0.017	0.130	0.112 (x_{12})
Nutrition and Health Status (x_{22})	-0.012	0.042	-0.054	-0.121 (x_6)

Total Effect= TE, Direct Effect= DE, Indirect Effect= IE, Highest Indirect Effect = HIE, Residual effect: 0.44477

the highest indirect effect on productivity. This may derive an element of doubt that whether the income from farm has proportionately been recycled into the overall process of farm entrepreneurship. The variable holding size (x_6) has routed the highest indirect effect of as many as 10 causal variables to ultimately characterize the performance of the consequent variable, productivity. So, in most cases, whatever may be the contributory factors, it needs to accompany the associate property of holding size (Karki and Gurung, 2012).

The residual effect being 44.48 per cent, it is to imply that 44.48 per cent of the variant in productivity (y_2) could not be explained with the combination of the 22 exogenous variables.

Figure 1 represents the canonical covariate analysis for interaction between left side dependent variables (y_1 and y_2) and right side independent variable (x_1 to x_{22}). It is quite discernible that theses solitary dependent variables family farm income (y_1) and productivity (y_2) here have been directly and strongly impacted by following independent variables age of the respondent (x_1), education (x_2), family size (x_3), family education score (x_5), homestead (x_7), no. of land fragments (x_8), cultivable land area (x_9), cropping intensity (x_{10}), social

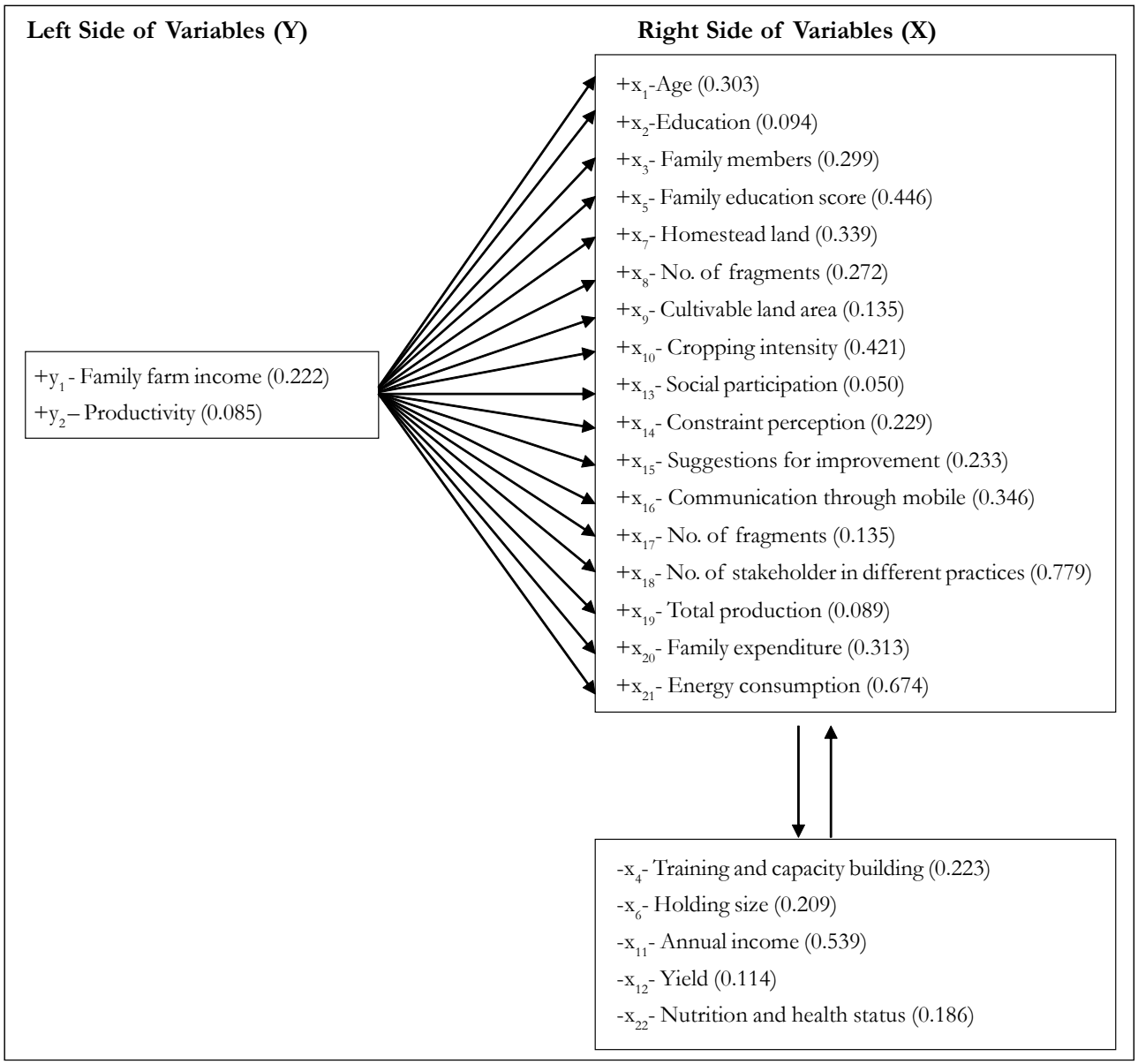

Figure 1: Canonical correlation analysis to derive the interaction pattern of left and right side variables (dependent and independent variables)

participation (x_{13}), constraint participation (x_{14}), suggestions for improvement (x_{15}), communication through mobile (x_{16}), no. of fragments (x_{17}), no. of stakeholders in different practices (x_{18}), total production (x_{19}) family expenditure (x_{20}), and energy consumption (x_{21}) (Mittal and Tripathi, 2009; Singh *et al.,* 2007). This Canonical Covariate Analysis (CCA) analysis implies that family farm income (y_1) and productivity (y_2) are the most significant and multifunctional predictive character. The intra mode of interaction is based on cross loading. Here, in this CCA, the y-set of variables has been regressed in terms of x-set of variables and on the contrary, the x-set of variables has been regressed in terms of variables.

CONCLUSION

The empirical study depicts that the unique conciliation and conflict between and amongst sets of exogenous variables and their interaction. The variables- size of holding, no. of stakeholders, annual income, health, and nutrition, cropping intensity, perception on constraints, energy consumption have been found to exert strong and decisive impact on different planks of social ecology of productivity in agriculture. The marker variables have characterized the nature, intensity and direction of binary interactions between productivity, income, livelihood with a set of 22 exogenous variables. The following factors- farm economy, resource character, productive function, family health, educational capability, farm capacity, ecological proficiency, homesteads dynamics, social ecology as extracted, have got tremendous strategic importance for delineating micro level policy implication and intervention as well. It will, as we hope, for each golden harvest, there must be a happy income to bring a decent life and livelihood for each of the farmers in India

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Trends and Correlates of Sugarcane Production: A Case of Basti District in Uttar Pradesh

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ABSTRACT

Sugarcane (*Saccharum officinarum* L.) is commonly grown as a cash crop in India. Our country is second highest producer of sugarcane after Brazil. Among different states, Uttar Pradesh is the largest cultivator of sugarcane in India. With more than 177 million tonnes produced in 2021, this state tops the list of sugarcane producers. The study was conducted in Sadar block of Basti district of Uttar Pradesh to find out the trends and correlates of sugarcane production. The study revealed the lower share of sugarcane production of the district in the total of state level production and lower growth rate in area, production, productivity and lower instability was observed in the study area.

Keywords: Correlation analysis, Growth rate, Sugarcane, Trends analysis

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is widely grown as a cash crop in India. Sugarcane is one of the world's oldest commercial and viable crops in the tropics and sub-tropics. It is a significant source of raw materials, not just for sugar, as well as other related groups of industries. Sugarcane is becoming an important cash crop for farmers because the domestic market has created the immense potential for sugar based products. Sugarcane is ingenious crop because it is a rich source of food, fiber and fuel and used in chemical industry (Yadav and Solomon, 2006). The expansion of the sugarcane industry in India would therefore greatly benefit the economy through foreign exchange savings, job and income generation, rural growth and living standard of rural people. About 50 million farmers and 3-5 lakhs skilled and unskilled workers are engaged in cultivation of sugarcane and sugar industries and its allied industries (Kant *et al.,* 2015). The global production of sugarcane in top three countries i.e. Brazil producing 51 per cent of the world total with 743.10 million of tonnes and India producing 17 per cent of the total with 376.90 million tonnes, and China and Thailand producing about 6 per cent each (FAO Statistics, 2018). In India, area and production of sugarcane has been fluctuating from year to year depending upon pricing policy and climate conditions. According to Directorate of Economic & Statistics, DAC&FW (2021) sugarcane occupied 4.86 million hectares area while the production recorded as 399.25 million tonnes with 82205 kg/ha productivity in India. Among the various states, Uttar Pradesh recorded first in area followed by Maharashtra and Karnataka (Chandra, 2021). In Uttar Pradesh state, Sugarcane covered 2.16 million ha area accounting for 49.5 per cent of all India (Singh *et al.,* 2020). Eastern, Central and Western Uttar Pradesh is the major sugarcane (Kamta *et al.,* 2022). Sugarcane industry is the important industry in Uttar Pradesh and sugarcane is grown in 59 out of 75 district in the state (Prasad *et al.,* 2021). It is surprisingly to see that Tamil Nadu attains maximum

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productivity among the major sugarcane growing states. Sugarcane is the world's largest sugar source (80%) and has a high position as a cash crop. For processing of white sugar, brown sugar (*khandsari*) and *gur* or jaggery, sugar juice is used. Bagasses and molasses are the sugarcane industry's primary by-products. Bagasse is used primarily as a fuel. It is also used to make compressed cardboard, plastic, etc. Molasses are used to manufacture ethyl alcohol, butyl alcohol, citric acid, etc. in distilleries. Rum is the finest drinkable molasses-based liqueur. For animals, molasses is often used as a feed additive. In acidic and alkaline soils, pressed mud can be used as a soil improver. A good source of forage for livestock is green barrel spikes.

There are three sugarcane agro-climatic zones in the subtropical region, such as the North-West Zone, the North-Central Zone and the North-East Zone. Uttar Pradesh (UP), Bihar, Haryana and Punjab states face climate extremes in the North Central Region, such as high and low temperatures, relative humidity, sunshine hours and wind velocity, etc. are key distinctive features. The production and productivity of sugarcane in this area is very much affected by climate conditions throughout the region. The present research was conducted to analyze the growth, instability of area and production and also evaluate the extent of adoption of sugarcane production technology by the farmers in the study area.

MATERIALS AND METHODS

Time series data of sugarcane of Basti district of Uttar Pradesh for the past ten years was procured from the published reports of Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India and Directorate of Economics and Statistics, Government of Uttar Pradesh. To smoothen the fluctuation of data on sugarcane from year to year, Triennium data (TE) on area, production and productivity of sugarcane was computed for analysis. Ten year time series data from 2010-11 to 2019-20 on area, production and productivity of sugarcane was worked out. Compound Annual Growth Rate (CAGR) was calculated to inspect the trend in area, production and productivity sugarcane. The compound growth rate has been determined by using the following exponential function (Maurya, 2016; Kumar, 2010).

The significance of growth rate was tested using t-test statistic as t = r/S.E. (r), which follows t-distribution with n-2 degree of freedom.

Where, S.E. (r) is the standard error and 'n' is the number of years consider under study.

S.E.(r) = [(100*b/0.43429)] * SE(log b)

$Y=AB^t$

Where, Y= The variable for which growth rate is calculated

t= Time variable

B = The regression coefficient

A = Intercept

The log form of the above exponential equation is expressed as:

Log (Y) = Log (a) + t Log (b)

Compound Annual growth rate (CAGR) was then worked out as:

CAGR = [Antilog(b)-1] * 100

Further, in order to examine the extent of fluctuation or instability in area, production and productivity of cereals in different years, Cuddy Della Valle Index (CDVI) (Cuddy and Della Valle, 1978) was used. The CDVI is computed as given below:

$$CDVI = CV * \sqrt{1 - \overline{R^2}}$$

CV = Coefficient of Variation

$\bar{R}^2$= Adjusted Coefficient of Determination

CDVI =Cuddy Della Valle Index

Low instability: between 0 to 15

Medium instability: 15< CDVI <30

High instability: greater than 30

The data was recorded from 6 randomly selected villages from among the list of major sugarcane growing villages in the Basti sadar block and Gaur block each from Basti district. Total 10 respondents were further sampled randomly, thus, the making the total respondents of 120 for the study. The data on research variables like age, education, land holding, family size, social participation, annual income, occupation, credit acquisition, irrigation availability, source of information, scientific orientation, risk orientation, experience about sugarcane cultivation and knowledge was recorded either by direct questioning or using the interview schedule developed for the purpose and they were

subject for correlation analysis with the adoption level of sampled sugarcane farmers.

RESULTS AND DISCUSSION

The data in the Table 1 reveals that in 2019-20, area occupied by sugarcane was 4.6 million ha while the production was recorded as 370.50 million tonnes. Among various sugarcane producing states, Uttar Pradesh contributed nearly half of the area (47.93%). Rahman and Bee (2019) was also revealed that Uttar Pradesh is one of the leading producers of sugarcane in India. The share of production was estimated as 18.49 per cent. In the similar lines the study area contributed only 18.09 per cent area and least production (1.70%) in the state.

The trend analysis shows that in the decade the lowest area as well as production was observed in 2010-11 while the highest area and production was observed in 2020-21 (Figure 1). A consistence growth in area was observed throughout the study time period. In similar lines the growth in production was observed from 2010-11 to 2013-14 and from 2016-17 onwards. The time series data revealed that the highest productivity was observed in year 2018-19 while it was lowest in 2010-11.

The data from the Table 2 revealed the lower growth in area (2.4%), production (4.6%) and productivity (2.1%) during the time period and in similar lines the instability was also observed lower for the area (7.66%), production (6.20) and productivity (4.16%).

Table 2: Growth and instability analysis of sugarcane

Particulars	CAGR	Instability
Area	2.4%	7.66
Production	4.6%	6.20
Productivity	2.1%	4.16

The correlation coefficient between the independent variable and the adoption by sugarcane growers has been determined and the obtained correlation coefficient values are provided in Table 3.

It can be comprehended from the table that out of all listed variables correlation coefficient between education, land holding, annual income, sources of information, scientific orientation, risk orientation and knowledge about recommended sugarcane production technology were found to be positive and highly significant at 0.01 level of probability. Other variable such as occupation, credit acquisition and experience about sugarcane cultivation has positive and significant at 0.05 level of probability. On the other hand, family size and social participation were had no significant correlation with adoption of recommended sugarcane

Table 1: Area, Production and Productivity of Sugarcane (2019-20)

Particulars	India	Uttar Pradesh	Basti
Area (mh)	4.6(100)	2.21 (47.93)	0.4 (18.09)
Production (mt)	370.5(100)	179.54(18.49)	3.06 (1.70)
Productivity (t/ha)	80.54(100)	81.23 (10.08)	0.062 (0.07)

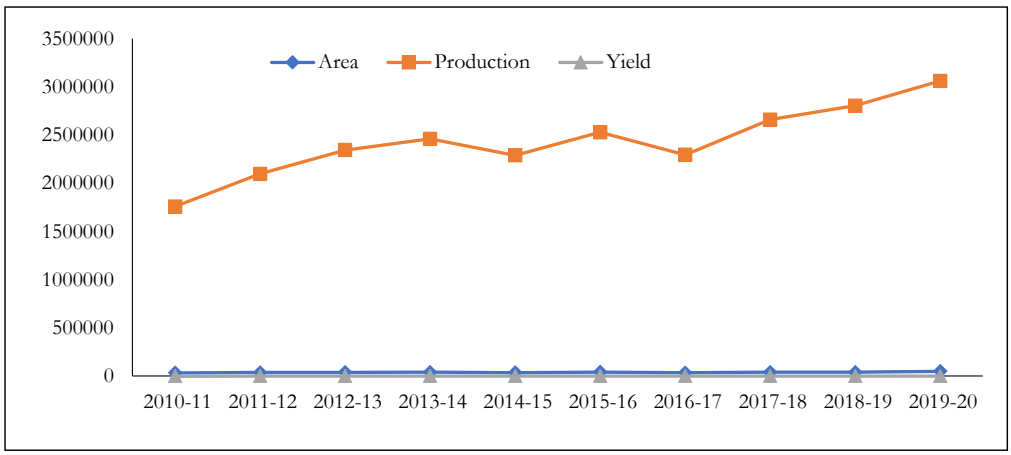

Figure 1: Decadal Trend analysis of sugarcane area and production in Basti district

Table 3: Coefficient of correlation analysis of selected independent variable with extent of adoption of recommended sugarcane production technology (n=120)

Variables	Coefficient of correlation value with extent of adoption
Age	-0.311**
Education	0.445**
Land holding	0.377**
Family size	-0.025 NS
Social participation	0.173 NS
Annual income	0.380**
Occupation	0.219*
Credit acquisition	0.324*
Source of information	0.438**
Scientific orientation	0.419**
Risk orientation	0.482**
Experience about sugarcane cultivation	0.262*
Knowledge	0.832**

* Significant at the 0.05 level of probability
** Significant at the 0.01 level of probability

production technology. Tripathi (2015); Prasad (2021) and Kamta (2022) also observed more or less similar trends in their study on sugarcane based dairy farming system.

CONCLUSION

The study revealed the lower share of the district in terms of sugarcane production with respect to the same for the UP state. The growth rate in area, production, productivity and instability was observed lower in the study area. The farmers' level variables like education, land holding, annual income, source of information, scientific orientation, risk orientation and knowledge about recommended sugarcane production technology showed positive and highly significant (at 0.01 level of probability) relation with the farmers' adoption level. While, family size and social participation showed no significant correlation with adoption of recommended sugarcane production technology.

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Technological Knowledge and Practices of Tribal Farm Women of Arunachal Pradesh in Fruit Crops Production

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ABSTRACT

The study was carried out purposely in seven districts of Arunachal Pradesh namely, Papumpare, Lower Subansiri, East Siang, West Siang, West Kameng, Namsai and Lohit. A total of 420 respondents were selected using a purposive sampling technique. A structured interview schedule was used to collect data through personal interview method. The statistical tools like frequency, percentage, mean, standard deviation, correlation and association etc were incorporated for analysing the collected data. Results of the study revealed that the majority of respondents (66.19%) had a 'medium level' of knowledge on fruit production. 95 per cent of respondents did not have the practice of growing a green manure crop to improve the physical and chemical conditions of soil. However, only 13.33 per cent of respondents had 'good level' of practice on fruit production. It was found that 95.48 per cent of respondents did not know that using pheromone traps and yellow sticky traps is a technique for pest control in some fruit trees. A large majority of respondents (97.62%) did not practice pre-cooling of fruits after harvesting to reduce their detoriation process. It was also found that respondents had 'low level' of knowledge in nutrient management (22.62%). There was a positive and highly significant relationship between knowledge of the respondents with their practice of growing fruit crops. There was a significant association between some selected independent variables like age, educational qualification and family size of the respondents with their knowledge level on fruit production.

Keywords: Arunachal Pradesh, Practices of fruit production, Technological knowledge, Tribal women

INTRODUCTION

In the present study, technological knowledge on fruit production refers to the information possessed by the tribal women on each of the parameter of fruit cultivation, namely land preparation and planting, inter-culture operations, nutrient management, management of pest and diseases, harvesting and post-harvesting practices. Practice of fruit production is operationally defined as the habit of performing the activities by the tribal women relative to each of the parameters of fruit cultivation to maintain their capability in fruit production.

Over the last few years, Arunachal Pradesh has shown great potential in the horticulture sector, specifically in the fruits and spices sector. The state has produced 1.76 lakh MT of horticultural produce from an area of 0.675 lakh ha in the year 2021-22 where the major share came from the production of fruits (71.18%) (NHB database, 2021). Arunachal Pradesh, the largest hill state in the North Eastern Region of India has the inherent potential for the growth of numerous fruit crops. This region is blessed with the unique advantage of growing fruit crops such as apple, pear, plum, peach, kiwifruit, walnut, chestnut, strawberries, etc. that are grown on a semi-commercial small scale.

Women play a significant and crucial role in agricultural development and allied fields including crop production, livestock production, horticulture, post harvest operation, agro/ social forestry, fisheries etc. (Chayal and Dhaka, 2010). The tribal farm women

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in Arunachal Pradesh play an important role in the production of horticulture crops. Women's participation plays a crucial role, especially in the pre and post-production of the horticulture crops. This includes seed sowing, cleaning, weeding, harvesting, sorting, grading etc except other activities like pit digging, levelling of field and crop protection measures, etc. However, the women have inadequate knowledge which brings challenges for them to access information about the various available farm tools and latest technologies, finances, training activities, etc. Thus might hinder them to have effective participation to empower their farm activities and letting them be dependent on other individuals for support. Knowledge has been found to be a key factor contributing to adoption of recommended technology by the farmers (Shakya *et al.,* 2008). In view of this, an attempt was made to assess the technological knowledge and practices of tribal farm women in fruit crops production.

MATERIALS AND METHODS

The present study was conducted in seven districts of Arunachal Pradesh. The districts, Papumpare, Lower Subansiri, East Siang, West Siang, West Kameng, Namsai and Lohit were selected purposely. One block from each district was selected by simple random sampling method. Twenty one (21) villages, 3 villages from each block were selected having higher fruit production. Twenty (20) farm women from each village were selected randomly by following the equal distribution method. A total of four hundred twenty (420) respondents were selected. The personal interview method was applied for collection of data with the help of an interview schedule to identify the existing knowledge and practice on different aspects of fruit production. For assessing knowledge level of respondents, a knowledge scale was developed and standardized by the researcher. It included some basic questions on each of the parameters such as land preparation and planting, inter-culture operations, nutrient management, management of pest and diseases, harvesting and post- harvesting in fruit production. The data collected was coded, tabulated and statistically analysed with the application of suitable statistical tests and techniques like percentage, standard deviation, mean, correlation, association etc.

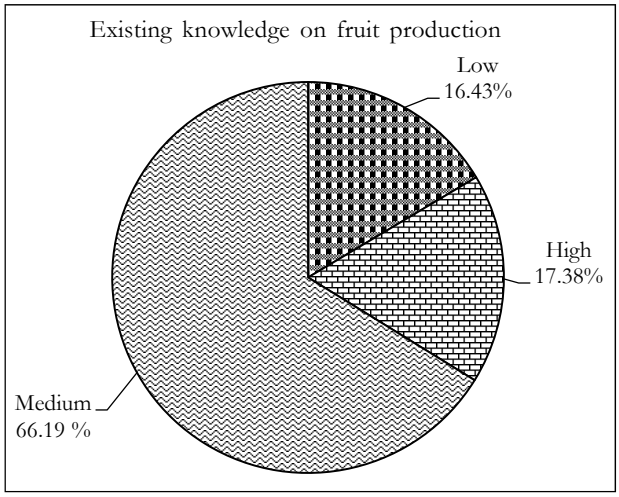

Figure 1: Distribution of respondents according to existing knowledge level on fruit production

RESULTS AND DISCUSSION

The data in Figure 1 shows that majority of the respondents (66.19%) had 'medium level' of knowledge on fruit production followed by 17.38 per cent had 'high level' of knowledge and 16.43 had 'low level' of knowledge. This study is in conformity with Gondkar *et al.* (2017) where it was found that majority of respondents possessed medium level of knowledge.

Table 1 shows that there is a significant association between the age, educational qualification, and family size of the respondents with knowledge level on fruit production. It was also found that independent variable like family type, organisational membership, frequency of training attended and contact with extension personnel had no significant association with knowledge

Table 1: Association between knowledge of respondents with selected independent variables (N=420)

Variables	Cramer's V	'p' value
Age	0.116	0.023*
Educational Qualification	0.254	0.000**
Family type	0. 053	0.665
Family Size	0.130	0.007**
Organisational membership	0.066	0.719
Frequency of training attended	0.073	0.339
Contact with extension personnel	0.098	0.092

**Significant at 0.01 level of probability; * Significant at 0.05 level of probability.

Table 2: Percentage distribution of respondents' existing knowledge on fruit production (statement wise) (N=420)

Statements	Known		Not known	
	f	%	f	%
Land preparation and Planting				
A green manure crop is to be grown to improve the physical and chemical conditions of soil before planting operations are taken up.	62	14.76	358	85.24
Mandarin orange planting is to be done during April to June.	127	30.24	293	69.76
Planting distance in most varieties of kiwi (*Golden spur, Red chief, McIntosh, Golden Delicious*) and sweet orange (*Blood Red, Hamlin, Pineapple, Jaffa, Valencia*) & mandarin (Khasi Mandarin) is 5m x5m.	235	55.95	185	44.05
Pit size is to be dug approximately twice the diameter of the root system of the fruit plant.	374	89.04	46	10.95
Filling of the pit should be done with a mixture of sand, soil and FYM in the ratio (1: 1: 1)	388	92.38	32	7.62
Correcting the soil problems before planting by adding amendments, organic matter is to be done about a year before planting.	403	95.95	17	4.05
Inter-culture operations				
Wrapping of fruit is a technique that extends the shelf life.	43	10.23	377	89.76
Smudging of fruit tree is done to minimize the attack of pest.	49	11.67	371	88.33
Drip irrigation is to be done for fruit crop growers in hilly areas.	53	12.62	367	87.38
Thinning is to be done to improve fruit size, colour and quality at fruit harvest.	65	15.48	355	84.52
Mulching adds humus to the soil and increase soil structure and controls weed.	86	20.48	334	76.52
Propping in banana is to be done to support the bearing plant.	259	61.67	161	38.33
Nutrient Management				
Vermicompost can be used as another source of organic manure for fruit trees.	39	9.29	381	90.71
Soil fertility can be maintained by application of FYM, lime and inorganic fertilizers	56	13.33	364	86.67
Nutritional deficiency, particularly of N and K may lead to irregular bearing in fruit trees.	119	28.33	301	71.67
Soil testing prior to planting helps in proper recommendation of fertilizer for desired fruit crop.	295	70.24	125	29.76
Well decomposed compost is to be used as a better source of organic manure than fresh cow dung that is used in fruit crops.	380	90.48	40	9.52
Heavy use of inorganic fertilizers may lead to soil deterioration.	420	100	0	-
Management of pest and diseases				
Using pheromone traps & yellow sticky traps is a technique for pest pest control in some fruit trees.	19	4.52	401	95.48
Extracts of neem, dhatura, calotropis, pongamia, callophylum and custardapple seeds can control a wide range of insects, bacteria, and some diseases.	31	7.38	389	92.62
Trunk borer is a very damaging insect pest of mandarin orange in Arunachal Pradesh.	132	31.43	288	68.57
Insects like aphids, caterpillar, borer, mites, moths, slugs & maggots can all destroy fruit trees.	420	100	-	-
Removal and burning of infected leaves, twigs, and fruit from the area are to be done to prevent the source of infection.	420	100	-	-
Harvesting				
Pre-cooling of fruits is done to reduce the detoriation process of fruits	91	21.67	329	78.33
The peak harvesting season of kiwi fruit starts from November to mid-December.	265	63.10	155	36.90
Banana is to be harvested when leaves get dried instead of the fruit ridges changes from angular to round.	275	65.48	145	34.52
Jack fruit matures towards the end of summer in July & is harvested by cutting the stalk end.	286	68.10	134	31.90

Table 2 contd...

Statements	Known		Not known	
	f	%	f	%
Absence of latex on scratching of fruits is an indication of maturity of mango and papaya.	306	72.86	114	21.14
Mandarin orange is to be harvested using ladder or fruit picker in order to prevent injury and loss of fruit crop.	414	98.57	6	1.43
Pose Harvesting				
Edible coatings (waxes) are applied to apples to enhance shelf-life.	46	10.95	374	89.05
Kiwi fruit can be stored at 0 degree with a relative humidity of 90-95% for up to 6 months.	72	17.14	348	82.86
Grading and sorting of fruits helps the grower to get better price as well as the consumer to get quality product with respect to price of the commodity.	352	83.81	68	16.19
The guava fruit cannot be kept for longer period in room temperature due to rapid development of fungal rots	393	93.58	27	6.42
Temperature plays a crucial role in the shelf life of fruit crop during the storage period.	400	95.23	20	4.76
Cleaning & sanitization of containers or bins used for transfer & storage of fruit is essential.	420	100	-	-

of respondents regarding fruit production.

Table 2 shows the distribution of respondents according to existing knowledge level on fruit production (statement wise) it reveals that regarding "land preparation and planting", majority of the respondent (85.24%) did not know that a green manure crop is to be grown to improve the physical and chemical conditions of soil before planting operations are taken up. They were not aware about the fact that green manure crops are beneficial for the growth of the fruit plants if grown before land preparation. Nearly 70.00 per cent of the respondents did not know that mandarin orange planting is done during April to June. This might be due to the fact that as the respondents were engaged in growing multiple fruit crops for which they might not give much importance to a single crop. Again, 44.05 per cent of the respondents did not know that planting distance in most varieties of kiwi (*Golden spur, Red chief, McIntosh, Golden Delicious*) and sweet orange (*Blood Red, Hamlin, Pineapple, Jaffa, Valencia*), and mandarin (Khasi Mandarin) is 5m x5m. This might be because most respondents did not consult with any horticultural expert regarding the planting distance before planting of any fruit crops. Furthermore, the table shows that under "inter-culture operations", majority of the respondents (89.76%) did not know that wrapping of fruit is a technique that extends the shelf life of the fruit followed by 88.33 per cent of the respondents did not know that smudging of fruit tree is done to minimize the attack of pest and 87.38 per cent did not know that drip irrigation is the best available technology for fruit crop grown in hilly areas. This might be due to the fact that the respondents lacked in scientific knowledge on intercultural operations. The table also reveals that under "nutrient management", majority of the respondents (90.71%) did not know that vermicompost can be used as another source of organic manure for fruit trees. This is due to the fact that most respondents were not aware of different types of organic manures. Further, it was found that 86.67 per cent of the respondents did not know that soil fertility can be maintained by application of farm yard manure, lime, inorganic fertilizer. The respondents should be made aware about different types of farm yard manure to have a better clarity and ability to distinguish between different farm yard manures so that they could avail it in their future farm requirement. While, 71.67 per cent of the respondents did not know that nutritional deficiency, particularly of N and K may lead to irregular bearing in fruit trees. This might be due to respondents' ignorance on soil minerals. Vocational trainings on such topics will benefit the respondents in the long run. Under "management of pest and diseases", a huge number of respondents (95.48%) did not know that using pheromone traps and yellow sticky traps is a technique for pest control in some fruit trees followed by 92.62 per cent of the respondents did not know that extracts of neem, dhatura, calotropis, pongamia, callophylum and custardapple seeds can control a wide

range of insects, bacteria, and some diseases and 68.57 per cent did not know that trunk borer is a very damaging insect pest of mandarin orange in Arunachal Pradesh. This might be resulting due to respondents' ignorance on pest management techniques and lack of giving much importance in proper management practice of fruit trees. It was interesting to note that under "harvesting", majority of the respondents (78.33%) did not know that pre-cooling of fruits is done to reduce the deterioration process of fruits. Under "post- harvesting", 89.05 per cent respondents did not know that edible coatings (waxes) are applied to apples to enhance shelf-life. followed by 82.86 per cent of the respondents did not know that kiwi fruit can be stored at 0 degree with a relative humidity of 90-95 per cent for up to 6 months. This might be on the grounds that since respondents cultivated an ample amount of fruit crops for self- consumption and small amount for sale mostly from their backyard garden or small fields which might have led them to practice fruit production on their own without the guidance from horticultural experts. The production techniques used by the respondents might be primitive and traditional hence an intervention programme and trainings should be given to the respondents on scientifically recommended fruit production technologies.

Table 3 reveals that reveals that respondents had 'low level' of knowledge in nutrient management (22.62%) followed by inter-culture operations (19.04%), harvesting (7.62%), land preparation and planting (6.67%). It was interesting to note that majority of the respondents (96.19%) had 'medium level' of knowledge in management of pest and diseases followed by post- harvesting (77.15%), land preparation and planting (75%), nutrient management (71.42%), inter- culture operations (70.24%) and harvesting (64.04%). This finding is in conformity with Ansari and Sunetha (2014) where they found that farm women had moderate to high need for information about the disease control/management, weed control/ management, and high yielding variety of crops.

Figure 2 shows that majority of respondents had 'moderate level' (68.57%) of practice on fruit production followed by 'poor level' of practice (18.10%) and only 13.33 per cent of respondents had 'good level' of practice on fruit production. This might be due to the inadequacy of modern scientific

Table 3: Distribution of respondents on the existing knowledge in different aspects of fruit production technologies

Aspects of fruit production	Category	Frequency	Percentage
Land preparation and planting	Low<0.473	28	6.67
	Medium 0.473-0.787	315	75
	High>0.787	77	18.33
Inter- culture operations	Low<0.063	80	19.04
	Medium 0.063-0.377	295	70.24
	High>0.377	45	10.72
Nutrient management	Low<0.372	95	22.62
	Medium 0.372-0.666	300	71.42
	High>0.666	25	5.96
Management of pest and diseases	Low<0.369	0	0.00
	Medium 0.369-0.603	404	96.19
	High>0.603	16	3.81
Harvesting	Low<0.481	32	7.62
	Medium 0.481-0.817	269	64.05
	High>0.817	119	28.33
Post- harvesting	Low<0.550	9	2.14
	Medium0.550-0.785	324	77.15
	High>0.785	87	20.71

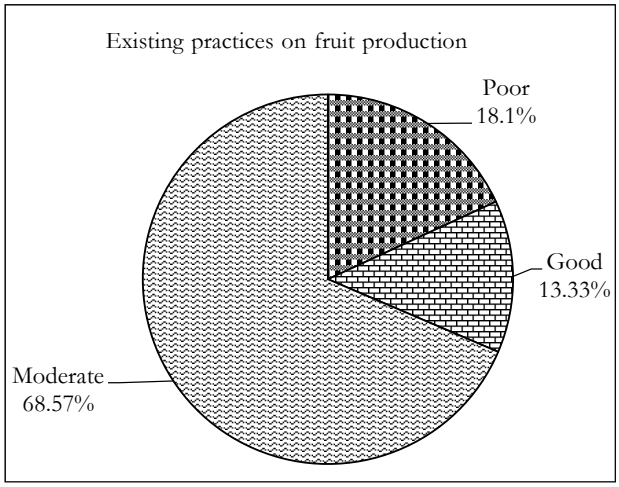

Figure 2: Distribution of respondents based on existing practices on fruit production

technologies related to fruit crops production. The tribal farm women should be provided with adequate knowledge through regular visits of extension supervisors. Enhancing their knowledge will enable them to practice modern scientific methods of fruit crops production in their home gardens and fields. This will lead to efficiency of yield and enhanced productivity.

Table 4 shows that under "land preparation and planting", a large majority (95.48%) of respondents did not have the practice of growing a green manure crop to improve the physical and chemical conditions of soil. This might be due to the fact that respondents had little knowledge about the importance of growing green manure. Whereas, 79.52 per cent of respondents

Table 4: Distribution of respondents according to their existing practices on fruit production (statement wise) (N=420)

Statements	Practice		Did not practice	
	f	%	f	%
Land preparation and Planting				
Growing green manure crop to improve the physical and chemical conditions of soil.	19	4.52	401	95.48
Correcting the soil problems before planting by adding amendments, organic matter is done about a year before planting.	86	20.48	334	79.52
Planting Mandarin orange during March to May.	139	33.1	281	66.90
Maintaining planting distance of 5mx5m in kiwi (*Golden spur, Red chief, McIntosh, Golden Delicious*) and sweet orange (*Blood Red, Hamlin, Pineapple, Jaffa, Valencia*), and mandarin (Khasi Mandarin).	148	35.24	272	64.76
Making pit twice the diameter of the root system of the fruit plant.	374	89.05	46	10.95
Filling the pit with a mixture of soil and farm yard manure in the ratio (1:1).	388	92.38	32	7.62
Inter-culture operations				
Using drip irrigation technology for fruit crop.	8	1.90	412	98.10
Wrapping fruits in fruit trees to extend its shelf life.	14	3.33	406	96.67
Practicing smudging of fruit trees.	37	8.81	383	91.19
Practicing fruit thinning.	39	9.29	381	90.71
Mulching to add humus to the soil.	63	15	357	85
Propping in banana plants.	152	36.19	268	63.81
Nutrient Management				
Using heavy inorganic fertilizers in your field	4	0.95	416	99.05
Testing soil prior to planting.	29	6.90	391	93.10
Using vermicompost as another source of organic manure for fruit trees?	37	8.81	383	91.19
Applying farm yard manure, lime, and inorganic fertilizer to your farm soil?	40	9.52	380	90.48
Taking care of nutritional deficiencies in fruit trees, particularly of N and K that may lead to irregular bearing in fruit trees?	54	12.86	366	87.14
Using well decomposed compost as a better source of organic manure than fresh cow dung for fruit crops?	79	18.81	341	81.19

Table 4 contd....

Statements	Practice		Did not practice	
	f	%	f	%
Management of pest and diseases				
Using extracts of neem, dhatura, calotropis, pongamia, callophylum and custard apple seeds to control a wide range of insects, bacteria, and some diseases in fruit trees.	3	0.71	417	99.29
Using pheromone traps and yellow sticky traps for pest control in fruit trees.	4	0.95	416	99.05
Protecting the fruit trees from the attack of insects like aphids, caterpillar, borer, mites, moths, slugs, and maggots.	26	6.19	394	93.81
Saving the mandarin orange trees from the attack of Trunk borer, a very damaging insect pest.	72	17.14	348	82.85
Removing and burn infected leaves, twigs, and fruit from the area to prevent the source of infection.	420	100	0	-
Harvesting				
Pre-cooling the fruits to reduce the detoriation process.	10	2.38	410	97.62
Harvesting Jack fruit by cutting the stalk end by the end of July.	65	15.48	355	84.52
Harvesting kiwi fruit from November to mid-December.	65	15.48	355	84.52
Scratching fruits to check the presence of latex in mango and papaya, in order to determine its maturity.	141	33.57	278	66.43
Harvesting banana when the fruit ridges changes from angular to round instead of drying leaving.	238	56.67	182	43.33
Harvesting Mandarin orange using ladder or fruit picker in order to prevent injury and loss of fruit crop.	243	57.86	177	42.14
Pose Harvesting				
Putting edible coatings (waxes) on apples to enhance shelf-life.	0	-	420	100
Storing kiwi fruit at 0 degree with a relative humidity of 90-95 percent for up to 6 months.	4	0.95	416	99.05
Storing guava fruit at room temperature for longer period.	4	0.95	416	99.05
Maintaining the room temperature of the fruit storage area to increase the shelf life of fruits.	20	4.76	400	95.24
Grading and shorting harvested fruits	74	17.62	346	82.38
Cleaning and sanitizing containers or bins that are used for transfer and storage of fruits.	420	100	0	-

did not have the practice of correcting soil problems before planting by adding amendments and organic matter about a year before planting, despite being aware of its importance. The possible reason could be that most respondents had mature fruit trees already growing in their fields that needed little or no attention to correcting soil problems and planting. Again, 66.90 per cent of respondents did not have the practice of planting mandarin oranges during March to May, which might be due to little knowledge of respondents on planting of mandarin oranges.

Under "inter-culture operations", it was found that 98.10 per cent of respondents did not have the practice of using drip irrigation technology for fruit crop. 96.67 per cent of the respondents did not have the practice to wrap fruits in fruit trees to extend its shelf life. Again, 91.19 per cent of the respondents did not practice smudging of fruit trees, 90.71 per cent of respondents did not practice fruit thinning, 85per cent of the respondents did not practice mulching to add humus to the soil and 63.81 per cent of respondents did not practice propping of banana plants. Further, under "nutrient management", almost all (99.05%) respondents did not have the practice of using inorganic fertilizers in their fields and 93.10 per cent of the respondents did not have the practice to test soil prior to planting. It was found that 91.19 per cent of respondents did not have the practice to use vermicompost as another source of organic manure for fruit trees, 90.48 per cent of respondents did not have the practice of applying farm yard manure, lime,

Table 5: Relationship between knowledge of respondents with their practice on fruit production (N=420)

Variables	Correlation coefficient (r)	'p' value
Knowledge Vs Practice on fruit production	0.423**	.000

**Significant at 0.01 percent level of probability.

and inorganic fertilizer to their farm soil and 87.14 per cent of respondents did not have the practice of taking care of nutritional deficiencies in fruit trees, particularly of N and K. Under "management of pest and diseases", almost all (99.29%) respondents did not have the practice of using extracts of neem, dhatura, calotropis, pongamia, callophylum and custard apple seeds to control a wide range of insects, bacteria, and some diseases in fruit trees. About cent percentage (99.05%) of the respondents did not have the practice of using pheromone traps and yellow sticky traps for pest control in fruit trees and 93.81 per cent of the respondents did not have the practice to protect the fruit trees from the attack of insects like aphids, caterpillar, borer, mites, moths, slugs, and maggots. Under "harvesting" aspect, 97.62 per cent of the respondents did not have the practice to Pre-cool the fruits to reduce the detoriation process. 84.52 per cent of respondents did not have the practice to harvest jack fruit by cutting the stalk end by the end of July. Similarly, 84.52 per cent of respondents did not practice harvesting of kiwi fruit from November to mid-December and 66.43 per cent of respondents did not have the practice to scratch fruits to check the presence of latex in mango and papaya, in order to determine its maturity. Under "post harvesting" process, cent per cent of respondents did not have the practice to put edible coatings (waxes) on apples to enhance shelf-life, 99.05 per cent of the respondents did not have the practice of storing kiwi fruit at 0 degree with a relative humidity of 90-95 percent for up to 6 months and similarly 99.05 per cent did not have the practice to store guava fruit at room temperature for longer period. From the above findings, it can be concluded that respondents had less knowledge on the above mentioned topics. Hence, they did not put it into practice. Table 5 reveals that there was a positive and highly significant relationship between knowledge of the respondents with their practice of fruit production. It implies whatever they knew they had been practicing.

CONCLUSION

The knowledge and practice of the respondents regarding fruit production was of moderate level. It was also revealed that there was a highly significantelationship of respondents' existing knowledge with their practice, which signifies that dissemination of knowledge to the respondents will be beneficial in the adoption of practices. To increase fruit production, respondents' knowledge should be enhanced on fruit cultivation. This could be possible only through empowering them with new technologies.

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Effect of Organic and Conventional System of Nutrient Management in Basmati-Wheat Sequence on Soil Properties

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ABSTRACT

Effect of organic and conventional system of nutrient management for six and half years in basmati-wheat sequence was studied on general soil properties and plant available macronutrients. Application of inorganic fertilizers (N, P and K) resulted in significant increase in mineral N, available P and available K, compared to unfertilized control. Among organic sources, farmyard manure (FYM) applications showed superior impacts on soil mineral N, available P, bulk density and porosity compared to rice straw compost and vermi-compost. Integrated use of organic and inorganic sources of nutrients favourably impacted these soil properties to a greater extent than application of either of the sources alone.

Keywords: Farmyard manure, Rice straw compost, Organic farming, Basmati, Soil fertility, Available nutrient

INTRODUCTION

Rice-wheat is the major cropping sequences of the Indo-Gangetic Plains and has played an important role in food security of India. In the last three decades, the area under the two crops has increased tremendously, resulting in the replacement of N-efficient cereals, pulses and legumes by the less N-efficient rice-wheat system (Benbi *et al.,* 2006; Benbi and Brar, 2009; Dhaliwal *et al.,* 2021). Currently, rice-wheat cropping system occupies 2.7 M ha area of the North Indian state of Punjab, which constitutes 78 per cent of the gross cropped area of the state (Benbi and Brar, 2009). About 20 per cent of the area under rice is grown to basmati because of its lesser water use, excellent cooking and eating quality. Both rice and wheat have high nutritional demands and remove large amounts of nutrients from soil. For example, a rice-wheat sequence that yields 7 t ha^{-1} of rice and 5 t ha^{-1} of wheat removes more than 300 kg N, 30 kg P and 300 kg of K ha^{-1} from the soil. Rice-wheat system coupled with imbalance nutrient management has shown the multiple nutrient deficiencies like available N, P and K. Nutritional demand can be met by green manuring for example: growing of sun hemp followed by the incorporation of 50 days old crop just before transplanting the rice/basmati (Anonymous, 2016; Jat *et al.,* 2019). Intensive land cultivation to meet the food and fibre demands of increasing population, and removal or burning of crop residues lead to organic matter depletion and nutrients losses from soils (Aulakh *et al.,* 2013; Sandhu *et al.,* 2020; Singh *et al.,* 2021). The intensification of agricultural crop production has led to farm specialization as well as higher dependency on nutrients, essentially nitrogen (N), phosphorus (P), and potassium (K) (Fangueiro *et al.,* 2008; Muzafar *et al.,* 2021).

Recently, organic farming has been advocated as an alternative form of agriculture to obtain high-quality food in an environment friendly manner. This excludes synthetic inputs with management practices to balance input and output nutrients, and to ensure productivity and long-term sustainability (Marinari *et al.,* 2006; Foissy *et al.,* 2013; Jat *et al.,* 2019). On mixed and livestock farms, animal manures, rice straw compost, vermicompost are the important sources for re-cycling of nutrients (Watson *et al.,* 2002; Sodhi *et al.,* 2009). Asiegbu and Oikeh (1995) found that N, P and K fertilizers were more efficient than the organic manures

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in supplying N, P and K to the growing plant at least in the short run, while the organic manure had an advantage to supply other macro- and micro-nutrients not contained in N, P and K fertilizers. Depending on the quality of organic manure, soil and crop conditions, application of animal manures can effect a saving of 40 to 60 kg N ha^{-1} as use of chemical fertilizers. Moreover, organic manures have considerable residual effect as well. The application of organic manures and green manure is generally made in *kharif* crops, as both temperature and moisture conditions permit their rapid decomposition in the field (Beri *et al.,* 1989). Organic resources quality is usually expressed as a combination of N, lignin and/or soluble polyphenol content, with high quality organic resources showing relatively quick net N release (Palm *et al.,* 2001). The N release is negatively related to the lignin-to-N and (lignin plus polyphenol)-to-N ratios of the organic resources while net release of available P is positively related to the P content of the organic resources (Vanlauwe *et al.,* 2008). Organic amendments not only improve soil N status singly but also play a pivot role in long-term maintenance of soil functions, such as enhancement of soil moisture holding capacity, build-up of available P and K status as well (Benbi and Biswas, 1999; Dhaliwal *et al.,* 2019).

Growing legumes, a major biological nitrogen source, is also a powerful option to reduce synthetic nitrogen fertilizers use (Bedoussac *et al.,* 2015). The leguminous green manures have greater N substitution potential as compared to the organic manures. For example, incorporation of 50-55 day old *Sesbania* green manure can save of N fertilizer in rice ranging from 60-120 kg N ha^{-1}, leaving some residual effect on succeeding crop of wheat.

Integrated nutrient management (INM) involves recycling of organic materials to convert them into valuable manure that can both supplement and complement the chemical fertilizers without impairing the soil (Benbi and Beri, 2007). Some of the recyclable organic resources for INM include animal manures, and value added composts (Beri *et al.,* 2003). The INM involving combination of organic manure and fertilizers is an essential tool for balanced fertilization and sustainability of crop production on long term basis (Hegde and Dwivedi, 1993; Dhaliwal *et al.,* 2021). For example, the application of FYM in conjunction with 100% NPK led to significantly greater accumulation of available P as compared to 100% NPK treatment alone despite the higher amount of total P removal in the former treatment than that from the latter (Benbi and Biswas, 1997; Benbi and Biswas, 1999). The aromatic value and export potential of basmati is high. It is interest of us to evaluate the impacts of organic *vis-a-vis* conventional system of nutrient management on soil properties. Therefore, it is essential to work out optimal combination of fertilizers and manures in the basmati-wheat cropping system for long-term soil fertility maintenance. The specific aim of present study was to investigate the effects of different nutrient management practices including fertilizers and manure applications either singly or in conjunction on soil properties.

MATERIALS AND METHODS

Soil sampling sites and soil characteristics: A field experiment was established during *rabi* 2006-2007 on basmati (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) cropping systems at Research farm of Punjab Agricultural University (PAU), Ludhiana, India (Latitude: 30° 56'N, Longitude: 75° 52'E and mean sea level=247.5m). The climate of the region is sub-tropical, semi-arid. The experimental area receives about 750 mm rainfall annually, of which ~80 per cent is received during the *kharif* season extending from 1 May to 31 October (Kaur and Hundal, 2008). The soil of the experimental field was a *Typic Ustorthent*, developed on alluvial material with a sandy loam texture. At the start of the experiment, the field soil (0-15 cm) had a pH (1:2 soil: water suspension) of 7.34, electrical conductivity (1: 2 soil: water supernatant) of 0.30 dS m^{-1}, and SOC of 3.22 g kg^{-1}. The experimental soil tested 175 kg ha^{-1} in alkaline permanganate oxidizable nitrogen (N), 16.4 kg ha^{-1} in available phosphorus (P), and 158 kg ha^{-1} in neutral 1*N* ammonium acetate exchangeable potassium (K).

Experimental details: The treatments included different organic sources of nutrients viz. farm yard manure (FYM), rice straw compost (RSC) and vermicompost (VC) and integrated use of FYM and inorganic fertilizers, and recommended rates of fertilizers (NPK) (Table 1). Prior to seeding basmati, a green manure crop of Sunnhemp (*Crotalaria juncea*) was raised *in situ* for 45-50 days, except in NPK and control

Table 1: Treatment details for basmati and wheat grown in a sequence at research farm, Punjab Agricultural University, Ludhiana

Treatment	Nutrient applied (kg $ha^{-1}yr^{-1}$)	
reference	Basmati	Wheat
Control	Nil	Nil
NPK	40 N + 30 P_2O_5	120N + 60 P_2O_5+ 30 K_2O
INM	GM	NPK+200 kg N ha^{-1} through FYM
FYM	GM	400 kg N ha^{-1} through FYM
RSC	GM	400 kg N ha^{-1} through RSC
VC	GM	400 kg N ha^{-1} through VC

NPK=Recommended fertilizer GM=Green manure (*Sunnhemp*), INM=Integrated nutrient management, FYM=Farm yard manure, RSC=Rice straw compost, VC=Vermicompost

plots. The green manure was incorporated in the soil one day before transplanting of basmati every year. A total of six treatments were replicated three times (plot size 40 m^2) and arranged in a randomized complete block design (RBD). Immediately after puddling the field, 30 days old seedlings of basmati (variety Super Basmati) were transplanted in third week of July. Nitrogen was applied in two equal splits at 3 and 6 weeks after transplanting. The crop was kept weed free manually. The crop was harvested manually in the third week of November each year.

After the harvest of basmati, FYM, vermicompost (VC) and rice straw compost (RSC) were applied in respective plots to supply 400 kg N ha^{-1}. In INM treatment, farmyard manure was applied to supply 200 kg N ha^{-1} with recommended fertilizers (NPK). The FYM, RSC and VC, on an average contained 7.2, 6.3 and 5.1 g kg^{-1} N, respectively. The organic sources were incorporated before seeding wheat. In recommended fertilizer treatments whole of P and K and half of recommended N were applied at the time of sowing. Remaining N was applied one week after first irrigation. Wheat variety (PDW 277 or PBW 550) was sown at 100 kg ha^{-1} in the fourth week of November and harvested in third week of April each year.

Soil sampling and analysis: Soil samples were collected from 0-7.5, 7.5-15, 15-30 and 30-60 cm soil depths (after wheat harvest) in April 2013. The soil samples were collected from three replicates of each treatment with a metallic soil core sampler (inner diameter 7 cm and 7.50 cm length) from each depth. Soil samples were air-dried in shade, ground to pass through 2 mm sieve for different analysis.

Bulk density: Soil bulk density (D_b) was determined by core method using metallic cores (inner diameter=7.0 cm and 7.5 cm length). Soil cores collected from each sampling depth were oven-dried at 105°C for 24 h, and dry soil weight was recorded (Blake and Hartge, 1986). The D_b (Mg m^{-3}) was calculated as:

$$Db = \frac{Ws}{Vt}$$

Where, '*Ws'* is weight of soil (Mg) and *Vt* is the volume of soil sample (m^3)

Soil porosity: Soil porosity was determined as ratio of bulk density to particle density using the following equation

$$Soil\ porosity\ (\%) = \left(1 - \frac{Db}{Dp}\right) \text{ x } 100$$

Where, D_b and D_p are bulk density and particle density, respectively. The D_p of the mineral soil was taken as 2.65 Mg m^{-3}.

Chemical analyses: Soil samples were analyzed for pH (1:2, soil: water), electrical conductivity (E.C., 1:2, soil: water supernatant), available P, available K and mineral-N as per the methods described briefly in Table 2.

Statistical analysis: Statistical analyses were performed with SPSS for Windows 16.0 (SPSS Inc., Chicago, U.S.A.). Data were subjected to analysis of variance (ANOVA) in a completely randomized block design. Mean separation for different treatments was evaluated at 95 per cent confidence interval using the Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Soil reaction and electrical conductivity: Nutrient management practices did not influence soil pH and EC significantly. Irrespective of the treatment, soils were neutral to near-neutral in reaction and ranged in pH between 7.01 and 7.13 in the surface 15 cm soil. Soil pH increased slightly with depth, and ranged between 7.14 and 7.21 at lower depths (Table 3). Soil electrical conductivity ranged between 0.17 and 0.20

Table 2: Brief description of the methods used for soil sample analysis

Property	Description of the method	Reference (s)
pH	1: 2 Soil: water suspension using glass calomel electrode	Jackson (1967)
EC	1:2 soil: water supernatant using a conductivity meter	Jackson (1967)
Available P	0.5M sodium bicarbonate (pH 8.5; 1:20 soil: extractant), P concentration determined using ascorbic acid method	Olsen *et al.* (1954); Murphy and Riley (1962)
Available K	1N ammonium acetate (pH 7.0) as extractant & measuring K on flame photometer	Jackson (1967)
Mineral-N	Mineral N (NO_3^--N and NH_4^+-N) was determined by extracting the soil samples with 2M KCl followed by by mineral N estimation by steam distillation of extract using MgO and Devarda's alloy	Mulvaney (1996)

Table 3: Effect of nutrient management practices on soil pH and EC (dS m^{-1}) at different soil depths under basmati -wheat cropping

Treatment	Depth (cm)							
	pH				EC			
	0-7.5	7.5-15	15-30	30-60	0-7.5	7.5-15	15-30	30-60
Control	7.04[a]	7.13[a]	7.17[a]	7.21[a]	0.20[a]	0.19[a]	0.16[a]	0.12[a]
NPK	7.03[a]	7.10[a]	7.16[a]	7.19[a]	0.18[a]	0.17[a]	0.15[a]	0.11[a]
INM[#]	7.03[a]	7.11[a]	7.14[a]	7.20[a]	0.19[a]	0.18[a]	0.14[a]	0.09[a]
FYM[†]	7.02[a]	7.12[a]	7.15[a]	7.18[a]	0.18[a]	0.19[a]	0.16[a]	0.11[a]
RSC[Δ]	7.01[a]	7.11[a]	7.14[a]	7.19[a]	0.17[a]	0.16[a]	0.15[a]	0.10[a]
VC[¶]	7.02[a]	7.12[a]	7.15[a]	7.18[a]	0.18[a]	0.17[a]	0.16[a]	0.12[a]

[#]INM=Integrated nutrient management, [†]FYM=Farm yard manure applied to supply 400 kg N ha^{-1}, [Δ]RSC=Rice straw compost applied to supply 400 kg N ha^{-1}, [¶]VC=Vermicompost applied to supply 400 kg N ha [1] [Mean values fin a column followed by same letter are not significantly different ($p<0.05$) by Duncan's multiple range test (DMRT)]

dS m^{-1} in the surface and 0.16 to 0.19 dS m^{-1} in the subsurface layers, respectively. Under all the treatments soil EC decreased with depth and ranged between 0.09 and 0.16 dS m^{-1} at the lower depths. The increase in pH with depth may be attributed to removal of bases from the surface to lower layers, decrease in SOC concentration with depth (Kumar and Singh, 2010; Dhaliwal *et al.,* 2019) and decrease in oxidation of ammonium to nitrate (Schoenau, 2006). The decrease in EC with depth shows decrease in salt content of the soil. The results on pH and EC show that the experimental soil was free from acidity/alkalinity and salinity problems.

Ammonical and nitrate-N distribution: In 0-7.5 cm soil, NH_4^+-N concentration was significantly lower (30 mg N kg^{-1}) in unfertilized control and increased by 90% with NPK application (Figure 1). The NH_4^+-N concentration increased by 75% in plots receiving NPK plus FYM (INM) compared to plots receiving NPK alone. The NH_4^+-N concentration also increased significantly in plots amended with organic sources viz. FYM, RSC and VC compared to plots amended with NPK, however, it was significantly lower than the INM plots. In sub-surface soil (7.5-15 cm), effect of different treatments was similar to that observed in surface soil (0-7.5 cm). At 15-30 and 30-60 cm soil depth, NH_4^+-N concentration ranged between 22.2 to 53.6 and 15.9 to 47.8 mg N kg^{-1}, respectively. At both the soil depths, NH_4^+-N concentration was significantly lower in control compared to all other treatments. Plots receiving NPK, RSC and VC exhibited similar NH_4^+-N concentration (Figure 1).

The NO_3^--N concentration was significantly higher (20.2 mg N kg^{-1}) in plots receiving NPK compared with unfertilized plots (13.6 mg N kg^{-1}) in 0-7.5 cm soil (Figure 1). The NO_3^--N concentration increased by 134.6 per cent in INM plots compared to plots receiving NPK alone. The NO_3^--N concentration also increased significantly in plots

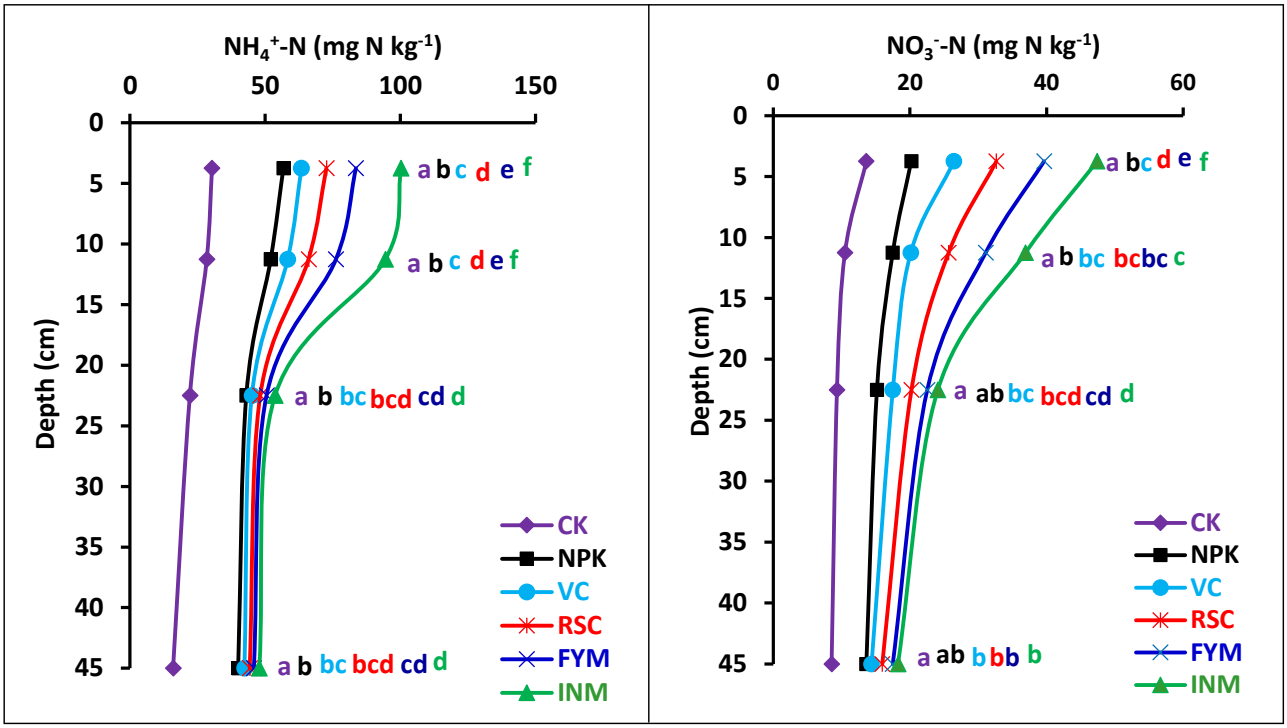

Figure 1: Effect of different treatments on profile distribution of NH_4^+-N and NO_3^--N concentration in soil under basmati-wheat cropping [Mean values for a soil property at a given depth followed by different letters differ significantly (*p<0.05*) by Duncan's multiple range test (DMRT)]

amended with organic manures (FYM, RSC, VC) compared to plots amended with NPK alone. The comparison of organic manure treated plots revealed that NH_4^+-N and NO_3^--N was significantly higher in soil receiving 400 kg N ha^{-1} through FYM, followed by RSC and the lowest in VC. In 7.5-15 cm soil, plots amended with either RSC or VC showed similar effect on NO_3^--N concentration. Effect of NPK, FYM and INM on NO_3^--N concentration was similar to that observed in 0-7.5 cm soil. At 15-30 and 30-60 cm soil depth, NO_3^--N concentration ranged between 9.3 and 24.1 and 8.6 and 18.3 mg N kg^{-1}, respectively. In 15-30 cm soil depth, NO_3^--N concentration increased significantly with application of either FYM alone or in combination with NPK compared to NPK alone and unfertilized plots. Plots amended with FYM, INM, RSC and VC showed significant increase in NO_3^--N concentration compared to control in 30-60 cm soil depth (Figure 1). The profile distribution of NH_4^+-N and NO_3^--N concentration shows that the concentration of NH_4^+-N and NO_3^--N was higher in the surface soil, and it decreased with depth, under all the treatments (Rajneesh *et al.,* 2017; Sandhu *et al.,* 2020). Significant increase in NH_4^+-N concentration might be due to the favourable conditions for microbial activity and increase in N mineralization in the presence of FYM coupled with mineralization of N from native sources during decomposition (Dinesh and Dubey, 1999; Zhang *et al.,* 2009; Shahid *et al.,* 2015; Dhaliwal *et al.,* 2019). Application of organic sources accelerates nitrification and amonification leading to greater release of mineral N (Kumar *et al.,* 1988; Jagtap *et al.,* 2007; Vimlesh and Giri 2009; Jat *et al.,* 2019). Increase in soil mineral N with manure application either alone or in conjunction with fertilizers has earlier been reported (Tabassum *et al.,* 2010; Sharma, 2012).

Available phosphorus and potassium: Available P concentration increased significantly with application of inorganic and organic fertilizers compared to unamended control (Table 4, Figure 2). The lowest P concentration was observed in unamended control and the highest in INM plots. While recommended rate of NPK application increased available P by 72-75 per cent at the two surface soil depths over control, the adoption of INM increased P concentration by 98-100 per cent. The three organic sources viz. FYM, RSC and VC did not differ significantly from each other as well as from NPK and INM treatments (Table 4).

Table 4: Effect of nutrient management practices on available P and available K concentration in the surface (0-7.5 cm) and subsurface (7.5-15 cm) soil under basmati-wheat cropping

Treatment	Available P (mg kg^{-1})		Available K (mg kg^{-1})	
	0-7.5 cm	7.5-15 cm	0-7.5 cm	7.5-15 cm
Control	5.7^{a}	5.4^{a}	55^{a}	47^{a}
NPK	10.0^{b}	9.3^{b}	86^{cd}	70^{cd}
INM$^{\#}$	11.4^{c}	10.7^{c}	108^{e}	94^{e}
FYM†	10.7^{bc}	10.0^{bc}	83^{bc}	63^{bc}
RSC$^{\Delta}$	10.4^{bc}	9.6^{bc}	91^{d}	77^{d}
VC¶	10.2^{bc}	9.5^{bc}	77^{b}	57^{b}

$^{\#}$INM=Integrated nutrient management, †FYM=Farm yard manure applied to supply 400 kg N ha^{-1}, $^{\Delta}$RSC=Rice straw compost applied to supply 400 kg N ha^{-1}, ¶VC=Vermicompost applied to supply 400 kg N ha^{1} [†Mean values within a column followed by different letters differ significantly ($p<0.05$) by Duncan's multiple range test (DMRT)]

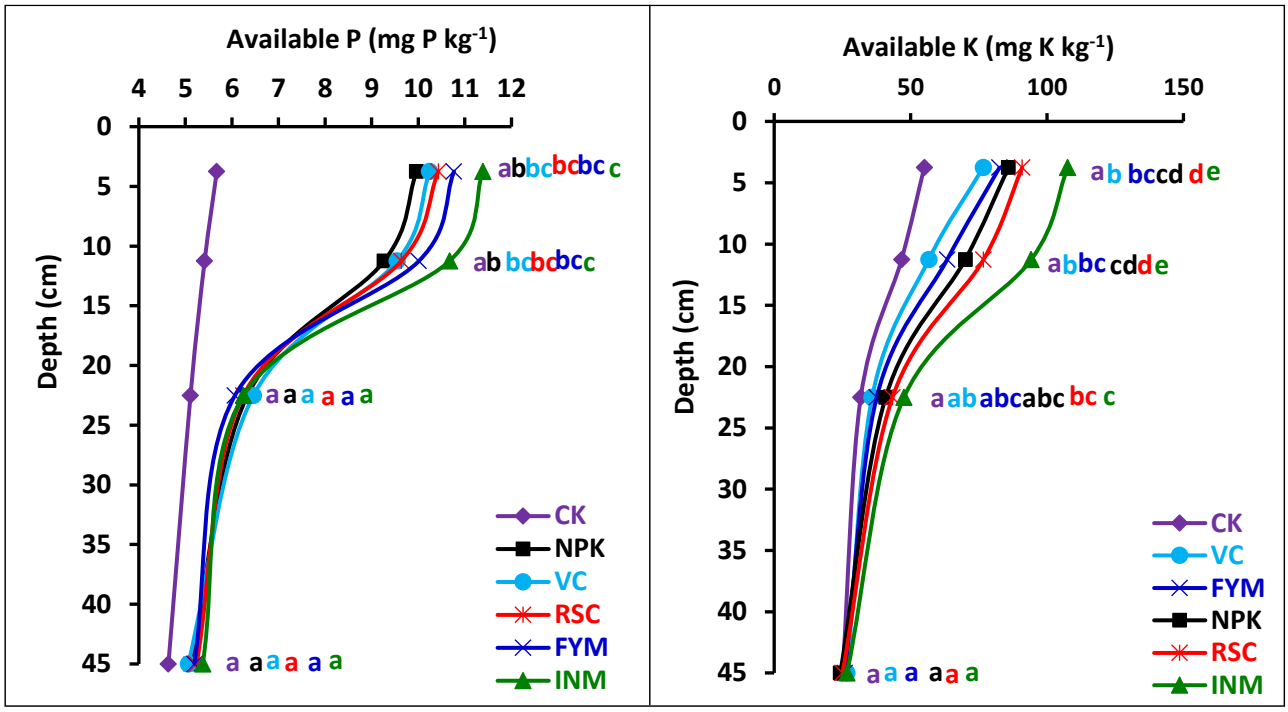

Figure 2: Effect of different treatments on profile distribution of available P and available K concentration in soil under basmati-wheat cropping [Mean values for a soil property at a given depth followed by different letters differ significantly ($p<0.05$) by Duncan's multiple range test (DMRT)]

Pizzeghello *et al.* (2011) reported 6-fold increase in available P concentration in FYM amended soils compared to unamended soils. Application of inorganic and organic fertilizer significantly improved available P in soil (Erich *et al.,* 2002; Pizzeghello *et al.,* 2011; Stroia *et al.,* 2013; Shahid *et al.,* 2015). Manure alone has a low potential of supplying P required for plant growth though it enhances P availability (Nyambega *et al.,* 2014). Favourable effect of INM practices on available P has earlier been reported by Bhattacharyya *et al.* (2008). Benbi and Biswas (1999) reported that the application of FYM in conjunction with NPK for 22 years in maize-wheat sequence led to greater accumulation of available P compared to NPK alone. Significant increase in concentration of available P in soils receiving organic manures either alone or in combination with inorganic fertilizers may be ascribed to addition of P through these sources, mineralization of organic P, decreased rate of P sorption and solublization of native-P (Sharpley *et al.,* 1984; Sui and Thompson, 2000; Gaston *et al.,* 2003; Singh *et al.,* 2010; Prakash *et al.,* 2017). The profile distribution of available P concentration in soils

showed that it decreased with depth (Rajneesh *et al.,* 2017). It ranged between 4.64 and 6.46 mg P kg^{-1} soil (Figure 2). Available P concentration decreased sharply below 15 cm soil depth, and all the treatments exhibited similar available P concentration. Higher available P concentration in the plough layer could be due to the application/mixing of fertilizer-P and organic manures viz. FYM, RSC and VC in the upper 0-15 cm soil depth. Further, a greater microbial activity in the 0-15 cm soil depth results in higher rates of P mineralization in the plots receiving organic manures (Stevenson, 1982; Dash *et al.,* 2014; Jat *et al.,* 2019; Dhaliwal *et al.,* 2021).

Available K concentration ranged between 55 and 108 mg K kg^{-1} in 0-7.5 cm soil depth and between 47 and 94 mg K kg^{-1} soil in 7.5-15 cm soil depth (Table 4). Application of inorganic fertilizer (NPK) significantly increased the concentration of available K by 56.4 and 48.9% at 0-7.5 and 7.5-15 cm soil depth, respectively, over unfertilized plots (Table 4, Figure 2). The INM resulted in further improvement in available K concentration by 25.6 and 34.3 per cent, respectively over NPK treatment. Sandhu *et al.* (2020) reported the similar findings after 31 years of experimentation in Punjab. Application of FYM and RSC did not differ significantly from NPK application but plots amended with RSC showed significantly higher available K concentration compared to FYM and VC amended plots. Available K responded significantly to the nature of applied organic manure viz. FYM, RSC and VC. In subsurface soil (7.5-15 cm), effect of different treatments was similar to those observed in 0-7.5 cm soil depth. Several studies (Singh *et al.,* 2001; Yaduvanshi, 2001; Jatav *et al.,* 2010; Venkatakrishnan and Ravichandran, 2012; Shahid *et al.,* 2015; Rajneesh *et al.,* 2017; Dhaliwal *et al.,* 2021) have reported higher available K in soils under long-term fertilizers, manures application and INM. At 15-30 cm soil depth, available K concentration ranged between 31.7 to 47.5 mg K kg^{-1} soil and adoption of INM significantly increased available K concentration compared to application of NPK alone and control. Application of RSC showed significant increase in available K concentration compared to control. The profile distribution of available K showed that its concentration decreased with depth particularly below 15 cm soil depth (Figure 2). Available K concentration ranged between 25 and 26.7 mg K kg^{-1} soil in 30-60 cm soil depth and all the treatments showed similar available K concentration in soil. Decrease in available K concentration with depth suggests that K movement did not occur in any treatment. The build-up of soil available K due to green manuring or organics application may be ascribed to the addition of K through these sources and the solubilizing action of certain organic acids produced during FYM decomposition and its greater capacity to hold K in the available form. Singh *et al.* (2008) observed increase in available K in soils, which were dressed with FYM, vermicompost, green manure and rice residue.

Soil bulk density: The data on effect of different nutrient management practices on soil bulk density (D_b) are shown in Figure 3. In surface soil (0-7.5 cm), the lowest D_b (1.43 Mg m^{-3}) was observed in plots receiving FYM alone and the highest (1.54 Mg m^{-3}) in unamended control. Application of FYM and VC significantly decreased soil D_b compared to NPK application and unamended control. Soil D_b did not differ significantly in plots receiving FYM, VC, RSC and FYM plus NPK (INM). Soil D_b ranged between 1.46 and 1.59 Mg m^{-3} in 7.5-15 cm depth and it decreased significantly in FYM, VC, RSC and INM plots compared to NPK amended plots. Soil D_b in NPK treated plots was similar to control. Soil D_b increased with depth and ranged between 1.66 and 1.71 in lower soil layer. It may be due to decrease in SOC with depth. Several researchers have reported decrease in soil D_b with NPK, FYM and NPK+FYM application (Hati *et al.,* 2008; Nayak *et al.,* 2012; Gami *et al.,* 2009; Meena *et al.,* 2018). Application of manure increases soil porosity leading to better soil aggregation, increased root growth and biopores (Selvi *et al.,* 2005; Benbi and Senapati, 2010; Dhaliwal *et al.,* 2021), which tends to decrease in soil D_b (Halvorson *et al.,* 1999; Sandhu *et al.,* 2020).

Soil porosity: Application of FYM, RSC and VC significantly increased soil porosity compared to control (Figure 3). Soil porosity in plots amended either with NPK alone or in combination with FYM (INM) did not differ significantly compared to plots amended with VC. In 7.5-15 cm soil, effect of different treatments was similar to that observed in 0-7.5 cm soil. Evidently, soil porosity decreased with depth and ranged between 35.3 to 36.0 per cent in lower soil

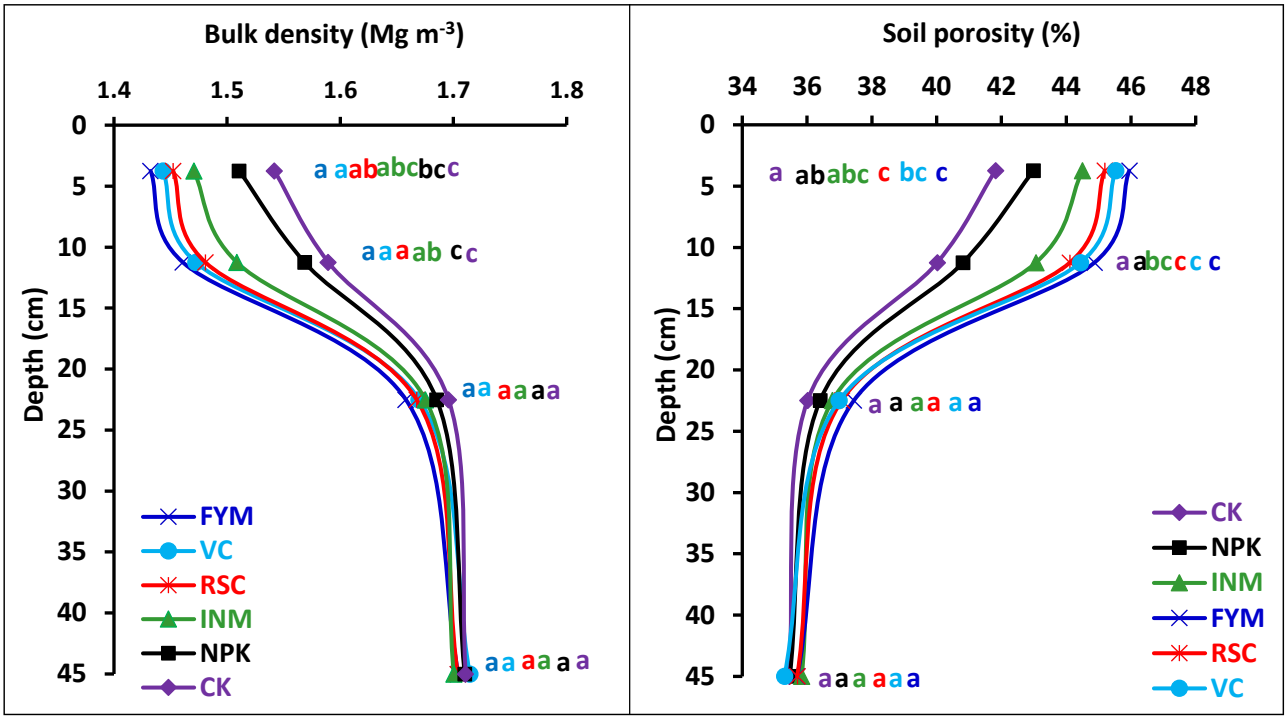

Figure 3: Effect of different treatments on bulk density (D_b) and soil porosity at different soil depths under basmati-wheat cropping [Mean values for a soil property at a given depth followed by different letters differ significantly ($p<0.05$) by Duncan's multiple range test (DMRT)]

layers, though all treatments exhibited similar soil porosity. A smaller change in soil porosity at lower soil depths could be due to the least disturbance of soil, compared to the plough layer. The change in soil porosity with manure application reflects the change in soil D_b due to the addition of more fibrous material. Lee *et al.* (2009) reported significant increase in soil porosity with NPK and compost application compared with unfertilized soils, because, organic amendments increase soil macro-aggregates proportion, thereby improving soil aeration (Dudal and Deckers, 1993; Aulakh *et al.,* 2013; Meena *et al.,* 2018). Another reason may be the production of various binding agents such as polysaccharides and bacterial gums from the microbial breakdown of manures that could lead to decrease the soil bulk density by promoting soil aggregation with concomitant improvement in soil porosity (Dhaliwal *et al.,* 2021).

CONCLUSION

Recommended fertilizers (NPK) significantly increased nutrient availability, compared to no fertilizer and manure applications. Adoption of integrated nutrient management (INM) improved soil mineral N, available P and available K to a greater extent compared to individual fertilizers or manure applications. Application of organic manures either alone or in combination with chemical fertilizer improved fertility status of soil over the years. Highest soil porosity was observed in plots receiving FYM, indicating better soil aeration. Regardless of the treatment, beneficial effects of different treatments were more in surface (0-7.5 cm) soil and decreased with depth. Therefore, the INM (NPK+FYM) could be beneficial for enhancing nutrient availability and physical suitability for cropping in the Indo-Gangetic alluvial soils.

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Global Overview of Research on Quality Protein Maize: A Bibliometric Perspective

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ABSTRACT

The bibliometric analysis uses the citation count of an article to measure its impact on the scientific community, yet there is still no comprehensive summary of research undertaken on the nutrition aspects of maize crop via bibliometric analysis. We aimed to evaluate the situations and trends of the most cited articles in maize nutrition via bibliometric analysis and to provide scientists with a practical guide in assessing the most influential articles and countries working on this subject. The top-cited articles in maize nutrition were compiled using the Scopus Index database. The articles selected were evaluated for their number of citations, year of publication, country of origin, type of study, and others. The database had articles published between 1980 and 2020. There is an incremental increase in the number of publications on the maize nutrition front after the 1990s. The United States of America is leading the research front as well as international research collaboration on QPM, followed by India and China. Our research presents a historical perspective on the scientific growth of maize nutrition and the countries that significantly impacted the development and progress of the concerned research area.

Keywords: Nutrition, Quality protein maize, Research, Scopus, Malnutrition

INTRODUCTION

Maize has been identified as one of the most significant crops for food, feed, and industrial purposes in most parts of the world (Prasanna *et al.,* 2001; Marcos, 2005; TAAS, 2015). Maize is also the world's leading cereal in terms of total yield (1,104.88 million metric tons) and yield per unit area (FAS, 2019). Maize alone accounts for more than 20 per cent of total calories in human diets in 21 countries, and more than 30 per cent in 12 countries with a population of more than 310 million people (Sentayehu, 2008; Aman *et al.,* 2016). However, like other grains, maize is low in critical amino acids including lysine and tryptophan (Wubu, 2011; Abate *et al.,* 2015). The identification of mutants (opaque 2 genes) that produce increased quantities of lysine and tryptophan sparked efforts to improve maize protein quality in the mid-1960s (FAO, 2002; Mpofu, 2012). From this perspective, this paper aims to analyze the global research scenario of Quality Protein Maize and the association of different countries on research fronts for its progress.

Nutritional quality is important in cereal crops as its benefits of it have been shared by millions of people worldwide. Nutritional quality in turn depends on the chemical composition of the kernel. Maize is considered a staple food across the globe due to the presence of an abundant amount of macro-nutrients like starch, fiber, and protein along with micronutrients like vitamins, carotene, and essential minerals. Maize possesses higher nutritive values in comparison to wheat and rice in many parameters (Table 1).

MATERIALS AND METHODS

To recognize the articles related to the field of maize nutrition, the professional citation indexing database, Scopus was used. To ensure the breadth and relevance

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Table 1: Nutrient content in selected cereals

Nutrient content	Maize	Rice	Wheat
Macro-nutrients (g/100g)			
Carbohydrate	81.8	80.4	78.4
Protein	10.2	7.2	14.3
Fat	4.7	2.2	2.3
Energy	408	372	392
Micro-nutrients (mg/100 g)			
Calcium	17.1	6.9	50.3
Iron	2.1	0.7	3.8
Magnesium	137.1	73.5	169.4
Phosphorus	292.6	137.8	467.7
Potassium	377.1	118.3	578.3
Zinc	2.9	0.6	4.7
Copper	0.24	0.28	0.36
Selenium	0.01	0.01	0.74
Thiamine	0.42	0.06	0.45-0.49
Riboflavin	0.1	0.06	0.17
Folic acid	0.026	0.02	0.078
Niacin	1.8	1.9	5.5

Source: Fardet *et al.* (2008)

of the search scope, the keywords were constantly filtered and finally were established after the number of articles stabilized in Figure 1. And then, "nutrition in maize, biofortification, Quality Protein Maize, nutrients, global malnutrition" which were included in the title, abstract, or topic was the final set of search terms. After confirming the search scope, the next step was to recognize the top-cited articles in maize nutrition from 1980-2020 which were expressed in ascending numerical order.

Research progress in maize nutrition – A bibliometric approach: The nutrition levels in maize are being enriched over years and have been gaining popularity and becoming an important area of research. Several nutrients are integrated into the crop as it forms a basic role in ensuring the nutritional security of the developing economies at large. From the graph (Figure 2), it is clear that the growth in publications on maize nutrition is exponential. There is a steep increase in the number of publications after 1990s with the emergence of QPM concept. In recent years, increased focus on research for improving the nutritional level of maize is

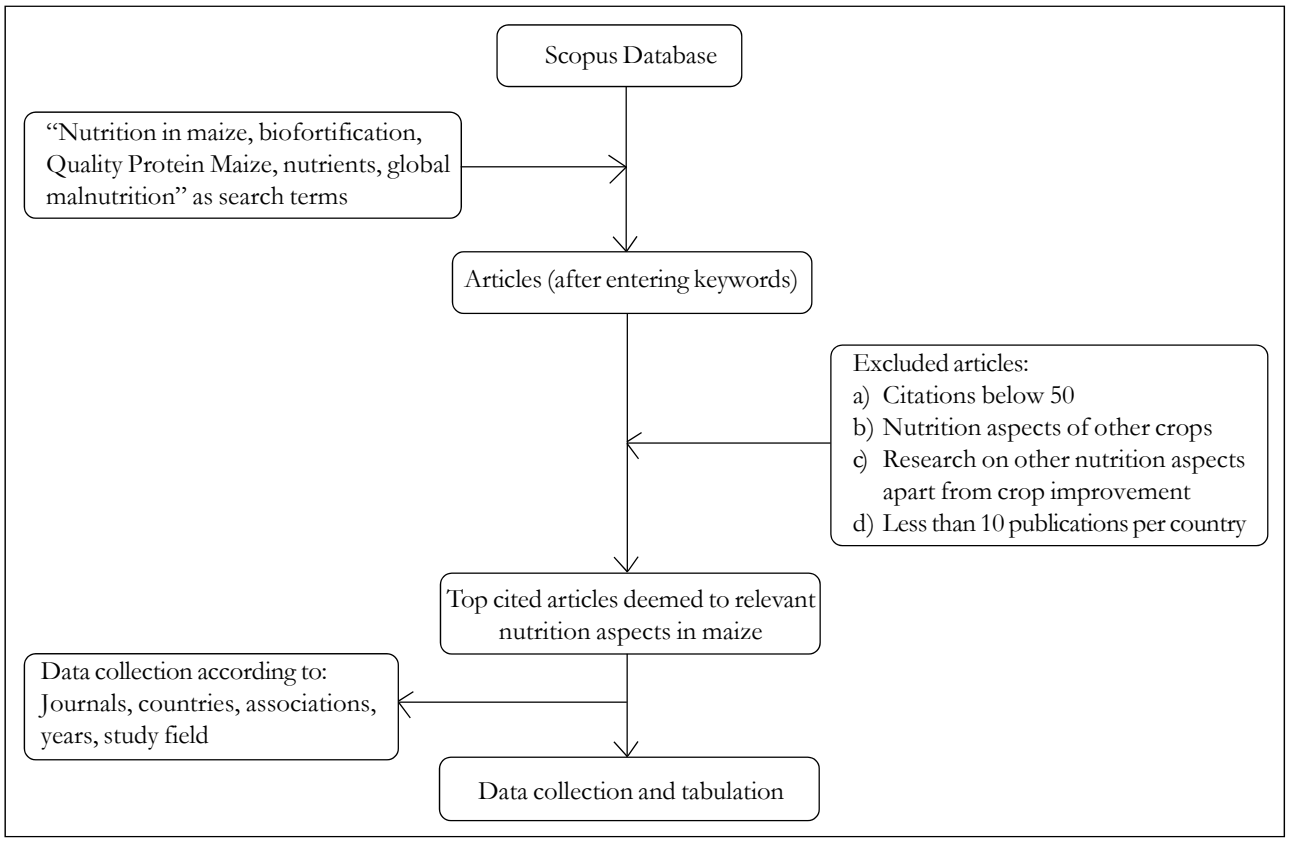

Figure 1: Flowchart showing methodology used in the study

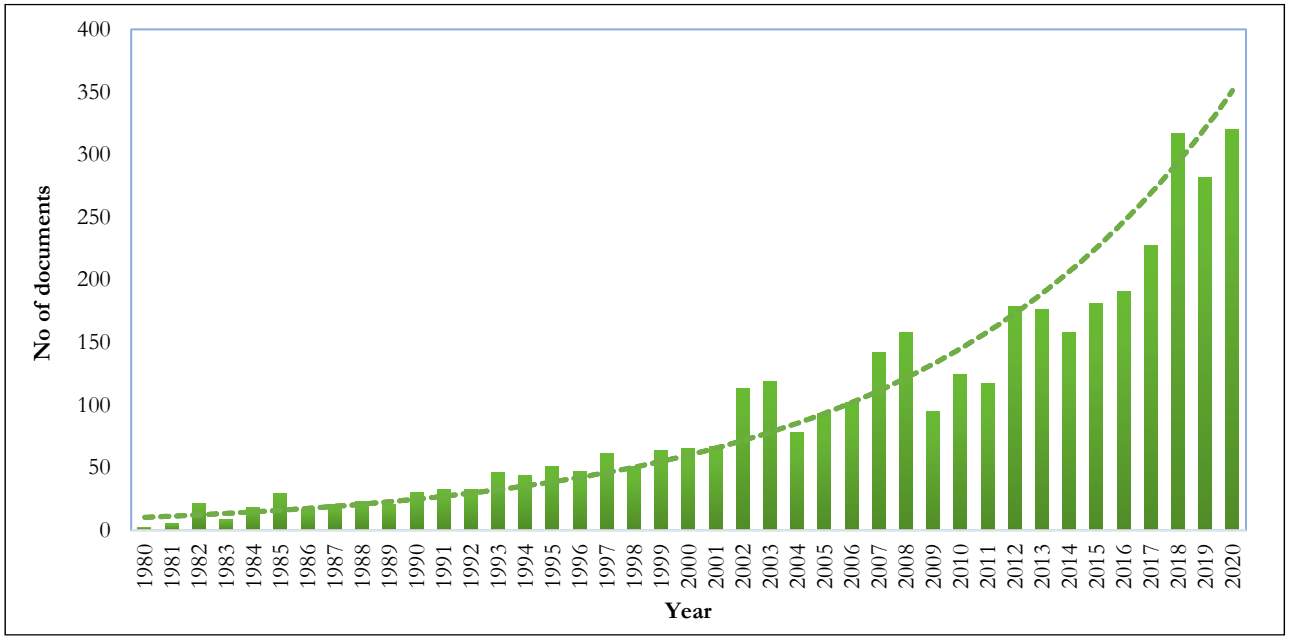

Figure 2: No of documents related to research in the nutrition aspects of Maize (1980-2020)
Source: Scopus Database, 2021

observed. Nutrition plays a very important role in defining maize research in the poor economies

Quality protein maize: Maize proteins contain only 1.81 and 0.35 per cent of lysine and tryptophan, respectively, which is quite low than the FAO recommendation (Motukuri, 2020). Almost 50 per cent of maize protein is zein protein which is completely devoid of two important essential amino acids *viz.,* lysine and tryptophan. Unlike, zein other protein fractions possess balanced proportion of amino acids particularly lysine and tryptophan. Hence, selective reduction of zein fraction can enhance the protein quality in maize. Quality protein maize is nutritionally superior cereal having enhanced levels of lysine and tryptophan amino acids, which are deficient in normal maize. In QPM, mutation at opaque-2 loci reduces the synthesis of zein fraction, thus enhancing the lysine and tryptophan concentration. As compared to normal corn, QPM is having 44 and 33 per cent higher lysine, and tryptophan, respectively (Table 2) in addition niacin availability is also higher due to lower leucine content than normal corn (Onimisi *et al.,* 2009). Gross or metabolizable energy and crude protein content of QPM did not differ with normal maize (Table 2). Moreover, the biological value of QPM protein is (80%) 1.8 times higher than that for normal maize (45%) (Prasanna *et al.,* 2001).

To know the progress in QPM research, an extensive bibliometric analysis was carried out (Figure 3). The selection criteria implied are the minimum number of documents per country *i.e,* 10, followed by a minimum number of 50 citations per country. From the graph, it is clear that the USA is leading the research front on QPM, followed by India and China. Regarding the international research collaboration, it is highest between the USA and China, followed by India and the USA based on the thickness ratio of the nodes. On the contrary, India has the highest research collaboration with the USA (link strength: 7782) followed by Mexico (link strength-3351).

Human trials proved that the introduction of QPM based diet into malnutrition-plagued regions, reduced protein deficiency in children (Marcos, 2005). Chopra *et al.* (2011) conducted a feeding trial on children and found that QPM-fed groups performed best in anthropometric measurements as compared to normal maize, control plus milk-fed, and control diets. Similarly, Mamatha *et al.* (2017) also found that children who get QPM based diet had higher body weight and arm circumference compared to children fed with normal maize grain. As compared to normal corn, a 40 per cent lesser intake of QPM is needed to meet the daily protein requirement of adults (Nuss *et al.,* 2011). Hence, QPM based diet is a better option to reduce

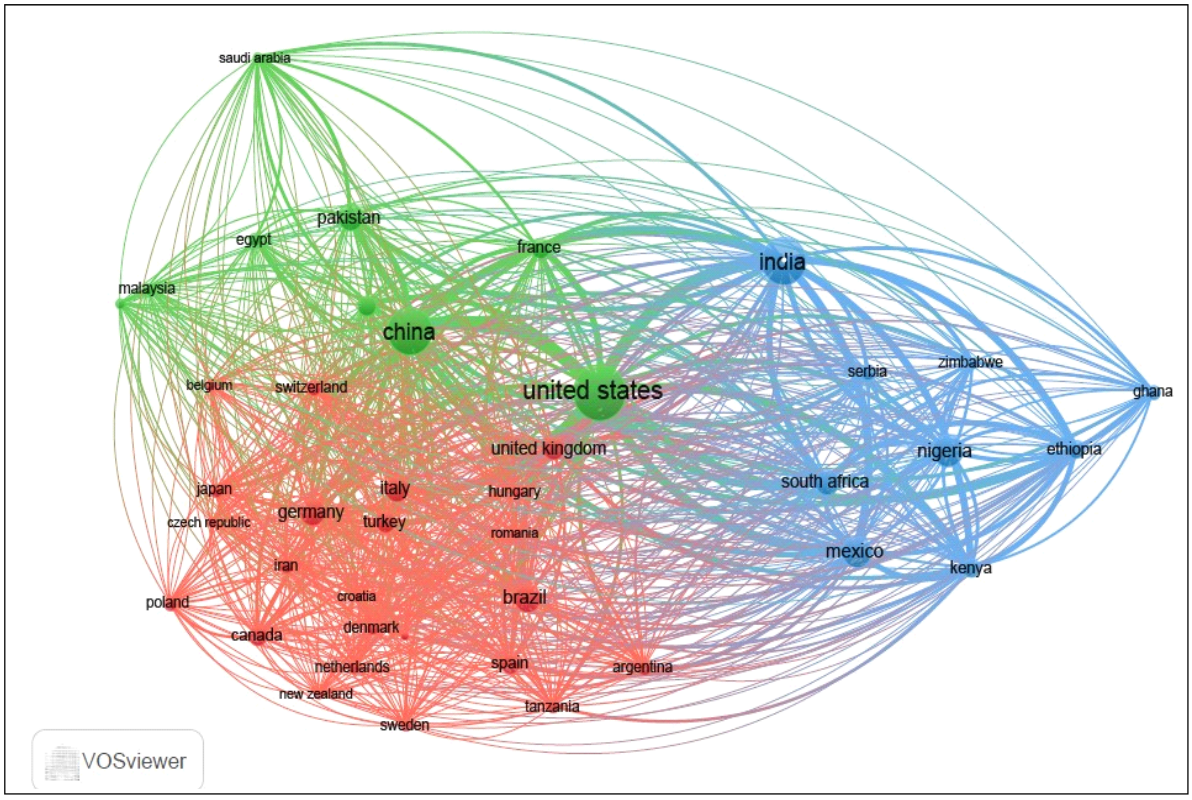

Figure 3: Network visualization map of countries doing extensive research on QPM
Source: Scopus Database (1990-2020)

Table 2: Chemical composition of QPM and Normal Maize

Components	Normal maize	QPM
Gross energy (Kcal/kg)	4127	4084
Metabolizable energy (Kcal/kg)	3351	3369
Crude protein	8.74	8.91
Amino acid (%)		
Arginine	0.39	0.63
Cysteine	0.18	0.27
Histidine	0.24	0.37
Isoleucine	0.28	0.30
Leucine	1.06	0.87
Lysine	0.25	0.36
Methionine	0.17	0.18
Phenylalanine	0.42	0.41
Theonine	0.29	0.36
Tryptophan	0.06	0.08
Valine	0.37	0.51

Source: Panda *et al.* (2011)

protein malnutrition in children who belongs to low socio-economic groups.

Maize is the most preferred cereal for poultry feed because of its higher energy density, low fiber content, and good palatability (Panda *et al.,* 2013). The inclusion of QPM in poultry feed formulations may eliminate the requirement of expensive amino acid supplementation to fulfill lysine and tryptophan deficiency. Hence, in animal nutrition, QPM can provide a cheaper way of obtaining balanced animal feed. Onimisi *et al.* (2009) conducted a feeding trial and observed weight gain in poultry with an increasing proportion of QPM in their diet. Similarly, Panda *et al.* (2010) reported that the replacement of 50 per cent normal maize with QPM in poultry feed significantly improved the body weight gain, feed conversion ratio, humeral immune response, and lowered abdominal fat content. Moreover, lysine supplementation is not needed if normal maize is replaced with 50 per cent of QPM. Nyanamba *et al.* (2003) during a broiler chicks study observed 5% reduction in feed cost when QPM was used instead of normal maize.

CONCLUSION

The bibliometric research revealed that the number of maize articles increased dramatically after the 1990s, coinciding with the introduction of the QPM idea. The United States is leading the way in QPM exploration, followed by India and China. The nutritional value of maize is critical in improving the global malnutrition situation. Our bibliometric analysis of the top-cited publications and countries enables the identification of major advancements and progress in the field of maize nutrition aspects, which can aid in identifying significant maize nutrition research, accelerating the progress of the study, and revealing research trends.

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Conflict of Interest

The authors declare no conflict of interest.

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Screening of Chilli (*Capsicum annum* L.) Genotypes Against wilt Disease

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ABSTRACT

The current study was conducted at the Experimental Field, Division of Vegetable Science and Mycology, and Forest Pathology Laboratory, Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar, with the title "Identification of resistant sources against wilt disease of chilli (*Capsicum annum* L.)" with 3 replications, the experiment was set up in RCBD. The pathogen linked with the disease was identified as *Fusarium solani* based on morphological and clinical traits as well as DNA barcoding. Symptoms of the sickness were induced by the pathogen after artificial inoculation. One genotype (SKAU-193) displayed immune reaction, 22 genotypes showed resistant reaction, and the remaining genotypes all showed moderately resistant, susceptible, or extremely susceptible reaction under field circumstances. 50 genotypes (1-immune, 22-resistant, 27-moderately resistant) were evaluated under artificially inoculated controlled settings to confirm their field resistance. The immunological reactivity of one genotype (SKAU-193) was confirmed, whereas 21 genotypes were determined to be resistant, 17 genotypes to be somewhat resistant, and the other 11 genotypes to be vulnerable.

Keywords: Screening, Chilli, *Fusarium,* DNA Barcoding, Resistant

INTRODUCTION

Chilli (*Capsicum annuum* L.) is a member of the Solanaceae family (2n=2x=24) (Nightshade). Because of the shape of the fruit, which neatly encloses seeds, the genus name Capsicum is derived from the Latin word 'capsa' meaning chest or box. *Capsicum annuum* L., *Capsicum chinense* Jacq., *Capsicum frutescens* L., *Capsicum baccatum* L., and *Capsicum pubescens* L. are the only five domesticated and cultivated species in the genus *Capsicum* (Bosland and Votava, 2000). Because it is difficult to distinguish intermediate forms resulting from natural interspecific crosses due to the large number of species, the former three species (C. *annuum* L., C. *chinense* Jacq., and C. *frutescens* L.) are now treated as a single species (C. *annuum* L.) with four major cultivar groups: *chinense* group (West Indies chilli), *frutescens* group (bird chilli), *annuum* group (hot chilli) and *baccatum* group (sweet pepper).

Chilli is grown on a global scale across 3767 thousand hectares, with a production of 40936 thousand tonnes (FOA, 2018). India, China, Ethiopia, Thailand, Pakistan, Bangladesh, Myanmar, and other major chilli-growing countries include India, China, Ethiopia, Thailand, Pakistan, Bangladesh, and Myanmar. Chilli production in India is the highest in the world, followed by China, Ethiopia, and Thailand. It is planted on 2.15 thousand hectares in Kashmir, with an annual production of 15.76 thousand metric tonnes (HSD, 2017-18). Chilli wilt caused by *Fusarium* wilt has become a severe concern in India during the last decade, with disease incidence ranging from 2-85% in various regions (Anoymous, 2005). In the Kashmir division of Jammu and Kashmir State, Najar (2001) discovered *F. pallidoroseum* and *R. solani* as the cause of chilli wilt. Chilli wilt is characterised by brown vascular discoloration, as well as wilting and chlorosis of the leaves, and plant mortality (Wani, 1994). A group of

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soil-borne pathogens is thought to be responsible for the sickness (Madi *et al.,* 2017). Wilt is defined by the plant wilting and the upward and inward rolling of the leaves. The leaves wilt and turn yellow. The disease starts with a mild yellowing of the foliage and withering of the upper leaves, then progresses to a permanent wilt with the leaves still attached after a few days. The plant's vascular system is discoloured by the time symptoms appear above ground, especially in the lower stem and roots (Belwansi, 2012). Because of the disease's complexity, most management techniques are ineffectual. The use of resistant variants is the most efficient and cost-effective way to combat the threat of soil-borne diseases, although the chilli cultivars used in Kashmir are more or less sensitive to the disease. Furthermore, there are just a few resistant sources available in the world's chilli germplasm (Naik *et al.,* 2007).

MATERIALS AND METHODS

Plants exhibiting wilt disease signs were gathered, and an attempt was made to isolate the related pathogen. The stems of the affected plants were washed with running tap water, cut into 5 mm segments, and surface sterilised by soaking for one minute in 0.1 per cent mercuric chloride, followed by three rinses in sterilised deionized water. The bits were blotter dried before being transferred aseptically to potato dextrose agar (PDA) medium in sterile petri plates and incubated at 251°C. The plates were checked on a regular basis, and any outgrowing mycelia were immediately subcultured.

The culture was purified using the single spore isolation technique (Johnston and Booth, 1983). The pure culture so developed was maintained on PDA slants by regular sub-culturing. The isolated fungus linked with chilli wilt disease was examined for its identification using morphological and cultural features in pure culture. The pathogen was identified using descriptions provided by Booth (1977) and Booth and Sutton (1977, 1984).

DNA extraction was done using 400 µl extraction buffer. The fungal mycelium was crushed in extraction buffer using motar and pestle to make a slurry. The mixture was transferred to a sterilized 2 ml microfuge tube and incubated at 65°C in a water bath for 1 hour. After incubation, 4 µl of RNase (20 mg ml^{-1}) was added to cell suspension and again incubated for 10 minutes at 65° with intermittent mixing. After that, 130 µl of 3M sodium acetate, pH 5.2 was added, and the tube was incubated at -20 C for 10 min. The lysate was then centrifuged at 4,000 rpm at 4°C for 15 min and supernatant was transferred to a clean microfuge tube. DNA was precipitated by the addition of 650 µl of isopropanol, pelleted at 4000 rpm for 10 minutes and washed with ice cold 70 per cent ethanol to remove salt contaminants, air dried for 30 minutes and resuspended in 100 µl of Tris-EDTA buffer, pH 8.0.

Primers were designed using manually Oligocalc (http://biotools.nubic.northwestern.edu/OligoCalc.html), ClustalW(http://www. ebi.ac.uk/Tools/msa/clustalo/) and Blast (http://blast.ncbi.nlm.nih.gov/Blast.cgi) online software shown in detail below in Table 1.

PCR amplification was carried out in a reaction volume of 25 µl in 0.2 ml PCR microfuge tubes. The reaction mixture contents are given in Table 2. The amplification reaction was carried out in thermocycler (*Applied Biosystems*). The cycling conditions are shown in Table 3.

Table 2: PCR reaction mixture used for amplification

Constituents	Volume
Autoclaved water	17.8 µl
PCR buffer (1 X)	2.5 µl
$MgCl_2$ (25 mM)	1µl
dNTPs (25 mM)	0.4 µl
Forward primer (10 µM)	1 µl
Reverse primer (10 µM)	1 µl
Taq Polymerase (5 U/µl)	0.3 µl
DNA sample	1 µl
Total volume	25 µl

Table 1: Primers used for amplification

Primer Name	Primer Sequence	Temperature °C
K-Lab-FusOxy-ITS1F2 Primer	5'CCTGCGGAGGATCATT A 3'	63.7
K-Lab-FusOxy-ITS4R2 Primer	5'TCCTCCGCTTATTGAT3'	53.6

Table 3: Thermal cycling conditions used for amplification

Steps	Temperature (°C)	Time	Number of cycles
Initial denaturation	94	5 minutes	1
Denaturation	94	30 seconds	35
Annealing	55	30 seconds	
Extension	72	2 minutes	
Final extension	72	30 minutes	1

The amplified product was electrophoresed on 1% agarose gel in TAE run at 100 volt for 45 minutes and compared with 100 bp DNA ladder. 30 µl PCR product amplified by ITS1F2 and ITS4R2 primers were put in 1.5ml microfuge tubes along with 50µl primer in separate microfuge tubes having a concentration of 10 mmol/µl and were outsourced for sequencing to Agri Genomics Labs, Kerala. The sequenced data was analysed using various bioinformatics tools like: BLAST, CLASTALW and OLIGOCALC for comparative sequence analysis between query sequences and database sequences. The pathogenicity of the isolated organism was established on potted chilli plants (cv. Kashmir Long-1) by confirming postulates of Koch. The method as adopted by Najar (2001) was followed.

On sand maize meal agar medium, the pathogen inoculum was multiplied. The medium was made by autoclaving 90 g dry sieved sand and 10 g maize meal with 40 ml distilled water for half an hour on three days at 1.05 kg cm^{-2} pressure. After that, the sterilised medium was infected with the test fungus and incubated at 25±1°C for three weeks. The flasks were manually shook for a few minutes each day during incubation to ensure uniform development. By properly mixing the inoculums in pots containing sterilised sand soil (2:1) potting mixture @ 10% (w/w), the inoculums were included in pots and allowed to infest soil for 7 days. To keep the pots moist, they were irrigated with tap water on a daily basis.

Chilli seedlings (cv. Kashmir Long-1), grown from surface sterilised seeds in a sterilised sand soil (2:1) potting mixture, were carefully uprooted and transplanted into the sterilised potting mixture containing the test pathogen 7 days previously. Seedlings put into sterilised soil that had not been infected served as a control. 107 lines of chilli germplasm were screened in the field for wilt disease during Kharif 2018 at the Experimental Field, Division of Vegetable Science, SKUAST-Kashmir, Shalimar Srinagar. The experiment was set up in a Randomized Complete Block Design (RCBD) with three replications of each accession, all of which followed the prescribed methods except for plant protection.

Up to harvesting time, all of the test genotypes' observations on percent wilt occurrence were recorded. The disease incidence as a percentage was determined using the following formula:

$$\text{Disease incidence (\%)} = \frac{\text{No. of diseased plants}}{\text{Total no. of plants observed}} \times 100$$

The per cent disease incidence calculated was used to assess the level of resistance and susceptibility of genotypes as per the disease rating scale of Kesavan and Chaudary (1977).

In order to validate field reactivity, genotypes that were found immune, highly resistant, or moderately resistant during field screening were screened again under artificially inoculated controlled settings. The method as adopted for pathogenicity test, was used for the preparation of inoculum and inoculation of test genotypes. The wilt incidence was recorded after 30 days of sowing to assess the level of resistance and susceptibility of each test entry as per the disease rating scale of Kesavan and Chaudary (1977).

RESULTS

The fungus cultures (isolated using tissue bit technology) were purified using the single spore method and kept on PDA by periodic sub-culturing at monthly intervals. The fungus' cultural and morphological characteristics were investigated (Table 4). The purified fungal culture first produced numerous fluffy, fussy white cottony colonies that later turned creamy white with yellowish pigmentation and formed a brownish colour on the petriplate's underside.

The genomic DNA was extracted and loaded for 30 minutes on 0.7 per cent agarose in 1X TAE. For all fungal species, the DNA isolation process was shown to be effective. The gel revealed intact DNA bands around the wells that were free of smearing and degradation.

The amplified product was run on a 1% agarose gel after PCR amplification under usual conditions, and the amplified product of ITS1 and ITS 2 can be seen (620 bp). The size of the amplicon was determined using a 100-bp ladder. The pathogen was gathered from Srinagar (Shalimar) and identified using DNA sequencing after the PCR product was sequenced. Fusarium solani was identified as the pathogen. The BLAST algorithm was used to detect regions of similarity between the query sequence and the NCBI (www.ncbi.nlm.in) database sequence. The sequence designated as Farwa-2 with accession No. MK990041.1 and 523 base pairs was successfully published in GenBank. The pathogenicity of isolated fungi was established by confirming postulates of Koch on potted chilli plants cv. Kashmir Long-1.

Under field conditions, 107 genotypes were tested for wilt disease. Only one genotype of chilli was discovered. *viz.*, SKAU-193 showed immune reaction against wilt disease and twenty two genotypes *viz.*, SKAU-221, SKAU-96, SKAU-177, SKAU-80, SKAU-84, SKAU-89, SKAU-91, SKAU-132, SKAU-173, SKAU-211, SKAU-227, SKAU-216, SKAU-148, SKAU-208, SKAU-231, SKAU-237, Arka Lohit, SKAU-191, SKAU-68, SKAU-77, SKAU-128 and SKAU-106 showed resistant reaction with disease incidence ranging from 10.10 to 27.70 per cent. The remaining genotypes were sensitive, somewhat resistant, or highly susceptible (Table 5).

To confirm the field resistance of fifty-one chilli genotypes, they were examined under artificially infected controlled settings. The findings validated one genotype's immunological response. *viz.*, SKAU-193, resistant reaction of twenty one genotypes viz., SKAU-

Table 5: Field reaction of chilli genotypes to *Fusarium solani*

Genotypes	Disease incidence (%)	Disease reaction
SKAU-193	0.0	I
SKAU-221	11.0	R
SKAU-96	11.0	R
SKAU-177	11.0	R
SKAU-80	11.0	R
SKAU-84	13.8	R
SKAU-89	13.8	R
SKAU-91	13.8	R
SKAU-132	13.8	R
SKAU-211	13.8	R
SKAU-227	13.8	R
SKAU-173	16.6	R
SKAU-216	16.6	R
SKAU-148	16.6	R
SKAU-208	16.6	R
SKAU-231	22.2	R
SKAU-237	22.1	R
Arka Lohit	22.2	R
SKAU-191	22.2	R
SKAU-68	24.9	R
SKAU-77	24.9	R
SKAU-128	24.9	R
SKAU-106	27.7	R
SKAU-43	30.5	MR
SKAU-58	30.5	MR
SKAU-111	30.5	MR
KL-1	30.5	MR
SKAU-218	33.3	MR

Table 4: Cultural and morphological characteristics of *Fusarium solani*

Fungal propagule	Colour	Shape	Size*	Septation
Colony	Initially white gradually turning creamish with yellowish pigmentation	Floccose, sparse aerial mycelium	90 mm dia. in 7 days	-
Mycelium	Hyaline	Smooth, slendrical, branched	1.2-3.6 µm (wide)	Septate
Microconidia	Hyaline	Cylindrical to oval shaped	4.8-9.6 x 1.8-2.4 µm	0-1 septate
Macroconidia	Hyaline	Sickle-shaped, slightly curved at apex & foot-shaped at basal end	17.3-23.1 x 2.4-4.8 µm	3-5 septate
Chlamydospore	Hyaline	Spherical, smooth, intercalary, single or in chains	8.4-12 µm (wide)	-

*Mean of 100 microscopic observations

Table 5 contd...

Genotypes	Disease incidence (%)	Disease reaction
SKAU-224	33.3	MR
SC-104	33.3	MR
SKAU-45	36.0	MR
SKAU-40	36.0	MR
SKAU-160	36.0	MR
IC-561617	36.0	MR
SKAU-38	36.0	MR
SKAU-62	36.0	MR
SKAU-153	38.8	MR
SC-1019	38.8	MR
SKAU-32	41.6	MR
SKAU-188	41.6	MR
SKAU-195	41.6	MR
SKAU-36	44.4	MR
SKAU-73	44.4	MR
SKAU-198	44.4	MR
SKAU-247	44.4	MR
IC-505242	44.4	MR
SKAU-52	47.1	MR
SKAU-139	47.1	MR
SKAU-118	47.1	MR
IC-391082	47.1	MR
SKAU-243	49.9	MR
SKAU-181	55.5	S
Local Kashmiri Chilli-1	58.2	S
SKAU-163	63.8	S
KAU-233	63.8	S
SKAU-122	66.6	S
SKAU-109	72.2	S
SKAU-141	74.96	S
SKAU-157	74.96	S
SKAU-167	80.4	HS
SKAU-249	100	HS
SKAU-251	100	HS
SKAU-257	100	HS
SKAU-259	100	HS
SKAU-261	100	HS
SKAU-263	100	HS
SKAU-265	100	HS
SKAU-267	100	HS

Table 5 contd...

Genotypes	Disease incidence (%)	Disease reaction
IC-413048	100	HS
IC-362021	100	HS
IC-302026	100	HS
SKAU-269	100	HS
IC-565072	100	HS
IC-505203	100	HS
SKAU-271	100	HS
SKAU-273	100	HS
SKAU-275	100	HS
SKAU-277	100	HS
IC-561622	100	HS
IC-278298	100	HS
IC-284648	100	HS
SKAU-285	100	HS
SKAU-287	100	HS
SKAU-289	100	HS
SKAU-291	100	HS
SKAU-293	100	HS
SKAU-295	100	HS
SKAU-297	100	HS
IC-572480	100	HS
IC-343448	100	HS
IC-3446540	100	HS
IC-362010	100	HS
IC-347044	100	HS
IC-561701	100	HS
IC-561721	100	HS
SKAU-299	100	HS
SKAU-302	100	HS
SKAU-305	100	HS
SKAU-310	100	HS
IC-561634	100	HS
IC-505276	100	HS
IC-276117	100	HS
IC-390033	100	HS
SKAU-253	100	HS
SKAU-255	100	HS
IC-344727	100	HS
IC-561615	100	HS

208, SKAU-224, SKAU-218, IC-505242, SKAU-198, SKAU-177, SKAU-211, SKAU-80, SKAU-43, SKAU-191, SKAU-68, Arka Lohit, SKAU-153, SKAU-188, SKAU-173, SKAU-128, KL-1, SKAU-216, SKAU-221, SKAU-96, SKAU-89; moderately resistant reaction of seventeen genotypes viz., SKAU-58, SKAU-40, SKAU-73, SKAU-160, SKAU-118, SKAU-84, SKAU-91, SKAU-106, SKAU-45, SKAU-62, SKAU-32, SKAU-36, SKAU-148, SKAU-132, SKAU-38, SC-1019, SKAU-195; and while susceptible reaction of twelve genotypes viz., SKAU-77, SKAU-231, SKAU-247, SKAU-52, SC-104, SKAU-227, SKAU-237, SKAU-111, IC-561617, SKAU-139, IC-391082, SKAU-243 (Table 6).

Table 6: Reaction of chilli genotypes to Fusarium solani under artificially inoculated conditions

Genotypes	Disease incidence (%)	Disease reaction
SKAU-193	0	I
SKAU-208	13.3	R
SKAU-224	13.3	R
SKAU-218	13.3	R
IC-505242	13.3	R
SKAU-198	13.3	R
SKAU-177	13.3	R
SKAU-211	13.3	R
SKAU-80	13.3	R
SKAU-43	13.3	R
SKAU-191	13.3	R
SKAU-68	13.3	R
Arka Lohit	13.3	R
SKAU-153	13.3	R
SKAU-188	20	R
SKAU-173	20	R
SKAU-128	20	R
KL-1	20	R
SKAU-216	20	R
SKAU-221	20	R
SKAU-96	20	R
SKAU-89	20	R
SKAU-58	33.3	MR
SKAU-40	33.3	MR
SKAU-73	33.3	MR
SKAU-160	33.3	MR
SKAU-118	33.3	MR
SKAU-84	33.3	MR
SKAU-91	33.3	MR
SKAU-106	33.3	MR
SKAU-45	46.6	MR
SKAU-62	46.6	MR
SKAU-32	46.6	MR
SKAU-36	46.6	MR
SKAU-148	46.6	MR
SKAU-132	46.6	MR
SKAU-38	46.6	MR
SC-1019	46.6	MR
SKAU-195	46.6	MR
SKAU-77	60.0	S
SKAU-231	60.0	S
SKAU-247	66.6	S
SKAU-52	66.6	S
SC-104	73.3	S
SKAU-227	73.3	S
SKAU-237	73.3	S
SKAU-111	73.3	S
IC-561617	80.0	S
SKAU-139	80.0	S
IC-391082	80.0	S
SKAU-243	80.0	S

DISCUSSION

The pathogen was identified as *Fusarium solani* based on morphological and pathological characteristics and a comparison to authentic reports. Various workers have previously reported *F. solani* as the causative organism of wilt disease (Hafizi *et al.*, 2014; Patil *et al.*, 2014; Gogoi *et al.*, 2017).

When the fungal pathogen isolated from wilted chilli plants was artificially infected on potted chilli plants using the rhizosphere inoculation technique, typical disease symptoms appeared. The pathogen was re-isolated from artificially inoculated and infected plants, confirming Koch's postulates. Yellowing and wilting in younger leaflets, epinasty, stunning, and yellowing of older leaves, adhering to the plant of dry leaves,

and brown vascular staining of the collar part are the first disease symptoms of *F. solani* inoculated seedlings. Tembhurne *et al.* (2017) and Thoyajakshi Bai *et al.* (2018) reported on the symptomatological development of chilli plants due to *F. solani* infection, which are more or less in agreement with the current findings.

Based on the scale devised by Kesavan and Chaudary, one genotype was classified as immune, twenty-two as resistant, twenty-eight as moderately resistant, totaling fifty-one genotypes, and fifty-six as susceptible and highly susceptible, totaling fifty-six genotypes (1977). Only one genotype was discovered immune, twenty one was found resistant, seventeen was found moderately resistant, and twelve showed susceptible reactivity when these fifty one genotypes were evaluated under controlled conditions. Similar efforts have been made earlier to identify chilli germplasm with varied levels of resistance by (Jabeena *et al*., 2009; Tembhurne *et al*., 2017; Singh *et al*., 2017; Shoba *et al*., 2018).

In the present study the ITS amplification with genera and species specific ITS primers, clearly identified *Fusarium solani*, based on amplification and size of amplicons which were identified with ITS primer combination viz., K-Lab-FusOxy-ITS1F2 and K-Lab-FusOxy-ITS4R2. The primers directed the amplification of 523bp ITS rRNA uniform amplicons in *Fusarium solani*. The present result was also in conformity with other workers (Larena *et al*., 1999; Arif *et al*., 2013; Datta and Lal, 2013).

CONCLUSION

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Testing of Wheat Establishment under Different Rice Residue Management Techniques

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ABSTRACT

The effect of different rice residue management and wheat establishment methods on wheat yield and economics is reported in this paper by conducting a farmer participated experiment in Ferozepur district with aim of timely sowing of wheat crop at low cost to get higher yield. High wheat sowing cost and delay in sowing due to rain are major concern for farmers. Different rice residue management methods including rice residue removal, residue incorporation and residue retention on soil surface as mulch were evaluated. Wheat seed broadcasting method being statistical at par with happy seeder and super seeder methods of wheat establishment recorded significantly (p<0.05) higher (9.9 %) grain yield ha^{-1} than conventional sowing. Rice residue management methods have non-significant effect on wheat plant height. Seed broadcasting method significantly increased effective tillers m^{-2} as compared to conventional sowing. Spike length, number of spikelets spike^{-1}, 1000-grains weight was affected non-significantly by rice crop residue management methods. Seed broadcasting gave high gross return (Rs. 120496.3 ha^{-1}), net return (Rs. 92684.3 ha^{-1}) and benefit cost ratio (3.3) because of low cost of cultivation (Rs. 27812.0 ha^{-1}) followed by super seeder and happy seeder methods of wheat establishment.

Keywords: Wheat, Rice, Residue management, Super seeder, Happy seeder, Broadcasting, Mulching

INTRODUCTION

The Rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) cropping system has been the major cereal based cropping system of north-western India, which constitute the part of Indo-Gangetic Plains (Bhatt *et al.*, 2019; Bhatt *et al.*, 2021). The sustainability of rice-wheat cropping system has been questioned since last about three decades due to rapidly declining ground water table (Bhatt *et al.*, 2021), large emission of greenhouse gases (GHGs) (Singh *et al.*, 2020; Singh *et al.*, 2021a), decreased soil health (Sharma *et al.*, 2020), for which open field rice residue burning is considered responsible. Over the last about one decade, several rice residue management technologies have been adopted by the farmers in the north-western India (Singh *et al.*, 2020; Singh *et al.*, 2021b) with variable impact on crop productivity (Sharma *et al.*, 2022), soil health, nutrient use efficiency (Sharma *et al.*, 2021) and C sustainability. In north-western India, farmers have preference for long-duration rice varieties, with potential of production of large quantities of rice residue after harvesting. On an average, the rice produced 1.8-2.5 times higher residue compared to grains (Datta *et al.,* 2020). In the state of Punjab estimates showed the production of 22.9 million tonnes (MT) of rice and 23.1 MT of wheat residues annually (Kaur Arjinder, 2017), of which about 21.8 MT of rice residue and 5.3 MT of wheat straw are burnt in the fields. Rice residue burning results in loss of nutrients e.g. 100% N, 20% P, 20% K and 80% S (Sharma and Mishra 2001). It is estimated that burning of one ton of straw cause loss of N (6-7 kg), P (1-1.7 kg), K (14-25 kg) and S (1.2-1.5 kg) (Bimbraw 2019). Additionally, rice residue burning results in loss of micro-nutrients, organic carbon (C) and micro-organisms living in soil, causing detrimental impact on soil health. About 25% N and P, 75% of K and 50% of S taken up by cereal crops are retained in crop residues (Shahid *et al.*, 2013).

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The present study was therefore conducted to investigate the impact on rice residue management and wheat cultivation on agronomic attributes of wheat, crop productivity and economics of different rice residue management strategies in wheat.

MATERIALS AND METHODS

The study area located in three villages viz. Wara Chain Singhwala (30°55'12"N,75°01'48"E), Mankianwali (30°56'30"N ,74°51'21"E) and Thatha Kishan Singh (30°01'20"N,74°54'53"E) of Ferozepur district in western plain zone of Punjab. Ferozepur district is divided into six blocks. Three rice crop residue management methods including rice residue removal, residue incorporation and residue retention on soil surface as mulch were evaluated during *rabi* seasons of 2020-21 and 2021-22. The four treatments include wheat sowing with happy seeder (HS) in uniformly scattered loose straw and standing stubble of rice as residue retention at soil surface, Wheat sowing with Super Seeder (SS) in uniformly scattered loose straw and standing stubble of rice as residue incorporation, Wheat seed broadcasting (BC) in rice standing stubble with uniformly scattered loose straw (15 cm height) followed by mulching operation with mulcher and conventional sowing (CS) with normal drill in fine prepared field after previous rice residues removal with baler. Cultural practices like seed treatment, fertilizer application, weed control, irrigation and plant protection were adopted as per recommendations of Punjab Agricultural University, Ludhiana. Rice was harvested with combine harvester without super straw management system (Super SMS). Rice loose straw was scattered uniformly in experimental area. The wheat variety HD 3086 was sown in first week of November 2020 and 2021. Seed was treated with insecticide Dursban 20 EC (Chlorpyriphos) @ 4 ml kg^{-1} wheat seed and fungicide Vitavax 75 WP (Carboxin) @ 2 gm kg^{-1} wheat seed. In HS treatment 100 kg ha^{-1} of wheat seed was sown with Happy Seeder in standing rice stubble. Wheat crop was sown with seed rate 100 kg ha^{-1}at row to row distance 22.5 cm. To supply phosphorus 162.5 kg ha^{-1} of DAP was drilled at sowing and urea 200 kg ha^{-1} was applied in two equal splits each of 100 kg ha^{-1} before first irrigation (21 days after sowing) and second irrigation (60 days after sowing). In SS treatment wheat was sown in standing rice stubble with Super Seeder which plough standing stubble in soil and sow wheat simultaneously. Working width of Super Seeder was 211 cm. Row to row distance was 19 cm. Seed rate and fertilizer application similar to Happy Seeder method. In BC treatment of wheat sowing 125 kg ha^{-1} seed was broadcasted followed by broadcasting of DAP 137.5 kg ha^{-1} in standing rice stubble and a mulcher was operated in the field which spread the rice straw on ground as mulch. Irrigation was applied immediately after operating the mulcher. Top dressing of first dose of Urea 110 kg ha^{-1} was done after 21 days after sowing followed by irrigation. Second dose of Urea 110 kg ha^{-1} was applied after 60 days of sowing and field was irrigated. In CS treatment previous rice crop residues were burnt in field. Pre-sowing irrigation (rauni) was given and field was prepared. Wheat was sown with normal drill with seed rate 100 kg ha^{-1}. Row to row distance was 20 cm. DAP 137.5 kg ha^{-1} was applied at sowing. Urea 112.5 kg ha^{-1} was applied with first (21 days after sowing) and second irrigation (60 days after sowing).

Data on 7 yield attributes viz. plant height (cm), plants m^{-2}, number of tillers m^{-2}, spikelets $spike^{-1}$, spike length, 1000 grain weight (gm) and grain yield q ha^{-1} were recorded during *rabi* seasons of 2020-21 and 2021-22. Data on grain yield were recorded by manually wheat harvesting from a net plot area of 16 m^2 (4.0 m x 4.0 m) at 10 per cent moisture content. Cost of cultivation, gross return, net return and benefit cost ratio (B:C ratio) were computed to compare the economics of different rice residue management treatments.

Data on grain yield and yield attributes under different treatments were compared using Least Significant Difference (LSD) test. Statistical analysis was performed with SPSS statistical program (SPSS Inc., Chicago, USA). Difference in treatments' mean at (p<0.05) was considered statistically.

RESULTS AND DISCUSSION

Wheat emergence per m^2 was significantly affected by rice crop residue management methods. SS treatment being at par with HS treatment recorded significantly (p<0.05) more plants m^{-2} than BC and CS treatments. Slightly less emergence in BC treatment was due to straw and stubbles of rice crop limits seed to soil contact even with mulcher operation. Singh *et al.* (2011) observed non-significant effect of mulched and non

mulched condition on emergence count m^{-2} of wheat crop. Rice crop residue management methods have non-significant effect on wheat plant height. However, plant height was slightly higher with BC treatment followed by SS and HS (Table 1). This was possibly due to conservation management practices enhanced micro-environment (Kumar, 2016). Rice crop residue management methods significantly affect wheat effective tillers m^{-2} (Table 1). BC treatment has significantly increased effective tillers m^{-2} as compared to CS treatment but was statistically at par with SS and BC treatments. BC treatment gave 298 effective tillers m^{-2} which were 11.4 per cent higher than CS treatment. Bohara and Kumar (2015), Sharma *et al.* (2006) also reported similar results. Spike length was affected non-significantly by rice crop residue management methods. However, BC treatment gave more lengthy spikes than CS treatment (Table 1). Rice crop residue management methods failed to affect number of spikelets $spike^{-1}$ significantly (Table 1). BC treatment increased number of spikelets $spike^{-1}$ as compared to CS treatment. These findings are in close agreement with Bohra and Rakesh (2015) and Sharma *et al.* (2006). Rice crop residue management methods revealed no significant affect on 1000-grains weight of wheat. BC treatment slightly increased 1000-grains weight of wheat (Table 1). These results are in close conformity with the findings of Bohra and Kumar (2015) and Sharma *et al.* (2006). Rice crop residue management methods recorded significant effect on wheat grain yield (Table 1). Significantly higher grain yield 53.8 q ha^{-1} was observed with BC treatment which was 9.9 per cent higher than CS treatment with grain yield 48.5 q ha^{-1}. BC treatment was statistically at par with SS and HS treatments. Higher grain yield in BC treatment was possibly due to higher value of growth parameters and yield attributes. Similar results were also reported by Bohra and Kumar (2015), Sharma *et al.* (2006). Improved soil moisture retention in BC treatment mitigates the effect of terminal heat stress (Gathala *et al.*, 2011a).

High net return (Rs. 92684.3 ha^{-1}) and low cost of cultivation of wheat crop (Rs. 27812.0 ha^{-1}) was recorded in BC treatment with higher benefit cost ratio (3.3) followed by SS and HS treatments (Table 2). However, highest cost of wheat cultivation (Rs. 33694.3 ha^{-1}) & lowest net return (Rs. 75033.2 ha^{-1}) was observed in CS treatment with lower benefit cost ratio (2.2).

CONCLUSION

Wheat crop in BC treatment gave significantly higher grain yield with low cost of cultivation and higher net return. Higher cost of cultivation in CS treatment reduced net return. Higher cost of fuel (Diesel), more number of operations for field preparation for sowing increased the cost of cultivation in CS treatment.

Table 1: Effect of rice residue management treatments on emergence count m^{-2}, plant height, effective tillers m^{-2}, spike length, number of spikelets $spike^{-1}$, 1000-grains weight and grain yield

Treatments	Emergence m^{-2}	Plant height (cm)	Effective tillers m^{-2}	Spike length (cm)	Number of spikelets $spike^{-1}$	1000-grains weight (g)	Grain yield (q ha^{-1})
HS	231.0^{ac*}	79.8^{a}	280^{ab}	30.2^{a}	30.2^{a}	42.6^{a}	51.0^{ab}
SS	234.3^{a}	80.7^{a}	289^{a}	30.6^{a}	30.6^{a}	42.4^{a}	53.0^{a}
BC	222.7^{b}	81.3^{a}	298^{a}	32.1^{a}	32.1^{a}	42.9^{a}	53.8^{a}
CS	229.2^{bc}	79.1^{a}	264^{b}	29.9^{a}	29.9^{a}	41.8a	48.5^{b}

*Mean values followed by different letters are significantly different from each other at $p<0.05$ by Least Significant Difference (LSD) test.

Table 2: Effect of rice residue management treatments on economics of wheat cultivation

Treatments	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
HS	27761.8	114325.0	86563.2	3.1
SS	28993.0	118815.0	89822.0	3.1
BC	27812.0	120496.3	92684.3	3.3
CS	33694.3	108727.5	75033.2	2.2

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Performance of Farmer Producer Companies in South Dinajpur District, West Bengal

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ABSTRACT

The present study is aimed at assessing the performance of purposively selected four Farmers Producers Company of Dakshin Dinajpur district, West Bengal. Performance index was calculated and found that Purnobhava Agro Farmer Producer Company Limited had the highest index value of 10.46. Trimohini Farmers Producer Company Limited came in second with an index value of 8.29. Krishi Jagoron Producer Company Limited was in third place (score 8.00) and Bhuihara Farmers Producer Company Limited, with a score of 6.83, was in the fourth position. The finding is supportive with the findings of the grading score of the four FPCs calculated as per NABARD's criteria. Technical efficiency score of the fish farmers, vegetable farmers and cereals crop farmers under the selected FPCs were also analyzed and found that the average measure of overall technical efficiency was 22.2 per cent for cereal crop farmers, 44.3 per cent for vegetable farmers and 63 per cent for fish farmers. Average scale efficiency was estimated at 79.4, 96.8 and 98.6 per cent for the said categories of farmers, respectively. Majority of the cereals crop farmers (93%) and a sizeable population (60%) of vegetable farmers were operating under sub-optimal scale. However, around 20 per cent of the fish farmers were operating under sub-optimal scale. The analysis indicates crop, vegetable and fish farmers can, on an average, increase their output by 78, 56 and 38 per cent, respectively by operating at an optimal scale and by eliminating pure technical inefficiencies through the adoption of best practices of the efficient farms

Keywords: Farmer producer company, Performance, Technical efficiency, Farmers' income

INTRODUCTION

Farmer Producer Company (FPC) is a hybrid between private limited companies and cooperative societies, registered under Companies Act, 2013. It is a registered body with farmers and producers as shareholders in the organization. It deals with business activities related to the farm produce and it works for the benefit of the member producers. It focuses on enhancement of farmers' capacity through advanced agricultural practices to increase productivity. In case of developing countries like India, where agriculture is dominated by small and marginal farmers with limited resource base, FPOs can play an important role by mobilizing and organizing them for better market access, higher bargaining power, and higher price to their produce, better information dissemination (Bachke, 2009), to bring economies of scale, reduce transaction costs and risks of farmers (Markelova *et al.,* 2009). FPC facilitates access to fair and remunerative markets including linking of producer groups to marketing opportunities through market aggregators. It undertakes many activities starting from procurement of inputs to disposal of produce and acts as a bridge between production and marketing. Government of India is promoting FPCs by mobilizing the farmers and helping them in registering as companies through Small Farmers' Agribusiness Consortium (SFAC) and National Bank for Agriculture and Rural Development

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(NABARD). Presently, around 7374 FPOs (including FPCs) are in existence in the country (Govil *et al.,* 2020). Small-scale farmers can have easy access to market information, credit and input for their production, processing, and marketing activities by joining Farmer Based Organizations (Asante *et al.,* 2011). Government of India has set a target of forming 10000 FPOs in agriculture with 500 FFPOs in fisheries sector. The Union Government has recently (in June 2020) launched Pradhan Mantri Matsya Sampada Yojana with an outlay of Rs 20,050 crores to turn India into a hotspot for fisheries and aquaculture products. There is clear shift in focus from production, productivity to quality produce, market and profit.

However, forming FPO is just the beginning; it needs to be strengthened so that it is enabled to run as a business entity. For an enterprise or any venture to be efficient all the intermediaries involved in the value chain system should be given importance. Though production plays an important role, post production factors also equally contribute to the success of an enterprise. If the FPO is to fulfill its purpose of being competitive in the value chain, it has to function like an agri-business company and think like a start-up even as it maintains member trust and allegiance. However, in spite of the widespread evolution of FPOs, their success across the world had shown mixed results (Chirwa *et al.,* 2005). Perhaps most critical, and yet less discussed, are the challenges that FPOs face in building both capacities and confidence. Similar situation is also observed in India. Producer companies are a promising tool to strengthen farmers' position in their relationships with supermarket chains in India; however, they need further improvement (Trebbin, 2014). According to recent statistics, only 14 per cent of farmer producer companies (PCs) in the country have paid-up capital of 10 lakh or more. On the other hand, 49 per cent of PCs have paid-up capital of 1 lakh or less (Govil *et al.*, 2020)

With the Government laying adequate emphasis for such innovative institutional approaches, it would be prudent to carry out an appraisal of performance of FPCs for better understanding and suggest mid-course correction. It would be important to understand how effective the FPCs are in managing the value chain. It is also necessary to identify the technical efficiency in various production practices of the member farmers under FPCs in running their business. With this background the study was conducted in 2022 to analyse the performance of four selected FPCs *vis-a-vis* technical efficiency in production practices of member farmers.

MATERIALS AND METHODS

The study was conducted in Dakshin Dinajpur district of West Bengal. Four different FPCs were selected from a variety of agricultural industries including cereals crops, horticulture, fishery, poultry, vegetable, seed, etc. The FPCs were selected purposively based on the two criteria of running more than 3 years and having membership of more than 400 farmers. Twenty member farmers from the each FPC were selected by simple random sampling method. Four official members of staffs including three directors and CEO of the FPC were also interviewed for the purpose of the study. Data were collected by semi structured interview schedule developed for the study.

Performance is the process or action of performing a function. In this research we have operationalize performance as how effectively the producer company carries out that its functions. It is more closely related to organisational performance, which measures how well a group of people who have been brought together with a common goal carry out a task. In an organization like Farmers Producer Company, it is important to take care of farmers satisfaction, empowerment, increasing income of farmers, ensuring value chain management, functional easiness, inclusiveness etc. By combining all these a performance index has been prepared in the line of Mukherjee (2018) which is used in this study. The index includes seven components (1) Functioning efficiency, (2) Increase in income, (3) Increase in farmers share in consumers rupee (4) Inclusiveness, (5) Sustainability of Farmers Producer Company, (6) Farmers satisfaction and (7) Empowerment.

The index was prepared based on the above-mentioned parameters and was calculated by the following equation.

$$E_{FPC} = \frac{FE \times W1 + I \times W2 + FSC \times W3 + Inc \times W4 + S \times W5 + FS \times W6 + E \times W7}{\sum_{i=1}^{7} Wi} \times 100$$

Where, E_{FPC} =Indicates The effectiveness of the particular company

(1) FE = Functioning effectiveness,

(2) I = Increase in Income,

(3) FSC= Increase in farmers share in consumers' rupee

(4) Inc = Inclusiveness,

(5) S = Sustainability of farmers producer company

(6) FS= Farmers satisfaction and

(7) E = Empowerment

W_i are respective weight calculated based on Analytical Hierarchy Process (AHP) of experts rating to the seven components based on Saaty (2008). The weights for each component were assigned based on experts judgments using Analytical Hierarchy Process (AHP) in line with Mukherjee, (2018).

The technical efficiency of a farm can be defined as the ability and willingness of the farm to obtain the maximum possible outcome with a specified endowment of inputs. Technical efficiency has both input and output orientations (Kamgna and Dimou, 2008).

Data envelopment analysis (DEA), a nonparametric method for estimating technical efficiency, is used in this study. It calculates the efficiency frontier using a mathematical programme. The pre-specification of the production function coefficients is not required. Contrary to parametric methods, DEA does not assume the distribution of the underlying data and assumes that all deviations are the result of inefficiency (Banker *et al.*, 1989). Farms are examined separately by DEA, and efficiency is calculated in relation to every observation in the sample.

Technical efficiency has both input and output orientations (Kamgna and Dimou, 2008). The output-oriented approach measures a production unit's capacity to produce as much as is feasible given a particular set of inputs and production technology (Coelli *et al.*, 2005). Technical inefficiency thus refers to either a production that is below the technical limit for a given quantity of inputs and a given technology, or a use of input quantities that are above the limit required for a given level of output. According to (Kontogeorgos *et al.*, 2017).

In this study, the case of single output, which is the gross return and five inputs were considered. All the inputs were converted into money for using across different farmers (Table 2). The inputs were field/pond preparation, seed (including seed treatment), labour, fertilizer/feed/chemical/micronutrients and others. Technical efficiency of scale and pure technical efficiency make up the DEA model's technical efficiency. Technical efficiency (inefficiency) scores from a CRS DEA (total technical efficiency) have been divided into two parts in numerous studies. While scale efficiency, or scale technical efficiency, determines whether a production unit operates at an optimal scale or not, pure technical efficiency reflects how resources are managed within the production unit. The proportion of total technical efficiency that is solely attributable to technical efficiency is expressed by one, which is due to pure efficiency (inefficiency) (VRS DEA). The second one, which is supplied by scale efficiency (inefficiency), is the portion of total technical efficiency that can be accounted for by the compatibility of the production scale that the bank uses. The best scenario in which the production unit can be achieved by increasing proportionately the quantity of all its factors is referred to as the optimal scale in this context.

If these two types of DEA show different efficacy ratios for a given firm, this suggests that the firm is not scaling up or down at the right scale. Scale inefficiency is then determined by the difference between the technical inefficiencies of the CRS and VRS. One can investigate the cause of efficiency or inefficiency level by following this pattern. The relative nature of this efficiency estimate results from its dependence on the sample's most effective units.

Let Y be the output vector and X be the input matrix of order k n. There are k inputs in this case. Thus, Xi and Yi stand in for the respective inputs and outputs for farm it. The issue now boils down to getting a ratio measure of 'Yi / v' Xi, where' and' stand for the input and output weights, respectively. Optimal weights are obtained by solving the following mathematical program:

$$\text{Max}_{\mu,\nu} (\mu_i' Y_i / \nu_i' X_i)$$

Subject to

$$\mu' Y_j / \nu' X_j \leq 1, \; j = 1, \ldots, n$$

$$\mu, \nu \geq 0$$

In order to avoid infinite number of solutions, imposing a constraint $\nu' X_j = 1$, we get

$$\min_{\theta,\lambda} \theta$$

subject to

$$-y_i + Y\lambda \geq 0$$
$$\theta x_i - X\lambda \geq 0$$
$$\lambda \geq 0$$

In this case, a scalar and an n-1 vector of ideal weights are present. The technical efficiency (TE) corresponded to a constant return to scale is represented by the symbol (CRS). The technical efficiency under variable return to scale is achieved by imposing an additional constraint (VRS). The DEA model's efficiency measurements can be used to calculate both scale and pure technical efficiencies (TECRS/TEVRS). The sum of these two determines technical efficiency overall. Efficiency scores are calculated in this study using the DEAP Ver. 2.1 computer programme, which is described in Coelli (1996).

RESULTS AND DISCUSSION

Below is a description of the contextual, structural, and operational performance of the four Farmer Producer Companies that were chosen:

Purnobhava agro farmers producer company limited: Purnobhava Agro Farmers Producer Company Limited is situated at Nildanga in Jalalpur, Gangarampur. There are almost 1000 people who are connected to this company. With the assistance of the supporting NGO ACCESS Development Services, with support from SFAC (Small Farmers Agribusiness Consortium) the company was officially constituted as a Farmer Producer Company in 25th July 2019. Before that, there were several Farmer Interest Groups (FIGs) in the nearby villages. It is one of the most active FPCs in the district, associated with diverse activities ranging from intercropping to giving District Rural Development Cell (DRDC) training to women under the "*Egiye Bangla*" Scheme of the Government of West Bengal. Recently the office of the directors has been shifted inside the premises of Gangarampur Kisan Mandi which is actually helpful for them to store their product in the warehouse and cold storage of the *krishak bazar*. The vision of the Purnobhava Agro Farmer Producer Company is: "to provide inclusive, innovative livelihood solutions and enable the poor to overcome poverty and live with dignity." Its mission is to build the capacity of community-based institutions that deliver relevant financial and livelihood services to the poor and unreachable households. The organization is guided and governed by a very efficient Board of Directors (BOD) including an enthusiastic CEO. They are constantly advising members on new farming practises and how to get the best price by selling their products through them. PurnobhavaAgro Farmer Producer Company Limited mainly focuses on mustard production and marketing, as mustard is grown on a large scale in the district. They provide it to the local oil mills and sell it to other parts of the state as well as several other states, including Delhi and Uttar Pradesh. Wheat is another major crop that is grown on a large scale in the local climatic conditions. They collect wheat from members as well as non-members and export it to neighbouring countries. In 2020, they sold it to Singapore via Bangalore. As insects become more resistant to insecticides, farmers are attempting to reduce the use of pesticides and insecticides in favour of intercropping and focusing on organic farming. They always try to introduce new and sustainable farming techniques to utilize the natural resource without harming the eco-system. Many women got training under the Utkarsh Bangla training programme and engaged themselves in various jobs like making school uniforms and cooking in the mid-day meal scheme of schools. Every year they have a yearly training programme in Kolkata in the head office of their mother institution ACCESS Development Services. For payment they have payment guarantor National Commodity & Derivatives Exchange Limited (NCDEX). The future plan of the FPC is to construct a large godown and a processing mill.

Trimohini farmers producer company limited: Trimohini Farmers Producer Company Limited is situated at Garna, in Hili Jamalpur. They started working as farmers' club in the year 2015. It is operationally sound with best use of certified seed production and marketing. Today the company is a leading producer

company in this field. There are more than 600 farmers working day and night for the company. This company is involved in crop production, crop protection and exploring marketing platform to the producer members in ameliorating the economic status by value addition to their produce. They have gained success by applying their training knowledge to producing certified BNKR-1 (Dhiren) variety, Swarna rice (MTU 7029) and D54, B14, B9 varieties of mustard seed and sell their seed throughout West Bengal and the rest of the country, particularly in the North Eastern states. The missions of the FPC is to organise the small growers and raise living conditions by making greater use of new technologies for growing, processing, and selling crops, vegetables and fish seed. Trimohini FPC is mainly working on foundation and certified rice and mustard seed production. They have gained success by producing the certified BNKR-1 (Dhiren) rice variety, which is a late-maturing, non-lodging cultivar that takes 130-142 days from seed to seed. It has a moderate level of resistance to leaf blast, neck blast, brown spot, sheath rot, and leaf folder. It yields 5000–5500 kg/ha on average. The grain is short and bold. The foundation seed of Swarna rice (MTU 7029), which has high adoptability, low nitrogen responsiveness, and is a bacterial blight tolerant variety with a stable yield, has been produced by some of the progressive farmers. Aside from that, they have produced and distributed D54 black mustard seed, B14 certified yellow mustard seed, and an improved B9 variety to many small and marginal farmers throughout the state. They have few fish seed production centre where they produce mainly seed of Singhi, Koi, Magur, Tangra, Gulsha, Pabda etc. Women are also engaged in binding of biri (locally produced usually from cut tobacco rolled in leaf). Some member farmers are cultivating different seasonal vegetables, like cucumber, bottle ground, pointed ground, pumpkin, and during the winter mainly potato, tomato, radish, beet root, cauliflower, etc. They rely on the local market district market and outside of the state to sell their produce.

Bhuihara farmers producer company limited: Bhuihara farmers Producer Company Limited is one of the important Farmers Producer Company working mainly on fish production and marketing situated at Panchagram, Bhuihara, in Dakshin Dinajpur district. Bhuihara Farmer Producer Company limited is established on 14th November 2019 under the able guidance of Nowpara Teor Samaj Kalyan Samiti, Hili, with the 515 members group. Its authorized share capital is Rs. 1,000,000 and its paid up capital is Rs. 850,300. The company seeks to empower and provide a sustainable life for small and marginal farmers. They provide both forward and backward linkage to the member farmers. They aim to become self-sufficient in all phases of fish farming and food production. They intend to do this by obtaining financial assistance from the government to construct a fertilizer production facility and outlet store. As the area is filled with numerous ponds (both natural and man-made), most of the rural people are engaged in fish farming. Indian major carp (IMC) that is rohu, catla, mrigal is the main culture species; along with that, silver carp, grass crap, american rohu, magur, singhi, tangra, are some of the other important culture species. Most of the individual farmers produce fish on their farms, and the harvested fish is weighted, loaded onto tracks, and sold directly to the markets of Malda, Siliguri, Assam, and some other states. At the start of the cultural period, the company signs a contract with farmers. Accordingly, companies provide fish seed, which they bring from local hatcheries, to the farmers, then provide fish meal, take care of the fish's health, and finally sell their produce at a profitable price and at a desired quantity.

Krishi Jagoron Kendra producer company limited: Krishi Jagoron Kendra Producer Company Limited is listed with the Registrar of Companies in Kolkata as a Non-govt company. Both its paid-up capital and authorized share capital are Rs. 500,000. It is involved with crop cultivation, market gardening, horticulture and animal husbandry. They are an MSME-registered company with registration number UDYAM-WB-19-0001147. The mission of the company is "to be the leading centre providing student farmer–responsive training and services for development of Agriculture and agro-industry". To spread for boosting production, rural development, and improving the standard of living for farmers, Krishi Jagoron Kendra is still steadfastly devoted. The major objectives of the Krishi Jagoron Kendra Producer Company Limited are:1. Collective marketing of Farmers produce at the best price option. 2. Removing middlemen who influence

product prices. 3. Assist the Farmers in marketing their producer directly to the seller/buyer to get a fair market price. 4. Capacity building of the farmers on better productivity, updated technology, storage practices, grading, packing etc., to add value to their produce for better income. 5. Providing agricultural input supplies like fertilizers, pesticides, lime, agricultural implements, etc., at lower than market costs. 6. Providing technical expertise and guidance to the farmers for growing their crops. 7. Create a stronger market for coffee, pepper and other produce through value addition and make the industry a "profitable profession," which will in turn encourage the younger generation to look at the agricultural industry as a sustainable profession. The company often also agrees to support the farmer through, e.g., supplying inputs, assisting with land preparation, providing production advice and transporting produce to its premises. They have started lemon grass farming as their new venture, as its demand has been increasing day by day. The Khaki Campbell duck variety has been distributed among the members as a part of their animal husbandry project, especially to make self-sustaining women farmers. Some of their other projects include the lac culture project, the Kadaknath project, tissue culture, integrated farming, etc. Now some progressive farmers cultivate fruit farming as one of their major activities and have gained success, which encourages other fellow farmers to start this type of farming and earn some more profit if their land is suitable for it.

NABARD's FPO Classification: The grading of selected FPCs based on NABARD's criteria are worked out and given in Table 1.

As per the data given in Table 1, Purnobhava Agro Farmers Producer Company Limited received an "A" grade, as can be seen in the aforementioned table, with a final score of 78. Trimohini Farmers Producer Company Limited received a grade of "B" with a score of 61. Krishi Jagoron Kendra Producer Company Limited received a grade of "C" with a score of 57, while Bhuihara Farmers Producer Company Limited received a grade of "D" with a score of 46 according to the NABARD's FPO Performance Management Tool.

Further, the performance based on effectiveness of Farmers Producer Companies was calculated by an index (FPC performance index) developed in the line of Mukherjee (2018). The index consisted of seven components: (1) functioning efficiency, (2) increase in income, (3) increase in farmers share in costumers' rupee (4) level of satisfaction about the performance of FPO, (5) empowerment, (6) inclusiveness and (7) sustainability of Farmers Producer organization. Table 2 presented below showed the mean score of all the seven components of the FPC performance index.

The table depicts the company-wise mean score of the components of performance. Functional effectiveness wise, Purnobhava Agro Farmer Producer

Table 1: FPO grading based on NABARD's criteria

Name of the FPC	Total marks	Grade
Purnobhava Agro Farmers Producer Company Limited	78	A
Trimohini Farmers Producer Company Limited	61	B
Krishi Jagoron Kendra Producer Company Limited	57	C
Bhuihara Farmers Producer Company Limited	46	D

Table 2: Performance of farmers producer organization

Company	Functional effective-ness	Increase in income (%)	Increase in share in consumers' rupee (%)	Level of satisfaction	Empower-ment	Inclusive-ness	Sustaina-bility
Purnobhava Agro FPC. Ltd.	0.745	15.50	20	0.86	0.87	1	0.937
Trimohini FPC. Ltd.	0.695	8.85	15.95	0.68	0.64	0.67	0.87
Bhuihara FPC. Ltd.	0.52	8.11	10.67	0.56	0.52	0.83	0.69
Krishi Jagoron Kendra P.C. Ltd.	0.73	12.55	15	0.64	0.615	1	0.75

Company Limited stood in first place with a score of 0.745, followed by Krishi Jagoron Kendra Producer Company Limited with a score of 0.69, which is a quite high score, and then came Trimohini Farmers Producer Company and Bhuihara FPC. If we consider the percentage increment in income, Purnobhava scored highest with a 15.50 per cent increment, and Bhuihara had the lowest increment, which is 8.11 per cent, but the good thing was that all farmer-producer companies had seen a positive increase in their income. All the member farmers studied were experienced an increase in the share in consumers' rupee after joining the Farmer Producer Companies. The lowest increase that was shown was a 10.67 per cent increase in the share in consumers' rupees, then 15 per cent, 15.95 per cent, and 20 per cent increases in consumers' rupees were shown by Krishi Jagoron Kendra Producer Company Limited, Trimohini Farmers Producer Company Limited, and Purnobhava Agro Farmer Producer Company Limited, respectively. It clearly shows the importance of farmer producer companies in increasing the farmers' share in consumers' rupees. The level of satisfaction of the farmers was also seen to have increased in a satisfactory manner, but the satisfaction level varied from FPC to FPC, as shown in the above table. All the member farmers felt empowered after joining the Producer Organization. Farmers of Purnobhava FPC were witnessed highest score in empowerment that is 0.87 followed by Trimohini FPC (Score 0.64). In the matter of sustainability, Purnobhava ranked first with a score of 0.94, followed by Trimohini FPC with a score of 0.87.

After analysing the overall performance index, it was found that Purnobhava Agro Farmer Producer Company Limited had the highest index score, which is 10.46. Trimohini Farmers Producer Company Limited came in second with an index score of 8.29. Krishi Jagoron Producer Company Limited was in third place (score 8.00), and Bhuihara Farmers Producer Company Limited, with a score of 6.83, was in the fourth position. The finding is supportive with the findings of the grading score as per NABARD's criteria of performance identified in the study as already mentioned.

Technical efficiency of the member farmers: In this study, the case of single output, which is the gross return and five inputs were considered. All the inputs were converted into money for using across different farmers (Table 4). The inputs were field/pond preparation, seed (including seed treatment), labour, fertilizer/feed/chemical/micronutrients and others. The technical efficiency obtained in DEA model consists of pure technical efficiency and technical efficiency of

Table 3: Overall performance of farmer producer company

Name of the Company	Index Score	Rank
Purnobhava Agro Farmer Producer Company Limited	10.46	I
Trimohini Farmers Producer Company Limited	8.29	II
Krishi Jagoron Kendra Producer Company Limited	8.00	III
Bhuihara Farmers Producer Company Limited	6.83	IV

Table 4: Technical efficiency of the member farmers

Cost items (Rs. /acre)	Cereals crop farming	Vegetable crop farming	Fish farming
Field/pond preparation	6778	18393	5202
Seed (incl seed treatment)	1263	7298	7412
Labour	3812	4722	2929
Fertilizer, feed, chemicals, micro-nutrients	2335	2725	20424
Misc.	2633	2996	8528
Total cost (Rs./acre)	16,821	36,134	44,495
Total return (Rs./acre)	27,482	1,28,243	2,42,049
Output/input	1.63	3.55	5.44
Net return (Rs./acre)	10,661	92,109	1,97,554

scale. Maximum net return among the three commodities was identified in Fishery (Rs.1,97,554/ acre) followed by vegetables farming (Rs.92,109/acre) and cereal crop farming (Rs.10,661/ acre).

Data envelopment analysis employed has produced the following results-

The average measure of overall technical efficiency was estimated at 22.2 per cent for crop farmers, 44.3 per cent for vegetable farmers and 63 per cent for fish farmers. Average scale efficiency was estimated at 79.4, 96.8 and 98.6 per cent for the above categories of farmers, respectively. Hence the results indicated that the fish farmers were more efficient in all the three measures of technical efficiencies. Further, the minimum TE score was also low in crop sector. The average efficiency scores indicate that the pure technical inefficiency was primarily responsible for overall technical inefficiency in crop and vegetable. All the fish farmers have efficiency score of above 0.60. The analysis indicates crop, vegetable and fish farmers can, on an average, increase their output by 78, 56 and 38 per cent, respectively by operating at an optimal scale and by eliminating pure technical inefficiencies through the adoption of best practices of the efficient farms

Computation of scale efficiency scores proves that on average the farmers suffer from scale inefficiency at a level of 21, 0.04 and 0.01 per cent, respectively for cereal, vegetable and fish, respectively. Both management practices (pure technical inefficiency) and production scale (scale inefficiency) affect efficiency level.

Majority of the cereal farmers (93%) and a sizeable population (60%) of vegetable farmers were operating under sub-optimal scale. However, around 20 per cent of the fish farmers were operating under sub-optimal scale. The frequency distribution of the farmers by level of efficiency is summarised in Table 6. The table indicated that, as far as overall technical efficiency is concerned, majority of the cereals crop farmers were below 0.5 efficiency level. Whereas, majority of the vegetable and fish growers were within the group of 0.5 and above. When the pure technical efficiency is considered it was found that it also follows the same trend of overall technical efficiency. Hence, the study

Table 5: Technical efficiency of the member farmers

Particular	Overall technical efficiency			Scale efficiency			Pure tech efficiency		
	Cereal	Vegetable	Fish	Cereal	Vegetable	Fish	Cereal	Vegetable	Fish
Average	0.222	0.443	0.630	0.794	0.968	0.986	0.287	0.452	0.642
Minimum	0.08	0.108	0.351	0.357	0.818	0.773	0.117	0.132	0.354
No. of farms with efficiency score 50% and above	0	7	24	29	20	30	2	7	6
Standard Deviation	0.089	0.206	0.194	0.116	0.044	0.040	0.160	0.202	0.182

Table 6: Distribution of farmers by TE scores under VRS and CRS assumptions
(Cereal crop farmer=30, Vegetable farmer=20, Fish farmer=30)

Overall TE	Cereal crop farming	Vegetable crop farming	Fish farming
Score <0.5	30	12	6
Score > 0.5	0	7	24
On the frontier score = 1	0	1	0
Total	30	20	30
Pure TE			
Score <0.5	28	12	6
Score > 0.5	2	7	23
On the frontier score = 1	0	1	1
Total	30	20	30

indicated that the largest problem of overall technical inefficiency can be tackled by solving the problem of pure technical efficiency.

CONCLUSION

Performance analysis of the four selected Farmer Producer Companies showed that Purnobhava FPC has performed in the best possible way among all four companies considering all seven components. Bhuihara FPC has not performed well due to weak business concept they had. Lack the interest in starting new ventures and diversification of income besides lack of managerial ability was also the major hindering factors. The Data Envelopment Analysis for technical efficiency estimation indicates that the fish farmers were more efficient than crop and vegetable farmers under the selected four FPCs. Further the pure technical inefficiency was primarily responsible for overall technical inefficiency as compared to the scale inefficiency. Majority of the crop and significant number of vegetable farmers were operating under sub-optimal scale. Technical inefficiencies could be improved through the adoption of best practices of the efficient farms. Hence extension efforts should be made to educate the farmers regarding scientific production practices.

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Analysis of Collectivization of Small Holders in India: Competencies, Opportunities and Economic Impact

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ABSTRACT

Farmer producer organizations (FPOs) act as an effective institutional mechanism in addressing the agricultural constraints of small holders and improving their wellbeing. The present study provides analytical inferences of the competencies, opportunities and economic impact of FPOs in the state of Andhra Pradesh. Primary cross-sectional data was collected from 94 managerial team members of FPOs, 150 FPO farmers, 150 non FPO farmers and 15 FPOs.The managerial team showed medium level of competencies with regard to organizing and techno-operational competency domains while exhibited low competencies for other components. The dummy variable regression results showed that compared to non-FPO farmers, FPO members had an average net savings of Rs. 38.83 for every Rs. 100 spent on marketing and realized a farm income of Rs. 12.14 higher for every Rs. 100 earned by non FPO farmers. Developing and implementing a need-based capacity building programmes coupled with external financial support considering the life cycle stage of FPO are important policy implications essential for FPOs to become potential social enterprises.

Keywords: Farmer producer organizations, Competencies, Economic impact, Marketing, Farm income

INTRODUCTION

With an average land holding size of 1.08 hectares, small and marginal farmers dominate Indian agriculture (GOI, 2020). The small holding agriculture especially in developing nations is faced with multiple challenges, thus making difficult to attain economies of scale (Dev, 2012; Loeper *et al.,* 2016). While collectivization of farmers act as an effective mechanism in addressing the small holders constraints and as well enhance their farm income (Trebbin and Hassler, 2012; Ahmed and Mesfin, 2017). Accordingly, Government of India in early 2000 initiated the concept of farmer producer organization (FPO), wherein the primary producers (farmers) get mobilized through various collectivization process and form a producer organization to reap the benefits of economies of scale through getting access to quality inputs, technology, information, credit, markets and other services (GOI, 2013; NABARD, 2021). Upon collectivization having an appropriate institutional structure is for good governance. FPOs in India, in general get registered either under cooperatives act or companies act (NAARM, 2022).

However, understanding of business dynamics and acting accordingly are crucial for FPOs to advance through their life stages. Competencies play an important role in this process as managerial skills and competencies are crucial for business success (Laguna *et al.,* 2012; Mustapha *et al.,* 2020). Competencies are a set of skills, capabilities, attitudes and behaviour possessed that allow individuals to achieve goals (Wong, 2020). Studies also emphasized a positive relationship between competencies (risk-taking, motivation, opportunity seeking) of farmers and farm productivity, technology adoption (Sinyolo and Mudhara, 2017; Arellano and Reyes, 2019) and increase of enterprises net worth (Mustapha *et al.,* 2020).

Farmers either by themselves or through facilitation from promoting organizations form FPOs. FPO

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formed through promoting organizations get financial and non-financial support in handling business operations for a limited period only and majority of FPOs in India belong to this category. However, FPOs to remain viable and sustainable in the longer run, they require competent managerial team for understanding the business dynamics and group dynamics. The key managerial team of FPOs comprises of elected board of directors, who in turn appoint a manager/CEO to look after business operations. Despite more than 9000 FPOs operating in India, less than 30 per cent are operating viability creating a need for understanding the existing competencies, assessment of internal strengths and weakness and external opportunities and threats essential for improving the performance of FPOs (GOI, 2019; NAARM, 2022). It was also reported in several studies that collective participation of farmers showed positive impact on productivity, technology adoption, farm income improvement, poverty reduction and wellbeing of households. (Verma *et al.*, 2019; Venkatesan *et al.,* 2020; Manaswi *et al.*, 2020; Wang *et al.,* 2021).

MATERIALS AND METHODS

Multi stage purposive cum random sampling method was employed for the present study. Chittoor, Kurnool, Nellore and Guntur districts of Andhra Pradesh state were purposively selected due to significant number of FPOs operating in these districts. The list of FPOs functioning in these districts were obtained from state horticultural department and resource supporting agencies (RSAs) of NABARD. From the list, a separate list of FPOs that were operational over last three years and meeting the statutory compliances were prepared and randomly 15 FPOs were selected for the study. Each FPO is given a representation code. All the managers and 50 per cent of board of directors of FPOs were randomly selected, thus constituting the total sample size to 94.

A group discussion was provoked among the managerial team of FPOs with regard to formation, handling of business activities, group dynamics etc. and the information was recorded to understand the collectivization process and assess SWOT (strengths, weakness, opportunities and threats) of FPOs. Through personal interview method, the perceived competencies of respondents were obtained using a well-structured pre-tested schedule. The competency assessment schedule compromised of 47 statements rated on a four-point Likert scale with categories of very low, low, medium and high was prepared and these categories were given a score of 1,2,3 and 4 respectively. Each statement has four sub statements depicting competency categories and these sub statements are unique for each statement. Mean scores of less than 1.75 indicate very low competencies, above 1.75 to 2.5 as low, above 2.5 to 3.25 as medium and above 3.25 as higher competencies.

From each FPO, randomly 15 farmer members were identified, thus constituting the total sample size to 150. Similarly, 150 non-member farmers were randomly chosen from the regions surrounding FPO member farmers. When choosing the members of the control group, care is given to similarities in agricultural patterns, irrigation sources, climatic conditions, and market conditions. Thus, the total sample size of farmers selected to assess the impact of FPO membership were 300. Primary data pertaining to various costs incurred and returns realized were obtained using a well-structured schedule from farmer member and non – members. Dummy regression model is used to find out how the outcome variables (average input costs, average marketing costs, average farm income) differs between FPO and non FPO farmers.

RESULTS AND DISCUSSION

The collectivization of farmers into FPO in general is of three different forms in the study area (Figure 1). In the first form, farmers at village level got mobilized themselves and formed into FPO in the designated area (SAMACS). In the second case, the promoting agencies mobilized farmers into small informal groups which may be called as either farmer interest groups (FIGs) or common interest groups (CIGs). An average of 15 to 20 members constitutes one FIG/CIG. These FIGs at the village level come together to form FPO. (KMACS, PALFPC, SNRFPC, SCMACS, MBFPC, NVFPC, PFFPC and RSMACS). In the third case, the promoting agencies leverage their long-standing experience of already existed village level organizations (VLOs) to form into FPO. The VLOs are large informal groups with an average of 100 to 200 members per VLO with either registered (MACS act)

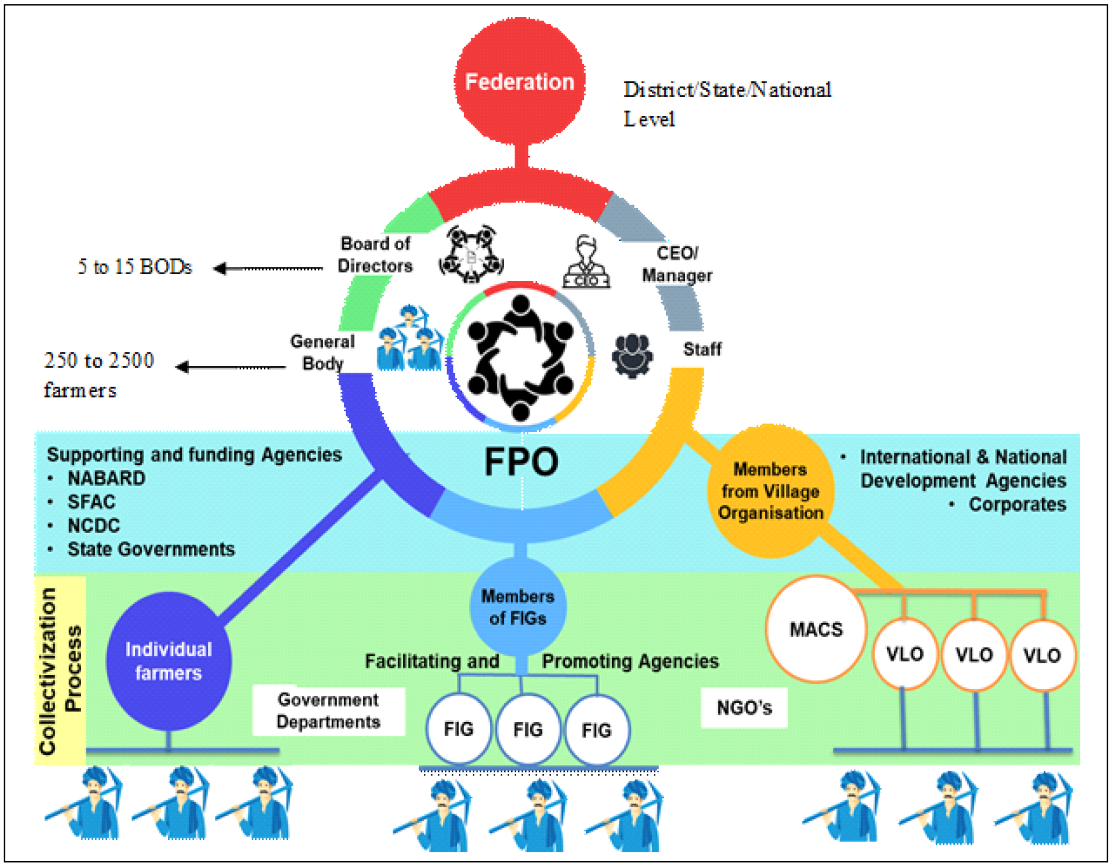

Figure 1: Collectivization process and organization structure of sample FPOs

or unregistered. The VLOs existing at different villages come together to coalesce into FPO. (MRFPC, YKFPC, SAFPC, AHMAC and PYKFPC).

Upon collectivization and FPO formation, appropriate institutional or organizational structure is essential for its effective functioning. The organizational structure of FPO in general comprises of general body constituting all member farmers, governing body comprising of BODs, CEO/manager and supporting staff. All the sample FPOs had the above said organizational structure. In general, the BOD members are elected either from member farmers directly or through representatives of FIGs or VLOs formed at village level. However, two scenarios existed with regard to farmer members nominated as BODs in the sample FPOs. In majority of sample FPOs, the farmer members (influential) were nominated as BODs in consultation with promoting agencies and without much member farmers involvement. While in other cases, farmer members were nominated as BODs through an election process at village or mandal level. The board may or may not engages professionals (CEOs/ manager) and supporting staff. However, all the sample FPOs had full time CEO along with supporting staff to manage the activities of FPOs. While the supporting staff ranged between from one to ten.

Organizations with competent human resources particularly managerial front plays a vital role in improving the business performance and lack of these capacities will act as a limiting factor for running rural enterprises (Defra, 2011). In this context, the perceived business competencies of managerial team of FPOs were assessed by employing competency assessment schedule and the results are presented in Table 1. In total, the schedule comprises of 47 statements that were broadly grouped into six major competency domains namely organizing, techno-operational and market, regulatory, collaborative and negotiation competencies. The reliability of the data collected was acceptable as the value of cronbach's alpha exceeded 0.7 (Cronbach and Shavelson, 2004). The mean values indicated that, the managerial team showed medium level of competencies with regard to organizing and techno-

Table 1: Competency assessment of sample managerial team members of FPOs

Competency Domain	No. of statements	Cronbach's alpha	Mean value	Perceived competency
Organizing	15	0.92	2.65	Medium
Techno-operational	6	0.85	2.51	Medium
Marketing	7	0.81	2.46	Low
Regulatory	5	0.72	2.37	Low
Collaborative	5	0.82	2.47	Low
Negotiation	5	0.85	2.44	Low

operational competency domains while exhibited low competencies for other components.

The SWOT analysis of sample FPOs were conducted and grouped into four categories (Figure 2) for making FPOs from survival for existence to potential for sustainable growth. The sample FPOs of 'supported existence' category had strong will to participate in collectivization but had teams with poor financial literacy and financial management skills. However, financial support for opex coupled with external support in capacity building would lead to stagnant category of FPOs and if external support management and financial assistance were withdrawn, it would lead to closure of FPOs under this category. The FPOs grouped under 'stagnant category', had strong will to pool resources for collective investments but had low financial literacy and medium financial management skills. But external support in capacity building and need based capital investments would lead to self-sustained FPO. However, any withdrawal of external support management and financial assistance leads to struggle for existence.

Struggle for existence		Supported Existence	Stagnant	Self sustained	Sustainable growth
FPO codes		DPPFPC, SNRFPC, SCMACS	KMACS, NVFPC, RSMACS, AHMACS	SAFPC, YKFPC, MBFPC	PFFPC, PYKFPC, PALFPC, SAMACS. MRFPC
Internal origin	Strength	Strong will to participate in collectivization	Strong will to pool resources for collective investments	Strong will to sustain the investment made in collective assets	Strong will to grow through expand operations and reinvestment in new collective assets
	Weakness	Poor financial literacy and management skills	Low financial literacy and medium management skills	Moderate financial literacy and medium management skills	Lack of professional management and strategic team to handle quantum of business operations
External origin	Opportunities	Financial support for Opex coupled with external support in capacity building would lead to FPO survival	External support in capacity building and need based capital investments would lead to self sustained FPO	External support in capacity building and community (farming) based investments would lead to sustained growth.	External support for scaling up operations across agri value chain and professional trainings to build core team lead to potential social organization
	Threats	Withdrawal of external support management and financial assistance leading to closure	Withdrawal of external support management and financial assistance leading to struggle for existence	Poor external support in capacity building and community investments prevent growth of FPOs to achieve sustained growth	Too much or too little external interferences in directing, monitoring, control may lead to social exploitation

Potential social enterprises

Figure 2: SWOT Analysis of FPOs

'Self-sustained' FPOs had strong will to sustain the investments made in collective assets but had moderate financial literacy and medium financial management skills. Opportunities such as external support in capacity building and community (farming) based investments would lead to sustained growth. But poor external support in capacity building and community investments prevents the growth of FPOs to achieve sustained growth. The FPOs grouped under 'sustainable growth' category had strong will to grow through expanding operations and reinvestment in new collective assets. However, lack of professional management and strategic team to handle quantum of business operations were hindering their growth. These FPOs had opportunities for scaling up operations across agri value chain if rendered external support and had scope of becoming a potential social organization, if professional trainings were given to build a core team. But too much or too little external interferences in directing, monitoring, control may lead to social exploitation

The results of dummy variable regression model indicated that the average input costs incurred by farmers was Rs. 41468.84 per acre per annum (100.00%), while the member farmers realized an average net savings in input costs by Rs. 1632.11 (3.94%) per acre per annum over non-members. The average marketing costs incurred by farmers were Rs. 8705.53 per acre per annum (100.00%) while the average net savings in marketing costs realized by member farmers of FPOs compared to non-members was Rs. 3380.68 per acre per annum (38.83%) at 1% significance level. The average net farm income realized by farmers in the study area were Rs. 53343.36 per acre per annum (100.00%) while member farmers of FPOs reported an increase of average net income by Rs. 6473.69 per acre per annum (12.14%) compared to non-members at 5% significance level.

Thus, the economic impact of operations of arranging input supplies to member farmers by FPOs were substantially low compared to non FPO farmers (3.94% of cost savings) and hence there existed no significant differences in the average input costs between the two groups. But the member farmers realized substantially higher average net savings of Rs. 38.83 for every Rs. 100 spent by their counter parts for marketing. The impact derived was due to a result of collective bargaining combined with aggregated effect of varied services offered by FPOs to their member farmers such as direct farm procurement, arranging for primary processing activities and logistics that resulted in reduced marketing costs and better price realization. With regard to net farm income, the member farmers realized Rs. 12.14 higher for every Rs. 100 earned by their counter parts. The results are consistent with findings of Fischer and Qaim (2012), Prathiban *et al.* (2015) and Latynskiy and Berger (2016) that reported membership in farmer collective organizations significantly improved farm income levels of farmers.

CONCLUSION

The small agricultural holders get collectivized into farmer producer organizations (FPOs) majorly to get improved access to various agricultural inputs, markets and technology. FPOs through establishing linkages with

Table 2: Assessment of economic impact of membership in FPOs

Outcome variables		Coef.	Std. Err.	t value	P>t	95% Conf. Interval	
Average net savings in input cost (Rs/per acre/per annum)	FPO member ^{NS}	-1632.11 (3.94)	2742.01	-1.02	0.31	-8183.27	1559.05
Average input costs (Rs/per acre/per annum)	Constant	41468.84	1938.9	20.57	0.00	36061.18	43692.50
Average net savings in marketing cost (Rs/per acre/per annum)	FPO member ***	-3380.68 (38.83)	1156.55	-2.66	0.008	-5356.71	-804.64
Average marketing cost (Rs/per acre/per annum)	Constant	8705.63	817.802	12.49	0.00	8606.23	11825.03
Average net farm income (Rs/per acre/per annum)	FPO member **	6473.69 (12.14)	3813.62	2.01	0.045	168.66	15178.72
	Constant	53343.36	2696.63	19.31	0.00	46776.50	57390.22

various actors in agri value chain undertake business activities. However, competencies of FPOs are crucial for improving the business performance and improving the income levels of small holders as well. Hence, the present study focus on understanding the various modes through which farmers get collectivized into FPOs, assess their competencies, SWOT and impact created from the collectivization. The highlights of the study indicated that farmers get collectivized into FPOs either by themselves, or by combining small informal groups or large informal groups formed at village level by the promoting agencies. The managerial team of FPOs showed medium level of competencies with regard to organizing and techno-operational competency domains while exhibited low competencies with regard to market, regulatory, collaboration and negotiation competency domains. The SWOT analysis revealed that external financial support coupled with need-based capacity building are essential for FPOs to become potential social enterprises. The economic analysis of FPOs indicated that although there existed no much difference with regard to average input cost of FPO and non FPO farmers, but FPO farmers realized an average net savings of Rs. 38.83 for every Rs. 100 spent on marketing and a higher farm income of Rs. 12.14 for every Rs. 100 earned by the counterparts. Thus, the policy implications that can be drawn from the study are:

1. The current FPO supporting schemes are generalized, and do not consider the life cycle stage requirements of FPOs. The supporting schemes formulated to strengthen up FPOs, need to look farmer collectives as business organization with regional specific, market specific, value chain specific requirements. And it doesn't fit in to the old school thought of "one size for all". Considering the fact that, each FPO and its requirements are unique, a high level of customized supporting program system considering the life stages of FPOs need to be developed instead of generalized programmes.

2. A need for policy support for pivoting production centric approached business activities of FPOs to market centric approached activities, through providing need based support in terms of funding and matching competencies through capacity building for creating sustainable impact on farming community

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Role of Water Quality on Incidences of Motile Aeromonas Septicaemia (MAS) in the Carp Culture System of Assam

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ABSTRACT

Influence of water quality on the incidence of bacterial disease *i.e.* Motile Aeromonas Septicaemia (MAS) in the Indian Major and minor carps was studied in three selected districts of Assam (India). The diseases incidences in fish varied with season with higher incidences during winter. Estimation of key water quality parameters and other predisposing factors *i.e.* high stocking density has a direct relation with MAS. Deterioration of water quality under suboptimal range during the winter season influences in the occurrence of MAS. A negative correlation of important water quality parameters *i.e.* temperature, pH, dissolved oxygen and alkalinity that indicated that fall in temperature, pH, dissolved oxygen and alkalinity influences on the occurrence of disease. While carbondioxide and ammonia were found to be positively correlated that indicated that increased value of ammonia and carbondioxide has a direct bearing on MAS. The regression of MAS (%) on water quality parameter was analysed. The functional relationship estimated by linear regression revealed positive and negative impact of water quality parameters on MAS with a coefficient of determinants ranged from 23.25 to 60.96 per cent. The data reveals that temperature had a negative impact on MAS b= (-2.69), $p<0.01$) indicating an increase of temperature by unit degree would lower MAS by 2.69 per cent. Similarly, increase in pH by unit degree would lower MAS by 12.16 per cent, unit degree increase in alkalinity would lower MAS by 0.41 per cent. Same way unit degree increase in DO and turbidity would lower MAS by 13.49 and 1.34 per cent, respectively. However, the scenario of CO_2 and ammonia was found to be reversed in which the value was positively correlated and revealed that for unit degree increase in CO_2, the MAS % was supposed to increase by 3.9 and 9.97 per cent in case of ammonia.

Keywords: Incidence, Motile Aeromonas Septicaemia, Motile Aeromonas, Water quality parameters

INTRODUCTION

Aquaculture has been growing actively in the last 30 years and always has been an important source of food, nutrition, income and livelihood (HLPE, 2014). Talking about the doubling farmers' income, it is obvious that farmers are the key participant who will have to do the farming involving his time, labour, inputs and intellects. For fulfilling the dreams of doubling farmers' income by 2022-23 the farmers will have to work together for higher productivity and increased income (Bora *et al.*, 2018). The agriculture sector which comprise of lot of activities ranging from crop, livestock to fisheries is still seen as one of the sector which expected to offer many job opportunities (Som *et al.*, 2018). Currently, India ranks second in the world in total fish production with the total annual fish production of about 13.00 MT. The three Indian major carps, *viz.* Catla (*Catla catla*), Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus mrigala)* contribute to the bulk of production to the extent of 90 per cent of the freshwater aquaculture production. In India, carp culture is the backbone of the aquaculture industry. Andhra Pradesh, West Bengal, Orissa, Bihar, Uttar Pradesh and Assam are important states for aquaculture production and carps are the most preferred species

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in these states and also other parts of the country. Poor management and disease outbreak lead to substantial financial losses in aquaculture. In India, Epizootic Ulcerative Syndrome (EUS) in fishes and white spot disease in cultured shrimp has sufficiently demonstrated their economic impacts on aquaculture (Mohan and Bhatta, 2002). However; loss due to bacterial diseases in finfish aquaculture has not been widely studied. It has been realised that loss in income was as high as 10–15 per cent of the total value of fish production worldwide (Klesius *et al*., 2006).

The growing interest in aquaculture activity and, consequently, the hunt for higher profitability, have been driving the producers to adopt super-intensive production systems. However, inadequate farming management practices, high-density stocking practices and water contamination due to pollution cause chronic stress and immunosuppression in farmed fishes. These effects lead to the occurrence of disease and epizootic outbreaks caused by pathogens that generally don't have high expression in natural environments (Dash *et al.,* 2009).

Water quality can be an important detriment of fish health and possibly, of disease resistance (Plumb, 1999; Wedemeyer *et al*., 1976). Microbial quality of farmed fish is largely determined by the quality of water in which they are cultivated (Black, 2009). Moreover, water quality influences the bacterial load in fish ponds (Roy and Barot, 2011). Except for acute effects of large fluctuation in water quality which cause severe stress or death, elusive deterioration in water quality might lead to compromised fish health and seriously affect inferences of epidemiologic studies. Therefore, the effect and potential fluctuation of water quality always should be predicted and accounted for in the design of any epidemiological studies. There is a relationship between water quality deterioration, environmental stress and bacterial infection (Plumb *et al.,* 1994).

Environmental stress and other water quality parameters are often considered to be contributing factors in the outbreak of disease caused by bacteria. Such stressors are most commonly associated with environmental and physiological parameters that adversely affect fishes reared under unscientific means of practices. Snieszko (1972) pointed out that communicable diseases of fish can occur only when the susceptible host and virulent pathogens meet in unfavorable environmental conditions requisite for disease induction. A stressed stock of fish population becomes vulnerable to a potential pathogen either from the environment or from a carrier fish and ultimately succumbs to infection. There is no proper documentation of prevailing fish diseases of Assam and so far no studies have been conducted in connection with pathogenic *Aeromonas* species that causes MAS in the fish culture system of Assam. Thus keeping in view the above points, the present work has been undertaken to study the influence of water quality parameters and occurrence of Motile Aeromonas Septicaemia (MAS) in the freshwater culture system of Assam.

MATERIALS AND METHODS

The present study was carried out in the three districts namely Nagaon, Morigaon and Sonitpur in the Central Brahmaputra Valley of Assam. These three districts were selected based on their significant contribution to the total fish production of the state.

The present investigation was carried out during the month of June 2016 to May 2017. A total number of 2659 of diseased fish having clinical signs and symptoms were collected from the different fish farms. Samples consisted of moribund fishes irrespective of species with clinical signs were brought to the Fish Disease Diagnostic Unit of College of Fisheries, AAU, Raha, Assam. Fish samples with clinical signs of ulcer, haemorrhages, red spot, dropsy were packed in insulated boxes with gel ice packs during transportation from the sampling site to the laboratory. Fishes with clinical symptoms were used within 3 to 4 hours for analysis and detection of pathogens.

Apart from collecting fishes with clinical signs and symptoms for isolation and identification of pathogens, samples with a parasitic infestation, pinhead, lordosis/scoliosis etc. were also collected and recorded to have an overall idea of prevalent fish disease in the districts under study. Month wise and species wise incidence of disease was also recorded separately for each district.

Investigation on the occurrence of disease and other information such as production-related data, history of disease occurrence, mortality, pond management measures and stocking density were

systematically investigated and recorded through the questionnaire interview and Participatory Rural Appraisal (PRA) with the fish farmers while visiting the farm during disease outbreak.

During sampling, sterilized plastic sampling bottles (1.5 lit capacities) were carried, immersed into the water about 50 cm below the surface to collect the water samples to estimate the different parameters. Some of the parameters were determined in situ such as temperature using dry mercury thermometer and dissolved oxygen (DO) using digital dissolved oxygen meter (Systronics). The rest of the water samples were acidified on spot with 10 per cent nitric acid and brought to the fish disease diagnostic laboratory in ice bath and prepared for analysis as described by APHA (1998). The purpose of water quality analysis was to correlate with the outbreak of MAS during the investigation period.

RESULTS

During the study, water quality parameters of infected ponds were analysed and recorded. Monthly fluctuation of water quality parameters of infected ponds was recorded to correlate the water quality parameters with the incidence of disease during different months of the year. Water quality parameters along with monthly prevalence percentage of MAS in Nagaon, Morigaon and Sonitpur districts are presented in the (Table 1, 2 and 3).

Variation in water temperature was observed in different months of the year during the study. The highest and lowest water temperature in the Nagaon district recorded were 33°C±1.80 in the month of June 2016 and 21°C±1.50 in the month of January 2017. In Morigaon district the highest and lowest temperature was 34°C±2.64 recorded in the month of August 2016 and the lowest was 19.5°C±1.32 in the month of January 2017. While in the Sonitpur district the highest temperature was recorded 34°C±1.32 in the month of June 2016 and lowest value of temperature was recorded 19.5°C±2.64 in the month of January 2017. During the winter season, the state of Assam experiences severe cold due to drastic fall in temperature resulting in a drop in water temperature. It is obvious that temperature plays an important role in the chemical and biological process and therefore it has a direct effect on important factors such as growth, oxygen demand,

Table 1: Monthly fluctuation of water quality parameters (monthly average ± SE) in different months and percentage of occurrence of MAS in Nagaon District

Months	Water Temp (°C)	pH	Alkalinity (ppm)	Free CO_2 (ppm)	Dissolve Oxygen (ppm)	Turbidity (Secchi disc reading (cm)	Ammonia (ppm)	No. of pond surveyed	MAS infected ponds	MAS (%)
June 2016	33.00±1.80	6.50±0.36	116.00±2.64	6.00±0.26	6.00±1.32	34.00±2.17	0.03±0.26	1	0	0
July 16	32.00±1.60	6.70±0.17	112.00±3.05	5.40±0.26	6.50±0.26	40.00±1.52	0.02±0.01	8	1	12.50
August 16	32.00±0.86	7.00±0.52	98.50±2.64	4.10±1.04	6.20±0.10	33.00±2.17	0.03±0.01	7	1	14.28
September 6	30.00±0.41	6.20±0.65	65.00±1.32	5.70±0.26	6.50±0.26	22.50±2.64	0. 01±0.10	5	1	20.00
October 16	28.00±0.34	6.80±0.65	56.00±1.73	4.90±0.10	6.00±1.10	21.60±1.52	0.14±0.01	4	1	25.00
November 16	27.50±1.57	5.8±0.45	60.00±2.64	6.70±0.26	5.20±0.10	26.00±2.17	0.23±0.02	14	5	35.71
December 16	24.00±1.32	5.6±0.43	65.00±0.57	6.80±0.26	5.00±0.51	21.60±1.52	0.36±0.02	13	6	46.10
January 2017	21.00±1.50	5.20±0.36	71.00±0.26	7.80±0.76	4.90±0.26	18.00±2.64	0.45±0.01	22	12	54.54
February 17	23.00±1.25	5.30±0.43	74.00±1.73	6.80±1.25	5.10±0.17	28.00±1.73	0.07±0.02	15	4	33.30
March 17	26.00±1.57	6.90±0.78	79.50±0.57	4.5±0.45	5.80±0.81	33.00±3.60	0.07±0.93	14	5	35.71
April 17	29.00±3.54	7.70±1.22	114.00±2.64	4.3±0.86	6.70±0.10	31.00±1.32	0.04±0.01	1	0	0
May 17	31.00±1.04	7.80±0.30	123.00±0.76	3.5±0.10	7.40±0.36	42.00±2.64	0.02±0.02	1	0	0

Table 2: Monthly fluctuation of water quality parameters (monthly average ±SE) in different months and percentage of occurrence of MAS in Morigaon District

Months	Water Temp (°C)	pH	Alkalinity (ppm)	Free CO_2 (ppm)	Dissolve oxygen (ppm)	Secchi disc Transparency (cm)	Ammonia (ppm)	No. of pond surveyed	MAS infected ponds	MAS (%)
June 2016	30.50±1.32	6.80±0.26	88.00±3.46	5.50±0.70	6.00±2.64	48.00±3.60	0.04±0.02	1	0	0
July 16	31.00±2.17	6.20±0.91	92.00±1.73	5.00±3.04	6.20±1.32	41.00±2.64	0.06±0. 01	2	0	0
August 16	34.00±2.64	7.70±1.38	98.00±0.57	4.50±1.32	5.60±0.75	29.50±4.35	0.05±0.02	11	1	9.09
September 16	32.00±1.32	6.80±0.85	100.00±2.08	4.80±0.65	5.80±0.26	24.00±2.64	0. 1±0.10	4	1	25.00
October 16	29.00±1.32	6.40±0.871	45.00±0.81	5.20±0.85	5.40±1.51	21.00±3.46	0.13±0.04	6	1	16.66
November 16	27.00±0.28	6.90±0.65	32.00±1.52	6.50±0.85	5.00±1.22	14.00±5.56	0.25±0.02	9	4	44.44
December 16	22.00±0.86	6.00±1.04	26.00±0.57	6.80±2.64	5.00±0.98	16.00±4.58	0.34±0.05	16	6	37.50
January 2017	19.50±1.32	6.20±0.26	18.00± 2.08	7.00±1.32	5.10±0.36	13.00±3.60	0.41±.0.02	27	12	44.44
February 17	22.50±1.52	6.00±1.24	22.00±2.64	6.90±1.32	4.90±0.36	21.00±2.64	0.08±0.01	16	5	31.25
March 17	25.00±2.64	7.00±0.50	45.00±2.08	4.9±2.64	5.80±1.21	30.00±4.35	0.04±0.01	2	0	0
April 17	27.00±1.04	7.80±0.26	61.00±1.73	4.80±2.17	6.40±0.17	31.00±2.64	0.03±0.01	2	0	0
May 17	29.00±2.64	7.00±0.40	76.00±1.32	5.50±0.45	6.8±0.36	42.00±1.73	0.06±0.02	2	0	0

Table 3: Monthly fluctuation of water quality parameters (monthly average ± SE) in different months and percentage of occurrence of MAS in Sonitpur District

Months	Water Temp (°C)	pH	Alkalinity (ppm)	Free CO_2 (ppm)	Dissolve oxygen (ppm)	Secchi disc Transparency (cm)	Ammonia (ppm)	No. of pond surveyed	MAS infected ponds	MAS (%)
June 2016	34.00±1.32	7.00±0.43	115.00±3.60	3.50±0.26	6.20±1.31	34.00±1.73	0.05±0.01	3	0	0
July 16	33.50±1.80	7.50±0.45	109.00±2.64	3.40±1.32	6.90±1.32	41.00±2.17	0.08±0.02	2	0	0
August 16	33.00±0.86	7.20±0.95	93.00±2.64	3.30±0.35	6.80±0.81	38.00±2.17	0.03±0.01	6	1	16.66
September 16	32.50±1.80	7.00±1.32	67.00±6.08	4.20±2.30	6.90±0.36	22.00±2.64	0.01±0.04	5	1	20.00
October 16	32.00±3.60	6.80±0.52	59.00±4.58	5.00±0.36	6.60±1.12	21.00±5.29	0.12±0.04	5	1	20.00
November 16	27.00±1.73	6.20±0.26	58.00±3.60	6.50±0.62	5.50±0.45	15.00±2.64	0.34±0.17	14	4	28.57
December 16	21.00±2.64	6.10±0.36	55.00±2.64	6.80±0.86	5.00±1.15	14.00±3.12	0.40±0.21	8	4	50.00
January 2017	19.50±2.64	5.60±0.17	54.00±3.60	7.20±1.80	5.10±0.81	14.00±4.58	0.30±0.13	21	10	47.61
February 17	20.50±1.80	5.50±0.86	62.00±3.81	6.4±2.64	4.90±0.65	12.00±2.64	0.25±0.36	13	3	23.07
March 17	27.00±0.86	6.90±0.55	79.00±4.35	6.5 ±0.61	5.50±0.78	26.00±1.73	0.08±0.01	5	1	20.00
April 17	27.50±1.32	7.00±1.32	114.00±2.64	5.50±1.67	6.20±1.21	31.00±2.17	0.05±0.01	6	0	0
May 17	29.00±2.64	7.40±0.69	123±3.60	4.50±1.32	7.00±1.13	42.00±2.64	0.03±0.02	2	0	0

food requirements and food conversion efficiency (Byod, 1998). Generally, below 20°C of water temperature, fishes lose much of their activity and appetite as a result fishes come under severe stress and become more susceptible to diseases.

The average of total alkalinity recorded during the study is given in the (Table 1, 2 and 3). The minimum and maximum total alkalinity was 56 ppm ± 1.73 ppm in the month January 2017 and 123 ppm ± 0.76 ppm during May 2017 in the Nagaon district. The minimum and maximum values in Morigaon district were 18 ppm ± 2.08 ppm and 100 ± 2.08 for January 2017 and September 2016 respectively. While in Sonitpur district the minimum and maximum total alkalinity was 54 ppm ± 3.60 ppm and 123 ppm ± 3.60 pp min the month of January 2017 and May 2017 respectively. Low alkalinity reduces the buffer capacity of water and badly affects the pond ecosystem that in turn cause stress to the fish and become more susceptible (Agarwal *et al.,* 2010). So there was a relationship between fish disease, mortality with the changes of water quality parameters.

The minimum and maximum pH value observed were 5.2 ± 0.36 and 7.8 ± 0.30 in the month of January 2017 and May 2017 respectively for Nagaon district. Similarly, minimum and maximum pH value was 6.0 ± 1.24 and 7.8 ± 0.26 in the month of February 2017 and April 2017 respectively for Morigaon district. While the minimum and maximum pH values recorded for Sonitpur district were 5.5 ± 0.86 in the month of February 2017 and 7.5 ± 0.45 in the month of July 2016. The value of pH remained acidic throughout the winter months in all the districts under study and it was below the acceptable range (Boyd, 1998). This nature of pH may be the result of various biological activities (Gupta *et al.,* 1996) and due to a decrease in photosynthesis during winter while during monsoon it may be due to a greater inflow of water (Agrawal and Rajawar, 2010).

The value of free CO_2 in water in fish ponds of the three districts are given in the (Table 1, 2 & 3). In the Nagaon district maximum free CO_2 value 8±0.76 ppm was observed in the month of January 2017 whereas minimum value 4.5±1.32 ppm in the month of August 2016. On the other hand, the maximum free CO_2 value for Morigaon was 7.00 ±1.32 ppm in the month of January 2017 and a minimum 5.0±3.04 ppm was recorded in the month of July 2016. In Sonitpur district maximum value was 7.20±1.80 ppm in the month of January 2017 and a minimum of its value 30±0.35 ppm was reordered in April 2017.

Dissolved oxygen recorded during the study is given in the (Table 1, 2 &3). In Nagaon district the highest and lowest concentration of DO in the *Aeromonas* infected ponds was 7.40 ±0.36 ppm in the month of June 2016 and lowest DO concentration was 4.9 ±0.26 ppm in the month of January 2017. In Morigaon district, highest and lowest DO concentration was 6.8±0.36 ppm in the month of May 2017 and 4.9±0.36 ppm respectively in the month of February. In Sonitpur, highest DO was 7.0 ± 1.13 ppm in the month of May 2017 and lowest 4.9±0.655 in February.

The highest and lowest value of turbidity in the Nagaon district was recorded 42±2.64 cm in the month of May 2017 and 18±2.64 cm in the month of January 2017 respectively. In Morigaon district, turbidity was found to highest 48±3.6 cm in the month of June 2016 and the lowest value 13±3.60 cm was recorded in the month of January 2017. While highest and lowest value of turbidity was recorded in the *Aeromonas* infected fish pond was 42±2.64 cm in the month of May 2017 and 18 ±2.64 cm in the month of February 2017 in Sonitpur district. In the winter months, turbidity recorded was below the desired level in all the district under studies. The depth of transparency between 20 cm and 60 cm are recommended for optimal management of freshwater ponds (Boyd, 1998).

The recorded value of ammonia concentration in infected ponds is depicted in the (Table 1, 2&3). In Nagaon district, the highest and lowest value of ammonia was 0.45 ±0.01 ppm in the month of January 2017 and 0.02 ±0.02 ppm in the month of May 2017, respectively. In Morigaon district, the highest value was 0.41±0.02 ppm in the month of January and lowest value 0.03±0.01 ppm was in the month of April 2017. While the highest and lowest value of ammonia was 0.40±0.21 ppm in the month of December 2016 and 0.01±0.10 ppm in the month of September respectively in Sonitpur district.

DISCUSSION

Being poikilothermic aquatic animals, like other organisms fish are also prone to various diseases. Both culture and feral fishes have to suffer the rigor of

degraded water quality parameters in aquaculture. Numerous ecto and endo parasites are potential host to almost all the fishes. Although fishes have very high resistance to diseases, yet they become susceptible under the adverse influence due to variation in water quality. The present study revealed that the concentration of DO content was comparatively found to be lower during the month of Nov 2016 to February 2017 in the infected ponds. In the present study it was clearly observed that the majority of ponds were not managed in a scientific manner. Liming, manuring and other prophylactic measures were not practiced by the majority of the farmers. Ponds were heavily stocked and there seemed to be profuse growth of blooms of phytoplankton. This may be the reasons for record of low DO during the winter months of the year under study. High stocking density, large blooms of phytoplanktons and excess turbidity limit the concentration of DO. Low DO can be lethal to the aquaculture species. The effects include stress, increased susceptibility to disease, poor feed conversion, poor growth and even death. In the present investigation, it has been found that the DO value was below the acceptable range during winter months (Table 1, 2 & 3). Similar observation for DO minimal during winter months have been reported (Sehgal, 1980 & Parikh and Mankodit, 2012).

Hazen and Esch (1983) and Kaper *et al.* (1981) conducted a number of studies and had shown that the abundance and distribution of *Aeromonas* species in aquatic habitat were influenced by temperature, redox potential, pH, secchi disc depth. The present study was in agreement with their observation.

Bhatnagar and Garg (2000) also stated that oxygen depletion in water leads to poor feeding of fish, starvation, reduced growth and more fish mortality either directly or indirectly. Growth and feeding decreases at 1-5 ppm of DO while growth and production was found optimum at 5 ppm and above (Jhingran, 1988).

As the water of the pond was found to be highly turbid, there was a hindrance of penetration of light during the winter season. The temperature had a bearing on the chemical and biological process and therefore has a direct effect on important factors such as growth, oxygen demand, food requirements and food conversion efficiency (Byod, 1998). Usually, at 20°C, fishes lose much of their activity and eat less food as a result fishes are under severe stress and become susceptible to disease.

The pH remained in acidic condition throughout the winter months in all the district under study and it was below the acceptable range as recommended (Boyd, 1998). Gupta *et al.* (1996) opined this nature of pH might be the result of various biological activities going on in ponds. Moreover, Agrawal and Rajawar (2010) had reported that low pH value during winter is due to a decrease in photosynthesis. A lower concentration of pH increases the toxicity of hydrogen sulphide (H_2S), copper and other heavy metals which is lethal to the aquatic ecosystem. Fishes are susceptible to the attack of parasites and diseases in acidic water. The depth of transparency between 20 cm and 60 cm are recommended for optimal management of freshwater ponds (Boyd, 1998). The suboptimal range of turbidity may result in gill clogging resulting in asphyxia and may prevent phytoplankton growth and thereby reduced the level of DO. The record of CO_2 in the present study reveals that a high concentration was recorded during the winter season. Sahai and Singha (1969) also reported the high value of free CO_2duringwinter and found to have a positive correlation with disease manifestation that was in agreement with the present study. Roy *et al.* (1966) and Islam and Haroon (1974) reported similar conditions of some water bodies and were in agreement with the present studies. The present studies were also in agreement with Phillips and Keddie (1990) where stress due to deterioration of water quality also influenced the outbreak of *Aeromonas* infection. The alkalinity was recorded in the three districts separately. The highest value was recorded in the summer months whereas during winter, alkalinity was found to be low and values were almost below the acceptable range (Boyd, 1998).

The unionized form of ammonia (NH_3) is extremely toxic while the ionized form (NH_4^+) is not and both the forms are grouped together as "total ammonia". Ammonia in the range >0.1 ppm tends to cause gill damage, destroy mucous producing membranes, while "sub-lethal" effects like reduced growth, poor feed conversion, and reduced disease resistance at concentrations that are lower than lethal

concentrations. Bhatnagar *et al.* (2004) suggested 0.01-0.5 ppm is desirable for shrimp; >0.4 ppm is lethal to many fishes and prawn species; 0.05-0.4 ppm has a sublethal effect and <0.05 ppm is safe for many tropical fish species and prawns. Bhatnagar and Singh (2010) recommended the level of ammonia (<0.2 ppm) suitable for pond fishery. Saha *et al.* (2002) indicated that ammonia excretion increased with increasing pH. In the present study, record of ammonia in certain months of the year during the study was found to be higher in comparison to the recommended level. The highe rrange of ammonia was observed specially in the winter months of the year and that probably made the fish under stress and susceptible to disease.

The process of disease outbreaks is generally brought in by factors including stress, changes in environmental conditions, overcrowding, handling, transportation, poor water quality, changes in temperature, low dissolved oxygen, high CO_2 levels, high nitrite levels, and high ammonia levels. These are the most common predisposing factors associated with *A. hydrophila* infection. Moreover, the pathogenicity of *Aeromonas hydrophila* appears to be associated with the stress of the host. *Aeromonas hydrophila* with high virulence can infect healthy fish; however, the stress coming from intensive fish farming also contributes to and triggers outbreaks (Suomalainen *et al.,* 2005). Experimental demonstration carried out by Swan (1989) showed that fish which are in poor environmental condition due to unsatisfactory water quality such as high nitrite levels, low levels of dissolved oxygen (DO), or high levels of carbon dioxide (CO_2) were more susceptible to infection by *Aeromonas hydrophila*. In addition to this, the seasonal incidence of a higher number of fish deaths in the spring was observed with decreased water temperature.

In the present study, it was found that stocking density of fish was much higher in almost all the category of ponds in the 3 districts under study. Moreover, deterioration of water quality was also observed in all the infected ponds and parameters were under suboptimal range during winter. Thus the present findings are fully agreed with Suomalainen *et al.* (2005), Swan (1989), Huizinga *et al.* (1979) and Anderson (1990) who indicated that fluctuation of water temperature leads to increased metabolism, decreased overall condition, and stressed the fish. Stressed fish are found increased production of corticosteroids, which in turn increased their susceptibility to infection.

The deterioration of water quality parameters found in the present study might be responsible for inducing stress and thereby fishes are susceptible to disease and the eventual death of fishes. The present outcomes on the occurrence of fish diseases are also in agreement with Patra and Azadi (1987) and Hossain *et al.* (1993) who found that suboptimal range of water quality parameters keep fish under stress and thus prone to the attack of parasites and pathogens.

The regression of MAS (%) on water quality parameter are presented in (Table 4). The functional relationship estimated by linear regression revealed positive and negative impact (Figure 1) of water quality parameters on MAS with a coefficient of determinants ranged from 23.25 to 60.96%. The data reveals that temperature had a negative impact on MAS b= (-2.69), $p<0.01$) indicating an increase of temperature by unit degree would lower MAS by 2.69 per cent. Similarly, increase in pH by unit degree would lower MAS by 12.16 per cent, unit degree increase in alkalinity would lower MAS by 0.41 per cent. Same way unit degree increase in DO and turbidity would lower MAS by

Table 4: Regression of MAS on water quality parameters in 3 districts

Water parameters	Mean ± SE	a	b	p	r^2 (%)
Temperature (°C)	28.00± 0.70	96.12	-2.69	<0.0001	41.99
pH	6.70±0.10	102.58	-12.16	0.0029	23.25
Alkalinity (ppm)	75.67±4.93	51.56	-0.41	<0.0001	49.00
CO_2 (ppm)	9.16±0.46	-15.32	3.90	<0.0001	39.00
Dissolve Oxygen (ppm)	6.21±0.14	104.43	-13.49	<0.0001	52.00
Turbidity Secchi disc (cm)	27.47±1.68	57.42	-1.34	<0.0001	60.04
Ammonia (ppm)	0.14±0.02	7.47	99.77	<0.0001	60.96

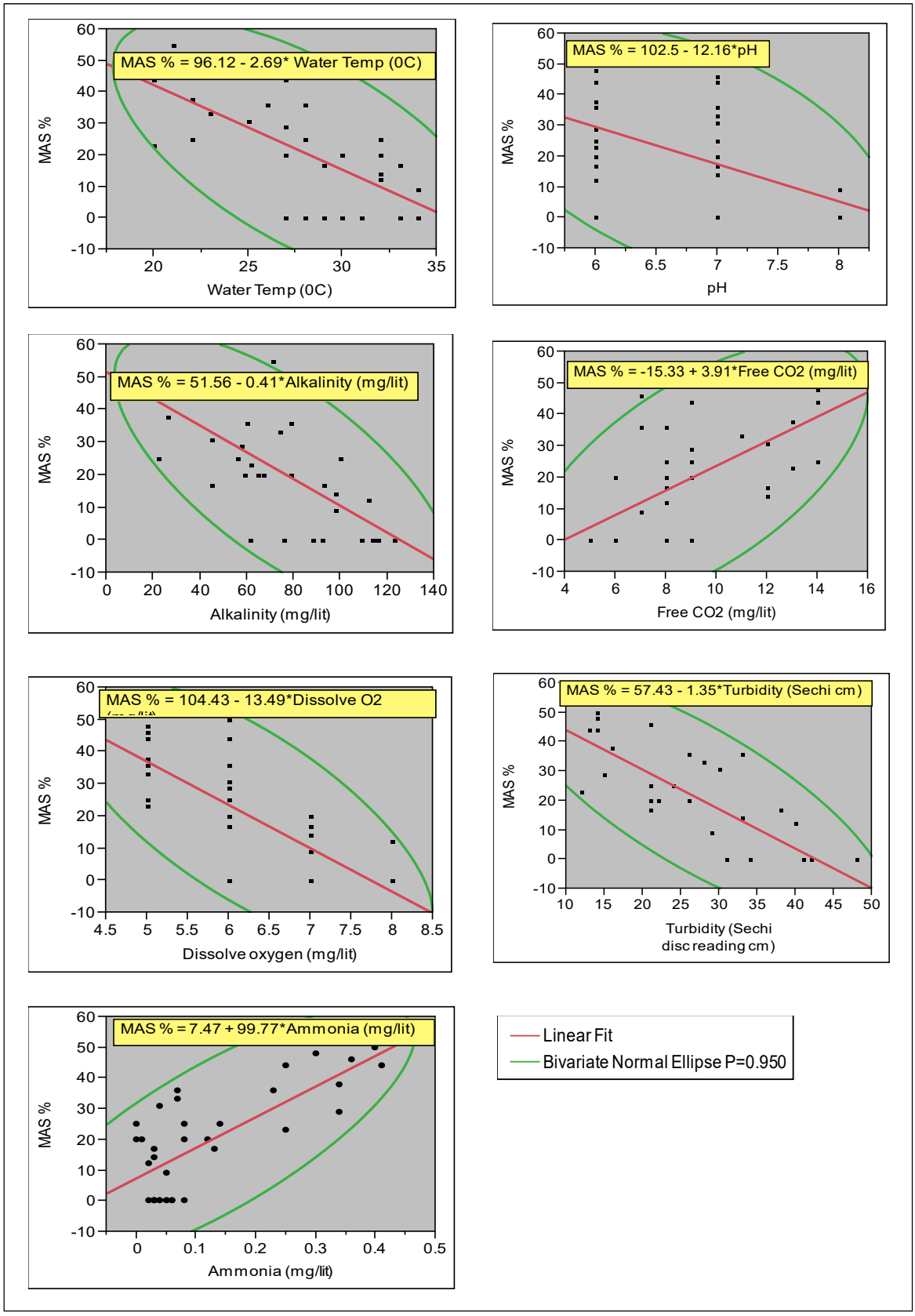

Figure 1: Positive and negative correlation of water quality parameters and mas
(Bivariate Fit of MAS % by water temp (°C), pH, alkalinity (mg/lit), DO (mg/lit), turbidity (cm), CO_2 (mg/lit) and ammonia (mg/lit)

13.49 and 1.34 per cent, respectively. However, the scenario of CO_2 and ammonia was found to be reversed in which the value was positively correlated and revealed that for unit degree increase in CO_2, the MAS % was supposed to increase by 3.9 per cent which is 9.97 per cent in case of ammonia.

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Adolescents' Aggression as Perceived by Self - An Interventional Approach

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ABSTRACT

Aggressive behaviour has become a topic of vital importance and a major concern in most of the societies. Identifying, controlling and managing highly aggressive behaviour and its ill effect of school going adolescents have not yet been a major focus of education system of India. Hence, the present study was undertaken to identify the types and level of aggression of adolescents and intervene them with mindful activities. The study was conducted in Sonitpur district of Assam. The sample for the study was selected purposively from a population of 185 students belonging to IXth (Ninth) standard of selected schools. A standardized questionnaire namely Direct & Indirect Aggression Scales developed by Bjorkqvist *et al.* (1992) was used to gather data from self to find out the prevalence of aggression among adolescents. A Mindfulness-Based Intervention programme was conducted to manage and regulate unpleasant emotions. Descriptive statistics were used to analyze the data. The findings of the study revealed that three types of aggression viz. physical verbal and social were present among the respondents which were categorized as high, average and low. According to self, physical and verbal aggression were most frequently showed by the adolescents. A significant increase ($P<0.01$) in the percentage of respondents in low category in all three types of aggression revealed that a large section of respondents abate the level of aggression considerably after intervention.

Keywords: Aggression, Adolescents, Coping skills, Intervention, Mindfulness

INTRODUCTION

Aggression leading to violence is currently a global problem which cannot be ignored. The dictionary meaning of aggression is the feeling of anger resulting in hostile or violent behaviour; readiness to attack or confront. According to Buss, (1961) "Aggression is an action or response by an individual that delivers something unpleasant to another person". It is a forceful behaviour, action or attitude that is expressed physically, verbally or symbolically.

Adolescence is the period of change, in which young people often engage in conflicts with parents and become involved in risky behaviour. Adolescents manifest aggressive behaviour in various forms ranging from social and verbal aggression to physical aggression and more serious kinds of violence. Uncontrolled aggression causes social, occupational, educational, physical and mental health problems and often leads to alcohol and drug use, smoking, low adaptability at school, educational failure, depression, delinquency, and other disorders among adolescents. The negative impact of aggressive behaviour has become a serious problem and poses a persistent challenge in the society. But the education system of India has not yet given focus on identifying, controlling and managing highly aggressive behaviour and its ill effect on school going adolescents. Aggressive behaviour is a multifaceted phenomenon and can be examined from different perspectives (Lewis, 2005). Various definitions of aggressive

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behaviour and what causes it also lead to inconsistencies in aggression management. In this regard, mindfulness seems to be a popular trend adopted by researchers and practitioners. Mindfulness is the psychological process of bringing one's attention to the internal and external experiences occurring in the present moment which can be developed through the practice of meditation or other training (Brown and Ryan, 2003; Kabat-Zinn, 1990). Mindfulness is considered to be an effective way of intervention included in public policy and education policy of other countries for improving health and psychological well being of the adolescents.

MATERIALS AND METHODS

The sample for the study was the students showing aggressive behaviour, identified and selected from 185 numbers of students of class IX (14-16 years) from two selected schools. Students from class IX were selected under as they belong to early and middle adolescence period (WHO, 1989) in which aggression reaches in its peak led by heightened emotionality. To select the desired sample, self opinions were taken into consideration. Intervention was given to the respondents showing aggressive behaviour after doing baseline assessment. Hence, quasi experimental design was used. Sociometry was used in this study to identify two groups of respondents, namely a popular group with a high frequency of positive nominations and a disliked group with a maximum/high frequency of negative nominations. Only the later group (32 students) with negative nominations had been taken into account for the purpose of the study.

A self structured questionnaire was used to collect background information of respondents. In order to assess the types and levels of aggression of selected respondents, a standardized structured questionnaire namely Direct & Indirect Aggression Scales (DIAS; Bjorkqvist *et al.,* 1992) was used. DIAS measures three kinds of aggression, namely Physical, verbal, and indirect or social. A five-point scale (0=Never, 1=Seldom, 2=Sometimes, 3=Quite often, 4=Very often) has been used for responses to all items for self-estimations.

The total scores of each respondent for physical, verbal and social aggression were calculated. The categories of "High", "Average", and "Low" for each type of aggression were made by following the method of class interval in which class intervals were decided by arranging the scores in different classes and width i.e. based on the highest and lowest scores obtained by the respondents.

"Emotion-Focused Coping Skills-a Mindfulness Approach", is an intervention package developed specially for adolescents with a view to reduce aggression leading to management of uncomfortable emotions mainly through mindfulness activities. This user friendly intervention package was a combination of learning psychoeducational component, mindfulness and meditative activities as well as essence to abate aggression. Sensitization programme for parents and teachers was also a part of this intervention.

In order to judge whether the mindfulness activities for management of aggression can really change the behaviour of the selected subject or not, post tests (First and Second) have been conducted after intervention (during 3rd month and during 5th month). Additional information were collected by interviewing the parents through home visit, observation of the home environment during home visit, obtaining required information from parents through telephonic discussion, direct discussion with peer group and teachers in the school. The data were analyzed to find out the prevalence of aggression (First Phase). After intervention, the collected data were again analyzed to find out the efficacy of the intervention (Second Phase). Descriptive Statistics such as frequency, percentage, mean and standard deviations were calculated using Microsoft Office Excel. Inferential Statistics namely Paired t-Test was calculated by using SPSS 23.

RESULTS AND DISCUSSION

The data of the baseline assessment have demonstrated that three types of aggression viz. physical verbal and social among the respondents which were categorized as high, average and low based on the scores obtained by the respondents. According to self, physical and verbal aggression were most frequently showed by the respondents.

Distribution of respondents according to types and levels of aggression as reported by self is depicted in Figure 1. It is evident from the results that the highest percentage (84.38%) of adolescent respondents had

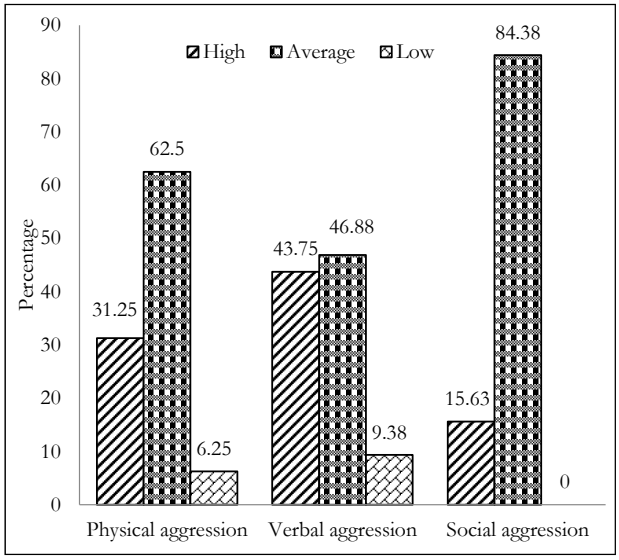

Figure 1: Distribution of respondents according to types and levels of aggression as reported by self

manifested average level of social aggression, which reveals that these respondents sometimes showed behaviours of social aggression like gossiping, personal rejection, excluding others from a social group, rumour spreading and criticizing other's appearance or personality. They modify, distort, and misinterpret the sayings of others and express in front of third person and dismiss the opinions of others. It may be attributed to the fact that social aggression is the primary means of aggression (Bjorkqvist *et al.,* 1992) and hence most of the adolescents find it easy to adapt this primary means to express their aggression. Moreover, the period of adolescence is a time of heightened emotionality and identity crisis, they are self threatened and they defend themselves and generally adopt certain ways for psychological manipulation. Besides, some adolescents want popularity among groups and they have a hidden intention to spoil the relationship of others. Research findings of Prinstein *et al.* (2001) opined that social aggression and victimization are distinct constructs among adolescents and may be particularly relevant for this developmental stage compared with overt behaviors.

As many as 43.75 per cent and 46.88 per cent of respondents showed high and average levels of verbal aggression respectively. These adolescents very often yell, insult and tease others out of anger, anxiety and frustration. They also call the other one's name and threaten him by saying that he is going to hurt him. Many of them (43.75%) showed these behaviours quite often while only 9.38 per cent of them were found to be in low level of verbal aggression, who seldom expressed these kinds of behaviours. This may be due to the fact that with increase in age adolescents are able to understand the ill effect of inflicting harm to others and therefore they prefer to show their aggression verbally to their siblings, parents, peers and others more often than that of other types of aggression. These results are in concurrence with the findings of Burke *et al.* (2014) and Hartley *et al.* (2015) who found that verbal aggression is the most prevalent form of aggression in school campuses.

It is worth mentioning that majority (62.50%) of the respondents were found to be in average level of physical aggression, reflecting that they sometimes engage in hitting, kicking, shoving, punching, taking things from others, pushing and pulling their peers while 31.25 per cent of respondents very often and only few (6.25%) of them seldom involved in physical aggression. This may be due to the fact that adolescents generally initiate conflicts with verbal aggressiveness which often leads to physical aggression. In a school situation verbal aggressiveness frequently occurs on the playground, in the hallways between classes, or in the leisure times which sometimes leads to physical aggression. This can be supported by the research findings of Cole *et al.* (2014) and Roberto *et al.* (1996), who demonstrated a strong correlation between verbal aggression and consequent physical aggression. Verbally aggressive behaviour significantly predicts physically aggressive behaviour among children and adolescents. Kumar *et al.* (2016) found that aggression is high among school-going adolescents and particularly among young adolescents, especially physical aggression. Shaikh *et al.* (2014) found that aggressive behaviour was common among adolescents, with increasing trend of physical aggression from VII standard to X standard. The peak ages of involvement in physical and social aggression are comparable with the findings of Farrell *et al.* (2005), who determined that physical aggression peaked in seventh and eighth grade (ages 13 to 14 years). In the study conducted by Fayso (2019) three forms of aggression namely social, verbal and physical were prevalent among adolescents in secondary school, specifically, students showed greater social aggression followed by verbal and physical ones. UNESCO (2018)

estimated that approximately 30 per cent of all students annually experienced some type of aggression at school.

The types and levels of aggression as reported by self after intervention are presented in Table 1. The overall picture emerging from these results revealed that there was a remarkable variation in the percentages of levels of aggression in all types of aggression i.e. physical aggression, verbal aggression and social aggression after conducting intervention programme. It can be observed that the results of calculated paired *t*-test were highly significant (P<0.01) in post test 1 and post test 2 for all types of aggressions.

The results of the paired *t*-test showed statistically significant difference in the aggression level of the respondents before and after intervention which proved the efficacy of intervention programme on reducing the levels of aggression. As a primary care giver parents were also encouraged to participate in their child's home practice sessions. The respondents were under close supervision of their parents who monitored and observed their child's activities at home setting. From the telephonic reporting of the parents the researcher could gather the picture of the changing behaviour of the respondents. The structured activities of the intervention programme helped the respondents to improve the ability to control and manage their aggression. Socio emotional skills were taught to the respondents which helped them to control their impulses. The respondents could realize that inflicting harm to others, bullying, social rejection etc. are not socially acceptable behaviour. They can comprehend the ill effect of high level of aggression. Learning to empathize can enhance relationship which leads to emotional regulation, lowers the likelihood of bullying and lessens aggressive behaviours. Besides, emotional self-regulation has been suggested as a key foundation for emotional well-being. By practicing the skills of mindfulness and socio emotional regulation the respondents could change their aggressive behaviour after the intervention. This can be supported by the findings of Eisenberg *et al.* (2010) and McClelland *et al.* (2007) who summarized that emotional regulation are more likely to demonstrate a greater ability to concentrate and pay attention in school, and exhibit better impulse control and reduced externalizing behaviours such as hostility and aggression. This is also in concurrence with the findings of Singh *et al.* (2016) who found that the verbal aggression decreased to minimal levels following mindfulness-based practice and physical aggression was nearly eliminated on mindfulness-based intervention for self-management of verbal and physical aggression by adolescents. The variation of results after intervention also may be due

Table 1: Distribution of respondents according to types and levels of aggression as reported by self after intervention

Levels of aggression	**Number of respondents as reported by self (N=32)**													
	Pre test		**After intervention (Post test 1)**						**After intervention (Post test 2)**					
	F	**P**	**F**	**P**	**Diff. of Mean**	**df**	**t**	**Sig (2-tailed)**	**F**	**P**	**Diff. of Mean**	**df**	**t**	**Sig (2-tailed)**
Physical aggression														
High	10	31.25	1	3.13	3.44	31	10.73	.000	0	0.00	5.94	31	14.70	.000
Average	20	62.50	22	68.75					9	28.13				
Low	2	6.25	9	28.13					23	71.88				
Verbal aggression														
High	14	43.75	3	9.38	1.75	31	8.51	.000	0	0.00	4.00	31	11.80	.000
Average	15	46.88	22	68.75					13	40.63				
Low	3	9.38	7	21.88					19	59.38				
Social aggression														
High	5	15.63	2	6.25	2.91	31	14.01	.000	0	0.00	6.28	31	15.06	.000
Average	27	84.38	26	81.25					9	28.13				
Low	0	0.00	4	12.50					23	71.88				

F = Frequency; P = Percentage

to neurobiological changes. Davidson and Lutz (2008) and Holzel *et al.* (2011) had found that mindfulness meditation alters the parts of the brain linked with attention and concentration, which is linked with self-regulation of attention and a substantial reduction in emotionally reactive behaviours. Likewise, recent neuro developmental findings of Davidson *et al.* (2003) and Sanger *et al.* (2015) showed that mindfulness and social-emotional learning programs implemented in regular school curriculum improved executive functions in children and adolescents in terms of inhibitory control, enabling them to manage excessive levels of negative emotions that interfere with academic performance. Studies by many researchers (Heeren *et al.,* 2009; Speca *et al.,* 2000), also suggested that mindfulness practice improves performance on a variety of measures of self-regulation, stress and mood disturbance. Mindfulness helped in reducing ruminations related to aggression, which leads to reduction in the expression of aggression (Borders *et al.,* 2010).

CONCLUSION

The results of the study revealed that three types of aggression viz. physical, verbal and social were present among the adolescents which were categorized as high, average and low The results also proved the efficacy of intervention programme in acquiring and practicing the skills for management of aggression. Practicing the skills for emotional control and regulation were a great help for the respondents to reduce their level of physical, verbal and social aggression. All the selected respondents had adopted the skills of mindfulness activities and knowledge which made them versatile and thereby motivated to practice it. Therefore, counseling programmes must be a regular feature of school curriculum for promoting socioemotional wellbeing of school children.

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Impact Study of Biofortified Pearl millet Production and its Utilization for Livelihood and Nutrition Security

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ABSTRACT

Biofortification is a cost effective and sustainable agricultural strategy to address the problem of livelihood security and micronutrient malnutrition. Therefore Krishi Vigyan Kendra, Morena initiated production of biofortified pearl millet in RVSKVV-Krishi Vigyan Kendra, Morena and in Nutri Smart Village of Morena district. The investigation was also conducted to study the effect of biofortified pearl millet supplementation on nutritional status of adolescent girls of Nutri Smart Village of the district. The biofortified pearl millet variety AHB 1269 produced an average grain yield of 31.5 q/ha while variety AHB 1200 produced an average grain yield of 30.5 q/ha. The overall acceptability score for biofortified pearl millet AHB 1269 was found higher (8.6) whereas control sample received the lowest score (7.9). There was 2.7 to 3.8 per cent increase in hemoglobin level of adolescent girls through consumption of value added products of pearl millet for 90 days. Thus production of biofortified pearl millet and its consumption in form of different value added products could be an efficient vehicle for protecting the livelihoods of farmers and farm women and improving nutritional status of vulnerable group.

Keywords: Pearl millet, Biofortification, Malnutrition, Iron, Zinc

INTRODUCTION

Micronutrient malnutrition, primarily the result of a poor quality of diets or a poor intake of vitamins and minerals, affects more than 2 billion people in developing countries, especially women and preschool children (Kramer 2015; Saltzman *et al.,* 2017). According to India's fourth National Family Health Survey data from 2015–2016, among adolescents aged 15–19 y (n = 169,228), 52 per cent of girls and 29 per cent of boys were anemic (NFHS-4). Majority of the people in the developing countries depend mainly on cereal grains as their staple food because of their limited income and the high prices of animal foods. The demand for cereals as food and feed is increasing because of population explosion in developing countries and short falls in cereal production in several developed countries (Sokrab *et al.,* 2012). The nutritional quality of food is a key element in maintaining human overall physical well-being because nutritional well-being is a sustainable force for health and development and maximization of human genetic potential. Therefore, for solving the problem of deep-rooted food insecurity and malnutrition, dietary quality should be taken into consideration (Singh and Raghuvanshi, 2012).

India is the largest producer of millets in the world, harvesting about 11 million tons per year, nearly 36 percent of the world's output. Pearl millet, which accounts for about two-thirds of millet production in India, is grown in the drier areas of the country, mainly in the states of Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, and Haryana. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat, and maize. It occupies an area of 6.93 million ha with an average production of 8.61 million tons and productivity of 1,243 kg ha^{-1} (Directorate of Millets Development, 2020).

Pearl millet is principal source of energy, protein, vitamins and minerals for millions of poorest people

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in the region where it is grown. It is major source of iron, zinc, calcium, potassium, manganese, riboflavin, thiamine, niacin, lysine and tryptophan (Tarasatyavathi, 2017). Bio-fortification deals with the development of cultivars having higher levels of micronutrients and it is of special significance due to its cost effectiveness and sustainability. In case of iron and zinc bio-fortified cultivars have an additional advantage of unhindered acceptance since grains of these cultivars are no different in taste and acceptance from those produced from low-iron cultivars normally grown (Rai *et al.,* 2014). Therefore Krishi Vigyan Kendra, Morena initiated production of biofortified pearl millet in RVSKVV-Krishi Vigyan Kendra, Morena and in Nutri Smart Village of Morena district. The investigation was also conducted to study the effect of biofortified pearl millet supplementation on nutritional status of adolescent girls of Nutri Smart Village of the district.

MATERIALS AND METHODS

The study was conducted at RVSKVV-Krishi Vigyan Kendra, Morena and Nutri Smart Village Bisangpura of Joura block of Morena district. The two hybrid varieties of pearl millet were obtained from VNMKV, Parbhani, Maharashtra. The crop was sown in second week of July and all necessary packages of practices were adopted for obtaining good yield of the crop. The crop was harvested at maturity and the grains were sundried and weighed. The healthy grain were processed to develop value added nutritious products and then supplemented in the diet of malnourished adolescent girls.

All the subjects were randomly selected from the nutri smart village of the district, to find out their nutritional status along with their haemoglobin level. They consumed pearl millet based value added products for 100g per day regularly for 90 days. Wheat flour was taken as control sample (T1). Pearl millet flour from hybrid cultivar was taken as treatment T2. Flour made from biofortified pearl millet variety AHB 1269 and AHB 1200 were served as treatment T3 and T4. Pearl Millet grains were cleaned by sorting and winnowing to remove all the contaminant. The cleaned grains were dehulled, washed and dried at 50°C for 24 hour in a cabinet drier. The grains were reduced to powder using a hammer mill and sieved through 0.25 μm sieve, packed into a cellophane bag and stored for further analysis (Adebayo-Oyetoro *et al.,* 2017). The hemoglobin level was measured in all the groups at an identical period of time i.e. initially and after intervention. Impact analysis was exercised based on statistical calculations and general responses of the subject. Sensory evaluation was carried out by standard method using 9 point hedonic scale. All indexes were measured using a scale from 0 to 9, where a score of 9 represents excellent quality and a score of 0 represents the lowest quality level (Meilgaard and Civille, 1999).

RESULTS AND DISCUSSION

The result obtained during the present course of investigation was carried out to visualize a significant influence of different parameters of biofortified varieties. In case of plant height, it was observed that plant height was 175 and 150 centimeter in biofortified varieties AHB 1269 and AHB 1200, respectively. The biofortified pearl millet variety AHB 1269 produced an average grain yield of 31.5 q/ha while variety AHB 1200 produced an average grain yield of 30.5 q/ha (Table 1). The dry fodder yield of AHB 1269 was 73.6 q/ha as compared to 69.4 q/ha in AHB 1200. AHB 1269 and AHB 1200 were erect with an average plant height of 175 and 150 centimeter, respectively. The stems of AHB 1269 had green pigments at the nodes. White colored node pigmentation was noticed on stem in AHB 1200. The panicles were thick and conical in shape in both biofortified varieties. Both biofortified varieties were resistant to downy mildew disease (zero percent incidences) in natural condition. The study was also conducted to find out the attitude of the farmers' towards farming and their economic motivation for increasing farm income. It was found that a large majority (71.67%) of the farmers had

Table 1: Performance of biofortified pearl millet varieties

Parameters	AHB1269	AHB 1200
Average grain yield (q/ha)	31.5	30.5
Maturity (days)	80	77
Resistant to	Downy mildew	Downy mildew
Dry fodder yield (q/ha)	73.6	69.4
Plant height (cm)	175	150
Insecticide	Nil	Nil

Table 2: Sensory evaluation of nutritious flour made from biofortified pearl millet

Samples	Appearance	Aroma	Taste	Overall Acceptability
T1	8.4±0.49	7.8±0.59	7.8±0.40	7.9±0.24
T2	8.2±0.24	8.1±0.39	8.0±0.42	8.1±0.25
T3	8.3±0.48	8.5±0.49	8.5±0.49	8.6±0.41
T4	8.3±0.48	8.4±0.52	8.3±0.48	8.3±0.39

*Each value is the mean of three replications

moderately favourable attitude towards farming and 13.33 per cent farmers had highly favourable attitude. 68.33 per cent farmers were found with moderate level of motivation and 16.67 per cent possessed high level of motivation (Bora *et al.,* 2018).

Sensory evaluation is a scientific method used to evoke, measure, analyze and interpret human responses to food products as perceived through the senses of sight, touch, odor, taste and sound (Tomlins *et al.,* 2007). It was recorded that the overall acceptability score for sample T3 was found higher than other samples whereas T1 received the lowest score (7.9) (Table 2). The sample T3 was also reported as statistically as par with T2 and T4 samples and significantly superior than the T1 sample. The appearance serves as important parameter for the acceptance of food samples. Control sample had the highest score for appearance as compared to the other samples. It was due to grey colour of pearl millet seeds. The treatment T3 obtained highest score for aroma of nutritious flour (8.5). The lowest score found in the sample T1 score (7.8). The scores for taste ranged from 7.8 to 8.5. The highest was recorded for treatment T3 followed by T4, T2 and T1. The mean sensory scores showed that there was a major difference among treatments T1, T2, T3 and T4. The sample T3 was significantly superior to the other samples.

It was found that the iron content was present in high amount in T3 treatment followed by T4, T2 and T1 samples. The zinc content was same in treatment T1 and T2 while it was highest in T3 treatment followed by T4 treatment (Figure 1). The present investigation reports that there was no change in haemoglobin level of control group. While the hemoglobin levels after 90 days of intervention in treatment T2 increased 2.7 per cent, T3 raised to 4.4 per cent and T4 raised to 3.8 per cent (Figure 2). A clear reduction in iron deficiency status associated with the iron- biofortified pearl millet group was also documented (Finkelstein *et al.,* 2015). The study conducted by Kodkany *et al.,* 2013 also suggested that the increased concentrations of iron in pearl millet when consumed as a staple food, has higher bioavailability and meets the physiological requirements of iron in young children. Concerted efforts must be made for promotion of such varieties of the benefit of the farmers. With the efforts made

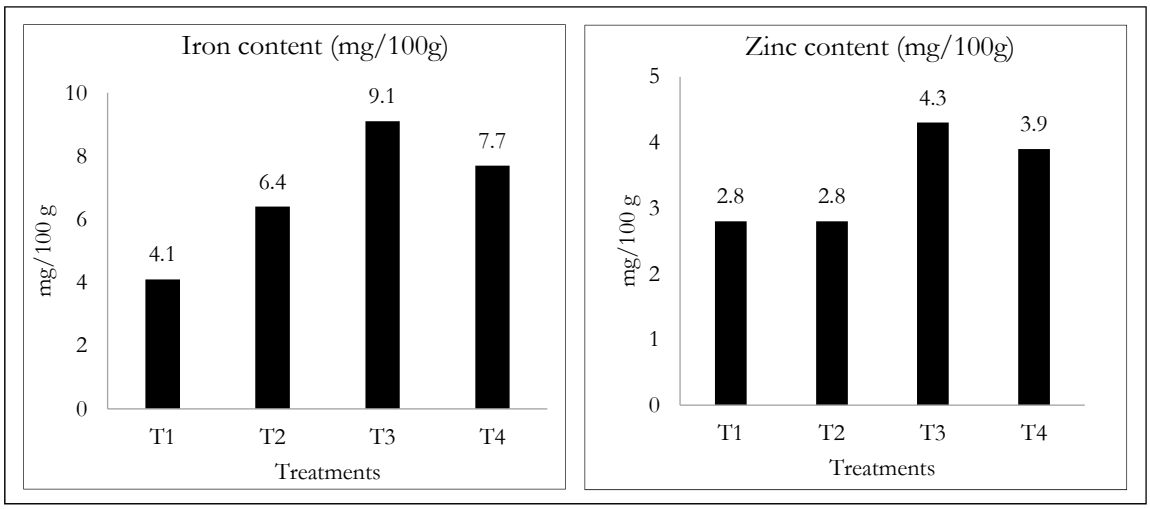

Figure 1: Effect of different treatments on iron and zinc content of nutritious flour

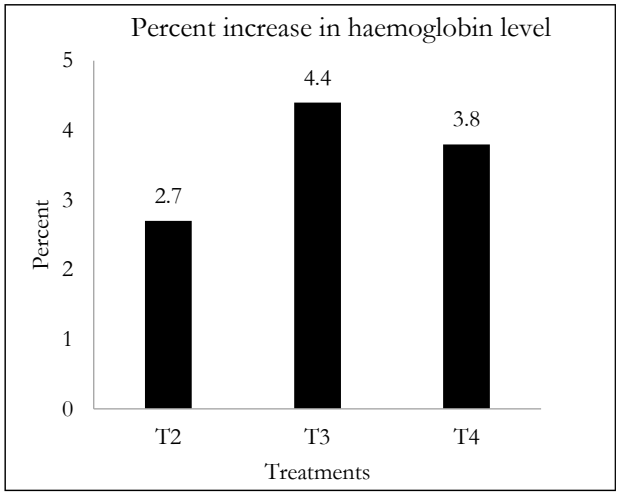

Figure 2: Percent change in haemoglobin levels of the subjects after intervention

by Krishi Vigyan Kendra, many farmers had adopted new technology and this is acceptable by the farming community (Shahi *et al.,* 2017). After imparting the nutrition and health education, a significant difference was observed in the score of pre and post-test of nutrition education intervention (Joshi *et al.,* 2018).

CONCLUSION

In the face of leading water scarcity, biofortified pearl millet varieties are the most preferred varieties due to its adaptive climate-resilience and nutritional features to combat drought threat situation and malnutrition problem. Biofortification is scientifically proven to be a sustainable and cost effective approach to address malnutrition. This approach targets the root cause of the malnutrition. Biofortified pearl millet has the potential to make significant contributions to the food-cum-nutritional security in dryland poor households. Pearl millet in general has higher iron and zinc content than other major cereals such as wheat, rice, maize and sorghum. From the above study it is concluded that the pearl millet biofortified varieties AHB 1269 and AHB 1200 is found to be suitable for Morena district of Madhya Pradesh. The value added biofortified pearl millet products showed good overall acceptability and improves the nutritional value of food product and rich in iron as well as zinc content and can be stored at room temperature for three months. Thus pearl millet based value added products could be an efficient and promiscuous vehicle for improving nutritional status of adolescent girls and protecting the livelihoods of farmers and farm women.

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Study of Pashu-Vigyan Incubator in Income and Employment Generation among Pig Entrepreneurs

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ABSTRACT

Non-ruminant livestock farming like piggery holds tremendous scope for solving the problem of unemployment for the youth while generating a steady source of income in uncertain times by making them *Atm-Nirbhar* or self-reliant. The present study attempted an overall analysis of the income and employment generation among the pig entrepreneurs of Pashu-Vigyan Incubator. These piggery entrepreneurs were the ones who had attended the Piggery Entrepreneurship Development Program at Agri-Business Incubator IVRI. The study revealed that the average employment generation for family and hired labour were 68.72 and 374.98 man-days respectively and a noteworthy overall employment generation (average of 245 man-days/labour) was seen due to pig enterprises. Substantial change in annual income of the entrepreneurs was observed owing to piggery farming. Majority of them (72.50%) were earning profit from piggery. Almost half of them (44.82%) were making medium level of profit (5-10 lakhs) and almost one third were even earning profit upto 50 lakhs annually. An average profit of Rs. 5,24,382 from piggery enterprises was elucidated and the benefit-cost ratio (BCR) was found to be 1.33.

Keywords: Piggery enterprises, Economics, Employment generation income generation, BCR, Profit

INTRODUCTION

India predominantly being an agrarian country with the agro-allied sector contributing 10 per cent of total GDP and employing 44.2 per cent workforce of the country (NSO 2019) is on the forefront of the livestock market as well both in terms of milk and meat products. The output value from livestock was about 31.81 per cent of the total agriculture and allied sector (National Accounts Statistics, 2019). Livestock sector contributes nearly 4.11 per cent of revenue to the country's gross domestic product (GDP). The percentage of people working in animal production is 2.10 per cent of the total workforce (Periodic Labour Force Survey Annual report, 2018-19). With 9 per cent of the population being youth the unemployment rate in the country is 7 per cent, with rural unemployment being 5.68 per cent and urban unemployment 8.45 per cent (CMIE report, 2020). The agribusiness incubator of ICAR- IVRI more popularly known as the Pashu-Vigyan Incubator is paving a way for mitigating the problem of youth unemployment under the RKVY-RAFTAAR program of the Government of India to Manifest the dream of "*Aatm-nirbhar Bharat*" through its various innovative entrepreneurship development programs and other interventions. Pig farming is an untapped way towards independence and self-employment for youth and farmers with low investment. The Pashu-Vigyan Incubator is creating an ecosystem for 'Entrepreneurship Development' and start-ups in diverse areas of livestock and animal science. It's "Entrepreneurship Development Programme" (EDP) on Piggery provides research knowledge on the technical front along with mentorship at the business level to the farmers and youth who are the budding entrepreneurs in pig farming. The larger perspective is to strengthen agri-businesses motivation in pig farming as a profession through entrepreneurship

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development, innovation and value addition as per need providing a thrust in the piggery sector which helps to open up opportunities for entrepreneurs/start-ups in the global scenario as well.

MATERIALS AND METHODS

The study was conducted in the 'Division of Extension Education' ICAR-Indian Veterinary Research Institute, Izatnagar. The *ex-post facto* design was used because the trainings considered in the present study had already occurred. A purposive sampling method was applied on the list of trainees who have attended the Piggery Entrepreneurship Development Programme organized by Agribusiness Incubator ICAR-Indian Veterinary Research Institute, during 2018-19, 2019-20 and 2020-21. A final sample size of 80 trainees (who had positively started their piggery enterprises and had returned the e-questionnaire duly filled) were selected. The data were collected via e-questionnaire which was developed for the purpose and individually followed-up telephonically. The employment generation was calculated in 'Man-days' (1 man day = 8 hours) generated by pig farming in a year. It was assessed by a structured mailed questionnaire consisting of questions on average time spent in various piggery operations. The time spent was multiplied to 365, elucidating working hours created in a year by a pig farm. Annual working hours created by pig farms was divided by 8 to obtain the man-days generated from the piggery enterprise and based on this categorization into low, medium and high levels was done according to the equal class interval method. For economic analysis, income and expenditure done by the entrepreneurs on the piggery enterprises both in terms of fixed capital and variable cost incurred, profit or loss experienced by the piggery entrepreneur and their level of profit was taken into consideration. The respondents were further segregated as low, medium, high based on their income, expenditure and net profit or loss. The data collected were scored, tabulated and analyzed using suitable descriptive statistical tools such as frequency, percentage, Mean, SD and correlation.

RESULTS AND DISCUSSION

The favourable and promising results were seen with regard to the performance of the piggery enterprises of the trainees of the Pashu-Vigyan Incubator in terms of income and employment generation.

It can be elucidated from Table 1 that more than half of the respondents (63.45%) had low level of total employment generation (≤547 man-days/annum) in piggery farming, followed by high (15%) and medium (2.5%) level of employment. The result is in line with Seth (2012) where piggery intervention had positive impact on overall employment generation. The result is in consonance with the findings of Gupta (2018), but in contrast with that of Tiwari (2000) and Lal *et al.* (2009) who reported a beneficial effect of training on the duration of employment spells. It is further contradicted by findings of Kumar *et al.* (2012) as well. Average annual employment generation for one individual labour was elucidated 245 man days. This is in sharp contrast and at better numbers as compared to the flagship rural employment generation programme of Government of India under MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) which guarantees a minimum of 100 days of wage employment in a year to every household whose adult members are willing to do unskilled manual work, for each adult member of the rural family.

Table 1: Distribution of respondents according to the level of total annual employment generation from pig enterprises

Total annual employment generation (man days)	Trainees (N=80)
Low (≤547)	51 (63.45)
Medium (548-890)	25 (31.25)
High (≥891)	4 (5.00)
Mean±S.E.	443.70±23.57

Figures in the parentheses indicate the percentage

From the Table 2 it is clear that more than half of the respondents made a total investment of less than 12 lakhs in the piggery enterprises and fell under the low investment category followed by medium category (11-22 lakhs) with 35 per cent of the respondents. Mere 15 per cent were in high investment category (>22 lakhs). The findings are somewhat similar to that of Panday *et al.* (1997).

More than two-thirds of the respondents reported an annual income upto Rs. 25 lakhs in piggery enterprises, followed by medium (Rs. 25-50 lakhs). About 9 per cent of them were also earning income

Table 2: Distribution of respondents according to the level of total expenditure per annum in piggery enterprises

Total expenditure/annum (lakhs)	Trainees (N=80)
Low (<11)	40 (50.00))
Medium (11-22)	28 (35.00)
High (>22)	12 (15.00)
Mean ± S.E.	15.76 ± 1.82

Figures in the parentheses indicate the percentage

of 50 lakhs and above. The finding is in consonance with that of Sasikala (2008); Jini (2008); Kumar *et al.* (2013) and Gupta (2018) but not in line with that of Seth (2012); Payeng *et al.* (2013) and Bhagavanrao (2015).

As the data in the current study is of the trainees starting their piggery enterprises after attending training at Pashu Vigyan Incubator IVRI in 2018 and onwards. Data collection and interaction with the pig entrepreneurs revealed the severe effect of global pandemic of COVID-19. Restrictions in the movement, lack of feed supply, shutting down of markets (both local and national), widespread disease and basic infrastructure failure shook the whole economy and piggery sector was also not spared. The lockdown negatively hampered the sale of pigs as there were no markets for the same. Furthermore, the meat consumption went down drastically during the pandemic due to the misinformation related to consumption of meat among the masses. The export sector was completely shut down. The pig entrepreneurs were forced to sell their kind at losses in order to prevent animals from perishing. Thus, very high income as per expectation was not met for most of the piggery entrepreneurs due to the pandemic,

Table 3: Distribution of the respondents according to the income from piggery enterprises per annum

Annual income from piggery enterprise (lakhs)	Trainees (N=80)
Low (<25)	61 (76.25)
Medium (25-50)	12 (15.00)
High (>50)	7 (8.75)
Mean±S.E.	21.00 ± 0.88

Figures in the parentheses indicate the percentage

although a significant number of them were able to generate a decent level of profit too.

Table 4 elucidates the various categories of average cost incurred in the pig farming enterprises. The cost of purchase of animals (piglets/sows/boars) formed 84 per cent (Rs 93,462) of the fixed cost incurred by the farmers in the piggery enterprises. Around 12 per cent was spent on construction of buildings (Rs 13,537) and a mere 4 percent on purchase of machinery and equipments.

Among the average variable expenditure, expenses on feed was almost 74 percent (Rs 10,73,565) forming the major part of the total expenditure as well. Average labour cost was around 15 percent of the total expenditure, amounted to Rs 2,10,936 forming the second most important expenditure. Next crucial expenses were on veterinary services and electricity comprising about 5 and 3.5 per cent (Rs 65,908 and Rs 51,765) respectively. Water and transport expenses consisted 1.5 and 1.7 per cent respectively and were less considerable. Miscellaneous expenditure was negligible (<1%).

Table 4: Economics of piggery enterprises

Category	Value in INR
Fixed cost	
Animals	93,462.5
Building	13,537.5
Machinery	4,210
Total fixed cost	1,11,210
Variable cost	
Feed	10,73,565
Labour	2,10,936
Veterinary expenses	65,908
Electricity expenses	51,765
Water expenses	23,056
Transportation expenses	25,579
Miscellaneous expenses	14,349
Total variable cost	14,65,158
Total average annual expenditure	15,76,368
Sale of pig meat (piglets/pigs)	21,00,750
Sale of manure	0.00
Sale of other items related to piggery	0.00
Total income from piggery enterprises	21,00,750

Sale of pig meat (Pigs and piglets) formed the sole source of income earned from the piggery enterprises. There was no income from the sale of skin and hides, manure, and other items related to piggery. Pig farmers were only selling the pig meat and were not focusing on earning by selling other by products of the pig farming. The findings are in consonance with that of Rajiv and Pandey (2000).

The average total expenditure on piggery enterprises was Rs 15,76,368 and the average total income was Rs 21,00,750. The average profit of Rs 5,24,382 was elucidated. The average benefit cost ratio (BCR) of 1.33 came out for the current study indicating the piggery enterprises are sustainable, profit yielding and will deliver positive net present value. The current findings are in line with that of Ezeibe (2010) and Nagaraj (2011). The BCR tends to be on the lower end due to COVID-19 lockdown and the resultant economic stagnation.

Majority (72.50%) of the entrepreneurs were earning profit whereas 27.50 per cent of them had suffered a loss. These findings are in consonance with Saikia *et al.* (2017). The losses faced was traced back to the global pandemic induced lockdown (from March 2020 to September 2020 and April 2021 to June 2021) due to COVID-19. Moreover, majority of enterprises were started in 2019 and onwards and it takes a minimum of 2 to 3 years for a piggery enterprise to sustain and start yielding profit. The prime period of profit making underwent a lockdown thus hampering their sales of pigs.

From Table 5 it is evident that 44.82 per cent of the pig entrepreneurs who had earned profit were from the medium profit category, making profit of 5 to 10 lakhs per annum whereas 24.13 per cent of them reported in low profit category making a profit of less than 5 lakhs per annum. More than 10 lakhs per annum was made by 31.03 percent of the respondents who earned high level of profit. The results of profit is in line with the findings of Goswami (1997) who also concluded piggery enterprises to be fruitful to the farmers. The entrepreneurs who reported low to medium level of profit, owe this to the lockdown imposed during the pandemic of COVID-19, which severely impacted the sales and profit in a negative way for them.

Table 5: Distribution of respondents according to their level of net income generation

Net annual income (lakh)	Trainees (N=58)
Low (<5)	14 (24.13)
Medium (5-10)	26 (44.82)
High (>10)	18 (31.03)

Figures in the parentheses indicate the percentage

The income generation from piggery enterprises was highly correlated with entrepreneurial behaviour of the respondents (r=0.305**), Social Participation (r=0.363**) and adoption of the scientific piggery practices (r=0.342**) indicating that respondents who had high income generation showed more social participation and had high entrepreneurial behavior (Table 6). Similarly, it is also clear that all those respondents who had adopted scientific piggery practices were generating higher annual income from piggery.

Table 6: Correlation of Income from piggery enterprises with various variables considered under study

Variables	'r' value
Social Participation	0.363**
Experience	0.339*
Attitude	0.172
Entrepreneurial Behaviour	0.305**
Adoption	0.342**

CONCLUSION

The final inferences are that majority of the respondents had no family involvement and went for hired labour for their piggery operations. Piggery enterprises resulted in substantial employment generation for family and hired labour. Economic analysis showed a medium to low level of initial investments, low level of fixed capital investment and variable cost per annum on the piggery enterprise. Almost one third of the entrepreneurs were earning profit. Among those in profit, almost half were making medium to very high level of profits as well. The study though under some influence of the global pandemic of corona virus, majority of the piggery enterprises showed resilience and sustained. Undoubtedly, piggery is a sustainable and promising alternative income and employment generating business

for the unemployed youth if backed by scientific push. And, also not forgetting that one of the crucial investment made should be towards mitigating and preparedness towards unprecedented circumstances like COVID.

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Beneficial Effects of γ-oryzanol in Rice Bran for Improving the Health Status of Community

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ABSTRACT

The development of a society depends on the health status of its community. The sedentary lifestyle and changes in eating pattern has led to increase in the lifestyle disorders among populations. There is a need to provide functional foods to people so as to improve their health. The γ-oryzanol is a non-saponifiable lipid which is present in rice bran. It owns many properties that play an important role in lowering plasma and serum cholesterol, improve insulin sensitivity, and reduce the growth of cancerous cells. It possesses a potential for elevating immune activity by humoral and cellular mediated mechanisms. Worldwide many companies are manufacturing tablets of γ-oryzanol and selling them as a health supplement. The market of γ-oryzanol as a nutraceutical is growing due to its enormous beneficial effects and no reported chronic or acute side effects. However, the data pertaining to behavior of γ-oryzanol in the human gut is limited and more research is needed in this area. The use of γ-oryzanol in different diet-based approaches to alleviate disorders related to lifestyle need to be explored as γ-oryzanol as a bioactive component has strong potential for inclusion in designer functional foods. It can play an effective role in improving the health status of community.

Keywords: γ-oryzanol, Rice bran oil, Nutraceutical, Health benefits, Safety

INTRODUCTION

Rice contributes to 50 per cent of the total dietary calories and is an important source of the protein intake for 520 million people residing in Asia and is, therefore, critical for food security (Muthayya *et al.,* 2014). In the developing world, it is also a major source of employment and income for more than 200 million households across the countries (FAO, 2004). Rice is mainly consumed after dehulling and milling. This has led to the development of rice processing industry which produce various products and by products. Rice bran has bioactive potential and is the outermost layer of the rice kernel comprising of germ, aleurone, pericarp and sub aleurone layer and is obtained as a byproduct during rice milling. In the developing countries, the byproducts are often used as an animal feed leading to wastage of the important bioactive compounds (Sharif *et al.,* 2014). Rice bran can be successfully incorporated into human diets specially in developed nations to improve health. It is an important under-utilized resource of phytochemicals (Borresen and Ryan, 2014). The γ-oryzanol, which is a combination of ferulate, triterpene alcohols and esters of fatty acid is present as non-saponifiable fraction in rice bran oil and has the potential to be used in nutraceutical preparation.

Nutritional properties of rice bran

Rice bran is rich in carbohydrates, protein, lipids, dietary fiber, minerals (calcium, potassium, phosphorus, manganese, magnesium and other trace elements) and many phytonutrients (Gurpreet and Sogi, 2007). The nutritional properties are described as protein 11-15 per cent; carbohydrates 34-62 per cent, lipids 15-20 per cent; crude fibre 7-11 per cent; ash 7-10 per cent (Cicero and Gaddi, 2001). Cereals are limiting in

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Table 1: Nutritional properties of rice bran (Cicero and Gaddi, 2001)

Nutrients	Amount (%)
Protein	11-15
Carbohydrates	34-62
Lipids	15-20
Crude Fiber	7-11
Ash	7-10
Linoleic Acid	34.4
Linolenic Acid	2.2
Oleic Acid	38.4
Palmitic Acid	21.5

essential amino acid lysine and so is the rice. Contrary to this, rice bran is rich in lysine and thus the proteins isolated from it contains good amounts of lysine (Kennedy and Burlingame, 2003; Tsuji *et al.,* 2001). The isolated proteins are nutritionally superior and highly digestible. These isolates can be used as a functional ingredient in various food preparations (Wang *et al.,* 1999).

Rice bran is a considered as a rich source of dietary fibre. Rice bran contains high amounts of dietary fibre that varies from 20-51 per cent and is a good choice for manufacturers. Rice bran fiber improves stool rates as it has a laxative effect and can improve fecal production (Abdul and Luan, 2000). It is an excellent source of essential fatty acids as it contains linoleic acid (34.4%), linolenic acid (2.2%), oleic acid (38.4%), palmitic acid (21.5%) and stearic acid (2.9%) and other unsaturated fatty acids. Rice bran contains good amounts of many antioxidants γ-oryzanol, tocotrienols and tocopherols (Gong and Yao, 2001). Rice bran oil contains 90-96 per cent saponifiable lipids and about 4 per cent unsaponifiable lipids. The saponifiable lipids include 68-71 per cent triglycerides, 5-6 per cent monoglycerides, 2-3 per cent diglycerides, 5-7 per cent glycolipids, 3-4 per cent phospholipids, 2-3 per cent free fatty acids and waxes, on the other hand, the principle component of the unsaponifiable fraction is γ-oryzanol (McCaskill and Zhang, 1999).

Extraction of γ-oryzanol

Conventional method of extraction of γ-oryzanol is by the use of hexane as a solvent. As γ-oryzanol is highly polar due to the presence of alcoholic group in the ferulic acid part, polar solvents like isopropanol and ethyl acetate may solubilize it (Watkins *et al.,* 1994). Oryzanol content obtained by extraction procedures depend on many factors like temperature and nature of extracting solvent, bran to solvent ratio, variety of rice and plant processing methods used. Supercritical fluid extraction (SFE) technique is another recent method to extract oryzanol extracted from rice bran and may result in recovery of 17.5 per cent oil with SFE at 350 bar pressure and 313K temperature with an extraction efficiency of 84.9 per cent while at a temperature of more than 315K and pressure of 250-350 bar showed the best results for the extracting γ-oryzanol and rice bran oil on the basis of response surface methodology (Chen *et al.,* 2008). Many studies were conducted for comparing the extraction efficiency of Soxhlet extraction technique with supercritical fluid extraction technique for extracting γ-oryzanol from rice bran (Jesus *et al.,* 2010). Maximum g-oryzanol recovery rate (31.3%, w/w), high γ-oryzanol content and presence of unsaturated fatty acids were observed at a temperature of 303 K and a pressure of 30 MP. Similarly, maximum oil yield (12.68%) and maximum antioxidant activity was shown by supercritical fluid extraction (71.67%) as compared to the extraction through liquefied petroleum gas and SFE (Soares *et al.,* 2016). A comparison of conventional extraction methods with microwave assisted extraction of rice bran oil showed that for obtaining good quality of rice bran oil, microwave extraction must be used (Terigar *et al.,* 2011). To improve the extraction rate of desired nutraceuticals, before employing conventional and novel techniques, the raw material must be pre-treated with microwaves. Before subcritical extraction, treating defatted rice bran with microwaves resulted in a decrease in the extraction time but improvement in the recovery of phenolic compounds (Wataniyakul *et al.,* 2012). Use of ultrasound assisted extraction and ethanol for the extraction of antioxidants and polyphenols from rice bran is a promising and may give better yield. The pre-treatment of rice bran oil with ultrasonic waves significantly affected the yield of rice bran oil. Moreover, the treatment resulted in lowering the amount of coloring pigments and free fatty acids (Tabarak and Nateghi, 2011).

Cost of oryzanol

The cost of oryzanol available in market depends upon the grade and the extraction procedure used. It is

available in the international market at the rate of $13.57/kg - $95/kg prepared using chemical treatment process and $203/kg to $1017/kg for solvent free processed products (Gopalakrishna, 2003).

Role of γ-oryzanol in disease prevention

Diabetes mellitus

According to the World Health Organization (WHO) estimate, by the year 2030, diabetes mellitus will be the 7th leading root cause of death. It is speculated that by 2030, in India, 79.4 million people will have diabetes mellitus, and a significant increase in number of diabetics will be observed in United States (30.3 million) and China (42.3 million) (Wild *et al.,* 2004). At the molecular and cellular levels, development of diabetes, insulin resistance and impaired glucose uptake is initiated by oxidative stress. Obesity and insulin regulation are closely related with each other. Adipocytes produce adiponectin which modulates lipid and glucose metabolism in insulin-sensitive tissues, like skeletal muscles and liver (Yamauchi *et al.,* 2002). Obesity is also promoted by dysfunction of adipocytes leading to lower secretions of adiponectin. In a stress-induced model of hypoadiponectinemia, γ-oryzanol helped in restoring the globular and sufficient levels of adiponectin. Sufficient adiponectin is linked to the activation and phosphorylation of 51-AMP-activated protein kinase (AMPK) which positively regulates glucose metabolism and insulin sensitivity by decreasing the formation of molecules involved in gluconeogenesis (Barthel and Schmoll, 2003). Oryzanols significantly increase the glucose uptake by insulin-resistant cells and translocation of glucose transporter type 4 (GLUT4) from the cytosol to the cell surface. The effect of oryzanols on adipocyte differentiation is dependent on mTORC1 activity as rapamycin blocks cell differentiation in oryzanol treated cells. Oryzanols enhance glucose uptake, stimulates adipocyte differentiation and is associated with cellular signaling mediated by PPAR-γ and mTORC1. The ã-oryzanol fed group of T2DM rats showed an increased insulin sensitivity as compared to control and palm oil fed rat groups showing a positive effect of γ-oryzanol for diabetes (Cheng *et al.,* 2010). The hypoglycaemic potential of γ-oryzanol in streptozotocin-induced diabetic rats with high serum glucose level of 340–400 mg/dl was studied. After 2-4 hours of administration of oryzanol at a dose of 50 and 100 mg/kg body weight, there was a decline in the serum glucose levels of rats (Ghatak and Panchal, 2012).

Cardiovascular diseases

Rice bran oil possesses a unique fatty acid profile as compared to other vegetable oils which has a potential in lowering hyperlipidemia. γ-oryzanol can help in increasing the high-density lipoprotein cholesterol to some extent either by influencing absorption of dietary cholesterol or by enhancing the conversion of cholesterol to sterols and fecal bile acids (Sharma and Rukmini, 1986). It acts as a potential lipid-lowering agent, reduces triglycerides and total cholesterol in dyslipidemia and it has an equivalent efficacy as a lipid-lowering agent in comparison to fibrate and statin in two dyslipidemia mice models (Filho *et al.,* 2014). Diet containing g-oryzanol at 0.5 per cent level increased the amount of bile acids and sterols by 246 and 107 per cent, respectively in the feces. An i*n vitro* study explained a decrease of inflammatory conditions by seven folds when γ-oryzanol was supplemented at a concentration of 30 μM (Sakai *et al.,* 2012). The absorption of cholesterol was negatively influenced by γ-oryzanol and the micelle formation was also impaired by at high concentrations of γ-oryzanol (Makynen *et al.,* 2012). In a human study, for a duration of 16 weeks, 100 mg of γ-oryzanol thrice daily was given to 20 chronic schizophrenic patients with dyslipidemia. The supplementation resulted in reduction of total cholesterol and low-density lipoprotein cholesterol levels from 204 and 124 mg/dl at baseline to 176 and 101 mg/dl after 12 weeks, respectively. No treatment side effects were recorded, hence γ-oryzanol is effective and quite safe in the treatment of dyslipidemia (Sasaki *et al.,* 1990). Mixing safflower oil with rice bran oil in specific proportion (3:7 w/w) increased the hypocholesterolemic activity as compared to the effect of individual oils (Makoto *et al.,* 1990).

Cancers

A remarkable effect of γ-oryzanol (50ìmol/L) has been observed on down regulation hepatic lipogenesis-related genes in a study on human hepatocellular carcinoma (HepG2) cells (Murray, 1996). A diet with 1 per cent oryzanol was able to regulate angiogenesis by suppressing 61 per cent of the blood vessels in

mice implanted with tumor. The authors in another study of rats with implanted tumor, reported that after supplementing the diets with various components having antioxidant potential, γ-oryzanol was found to be more effective. The dose-dependent reduction in colonic tumor size at 0.2, 0.5 and 1 per cent of γ-oryzanol in the diet was observed in these rats as the dose of 1per cent reduced the tumor size by 44 per cent (Sugano *et al.,* 1999).

Immunomodulatory function of γ-oryzanol

Rice bran oil (RBO) rich in γ-oryzanol has many beneficial effects on the immune system. The translocation of Nuclear Factor kappa-light-chain-enhancer of activated β-cells (NF-kβ) in lipopolysaccaride-stimulated (LPS) macrophages was reduced by 10 ng/ml with γ-oryzanol (Wang *et al.,* 2015). A reduction of 20 per cent was observed with ã-oryzanol having cycloartenyl ferulate at 10 ng/ml while reduction of 20-40 per cent was found with other components of γ-oryzanol. The activity of NK cells and macrophages increased significantly with the addition of γ-oryzanol in the diets of the mice. The phagocytosis was reported to be normal which was accomplished by preservation of IL-b, IL-1b and TNF-a (Murray, 1996). The role of minor constituents in unsaponifiable fraction of Rice bran oil on inflammatory markers was evaluated (Kim *et al.,* 2012). Different combinations of rice bran oil with unsaponifiable fraction were fed to Wistar rats for a period of 60 days. The peritoneal macrophages were activated and pro-inflammatory mediators such as eicosanoids, cytokines, hydrolytic enzymes of lysosomal origin and Reactive Oxygen Species (ROS) were monitored. The dietary oils supplemented with γ-oryzanol and unsaponifiable fraction of rice bran oil play a important role in lowering the secretion of pro-inflammatory mediators by macrophages, proving that γ-oryzanol significantly contributed towards the anti-inflammatory properties of Rice bran oil (Islam *et al.,* 2008). The innate immune response is an important host primary defense system against pathogens. The effect of γ-oryzanol-rich extract from black rice bran (cORE) on the activation of the innate immune system was determined (Rao *et al.,* 2016). The γ-oryzanol-rich extract increased the phagocytic activity of macrophages (RAW264.7) and increased the expression of CD14 and Toll-like receptor 4. The secretion of interleukin 8, innate cytokines and CCL2, which facilitate phagocytosis by RAW264.7 cells was promoted indicating that γ-oryzanol enhances innate immune responses by the secretion of innate cytokines facilitating phagocytosis. The γ-oryzanol has also shown the potential to enhance immune responses via humoral and cellular mediated mechanisms. In the haemagglutination test, oryzanol (25, 50 and 100 mg/kg) stimulated a significant increase in antibody titre values and enhanced the delayed type hypersensitivity reaction which is usually induced by red blood cells of sheep. It also significantly evoked myelosuppression in rats treated with cyclophosphamide and showed an increase in phagocytic index in the carbon clearance assay (Ghatak and Panchal, 2012). In the present situation of Covid-19, products developed using oryzanol or use of supplements can enhance the immunity of the population.

Digestibility, absorption and metabolism of γ-oryzanol

Till date, there are few studies explaining the way in which γ-oryzanol behaves in the human gastrointestinal tract. Many researchers have tried to explain the process of digestion of γ-oryzanol and its metabolites using chromatography in animal models.

The administration of 50 mg/kg of γ-oryzanol orally to the rats showed that the labeled γ-oryzanol was partially hydrolyzed in the intestine. Most of it (89.4%) remained unaffected by any of the enzymes of the digestive tract and it stayed in the luminal fluid. A small amount of administered dose i.e. 10-20 per cent was absorbed and metabolized in the intestinal tissues to yield ferulic acid. The study found that 9.8 per cent of the administered dose was excreted in urine (Kang and Chan, 2016). After an oral therapy with 300mg of g-oryzanol, the maximal plasma concentration of approximately 40 ng/ml was reported (Fujiwara *et al.,* 1983). The γ-oryzanol absorption was not observed in large intestinal cells of humans even after 2 hours when 0.1 mM of γ-oryzanol micellar solution was administered (Tsushimoto *et al.,* 1991).

The chromatography techniques were used to determine the remaining amount of γ-oryzanol. The results showed that after pancreatic and peptic digestion, the concentration of γ-oryzanol in micellar and crystalline form was decreased. The micellar

solution was more susceptible to enzyme activity. The enzyme cholesterol esterase was responsible for pancreatic digestion in a concentration dependent manner. The two forms *viz.* sitosteryl ferulate and campesteryl ferulate were most active to the enzymes of the digestive tract. Similarly, sitosteryl ferulate is hydrolyzed to a higher extent (50% pancreatin, 55–85 per cent cholesterol esterase) as compared to γ-oryzanol (35–55% cholesterol esterase, 0% pancreatin). Cholesterol esterase hydrolyzed sesitosteryl and campesteryl ferulates. The methyl and dimethyl group which is connected to sterol ring is absent in these two forms making it structurally similar to cholesterol and this could be the reason of their susceptibility towards digestive enzymes (Huang, 2003). Many studies about γ-oryzanol digestion found that it is metabolized to ferulic acid in the body and the fate of ferulic acid in the human digestive tract has been investigated (Miller *et al.,* 2004). In an experiment, the yogurt containing 3.4g of oryzanol was fed to human subjects for 3 days. It was observed that most of the functional ingredient was excreted in faeces. The γ-oryzanol concentrate from purified rice bran oil was prepared and administered it to mice at the level of 600mg/kg. The chromatograms of plasma obtained after 5 hours of administration showed the presence of oryzanol, indicated that unlike previous studies, part of oryzanol administered orally is directly absorbed in the blood stream and remains intact in the plasma. The study suggested that a part of oryzanol is hydrolyzed to triterpene alcohols, ferulic acid and plant sterols inside the body. Some of the oryzanol is still absorbed inside the body in sufficient amounts as its intact from. The intact form and its metabolites might contribute to the functional properties of γ-oryzanol in the body (Pan *et al.,* 2014).

Safety of γ-oryzanol supplementation

There are numerous studies showing the safety of γ-oryzanol in the animal models. The carcinogenic effect of γ-oryzanol for 78 weeks in mice by feeding them at the dose of 2 g/kg body weight/day was studied. In general conditions, no change in relation to treatment change was observed, mortality, food consumption, weight of organs and haematological profile of the mice (Sawada *et al.,* 2019). A 90-day study of oral toxicity of γ-oryzanol by administrating oral dose to male and female Sprague-Dawley rats at different doses of 0, 1000 and 2000 mg/kg body weight/day resulted in no observed adverse effect even at the level of 2000 mg/kg body weight/day for both female and male rats (Tamagawa *et al.,* 1992). The safety level of γ-oryzanol on 80 human subjects was determined by giving a dose of 300 mg/day for 6 months. The supplement was well tolerated by all the subjects and no adverse effect was found (Moon *et al.,* 2017). Similarly, administration of 100 mg of γ-oryzanol thrice a day for 16 weeks did not produce any adverse effects on body weight and laboratory values of 20 human subjects (Yoshino *et al.,* 1989). A dose of 500 mg of γ-oryzanol once a day for 9 weeks to 22 college aged males did not produce any adverse effects (Sasaki *et al.,* 1990). No side effects in males at a dose of 0.05g and 0.8g and of oryzanol/day has been observed (Fry *et al.,* 1997). No adverse effect on any of the body parameters was found when fifty-seven humans were given an oral administration of 40.2 mg/day of γ-oryzanol for four months (Berger *et al.,* 1997). A higher dose i.e. 600 mg/day of γ-oryzanol given orally to 16 humans for 9 weeks also showed no signs of any adverse events. Therefore, these studies indicate that γ-oryzanol is well-tolerated at multiple oral doses in adults and is safe for consumption by both male and female adults.

CONCLUSION

γ-oryzanol is effective and safe in improving metabolic syndrome which accompanies numerous pathological conditions including cardiovascular disease, obesity, diabetes and neurodegenerative disease in rodents, rabbits, non-human primates and humans. It has proven health benefits including reducing triglyceride concentration, total plasma cholesterol and increasing the HDL-C level. Other potential properties include inhibition of platelet aggregation and antioxidant action. In the present situation of Covid-19, products developed using oryzanol or use of supplements can enhance the immunity of the population The daily supplementation of 300-600 mg of γ-oryzanol to the human subjects have proven health benefits. As is well tolerated upto 800 mg/day by humans with no reported adverse effect, the use of this bioactive compound in designer foods need to be explored for the reduced disease burden, improved immunity and overall wellbeing of the community.

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Climate Vagaries in Two Green Revolution States of India: An Inter-zonal Variation Analyses Through Post Hoc Tukey's HSD Test

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ABSTRACT

India is an agrarian economy where around 50 per cent of its population is employed in the primary sector. In contrast, contrary agriculture and allied sectors contributed only 18.6 per cent in 2021-22 to the Indian GDP having a growth rate of meager 3.3 per cent. Punjab and Haryana are the two green revolution (GR) agrarian states of northern India. At present, climate change is the biggest threat to food security as per 1ºC increase in the world's average temperature would, on average, result in lower yields of wheat by (6.0%), rice (3.2%), maize (7.4%), and soybean by 3.1 per cent. The present study was intended to investigate the climate vagaries in all 6 agro-climatic zones of India's green revolution belt of Punjab and Haryana. The twin green revolution states were purposively chosen, and one representative district from each zone was selected. 60 farmers from each district were selected through probability sampling method in general and step-wise simple random sampling method in particular, thus making a sample size of 360 respondents. The results concluded that Rohtak (x=3.33, Zone-II in Haryana) faced the most climate vagaries trailed by Faridkot (x=2.567, South-western zone in Punjab), Karnal, Patiala, Ropar and Rewari (x=1.083, Zone-III in Haryana). Hypothesis testing was done though Post Hoc Tukey's Honestly Significant Difference test by conjecturing that there is no difference in climate vagaries among all 6 zones of the 2 green revolution states. From Tukey's HSD test it was inferred that when Rohtak (3) is opted as a reference category then it has maximum number of stark and significant difference with all 5 districts viz., significant at 1% level with Karnal, Patiala, Ropar and Rewari; while significant at 5% level with Faridkot. From the given result, it can be concluded that climate resilient and smart interventions are needed most in Zone-II of Haryana and South-western zone of Punjab.

Keywords: Climate change, Drought, IMD, Green revolution, Honestly significant difference (HSD), Post Hoc test, Unseasonal rain

INTRODUCTION

Punjab and Haryana are the two green revolution (GR) states of northern India, of which Haryana is a landlocked state (The Nations Online Project, 2019). Haryana is historically an agricultural state, but post green revolution, it has emerged as an industrial state (IBEF, 2019). On November 1, 1966, the state of Haryana was carved out from Punjab on the linguistic ground (The Tribune, 2018). But, the condition of these 2 G states are not so good as Southern Punjab's Sangrur and Bhatinda districts have been identified in the country as distressed hotspots where farmers are quitting farming and becoming laborer due to concurrent flood and drought, partially due to the

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Ghaggar river (Lal *et al.,* 2015). Climate change is the biggest threat to food security as devoid of CO_2 fertilisation, efficient adaptation, and genetic advancement, per 1ºC increase in world's average temperature, would on average, result in lower yields of wheat by (6.0%), rice (3.2%), maize (7.4%), and soybean by 3.1% (Chuang Zhao *et al.,* 2017; Janni *et al.,* 2020). Another study unrevealed that the projected impact of climate change (CC) on agriculture, as assessed by IIT Delhi and IISc Bangalore that on wheat crop increase of temperature from 28ºC to 32ºC results in a considerable decline in yield by ≥20% (Ahlawat, 2018). Most recent research endorsed that due to increased global warming, the world is witnessing CC and it is a major threat to declined agricultural productivity (Lal *et al.,* 2022). While heat stress on dairy animals may lead to a decline in milk productivity, and if the surrounding temperature reaches 34ºC, the mortality due to heat stress was highly significant in chickens (UT Chandigarh Action Plan for Climate Change, 2013). Shruti *et al.* (2016) emphasized the timely availability of Artificial insemination (AI) and other services by Lay Inseminators (LIs) to mitigate the heat stress effect among the bovines in Haryana. The need of the hour is to identify opportunities out of disaster, and it is a challenge for the agriculturist and the engineering scientists. Today, one of the biggest threats is CC and it is well evident that wheat output to be at least 10% (10 million tonnes) below the estimate due to heat wave in March 2022. The question now arises is how to deal with unprecedented climate change. For example, the optimum temperature for the tillering of the wheat crop is 22°C, so early sowing is one of the options. Wheat is heat-sensitive as evident during the 2021-22 rabi season, delayed sowing coupled with before time onset of summer with high temperatures conjoined with heat waves resulted in shriveling of the wheat crop in Punjab and Haryana. The 2nd advance estimate of food grain production yield estimates regarding the decline in wheat production is >10% (Samant, 2022) thus Ministry of Agriculture, on 16 February 2022, had placed wheat output at a record leap to 111.3 million tones and a 10% loss brings down wheat production 100 million tonnes. Kumar *et al.* (2022) studied migrant labour in Bihar after an outbreak of first and second wave of COVID-19 and revealed that Punjab was the 3rd top destination and Haryana was the 9th top destination of the migrant worker and numerous of these migrant workers are involved in climate-smart agricultural activities. It was consequently considered appropriate to investigate the current climate vagaries in two green revolution states of India during the golden jubilee year of green revolution as currently, agriculture and allied sectors contribute only 18.6 per cent in 2021-22 to the Indian GDP having a growth rate of meager 3.3% (DA&FW, 2022).

MATERIALS AND METHODS

The receiving of rainfall data from over 3500 stations located throughout India forms the basis for the computation of rainfall statistics (IMD, 2013). The present paper includes the zone-wise rainfall statistics for the green revolution belt. The data are provided for 4 seasons, viz., Winter (January-February); Pre-Monsoon (March-May); Monsoon (Jun-Sep), and Post-Monsoon (October-December), and it is summed up to do computation on an annual basis (CGWB, 2021). In addition to these numbers, percent deviations of rainfall from rainfall normals have been colour coded according to their categories. The list of categories, together with the relevant ranges and colour codes, is shown in Table 1.

It referred to the number of unexpected events faced by the respondents' viz., unseasonal rain/thundershowers/high-velocity winds/hailstorm/drought during the past 5 years (Kharif, 2012-Rabi, 2016-17), which had led to the destruction of ≥1/3rd or more of the crop area. It was ascertained on the recall-based memory of the respondents but verified dually by secondary data from reliable sources.

The twin green revolution states i.e., Punjab and Haryana were purposively chosen, and within those 6

Table 1: Different rainfall categories, their corresponding ranges and color codes

Category	Departures from Normals	Colour Code
Excess	20% or more	Blue
Normal	-19% to +19%	Green
Deficient	-20% to -59%	Orange
Scanty	-60% to -99%	Yellow
No Rain	-100%	Grey
No Data	Data Not Available	White

(*Source:* IMD, 2021; IMD, 2022)

districts were chosen, 3 each from both the states. In Punjab, 3 districts were Patiala, Faridkot, and Rupnagar and in Haryana 3 districts encompassed Rohtak, Karnal and Rewari were selected from each of the 3 zones. 60 farmers from each district were selected through probability sampling method in general and step-wise simple random sampling method in particular, thus making a total sample size of 360 respondents.

The collected data were scored, compiled, tabulated, and analyzed through SPSS software version 26 using various appropriate statistical tools, i.e., mean, standard errors, standard deviation, frequencies, one-way ANOVA, and Post-Hoc Tukey's HSD test. Inter-zonal variation analysis of climate vagaries in green revolution belt of India was done through Post-hoc test. There are various types of Post-hoc (Latin, denotation 'after this') tests to analyze the results of one's experimental data viz., Bonferroni Procedure, Duncan's multiple range test (DMRT), Fisher's Least Significant Difference (LSD developed in 1935), Dunnett's correction, Post Hoc Tukey's HSD test, but in this research HSD was ideal because it computes honestly significant difference (HSD) and is recognized to be the best method in a wide variety of cases (Schlegel, 2018; Lal *et al.,* 2019).

RESULTS AND DISCUSSION

Due to unseasonal rains during 1st week of March 2015, the worst affected district in Punjab was Patiala and in Haryana affected districts were Karnal & Rohtak, which caused colossal damage of wheat crop in the distressed district (ICAR, 2015). Chief crops damaged in March 2015 (rabi season of 2014-15) were wheat and mustard and for this ICAR had issued advisory sensing the gravity of the situation; these were draining out the excessive water from the fields, spraying of mancozeb (0.2%) to slow the process of grain discoloration (TNAU, 2019) in wheat and harvesting of matured mustard at the earliest. Again in the same year of 2015 (September), heavy rain lashed vast swathes of Ropar district, which received 108 mm of rain in a single day and damaged the paddy crop (Table 2). To substantiate and triangulate primary data with the secondary data IMD Rainfall Statistics of India in the past 5 years from 2012-2016 was thoroughly studied, tabulated, and analyzed. Positive and negative deviations from the normal have been denoted by bold text with the asterisk symbol in Table 3.

Descriptive statistics is a summary statistics to provide the basic structure and insight of the data set. Sinha et al. (2018) quantified descriptive statistics *viz.*,

Table 2: Affected districts due to unseasonal rains

Unseasonal thundershowers	Haryana	Punjab
2015 (March, September)	Karnal (97.4 mm) & Rohtak	Patiala (63.9mm); (Ropar 108 mm sept)

Source: (ICAR, 2015); (The tribune, 2015)

Table 3: IMD data for past 5 years in the selected districts/zones of the GR belt

District	Winter	Pre-Monsoon	Monsoon	Post-Monsoon	Annual
Percentage Departures of District-wise seasonal and annual rainfall – 2012					
Karnal	-88%	-60%	-43% *	-82%	-50%*
Rewari	-98%	-33%	-29%	-100%	-34%
Rohtak	-90%	-50%	-54% *	-85%	**-57%***
Faridkot	-59%	-90%	-57% *	7%	-57%*
Patiala	-80%	-52%	-46% *	-77%	-51%*
Ropar	-10%	-61%	-9%	-78%	-18%
% Departures of District-wise seasonal and annual rainfall – 2013					
Karnal	130%	-77%	-6%	-56%	-3%
Rewari	92%	-46%	-13%	116%	-5%
Rohtak	-85%	-62%	-56% *	-37%	**-57%***
Faridkot	198%	-41%	95%	137%	92%
Patiala	22%	-61%	-33% *	-77%	-33%*
Ropar	5%	-41%	7%	-34%	0%

Table 3 contd....

District	Winter	Pre-Monsoon	Monsoon	Post-Monsoon	Annual
% Departures of District-wise seasonal and annual rainfall – 2014					
Karnal	97%	97%	-44%*	30%	-21%
Rewari	-48%	317%	-46%	-43%	-32%
Rohtak	-75%	-37%	-81% *	-62%	**-76%***
Faridkot	-52%	176%	-16%	-100%	-5%
Patiala	29%	40%	-63%*	-7%	-47%*
Ropar	-3%	-1%	-45%*	-4%	-35%*
% Departures of District-wise seasonal and annual rainfall – 2015					
Karnal	-45%	**260%**	-22%	-72%	-10%
Rewari	-37%	825%	-32%	-74%	-2%
Rohtak	-81%	142%	-62%*	-72%	**-48%***
Faridkot	4%	238%	0%	-100%	18%
Patiala	-17%	149%	-43%*	-79%	**-32%**
Ropar	7%	59%	-21%	-64%	-13%
% Departures of District-wise seasonal and annual rainfall – 2016					
Karnal	-99%	74%	-32%	-99%	-35%
Rewari	-100%	362%	12%	63%	23%
Rohtak	-99%	-22%	**-51%** *	-100%	-54%*
Faridkot	-59%	129%	0%*	-100%	3%
Patiala	-92%	73%	-61%*	-95%	**-57%***
Ropar	-80%*	-23%	-2%	-72%*	-14%

Note: Excess (20% or more), normal (-19% to +19%), deficient (-20% to -59%), scanty (-60% to -99%) & no rain (-100%) (IMD, 2016).

Table 4: Descriptive Statistics of Climate vagaries

Codes		N	Mean	SD	SE	95% CI for Mean		Min.	Max.
						LB	UB		
1.0		60	2.050	1.0644	.1374	1.775	2.325	.0	5.0
2.0		60	1.083	.9074	.1171	.849	1.318	.0	3.0
3.0		60	3.333	1.4102	.1821	2.969	3.698	2.0	5.0
4.0		60	2.567	1.7502	.2260	2.115	3.019	.0	5.0
5.0		60	1.933	1.3761	.1777	1.578	2.289	.0	5.0
6.0		60	1.767	1.6299	.2104	1.346	2.188	.0	5.0
Total		360	2.122	1.5447	.0814	1.962	2.282	.0	5.0
Model	Fixed Effects			1.3880	.0732	1.978	2.266		
	Random Effects				.3115	1.321	2.923		

Acronyms & coding elucidation: 1=Karnal; 2=Rewari; 3=Rohtak; 4=Faridkot; 5=Patiala; 6=Ropar

n, Mean, Std. Deviation Minimum, Maximum, Rage Percentiles {25th 50th (Median) 75th} to compute non-parametric Wilcoxon Signed paired Rank test. From Table 4, it is evident that Rohtak (x=3.33, Zone-II in Haryana) climate vagaries was the most trailed by Faridkot (x=2.567, South-western zone in Punjab), Karnal, Patiala, Ropar and Rewari (x=1.083, Zone-III in Haryana). Subsequently, the mean climate vagaries wrath faced by the respondents was x=2.12 which implies on average more than 2 such climatic traumatic events were faced by the respondents (Table 4 and Figure 1).

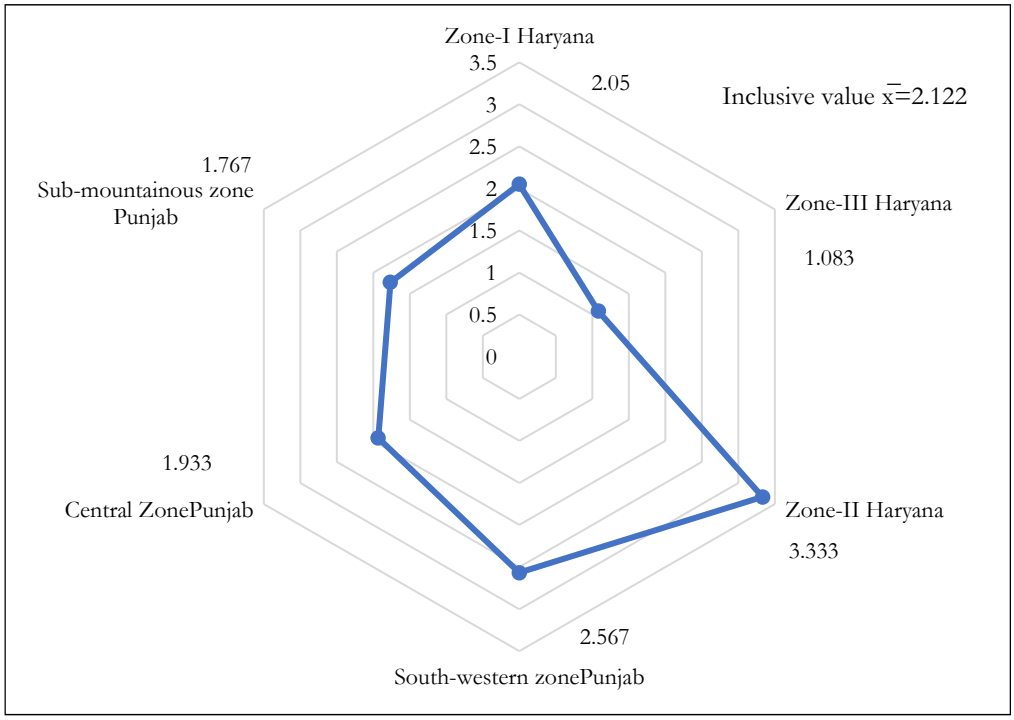

Figure 1: Spider diagram indicating quantum of climate vagaries in all the 6 zones

In order to apply Tukey's HSD test, initially all the 6 zones of Punjab and Haryana were coded from 1 to 6. Then reference code was denoted as (I) Code, and the comparison one was denoted by (J) Code. Karnal (1) was compared to Rohtak (3), and Mean Difference (I-J) {2.050-3.333=-1.283} was found to be significant at a 1% level. From this, it can be inferred that although Karnal was ranked 3rd and Rohtak was ranked 1st in terms of climate vagaries, even then, there was a significant difference between these 2 zones. Later, Karnal (1) was compared to Rewari (2), and it was also significant at a 1% level but weakly significant when comparing it with Karnal and Rohtak. If one picks Rohtak (3) as a reference category then it has maximum number of stark and significant difference with all 5 districts viz., significant at 1% level with Karnal, Patiala, Ropar and Rewari; while significant at 5% level with Faridkot. From this it can be deducted that Rohtak in Zone-II of Haryana was the most vulnerable district in terms of climate vagaries and the result is also substantiated by IMD data substantiated by IMD data (Table 5).

CONCLUSION

Punjab and Haryana are the two green revolution (GR) states of northern India, of which Haryana is a landlocked state. Climate Change is the biggest threat to food security as devoid of CO_2 fertilisation, efficient adaptation, and genetic advancement, per 1ºC increase in the world's average temperature, would, on average, result in lower yields of wheat by (6.0%), rice (3.2%), maize (7.4%), and soybean by 3.1%. The present study was intended to investigate the Climate vagaries in all 6 agro-climatic zones of the green revolution belt of Punjab and Haryana in India. The twin green revolution states, i.e., Punjab and Haryana, were purposively chosen, and within those 6 districts were chosen, 3 each from both the states. In Punjab 3 districts were Patiala, Faridkot, and Rupnagar, and in Haryana, 3 districts encompassed Rohtak, Karnal, and Rewari were selected from each of the 3 zones in both states. 60 farmers from each district were selected through probability sampling method in general and step-wise simple random sampling method in particular, thus making a total sample size of 360 respondents. The results concluded that Rohtak (x=3.33, Zone-II in Haryana) climate vagaries was the most trailed by Faridkot (x=2.567, South-western zone in Punjab), Karnal, Patiala, Ropar and Rewari (x=1.083, Zone-III in Haryana). Subsequently, the mean climate vagaries wrath faced by the respondents was x=2.12 which implies on average the respondents faced more than 2 such climatic traumatic events in the past 5 years. Climate

Table 5: Inferential Statistics Climate vagaries comparison through Multiple Comparisons Tukey's Honestly Significant Difference test

(I) Code	(J) Code	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.0 Karnal	2.0	.9667*	.2534	.002	.241	1.693
	3.0	-1.2833*	.2534	.000	-2.009	-.557
	4.0	-.5167	.2534	.322	-1.243	.209
	5.0	.1167	.2534	.997	-.609	.843
	6.0	.2833	.2534	.874	-.443	1.009
2.0 Rewari	1.0	-.9667*	.2534	.002	-1.693	-.241
	3.0	-2.2500*	.2534	.000	-2.976	-1.524
	4.0	-1.4833*	.2534	.000	-2.209	-.757
	5.0	-.8500*	.2534	.011	-1.576	-.124
	6.0	-.6833	.2534	.078	-1.409	.043
3.0 Rohtak	1.0	1.2833*	.2534	.000	.557	2.009
	2.0	2.2500*	.2534	.000	1.524	2.976
	4.0	.7667*	.2534	.032	.041	1.493
	5.0	1.4000*	.2534	.000	.674	2.126
	6.0	1.5667*	.2534	.000	.841	2.293
4.0 Faridkot	1.0	.5167	.2534	.322	-.209	1.243
	2.0	1.4833*	.2534	.000	.757	2.209
	3.0	-.7667*	.2534	.032	-1.493	-.041
	5.0	.6333	.2534	.127	-.093	1.359
	6.0	.8000*	.2534	.021	.074	1.526
5.0 Patiala	1.0	-.1167	.2534	.997	-.843	.609
	2.0	.8500*	.2534	.011	.124	1.576
	3.0	-1.4000*	.2534	.000	-2.126	-.674
	4.0	-.6333	.2534	.127	-1.359	.093
	6.0	.1667	.2534	.986	-.559	.893
6.0 Ropar	1.0	-.2833	.2534	.874	-1.009	.443
	2.0	.6833	.2534	.078	-.043	1.409
	3.0	-1.5667*	.2534	.000	-2.293	-.841
	4.0	-.8000*	.2534	.021	-1.526	-.074
	5.0	-.1667	.2534	.986	-.893	.559

vagaries in two green revolution states of India an inter-zonal variation analyses was done through Post Hoc Tukey's HSD test in which it was inferred that if Rohtak (3) is opted as a reference category then it has maximum number of stark and significant difference with all 5 districts viz., significant at 1% level with Karnal, Patiala, Ropar and Rewari; while significant at 5% level with Faridkot. From the given result, it can be concluded that climate-smart practices are needed most in Zone-II of Haryana and the South-western zone of Punjab.

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Heterosis Studies in Cherry tomato for Fruit yield and Yield Attributing Traits in Open and Protected Environment

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ABSTRACT

Heterosis breeding is mainly used to improve yield quantity of cherry tomato because traditional methods cannot be used to achieve this goal. A half diallel design was used to estimate the magnitude of heterosis for yield and its attributing traits in cherry tomato. Fifty-seven treatments comprising of 45 F_1's, 10 parents and 2 checks were evaluated for various yield and its component traits at Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar during the *Kharif* season, 2019 in Augmented Block Design. The maximum heterosis over standard checks was exhibited by the cross EC-914092 x EC-914097 in E_1 and E_2 for fruit yield and its one or more important yield attributing traits. Hence, these crosses exhibited commercial potential to replace the checks after further testing.

Keywords: Heterosis, Yield, Check, Cherry tomato, Diallel

INTRODUCTION

Cherry tomato, one of the important botanical variety of the cultivated tomato (*Solanum lycopersicum* L.) is a member of nightshade family 'Solanaceae', consisting of 96 genera (Akhtar *et al*., 2013) and over 3000 species (Sharma *et al*., 2019). It is considered to be the probable ancestor of cultivated tomato, on the basis of its wide presence in Central America and the presence of shorter style length in the flower (Cox, 2000; Grandillo *et al*., 2011). However, several studies have shown that tomatoes, known as '*cerasiforms*', are not the ancestors of modern cultivars, but have resulted from the hybridization of wild and cultivated tomatoes (Peralta *et al*., 2006; Grandillo *et al*., 2011) and true *Solanum lycopersicum* L. var. *cerasiforme* has been phylogenetically positioned between *Solanum pimpinellifoilum* and *Solanum lycopersicum* L. var. *lycopersicum* as its fruit morphology is diverse. Cherry tomato is perennial in its native habitat but is often grown as an annual crop in temperate climate. Being a self-pollinated crop, cherry tomato has enormous potential for heterosis breeding due to high seed number $fruit^{-1}$. Commercially, hand emasculation and hand pollination are utilized for hybrid seed production and a large number of commercial hybrids have been developed in this crop. As a result, the scenario of cherry tomato production changed tremendously with the increasing popularity of F_1 hybrids on account of several privileges as compared to purelines. The exploitation of hybrid vigour has been the salient breeding approach in its crop improvement programmes.

MATERIALS AND METHODS

The study of heterosis in cherry tomato was carried out at Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar, India during *Kharif* season, 2020 in two environments namely open environment (E_1) and protected environment (E_2). Fifty-seven treatments comprising of 45 F_1's, 10 parents and 2 checks were evaluated for various yield and its component traits in Augmented Block Design. The seeds of all accessions and their crosses were first sown in nursery and then transplanted to the main field at a spacing of 60 x 60 cm between rows and plants respectively. Recommended package of practices were followed to raise a healthy crop. The observations were

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recorded on number of fruits plant^{-1}, average fruit weight, fruit yield plant^{-1} and fruit yield hectare^{-1} by selecting five random plants and the average was worked out.

RESULTS AND DISCUSSION

In the present investigation, the heterosis was estimated over standard varieties/ checks (economic heterosis) for each trait in the individual as well as data pooled over environments (Table 1&2). Perusal of the findings indicated a wide range of heterotic patterns for different traits.

For number of fruits plant^{-1}, the highest positive heterosis was remarked in the cross WIR-5032 x EC-914092 (435.02 and 465.38) followed by WIR-5032 x EC-520074 (364.06 and 390.38) in E_1; cross Sun Cherry x EC-520074 (272.73 and 80.22) followed by WIR-5032 x VRT-02 (206.82 and 48.35) in E_2 and cross WIR-5032 x EC-914092 (338.36 and 220.20) followed by WIR-5032 x EC-914115 (257.97 and 161.48) in pooled data over environments.

For average fruit weight (g), the highest positive heterosis was remarked in the cross WIR-3957 x EC-914097 (104.97 and 52.00) followed by EC-914092 x EC-914097 (80.45 and 33.81) in E_1; cross EC-520078 x VRT-02 (124.09 and 145.89) followed by EC-914092 x EC-914097 (114.47 and 135.33) in E_2 and cross EC-914092 x EC-914097 (79.85 and 87.67) followed by EC-520078 x VRT-02 (78.74 and 86.52) in pooled data over environments.

For fruit yield plant^{-1} (kg), the highest positive heterosis was remarked in the cross EC-914092 x EC-914097 (144.44 and 92.10) followed by EC-914115 x EC-914092 (134.39 and 84.20) in E_1; cross EC-914092 x VRT-02 (256.80 and 89.35) followed by EC-520078

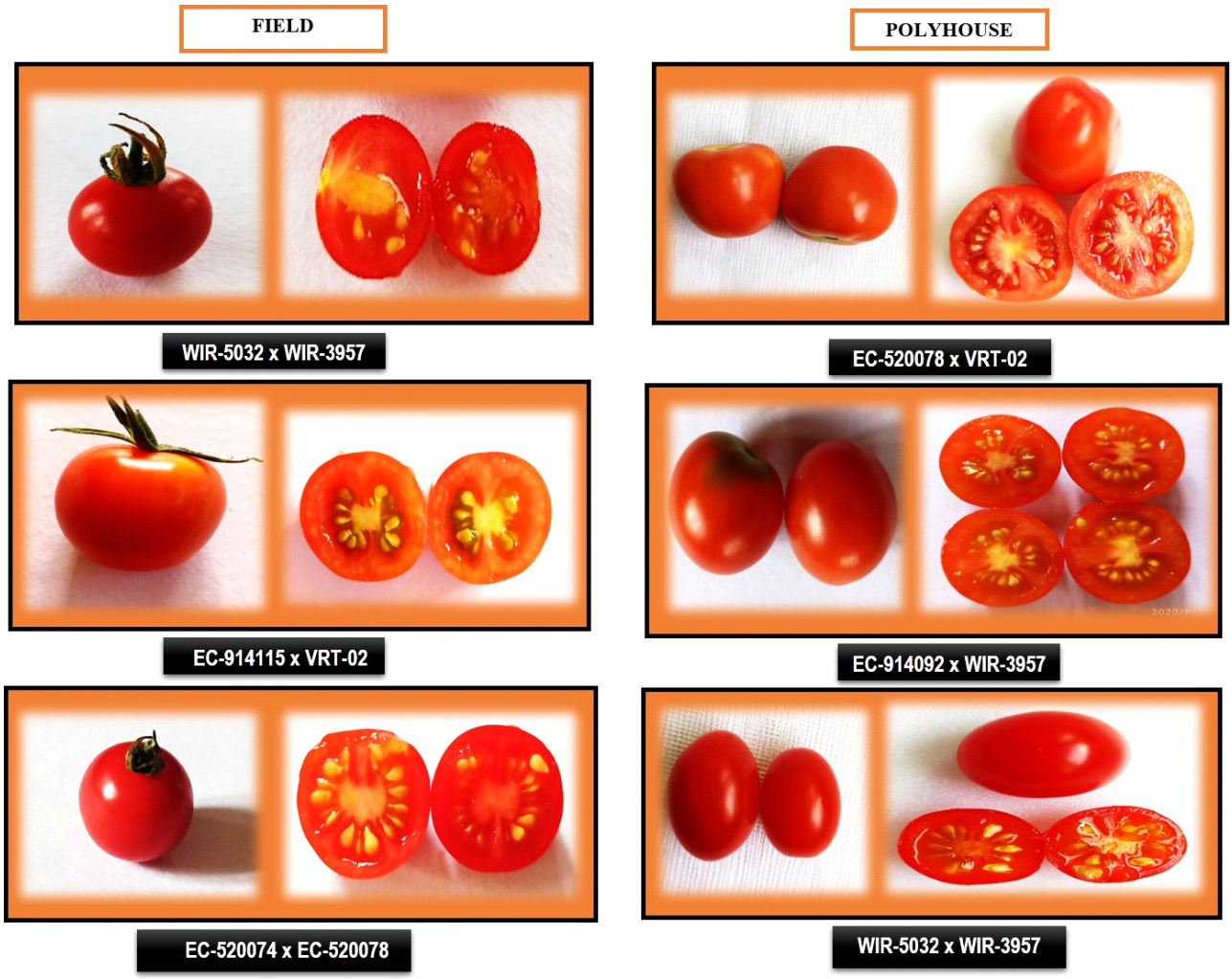

Figure 1: Best Crosses of Cherry tomato in terms of Average Fruit Yield per Plant

Table 1: Estimation of heterosis (%) over checks for yield attributing traits in Cherry tomato

S.No	Crosses	Number of fruits plant^{-1}						Average fruit weight (g)					
		E1		E2		Pooled		E1		E2		Pooled	
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
1	Sun Cherry x WIR - 5032	91.08**	101.92**	82.95 **	-11.54 **	81.02 **	32.23 **	-35.30**	-52.02**	-58.25 **	-54.19 **	-56.02 **	-54.11 **
2	Sun Cherry x EC – 520074	180.65**	196.57**	272.73 **	80.22 **	194.65 **	115.23 **	-61.62**	-71.54**	-75.03 **	-72.60 **	-73.79 **	-72.65 **
3	Sun Cherry x EC – 914115	20.74**	27.59**	109.09 **	1.10 **	40.25 **	2.45 **	-70.57**	-78.18**	-81.07 **	-79.23 **	-80.02 **	-79.15 **
4	Sun Cherry x EC – 165690	27.49**	34.72**	48.86 **	-28.02 **	28.19 **	-6.36 **	43.07**	6.10**	33.51 **	46.50 **	21.29 **	26.56 **
5	Sun Cherry x EC – 914092	81.87**	92.18**	20.45 **	-41.76 **	57.44 **	15.00 **	26.25**	-6.38**	-26.02 **	-18.82 **	-18.54 **	-14.99 **
6	Sun Cherry x EC – 520078	2.47**	8.28**	68.18 **	-18.68 **	16.46 **	-14.93 **	2.97**	-23.64**	-50.34 **	-45.51 **	-39.79 **	-37.17 **
7	Sun Cherry x WIR – 3957	64.22**	73.53**	110.23 **	1.65 **	70.24 **	24.35 **	-3.80**	-28.66**	-23.12 **	-15.64 **	-25.96 **	-22.74 **
8	Sun Cherry x EC – 914097	17.81**	24.49**	102.27 **	-2.20 **	36.37 **	-0.39 **	27.08**	-5.76**	-27.33 **	-20.26 **	-19.05 **	-15.53 **
9	Sun Cherry x VRT - 02	314.12**	337.62**	92.05 **	-7.14 **	235.74 **	145.24 **	-65.39**	-74.33**	-65.66 **	-62.32 **	-69.46 **	-68.14 **
10	WIR – 5032 x EC – 520074	364.06**	390.38**	-2.27 **	-52.75 **	243.71 **	151.06 **	-76.06**	-82.25**	-89.33 **	-88.29 **	-86.51 **	-85.92 **
11	WIR – 5032 x EC – 914115	349.01**	374.48**	86.36 **	-9.89 **	257.97 **	161.48 **	-53.30**	-65.37**	-88.96 **	-87.89 **	-79.38 **	-78.49 **
12	WIR – 5032 x EC – 165690	319.19**	342.98**	102.27 **	-2.20 **	242.03 **	149.83 **	-56.89**	-68.03**	-74.40 **	-71.91 **	-71.98 **	-70.77 **
13	WIR – 5032 x EC – 914092	435.02**	465.38**	164.77 **	28.02 **	338.36 **	220.20 **	-57.51**	-68.49**	-76.07 **	-73.74 **	-73.14 **	-71.98 **
14	WIR – 5032 x EC – 520078	119.19**	131.63**	117.05 **	4.95 **	109.64 **	53.13 **	-38.62**	-54.48**	-30.13 **	-23.34 **	-40.63 **	-38.05 **
15	WIR – 5032 x WIR – 3957	248.23**	267.98**	159.09 **	25.27 **	209.32 **	125.94 **	-34.27**	-51.26**	-66.67 **	-63.42 **	-60.61 **	-58.90 **
16	WIR – 5032 x EC – 914097	170.51**	185.85**	60.23 **	-22.53 **	128.93 **	67.22 **	-76.17**	-82.33**	-91.37 **	-90.53 **	-87.73 **	-87.20 **
17	WIR – 5032 x VRT - 02	237.17**	256.29**	206.82 **	48.35 **	214.98 **	130.08 **	-79.55**	-84.84**	-88.64 **	-87.53 **	-87.17 **	-86.61 **
18	EC- 520074 x EC – 914115	110.60**	122.55**	59.09 **	-23.08 **	87.74 **	37.13 **	-36.06**	-52.59**	-71.72 **	-68.97 **	-64.10 **	-62.54 **
19	EC- 520074 x EC – 165690	35.02**	42.68**	120.45 **	6.59 **	53.14 **	11.86 **	-39.65**	-55.25**	-60.97 **	-57.17 **	-58.92 **	-57.14 **
20	EC- 520074 x EC – 914092	149.31**	163.45**	71.59 **	-17.03 **	117.61 **	58.95 **	-38.55**	-54.43**	-64.96 **	-61.55 **	-60.92 **	-59.22 **
21	EC- 520074 x EC – 520078	168.96**	184.22* **	-14.77 **	-58.79 **	107.12 **	51.29 **	-26.11**	-45.21**	-56.65 **	-52.44 **	-52.29 **	-50.22 **
22	EC- 520074 x WIR - 3957	226.89**	245.43**	85.23 **	-10.44 **	174.32 **	100.38 **	-60.31**	-70.57**	-73.23 **	-70.63 **	-72.34 **	-71.14 **
23	EC- 520074 x EC – 914097	23.80**	30.83**	90.91 **	-7.69 **	37.31 **	0.30 **	64.70**	22.13**	31.36 **	44.13 **	26.60 **	32.10 **
24	EC- 520074 x VRT - -02	39.79**	47.72**	76.14 **	-14.84 **	44.14 **	5.28 **	28.08**	-5.02**	-75.01 **	-72.58 **	-46.55 **	-44.22 **
25	EC- 914115 x EC – 165690	7.37**	13.46**	104.55 **	-1.10 **	29.87 **	-5.13 **	80.59 **	33.91**	15.84 **	27.11 **	22.37 **	27.69 **

Table 1 contd....

S.No	Crosses	Number of fruits plant^{-1}						Average fruit weight (g)					
		E1		E2		Pooled		E1		E2		Pooled	
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
26	EC- 914115 x EC – 914092	176.50**	192.18**	97.73 **	-4.40 **	143.40 **	77.79 **	-14.96**	-36.94**	0.09	9.82 **	-15.82 **	-12.16 **
27	EC- 914115 x EC – 520078	221.20**	239.42**	110.23 **	1.65 **	177.36 **	102.60 **	-44.21**	-58.63**	-69.11 **	-66.11 **	-65.05 **	-63.53 **
28	EC- 914115 x WIR – 3957	67.28**	76.77***	76.14 **	-14.84 **	62.89 **	18.98 **	-44.15**	-58.58**	-65.17 **	-61.79 **	-62.74 **	-61.12 **
29	EC- 914115 x EC – 914097	196.61**	213.44**	73.86 **	-15.93**	150.52**	82.99 **	-46.77**	-60.53**	-67.30 **	-64.12 **	-64.77 **	-63.24 **
30	EC- 914115 x VRT - 02	321.66**	345.58**	94.32 **	-6.04 **	241.51 **	149.45 **	-46.49**	-60.32**	-66.68 **	-63.44 **	-64.33 **	-62.78 **
31	EC-165690 x EC- 914092	21.82**	28.73**	25.00 **	-39.56 **	17.72 **	-14.01 **	23.21**	-8.63**	66.50 **	82.70 **	34.51 **	40.35 **
32	EC-165690 x EC- 520078	57.44**	66.37**	60.23 **	-22.53 **	51.78 **	10.86 **	18.69**	-11.99**	-9.80 **	-1.03 **	-11.37 **	-7.52 **
33	EC-165690 x WIR – 3957	21.82**	28.73**	39.77 **	-32.42 **	21.81 **	-11.03 **	54.34**	14.45***	112.51 **	133.18 **	70.78 **	78.20 **
34	EC-165690 x EC-914097	69.12**	78.72***	56.82 **	-24.18 **	58.81 **	16.00 **	33.3**	-1.13**	107.21 **	127.36 **	61.32 **	68.33 **
35	EC-165690 x VRT - 02	2.14**	7.94**	-11.36 **	-57.14 **	-5.77 **	-31.17 **	-5.15**	-29.66**	7.12 **	17.54 **	-8.73 **	-4.77 **
36	EC-914092 x EC-520078	5.99**	12.00**	90.91 **	-7.69 **	25.16 **	-8.58 **	79.48**	33.09**	56.47 **	71.69 **	45.73 **	52.07 **
37	EC- 914092 x WIR – 3957	-47.30**	-44.31 **	23.86 **	-40.11 **	-29.76 **	-48.70 **	29.67**	-3.84**	22.13 **	34.01 **	10.59 **	15.40 **
38	EC-914092 x EC-914097	35.78**	43.49**	20.45 **	-41.76 **	25.99 **	-7.97 **	80.45**	33.81**	114.47 **	135.33 **	79.85 **	87.67 **
39	EC-914092 x VRT - 02	0.00	5.67**	104.55 **	-1.10 **	24.84 **	-8.81 **	-13.47**	-35.84 **	74.67 **	91.66 **	28.13 **	33.70 **
40	EC-520078 x WIR-3957	89.56**	100.32**	115.91 **	4.40 **	89.10 **	38.13 **	-73.51**	-80.35 **	-84.38 **	-82.86 **	-82.85 **	-82.10 **
41	EC-520078 x EC - 914097	198.16***	215.07**	-17.05 **	-59.89 **	126.42 **	65.38 **	-74.82* **	-81.33 **	-87.06 **	-85.80 **	-84.80 **	-84.14 **
42	EC-520078 x VRT - 02	-12.74**	-7.79**	50.00 **	-27.47 **	1.05 **	-26.19 **	58.34 **	17.42**	124.09 **	145.89 **	78.74 **	86.52 **
43	WIR – 3957 x EC - 914097	-10.44**	-5.36**	-5.68 **	-54.40 **	-12.78 **	-36.29 **	104.97 **	52.00 **	88.37 **	106.69 **	72.07 **	79.56 **
44	WIR – 3957 x VRT - 02	-25.18**	-20.94**	98.86 **	-3.85 **	6.08 **	-22.51 **	15.68**	-14.22 **	21.93 **	33.79 **	6.23 **	10.84 **
45	EC – 914097 x VRT - 02	-17.5**	-12.83**	-7.95 **	-55.49 **	-18.24 **	-40.28 **	65.35 **	22.62 **	60.57 **	76.19 **	43.83 **	50.09 **
	Range Minimum	-47.30**	-44.31 **	-17.05**	-59.89 **	-29.76 **	-48.70 **	-79.55**	-84.84**	-91.37 **	-90.53 **	-87.73 **	-87.20 **
	Range Maximum	435.02**	465.38**	272.73**	80.22 **	338.36**	220.20 **	104.97 **	52.00 **	124.09 **	145.89 **	79.85 **	87.67 **

*, ** Significant at 5 and 1 per cent levels, respectively.

Table 2: Estimation of heterosis (%) over checks for fruit yield in Cherry tomato

S.No	Crosses	Fruit yield plant^{-1} (kg)						Fruit yield hectare^{-1} (q)					
		E1		E2		Pooled		E1		E2		Pooled	
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
1	Sun Cherry x WIR - 5032	23.38**	-3.12	-23.47 **	-59.39 **	-11.41 **	-42.61 **	23.59**	-3.12	-23.61 **	-59.47 **	-8.35 **	-39.72 **
2	Sun Cherry x EC – 520074	7.41*	-15.59 **	-6.80 **	-50.54 **	-12.82 **	-43.52 **	7.67*	-15.61**	-6.91 **	-50.61 **	-11.04 **	-41.49 **
3	Sun Cherry x EC – 914115	-64.29**	-71.93 **	-60.54 **	-79.06 **	-67.82 **	-79.15 **	-64.43**	-72.12**	-60.40 **	-78.99 **	-67.57 **	-78.67 **
4	Sun Cherry x EC – 165690	81.75**	42.83 **	98.64 **	5.42 **	62.95 **	5.56 **	82.36**	42.94**	98.72 **	5.43 **	64.77 **	8.38 **
5	Sun Cherry x EC – 914092	128.84**	79.83 **	-10.88 **	-52.71 **	44.49 **	-6.40 **	129.52**	79.91**	-10.86 **	-52.71 **	52.08 **	0.03
6	Sun Cherry x EC – 520078	5.29	-17.26 **	-16.33 **	-55.60 **	-17.44 **	-46.51 **	5.48	-17.32 **	-16.46 **	-55.68 **	-15.48 **	-44.41 **
7	Sun Cherry x WIR – 3957	57.94**	24.12 **	61.56 **	-14.26 **	37.44 **	-10.96 **	57.95**	23.81**	61.60 **	-14.26 **	39.10 **	-8.50 **
8	Sun Cherry x EC – 914097	49.47**	17.46 **	46.94 **	-22.02 **	27.82 **	-17.19 **	49.69**	17.33**	46.99 **	-22.01 **	29.71 **	-14.68 **
9	Sun Cherry x VRT - 02	42.86**	12.27 **	-34.01 **	-64.98 **	-5.90 *	-39.04 **	43.36**	12.37**	-34.05 **	-65.01 **	-1.48	-35.19 **
10	WIR – 5032 x EC – 520074	11.11**	-12.68 **	-89.46 **	-94.40 **	-42.18 **	-62.54 **	11.13**	-12.89 **	-89.55 **	-94.46 **	-37.60 **	-58.96 **
11	WIR – 5032 x EC – 914115	108.99**	64.24 **	-79.59 **	-89.17 **	8.97 **	-29.40 **	109.66**	64.34 **	-79.39 **	-89.06 **	18.03 **	-22.36 **
12	WIR – 5032 x EC – 165690	80.42**	41.79 **	-48.30 **	-72.56 **	6.92 **	-30.73 **	80.66**	41.61**	-48.19 **	-72.51 **	13.40 **	-25.41 **
13	WIR – 5032 x EC – 914092	126.72**	78.17 **	-36.73 **	-66.43 **	33.72 **	-13.37 **	127.32**	78.18**	-36.62 **	-66.37 **	42.07 **	-6.55 **
14	WIR – 5032 x EC – 520078	34.13**	5.41*	51.36 **	-19.68 **	22.05 **	-20.93 **	34.49**	5.42 *	51.64 **	-19.54 **	23.27 **	-18.92 **
15	WIR – 5032 x WIR – 3957	128.31**	79.42 **	-13.61 **	-54.15 **	43.21 **	-7.23 **	128.79**	79.33 **	-13.61 **	-54.17 **	50.75 **	-0.84
16	WIR – 5032 x EC – 914097	-35.45**	-49.27 **	-86.05 **	-92.60 **	-63.46 **	-76.33 **	-35.54**	-49.48**	-86.14 **	-92.65 **	-61.13 **	-74.43 **
17	WIR – 5032 x VRT - 02	-31.22**	-45.95 **	-65.31 **	-81.59 **	-53.59 **	-69.93 **	-31.05**	-45.95**	-65.12 **	-81.49 **	-51.53 **	-68.12 **
18	EC- 520074 x EC – 914115	34.39**	5.61*	-55.10 **	-76.17 **	-17.95 **	-46.84 **	34.62**	5.52 *	-54.98 **	-76.11 **	-13.29 **	-42.97 **
19	EC- 520074 x EC – 165690	-18.78**	-36.17 **	-13.95 **	-54.33 **	-28.21 **	-53.49 **	-18.53**	-36.14 **	-13.93 **	-54.33 **	-27.32 **	-52.19 **
20	EC- 520074 x EC – 914092	52.65**	19.96 **	-39.80 **	-68.05 **	-3.33	-37.38 **	53.13**	20.03 **	-39.85 **	-68.09 **	1.70	-33.11 **
21	EC- 520074 x EC – 520078	98.15**	55.72**	-63.27 **	-80.51 **	9.87 **	-28.82 **	98.67**	55.73 **	-63.03 **	-80.39 **	17.84 **	-22.49 **
22	EC- 520074 x WIR - 3957	29.37**	1.66	-50.34 **	-73.65 **	-18.59 **	-47.26 **	29.66**	1.64	-50.37 **	-73.67 **	-14.34 **	-43.65 **
23	EC- 520074 x EC – 914097	103.44**	59.88**	150.34 **	32.85 **	92.95 **	25.00 **	103.86**	59.79 **	150.74 **	33.03 **	94.02 **	27.62 **
24	EC- 520074 x VRT - -02	78.57**	40.33**	-56.12 **	-76.71 **	3.08	-33.22 **	79.00 **	40.31**	-55.95 **	-76.63 **	9.86 **	-27.74 **
25	EC- 914115 x EC – 165690	93.65**	52.18**	136.73 **	25.63 **	83.08 **	18.60 **	93.85 **	51.95**	136.92 **	25.70 **	83.98 **	21.02 **

Table 2 contd...

S.No	Crosses	Fruit yield plant^{-1} (kg)						Fruit yield hectare^{-1} (q)					
		E1		E2		Pooled		E1		E2		Pooled	
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
26	EC- 914115 x EC – 914092	134.39**	84.20**	97.96 **	5.05 **	88.21 **	21.93 **	135.07 **	84.25 **	97.87 **	4.98 **	92.37 **	26.54 **
27	EC- 914115 x EC – 520078	78.84**	40.54**	-35.03 **	-65.52 **	11.15 **	-27.99 **	79.16**	40.43 **	-35.06 **	-65.55 **	17.12 **	-22.96 **
28	EC- 914115 x WIR – 3957	-6.88 *	-26.82**	-38.78 **	-67.51 **	-31.79 **	-55.81 **	-6.59*	-26.78 **	-38.64 **	-67.44 **	-29.49 **	-53.62 **
29	EC- 914115 x EC – 914097	57.41**	23.70**	-43.20 **	-69.86 **	-2.31	-36.71 **	57.85 **	23.73 **	-43.11 **	-69.81 **	3.08	-32.20 **
30	EC- 914115 x VRT - 02	124.87**	76.72**	-35.37 **	-65.70 **	33.33 **	-13.62 **	125.48 **	76.74 **	-35.25 **	-65.65 **	41.57 **	-6.88 **
31	EC-165690 x EC- 914092	49.74**	17.67**	108.16 **	10.47 **	51.03 **	-2.16	50.07 **	17.63**	108.11 **	10.41 **	50.91 **	-0.74
32	EC-165690 x EC- 520078	86.51**	46.57**	44.22 **	-23.47 **	44.74 **	-6.23 **	86.81**	46.43 **	44.53 **	-23.32 **	48.51 **	-2.32
33	EC-165690 x WIR – 3957	87.30**	47.19**	196.60 **	57.40 **	102.56 **	31.23 **	87.93 **	47.31**	196.98 **	57.57 **	101.47 **	32.52 **
34	EC-165690 x EC-914097	124.87**	76.72**	224.49 **	72.20 **	131.28 **	49.83 **	125.45 **	76.72 **	224.87 **	72.37 **	130.92 **	51.89 **
35	EC-165690 x VRT - 02	-3.17	-23.91**	-5.10 **	-49.64 **	-17.31 **	-46.43 **	-3.11	-24.05 **	-5.04 **	-49.62 **	-16.10 **	-44.81 **
36	EC-914092 x EC-520078	89.68**	49.06**	198.30 **	58.30 **	104.36 **	32.39 **	90.18**	49.07 **	198.65 **	58.46 **	103.24 **	33.69 **
37	EC- 914092 x WIR – 3957	-31.75**	-46.36 **	51.02 **	-19.86 **	-10.00 **	-41.69 **	-31.67 **	-46.44 **	51.27 **	-19.74 **	-11.87 **	-42.03 **
38	EC-914092 x EC-914097	144.44**	92.10**	158.16 **	37.00 **	115.77 **	39.78 **	144.96 **	92.01**	158.30 **	37.05 **	118.37 **	43.64 **
39	EC-914092 x VRT - 02	-13.49**	-32.02**	256.80 **	89.35 **	76.41 **	14.29 **	-13.48 **	-32.18 **	257.19 **	89.51 **	68.50 **	10.83 **
40	EC-520078 x WIR-3957	-50.00**	-60.71**	-65.99 **	-81.95 **	-62.95 **	-76.00 **	-49.78 **	-60.64 **	-66.24 **	-82.09 **	-61.83 **	-74.89 **
41	EC-520078 x EC - 914097	-25.13**	-41.16**	-88.78 **	-94.04 **	-59.49 **	-73.75 **	-24.88 **	-41.12**	-89.23 **	-94.29 **	-56.55 **	-71.42 **
42	EC-520078 x VRT - 02	37.83**	8.32**	235.71 **	78.16 **	93.33 **	25.25 **	38.11**	8.26**	236.07 **	78.31 **	88.54 **	24.02 **
43	WIR – 3957 x EC - 914097	83.07**	43.87 **	77.55 **	-5.78 **	55.64 **	0.83	83.52 **	43.85 **	77.64 **	-5.75 **	58.15 **	4.02 *
44	WIR – 3957 x VRT - 02	-13.76**	-32.22 **	142.18 **	28.52 **	33.08 **	-13.79 **	-13.46 **	-32.17 **	142.43 **	28.63 **	29.08 **	-15.09 **
45	EC – 914097 x VRT - 02	35.98**	6.86**	47.96 **	-21.48 **	21.67 **	-21.18 **	36.36 **	6.89**	47.79 **	-21.59 **	22.93 **	-19.14 **
	Range Minimum	-64.29**	-71.93 **	-89.46 **	-94.40 **	-67.82 **	-79.15 **	-64.43**	-72.12**	-89.55 **	-94.46 **	-67.57 **	-78.67 **
	Range Maximum	144.44**	92.10**	256.80 **	89.35 **	131.28 **	49.83 **	144.96 **	92.01**	257.19 **	89.51 **	130.92 **	51.89 **

*, ** Significant at 5 and 1 per cent levels, respectively.

x VRT-02 (235.71 and 78.16) in E_2 and cross EC-165690 x EC-914097 (131.28 and 49.83) followed by EC-914092 x EC-914097 (115.77 and 39.78) in pooled data over environments.

For fruit yield hectare^{-1} (q), the highest positive heterosis was remarked in the cross EC-914092 x EC-914097 (144.96 and 92.01) followed by EC-914115 x EC-914092 (135.07 and 84.25) in E_1; cross EC-914092 x VRT-02 (257.19 and 89.51) followed by EC-520078 x VRT-02 (236.07 and 78.31) in E_2 and cross EC-165690 x EC-914097 (130.92 and 51.89) followed by EC-914092 x EC-914097 (118.37 and 43.64) in pooled data over environments.

Similar findings with respect to heterosis were also reported by Bhatt *et al.* (2001b); Singh *et al.* (2005); Singh *et al.* (2008); Saleem *et al.* (2009); Kumari and Sharma (2011); Singh and Asati *et al.* (2011); Droka *et al.* (2012); Nosser *et al.* (2012); Muttappanavar *et al.* (2014); Kumar *et al.* (2018) and Sah *et al.* (2020).

CONCLUSION

From this study, it is concluded that cross EC-914092 x EC-914097 and Sun Cherry x EC-914097 in E_1; cross WIR-5032 x VRT-02 and EC-914092 x EC-914097 in E_2 and cross Sun Cherry x EC-914097 and EC-914092 x EC-914097 in pooled data analysis exhibited significant and desirable heterosis for most of the traits. Hence, these could be used to develop a hybrid which can have maximum number of desirable traits, keeping the yield as primary concern.

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Constraints and Suggestions Under Study the Knowledge and Adoption of Vegetable Crop Technologies by Atma Beneficiaries in Indore District of Madhya Pradesh

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ABSTRACT

In India Agricultural Technology Management Agency (ATMA) is a big public extension system, which is attempt to converge various extension service providing agencies, research institutes, NGOs, and other such agencies at district level with the farming community. The requirement of farmers' organization has grown importance in this connection. The major aim of the activities of ATMA is to bring about desirable changes in attitude, knowledge and adoption pattern of the targeted farming community. Hence, it is worthwhile to assess the knowledge vegetables crop production technologies. In Indore district comprises five blocks out of that Indore block selected purposively due to maximum number of ATMA beneficiaries registered in this block during the last five years (according district ATMA office). Since, A cluster often villages panchayats were selected purposively the basis of higher concentration of beneficiaries of ATMA activities i.e., demonstration, farmer field school capacity development programme etc. A village panchayats wise list of ATMA beneficiaries prepared with the help of ATMA Office. The major constraints faced by the respondents in relation to vegetable production through ATMA programme appeared were as, lack of improved quality seeds, market facilities poor at village level, Storage facilities available in village level and many other and out of many views given by the respondents for improvement of ATMA activities the important suggestions are appeared followed by telling the vegetable production techniques to the respondents from time to time, proper guide to respondents about plant protection measures in vegetable production.

Keywords: ATMA, Knowledge, Vegetable crops, Production technology, Constraints, Suggestions

INTRODUCTION

Since independence several extension strategies have been used in India for sustaining agricultural productivity. In order to address the key constraints faced by extension system in the country, during the mid-1990s, this model In India were pilot tested in 28 Districts of 7 States namely (Andhra Pradesh, Bihar, Himachal Pradesh, Jharkhand, Odisha, Maharashtra and Punjab) during the years 1998 to 2005. This successful experiment served as a basis to launch ATMA Scheme in 2005-06 by Ministry of Agriculture. It is a focal point for integrating research and extension activities and decentralizing day to day management of the public agricultural technology system (ATS) with bottom-up approach. The concept of ATMA was introduced in 1999 as an autonomous organization under the National Agricultural Technology Project (NATP) by providing flexible working environment with an objective of integrating research, extension and all other stake holders at the district level to support the farmers' needs and interest through an integrated approach of strategic plan.

Under this project problems of farmers are solved through the PRA method as well as in the farmer's

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field school (FFS) at the village level and demonstration conducted at farmers' fields in different seasonal crops with suitable recommended crops production Technology. The beneficiaries of the project acquire skills and knowledge through FFS and through other extension activities. As per the provisions of the social strategy is chalked out the district level for extension activities and their implementation of the ATMA project is effectively and successfully executed.

In context to Indore district of Madhya Pradesh ATMA project has been running for more than 10 years. During this period the farmers have been benefitted from various activities of the ATMA programme. Under this project, various agricultural development activities and technology dissemination programmes viz. demonstration, farmer field school, a capacity development programme for rural development, etc. are being carried out with farmers' participatory approach. The major aim of the activities of ATMA is to bring about desirable changes in attitude and knowledge and adoption patterns of the targeted farming community. Hence it is worthwhile to assess the impact of the ATMA programme on the socio-economic status of farmers.

MATERIALS AND METHODS

The study was conducted in purposively selected Indore district of Madhya Pradesh. In Indore district comprises five blocks out of that Indore block was selected purposively due to a maximum number of ATMA beneficiaries registered in this block during the last five years according to the district ATMA office. Since, A cluster of ten village panchayats will be selected purposively on the basis of higher concentration of beneficiaries of ATMA activities i.e., demonstration, farmer field school, capacity development programme etc. A village panchayats-wise list of ATMA beneficiaries was prepared with the help of the ATMA Office. From the prepared list twelve beneficiaries under ATMA were selected from each selected village panchayats through a random sampling method from each selected village panchayats to select 120 ATMA beneficiaries. A well-structured and pretested interview schedule was used for data collection through the personal interview method. The statistics were used for the study as frequency, percentage, rank order, and statistical midpoint.

RESULTS AND DISCUSSION

Table 1 out of a lot situations faced by the respondents in relation to vegetable production through ATMA programme appeared were as, lack of improved quality seed (79.66) followed by Provide sufficient rate of vegetables (75.83), Irregular supply of Agri inputs by cooperatives (71.66), Highly infestation of insect and disease (65.00), Poor connection to respondents and scientist (62.50), Lack of awareness about vegetables production (56.66), Market facilities is poor at village level (55.00). Storage facilities in village level (52.50), Supply literature of vegetable production at village level (50.00) and insufficient knowledge about communication tools (46.67).

The respondents were questioned to say the constraints enhancing them in vegetable construction through ATMA programme. The main constraints are presented below by them.

Table 1: The constraints of ATMA beneficiaries

S.N.	Constraints	No.	Percent	Position
1.	Unavailability of improved good seed	95	79.16	I
2.	Lack of awareness about vegetables production	68	56.66	VI
3.	efficient knowledge about communication tools	56	46.67	X
4.	Irregular supply of Agri inputs by cooperatives	86	71.66	III
5.	Storage facilities available in village level	63	52.50	VIII
6.	Provide sufficient rate of vegetables	91	75.83	II
7.	Highly infestation of insect and disease	78	65.00	IV
8.	Market facilities is poor at village level	66	55.00	VII
9.	Poor connection to respondents and scientist	75	62.50	V
10	Supply literature of vegetable production at village level	60	50.00	IX

Table 1: The suggestion of ATMA beneficiaries

S.N.	Suggestion	No.	Percent	Position
1.	Presence of improved good seed at proper time	101	84.17	I
2.	Telling the vegetable production techniques to the respondents from time to time	93	77.50	II
3.	Proper guide to respondents about plant protection measures in vegetable production	89	74.16	III
4.	Better connection to respondents and scientist at time to time	86	71.66	IV
5.	Provide minimum support prize of vegetables	80	66.66	V
6.	Provide sufficient knowledge about vegetable production	73	60.83	VI
7.	Assessment evils of respondents and their treatment at local level	53	44.17	X
8.	Info about reserve availability, marketing and faith orientation be supposed to furthermore be known	66	55.00	VIII
9.	Training should be provided on vegetable production	56	46.67	IX
10.	Demonstrations, farm days, kisan melas and the rest must be organized repeatedly	71	59.16	VII

Table 2 out of many views given by the Respondents for improvement of ATMA activities the important suggestions appeared were as, availability of improved quality seed at proper time (84.17) followed by telling the vegetable production techniques to the respondents from time to time (77.50), proper guide to respondents about plant protection measures in vegetable production (74.16), better connection to respondents and scientist at time to time (71.66), provide minimum support prize of vegetables (66.66), provide sufficient knowledge about vegetable production (60.83), Demonstrations, farm days, kisan melas and the rest must be organized repeatedly (59.16), knowledge about present resources, marketing and credit orientation should also be given (55.00), training should be provided on vegetable production (46.67), and assessment evils of respondents and their treatment at local level (44.17).

CONCLUSION

Major constraints faced by the respondents in relation to vegetable production through ATMA programme appeared were as, lack of improved quality seed (79.66) followed by Provide sufficient rate of vegetables (75.83), Irregular supply of Agri inputs by cooperatives (71.66), Highly infestation of insect and disease (65.00), Poor connection to respondents and scientist (62.50), Lack of awareness about vegetables production (56.66), Market facilities is poor at village level (55.00). Storage facilities available in village level (52.50), Supply literature of vegetable production at village level (50.00) and insufficient knowledge about communication tools (46.67).

The Suggestions for the ATMA beneficiaries

Suggestions proposed by the respondents for improvement of ATMA activities the important suggestions appeared were as, availability of improved quality seed at proper time (84.17) followed by telling the vegetable production techniques to the respondents from time to time (77.50), proper guide to respondents about plant protection measures in vegetable production (74.16), better connection to respondents and scientist at time to time (71.66), provide minimum support prize of vegetables (66.66), provide sufficient knowledge about vegetable production (60.83), demonstrations, field days, kisan melas etc. should be organized repeatedly (59.16), Info about resource availability, marketing and credit orientation should also be given (55.00), training should be provided on vegetable production (46.67), and assessment problems of respondents and their solution at village level (44.17).

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Designing and Development of Decision Support System for the Management of Lifestyle Diseases

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ABSTRACT

The research work was conducted in Ludhiana city of Punjab, India (2019-22) to design and develop a decision support system for management of lifestyle diseases. In analysis of surveys conducted in last 5 years, it was found that Punjab is one of the leading states with high percentage of people suffering from various lifestyle diseases and its common risk factor obesity. Based on this analysis of secondary sources three prominent lifestyle diseases viz. Hypertension, Diabetes and Cardiovascular diseases were identified for development of Decision Support System (DSS). DSS was designed with the aim of managing three selected lifestyle diseases and their common risk factor obesity. Development process involved a three-tier development model. Each step involved in designing and development of DSS was validated by a group of experts. Content, design, and development phase had undergone process validation by experts from three different departments at Punjab Agricultural University, Ludhiana i.e., Department of Food and Nutrition (FN), Department of Extension Education and Communication Management (EECM) and Department of Electrical Engineering and Information Technology (EEIT) and by the chief medical officer at PAU hospital respectively to ensure that content, design, message clarity and coding for developing DSS was appropriate to manage selected lifestyle diseases. Appropriateness scores were provided by the experts on different parameters. Sign test was applied to statistically validate appropriateness scores. Results of process validation revealed that the overall mean score for appropriateness of content of DSS by experts from FN and Chief Medical Officer, PAU was 2.36 (mean score range 1-3). The overall mean score for appropriateness of design and clarity of message as provided by experts from EECM was 2.62 (mean score range 1-3). And the overall mean score for coding and development process of DSS by experts from the department of EEIT was 2.68 (mean score range 1-3). Overall scores of process validation by experts from different departments proved that content, design, message clarity and coding for designing and development of DSS was appropriate. After, process validation by the experts a working prototype of DSS for management of lifestyle disease was developed.

Keywords: Development, Decision support system, Validation, Management and lifestyle diseases

INTRODUCTION

The Lancet (2009) defined health as a body's ability to adapt to infirmities and new threats. This definition was based on idea that in the past few decades modern science has taken considerable steps in creating awareness of diseases and understanding how diseases work, determining novel methods to stop or slow them and accepting that lack of disease may not be possible. One such novel method is Decision support system. A Decision Support System (DSS) is a computer-based information system that help users to find a solution to their problem and assists them to take a decision best suited to their local condition. Most of the decision support systems are developed to support agriculture or business models. There are thousands of computer-based systems in the market for issues as big as cancer and as small as drinking water (Kharkwal and Sharma, 2022). Recent attempt

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in this research work is more focused towards developing a DSS to cater health and lifestyle related needs of users. Present study is based in Punjab, and it was identified that Punjab is a leading state in terms of population suffering from lifestyle disease and its major risk factor obesity (NFHS, 2021). The reason for increase of obesity in Punjab can be found in a study aimed to analyze pattern of food consumption of farming families in Punjab conducted by Vij and Mann (2022). Study revealed that there was high consumption of fats and oils in nearly half of the subjects and consumption of fruits, nuts and oil seeds was found to be very low. It was found that there is an imbalance in consumptions of different food groups and suggestions were made regarding the need to spread awareness among people of Punjab to incorporate a variety of food items from different food groups in their diet. Another study by Saikia and Mittal (2022) revealed that lifestyle of an individual can be measured through different parameters like meal frequency, dietary diversity score, physical activity, stress management, nutrition intake, substance abuse, availing medical advice and personal health habits. So, an attempt has been made to develop a decision support system to help population suffering from aforementioned conditions to adapt a better lifestyle, manage lifestyle diseases and its major risk factors with which they are suffering or might suffer. Based on analysis of secondary sources three major lifestyle diseases viz. Hypertension, Diabetes and Cardiovascular diseases were selected. Strategies like eating behavior, diet, physical activities, sleeping pattern etc. are used to manage those diseases. The developed DSS assures better decision making related to diagnosis and treatment of lifestyle diseases based on inputs by the users which are then used to present tailor made solutions as output. There is a need for development of such health-related support systems as they can ensure more self-reliance especially in people coming from weaker sections of society. All in all, the developed DSS caters health related needs of population and contributes to development of a disease- free nation.

MATERIALS AND METHODS

The current research work 'Designing and Development of Decision Support System for the Management of Lifestyle Diseases' has been caried out in Ludhiana district of Punjab (2019-22). on the basis of analysis of secondary data three main lifestyle diseases viz., Hypertension, Diabetes and Cardiovascular diseases were selected for development of DSS. The analysis of secondary data was performed by reviewing all the survey work related to lifestyle diseases conducted in last five years in Punjab. The whole process of designing and development of DSS took place in three steps: Content development, designing of DSS and development of DSS. Each step undergone process validation by a group of experts. Content development involved generation, organization, and translation of content. The validation of content was performed by six experts from the department of FN and one chief medical officer from PAU Hospital. They validated subject matter in terms of Title, content/ subject matter, sequence of content, sub heads, informative value, usability, suitability to purpose, convincing value. Designing of DSS involved preparing a blueprint for all the pages/ interfaces of DSS and deciding the flow of information from one page to another. Designing was performed on MS PowerPoint and flow diagram was prepared to decide the flow of information from one page to another. Validation of designing phase of DSS was performed by five experts from the department of EECM. They validated the design and message clarity of content on parameters like title, sequence/continuity, layout, content (need based), understandability, comprehensibility, clarity of message, selection of words, sentence formation, relevance. The third and last step was development of DSS which involved use of three tier model to develop DSS. Languages used were HTML, CSS, JAVA, JAVA Script, and PHP. Framework used to develop front end was Bootstrap. Microsoft Virtual studio code has been used as a source code editor for code building, debugging etc. My SQL was used as database management system.

The validation of development phase of DSS was performed by five experts from department of EEIT. They validated language used and coding process on parameters like Layout, overall presentation, user interface, framework, front end, back end, page load time. The experts were chosen on the basis of availability for process validation. During process validation, experts provided score for each parameter ranging from 1-3 (where 1= not appropriate, 2= somewhat appropriate and 3= appropriate). Sign test

was used to statistically validate that the appropriateness score provided by the experts for each parameter was significantly higher than 1 i.e., appropriate. After process validation by the experts a working prototype of Decision Support System for management of lifestyle diseases was finalized and developed.

RESULTS AND DISCUSSION

Identification of lifestyle diseases: The identification of lifestyle diseases was performed by doing an analysis of secondary data. All the studies conducted in Punjab in the last five years related to lifestyle diseases were reviewed. This review revealed that most of the research work has been conducted on Diabetes, Hypertension and Cardiovascular diseases. It was emphasized in those studies that above mentioned diseases are on rise in Punjab and thus raised serious concerns. So, on the basis of number of studies conducted and suggestions provided in those studies three lifestyle diseases i.e., Diabetes, Hypertension and Cardiovascular diseases were selected for the development of DSS.

Content development for designing and development of decision support system: The very first step involved before designing and development of DSS was content development. Content related to the selected lifestyle diseases i.e., hypertension, diabetes and cardiovascular diseases was required in order to design and develop DSS. Content development has been carried out in four phases. Content generation, organization, translation and validation.

Content generation: The content for DSS was generated with the help of available literature and authentic sources like ICMR, NIN and WHO. The material was collected under following heads:

Information about lifestyle diseases: This included information like types of lifestyle diseases, factors affecting lifestyle diseases, consequences of lifestyle diseases.

Diagnosis: It included the identification of lifestyle disease a user might be suffering from. All the parameters for diagnosing of selected lifestyle diseases were identified such as age, weight, blood pressure, blood sugar level, level of HDL and LDL.

Diet: Total 84 diet plans were prepared to reduce weight keeping in mind the lifestyle disease with which the user might be diagnosed. The Recommendary Dietary Allowances (2010) was used to prepare 7 days diet plan for both vegetarian and non-vegetarian users. Diet calculator was also used to prepare recommended diets.

Exercises: The exercises were suggested to change the lifestyle of the users from sedentary to active. For this, the content for cardio, strength and resistance exercises was collected.

Mindful eating: An eating aptitude test based upon the principals of mindful eating was developed to analyze eating behavior of the user and concept of mindful eating was introduced to rectify the eating behavior, if found unhealthy.

Circadian rhythm: Circadian rhythm, also known as sleep cycle, plays a very important role in the management of lifestyle diseases. Number of hours the user sleeps in a day were recorded and analyzed. Suggestions as per the concept of at least eight hours of sleep per day were made.

Energy balance: The information like MET score for each physical activity and amount of calories in each food items were collected in order to calculate the energy balance for each user.

Organization of content: All the generated content was organized by segregation, categorization, and sequencing of content as per the selected lifestyle diseases. The content was segregated into manageable segments to retain the interest of the reader. All the content related to one lifestyle diseases was placed under the heading of that respective lifestyle disease. The generated content was sequenced based on the principle of general to specific for easy comprehension.

***Translation of content*:** The content was translated into vernacular language (Punjabi) for proper understanding of the local people.

***Content validation*:** This validation was required before designing and development of the DSS and was performed by the experts from the department of Food & Nutrition, PAU and Chief medical officer at PAU hospital. The appropriateness scores provided by experts on different parameters for content validation are presented in Table 1.

Table 1: Validation of content by the experts from the Department of Food and Nutrition and Chief Medical Officer (n=7)

Categories	Appropriateness		
	Mean score	Sign test	p-value
Title	2.57	2.42*	0.015
Content	2.29	2.25*	0.024
Sub heads	2.57	2.42*	0.015
Sequence of Content	2.00	2.07*	0.038
Informative value	2.57	2.42*	0.015
Usability	2.57	2.42*	0.015
Suitable to Purpose	2.00	2.07*	0.038
Convincing	2.29	2.25*	0.024
Overall	2.36	2.37*	0.018

(Mean Score Range 1-3). *Significant at 5% level of significance

The mean scores for all the parameters of content were found significant at 5 per cent level of significance ($p<0.05$). Sign value indicates significant difference between the obtained and hypothesized mean score (1- not appropriate). Parameters like title, sub heads, informative value and usability were given the highest mean score of 2.57. This score depicts that these above-mentioned parameters were considered most appropriate by the experts followed by content and convincing ability of the content with the mean score of 2.29. Sequence of content and suitability to purpose were provided mean score of 2.00 (somewhat appropriate). It showed that these two parameters needed a little improvement. All the suggestions provided by the experts related to the improvement of content were incorporated and the content was finalized.

Designing of the decision support system

Design is a blueprint or specification for construction of any item or implementation of a system in the form of a product, prototype, or process (Simon, 1969). Designing of DSS involved designing a blueprint for all the pages/ interfaces of DSS and deciding the flow of information from one page to another. Each page of DSS was designed on Microsoft Power point and the order of each page with the direction of flow of information from one page to another was decided.

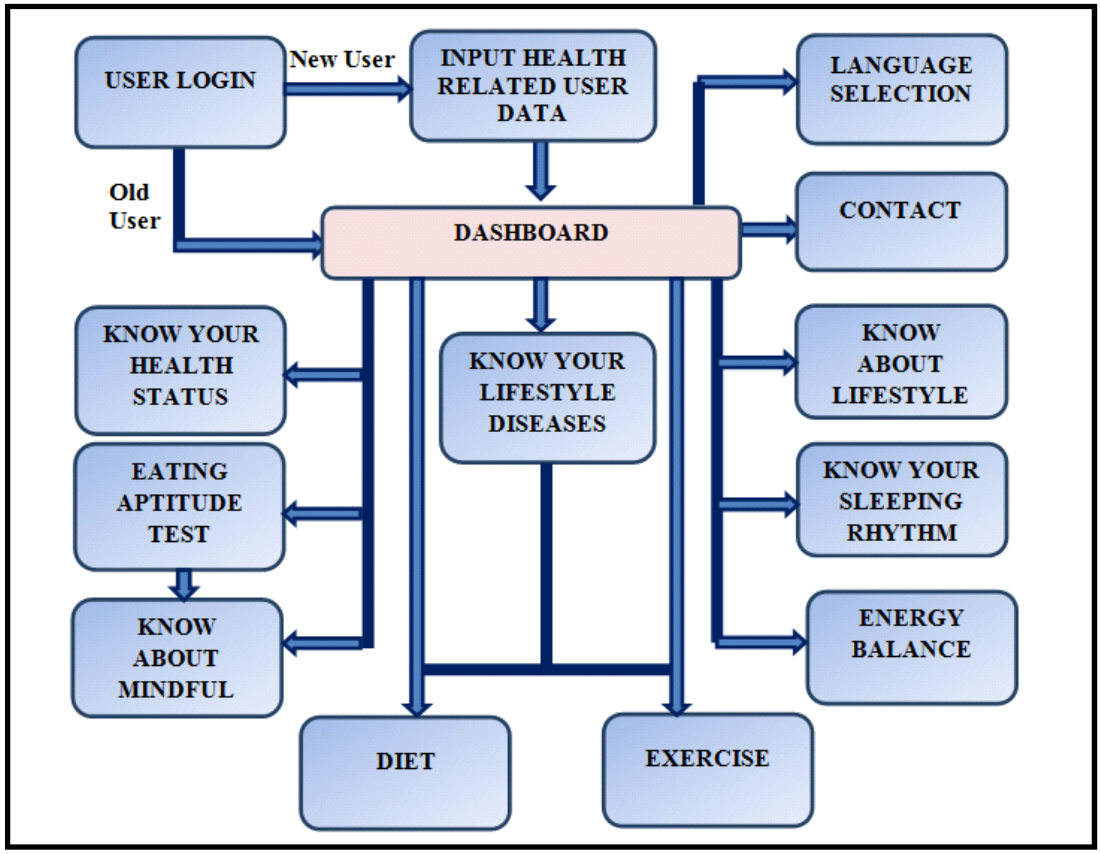

Figure 1: DSS Flow Diagram

Each interface and flow of information in DSS is depicted in Figure 1 and described under following sections.

User login: First page of DSS asks user to log in into the system by using mobile number. User's data was also stored into the database corresponding to their mobile number. The mobile number acted as a primary key in the MY SQL server database. Logo for the DSS was also designed using Canva software.

Language selection: Second option provided to users was to change language of the system. Users were allowed to change language to either English or Punjabi as per their choice. All the content and information from this step onwards was coded to be in the chosen language.

Input health related user data: Inputs by the users were taken under this section. User is asked to fill out data like Age, Height, Weight, Sex, HDL/LDL level, blood glucose level, blood pressure (Systolic and Diastolic).

Dashboard: Dashboard is the central front-end page. It provides access to all other sections of DSS. It is the main navigation page. Once user logs in the DSS, this section becomes primary page that would open every time user opens the DSS (with the same number).

Know your health status: This section of the DSS allows users to calculate their BMI, BMR, energy requirement, advised energy requirement in order to reduce weight. This page also specifies if one possess any lifestyle disease or not.

Know your lifestyle disease: This section provides option to users to know what all lifestyle diseases they are suffering from. This section also provides navigation buttons for managing those disease either through diet or exercise.

Know about lifestyle diseases: This page fulfilled the purpose of increasing awareness among users regarding lifestyle diseases, their types, factors affecting lifestyle diseases and their consequences.

Eating aptitude test: This section contained a questionnaire with 10 multiple choice type questions. Based on the answers provided by user for these questions, DSS identified eating behavior of a particular user as good or bad.

Know about mindful eating: This section had been introduced in DSS to improve eating behavior of users. It introduced the concept of mindful eating which is very essential to improve eating behavior of individuals to save them from various lifestyle diseases.

Your circadian rhythm: This page allows users to calculate amount of time they sleep in a day and on the basis of their sleeping hours, DSS analyses whether or not their sleeping rhythm is satisfactory.

Diets: Total 84 diets were prepared for all possible energy requirements and age group (18-60 years) to provide tailor made seven-days diet plan to Punjab population as per their energy requirement, choice (veg and nonveg) and availability of ingredients. Method of preparation page in the diet section provided instructions to prepare meals suggested by DSS. Measurements page provided standard measurements of ingredients to be used in preparing a meal.

Exercises: Considering that one of the major factors for lifestyle diseases is sedentary lifestyle. Three types of exercises cardio, resistance and strength were suggested by DSS to users. The gif files for each exercise assisted users on how to perform these exercises. Schedule for these exercises has also been provided stating the time, repetitions and duration of rest between the sets.

Your energy balance: Last section of DSS calculated energy balance of users. With the help of this section, users could easily find out their energy consumption and expenditure for each day. Energy consumption page allowed users to tick items they ate in a day and DSS calculated total consumed energy (Kcal). Energy expenditure page allowed users to input duration and type of physical activities they did in a day and DSS calculated total energy expenditure. Database of the DSS stored users' data date wise, so that they could easily assess it later as per specific date.

Contact: A contact page was prepared so that users could contact to the department (EECM) if they had any query related to DSS.

Validation of the designing process of decision support system

Validation of the designed DSS was required before the development of a working prototype. Five experts

Table 2: Validation of DSS by the experts from the Department of Extension Education and Communication Management (n=5)

Categories	Appropriateness		
	Mean score	Sign test	p-value
Title	2.60	2.07*	0.038
Sequence/ Continuity	2.60	2.07*	0.038
Layout	2.40	1.89*	0.059
Content (Need Based)	2.60	2.07*	0.038
Understandability	2.80	2.12*	0.034
Comprehensibility	2.60	2.07*	0.038
Clarity of Message	2.60	2.07*	0.038
Selection of Words	2.80	2.12*	0.034
Sentence Formation	2.60	2.07*	0.038
Relevance	2.60	2.07*	0.038
Overall	2.62	2.03*	0.042

(Mean Score Range 1-3) *Significant at 5 % level of significance

from the department of EECM validated design of DSS to ensure that it possessed ease in usage and output provided by DSS was need based and comprehendible for Punjab population. The results of which are depicted in Table 2.

Mean scores provided by experts for all the parameters of designed DSS revealed that understandability and selection of words were found most appropriate by experts with mean score of 2.80. Title, sequence, content, comprehensibility, clarity of message, sentence formation and relevance were found to be the second most appropriate parameters by experts with the mean score of 2.60. Layout was provided a mean score of 2.40. Suggestions provided by experts to improve the layout of DSS were incorporated. Sign test revealed that all the mean scores were significantly higher than the hypothesized mean (1- not appropriate) at 5 per cent level of significance ($p<0.05$). This proved the design of DSS appropriate for developing the prototype.

Development of the decision support system

Development means adding functionality to the website (Berners-Lee, 1989). In this research work development involved the functioning of front end, back end, and use of logic so that the DSS provide accurate output for each input. User interface, knowledge base (database), logic (algorithm) was developed using a three-tier architecture model, and all the tiers were connected to ensure full functionality of DSS. The proposed DSS was developed as a web application that is not required to be installed on any smart device instead it can run on any browser either on a computer/ laptop or any smart device. To access the DSS, users are navigated to a special URL. The developed DSS was named as 'Be Healthy Be Fit' and URL for the developed DSS was www.lifestyledss.com that can be

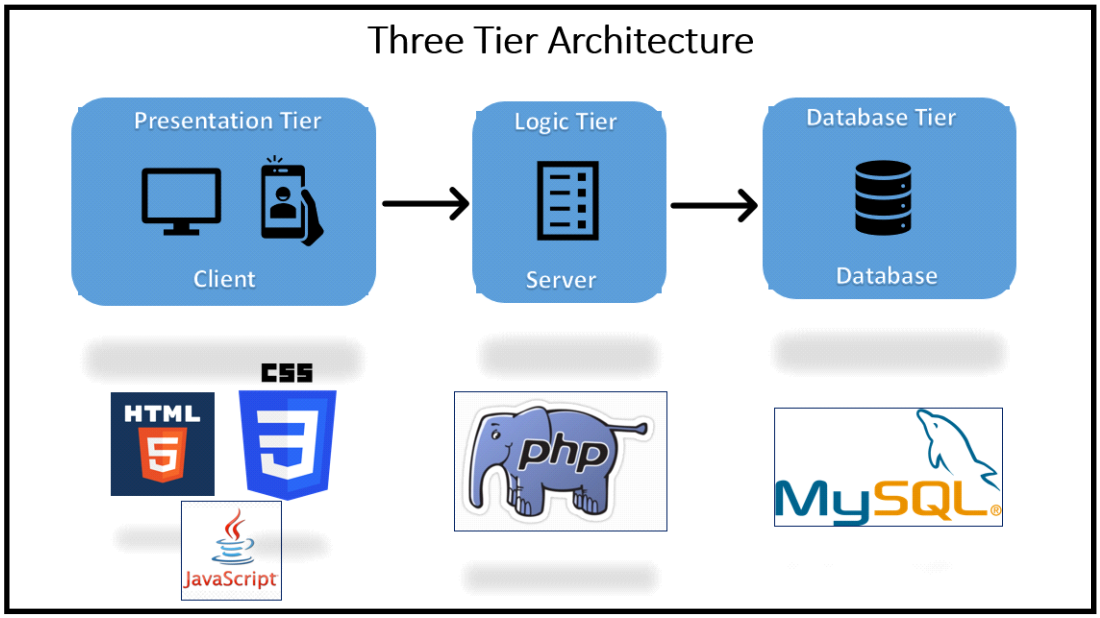

Figure 2: Architecture of DSS

visited on any web browser. The complete three architecture model and tools used to develop DSS has been described below & has been depicted in Figure 2.

Tier 1: First tier of architecture model is the front end of DSS. It can be called as client side of the system. It was responsible for appearance of presentation interface (front end) of DSS. It involved coding process that develops Graphical User Interface (GUI) and particularly interactive windows for users. With the help of this tier, data could be collected from users and transferred to system's second tier for processing.

Tier 2: It is called logic layer of architecture model. This tier processes requests/ inputs obtained from users in conjunction with tier three, where all the data is stored. As this is middle layer, it is also responsible for transfer of data (Input and output) from one end to another. Logic layer regulates the data. It decides which data is to be presented to user. Tier 2 not only works as a logic, but it also works as a client to third tier. The input is processed at this layer and the required information is presented to the user.

Tier 3: It is the backend side of the architecture model. This layer is called as database or knowledge base of DSS. This layer stores all the data and information related to DSS. Tier 3 not only stores output data but also stores the records of the users (Inputs).

Validation of the development process of decision support system

The development process of DSS undergone final process validation performed by five experts from the department of EEIT to ensure that the layout, coding, and software used to develop DSS are appropriate. Results of validation are presented in Table 3.

Parameters like overall presentation, framework, front-end, and page load time were considered most appropriate parameters of DSS by experts with the mean score of 2.80. User interface was provided a mean score of 2.60 which proved it to be the second most appropriate parameter of DSS. Layout was found to be comparatively less appropriate by the experts with the mean score of 2.40. Suggestions related to layout were incorporated in the DSS. Mean scores for all parameters were found significantly higher than the hypothesized mean (1- not appropriate) at 5 per cent level of significance ($p<0.05$). This proved that the developed DSS was considered appropriate by the experts from the department of EEIT.

Table 3: Validation of DSS by the experts from the Department of Electrical Engineering and Information Technology (n=5)

Categories	Appropriateness		
	Mean score	Sign test	p-value
Layout of DSS	2.40	2.07*	0.038
Overall Presentation	2.80	2.12*	0.034
User Interface	2.60	2.07*	0.038
Framework	2.80	2.12*	0.034
Front end	2.80	2.12*	0.034
Back end	2.60	2.00*	0.046
Page load time	2.80	2.12*	0.034
Overall	2.68	2.06*	0.039

(Mean Score Range 1-3) *Significant at 5 % level of significance

Considering all the appropriateness scores and sign values depicted in Table 1, 2 and 3 which clearly revealed that the content, design, and developed DSS were appropriate a working prototype of DSS was finalized and developed.

CONCLUSION

In this age of digital revolution, Punjab being one of the leading states in terms of population suffering from lifestyle diseases, overweight and obesity, needed a technological solution to manage these conditions. DSS has been proved to be a great digital measure to induce self-reliance in various fields like agriculture and supply chain planning etc. but rarely been used in health sector so far. Development of a decision support system for the management of lifestyle diseases in Punjab is a novel initiative in this direction. This work elaborates the process of designing and developing a decision support system and its validation so that it can be effectively used by the target audience. The working prototype of DSS named '*Be healthy Be fit*' was found to be statistically valid and appropriate in providing sound management strategies to deal with lifestyle diseases like Hypertension, Diabetes, Cardiovascular diseases, and their major risk factor obesity for specific

population (Punjab). It is suggested that more DSS could be developed by using the designing methodology and validation process detailed in this paper and it could be very helpful in designing DSS for specific audiences for managing other diseases in future. In the long run, projects like this could not only contribute to reducing pressure on health sector but could also help a country to progress as a healthier nation.

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Value Generation through Mobility and Transshipment along the Value Chains: The Farmer Producer Organisation (FPO) Reality and Ecosystem

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ABSTRACT

Value chain in enterprise ecology plays the pivotal role and it provides an arterial services to the enterprise ecosystem dynamics. Now almost 35-40 per cent of agricultural produce are damaged due to lack of value chain. If you want to enhance the marketability and consumer's preferences, this is the high time to focus on the value chain management with extreme importance. The success of Farmer producer organisations (FPOs) depends on how best they can keep on doing value chain operations, else there won't be any discernible success in placing the agricultural produce to the target market. The present study was carried out to elicit the facts and information in regard to value chain operation and marketability of certain selected FPO enterprises, which has been studied in state of Odisha. One hundred (100) respondents in total were selected from two FPOs, fifty (50) from each FPO of Ranpur block of Nayagarh district of Odisha to conduct the study following snowball sampling method. The data were collected through pilot survey and structured interview schedule. The statistical tools used for data analysis are; correlation coefficient, multiple regression analysis, stepwise regression analysis and path analysis. The correlation coefficients found that marketed surplus is showcasing significant relationship with expenditure for surplus movement. Regression results implied that 24 causal variables together have contributed 71.10 per cent of variance in the consequent variable. Four out of twenty-four independent variables were retained in the last step of step down regression analysis. The results of path analysis reveals that the variable marketed surplus have got highest indirect effect on expenditure for surplus movement (y). This empirical study has got tremendous policy implications for Odisha and anywhere in India as well.

Keywords: Farmer producer organization (FPO), Institutional innovation, Marketed surplus, Training exposure, Transport cost, Value chain

INTRODUCTION

The ecology of value generation imbibes both structural and functional inputs, when one is a framework enterprise, the other is taking care of the entrepreneurial kinetics. Value generation and value addition are both ways to make enterprise acceptable, labile and tenable. Value addition helps faster movement and wider adaptation across the economical class and layers. Transport costs are vital to explain cropping decisions in a deterministic setting (Omamo,1998). Higher transport costs drive up the size of the agricultural workforce and the fraction of subsistence (Gollin and Rogerson, 2014). Changes in relative transit costs are demonstrated to alter relative regional wage rates, therefore also affecting the location of "production-cost-oriented" enterprises (Kilkenny, 1995).

Farmer producer organisations (FPOs) provide a desirable platform for farmers to make institutionalised

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collective decisions about their farm enterprises. It also sets the door for the acquisition of numerous company prospects on a local and large scale. FPOs are reinventing and modernising agriculture's commercial dent through public-private partnerships, entrepreneurial concepts, marketing methods, branding, and socialisation in order to navigate numerous government conventions and formalities. The basic concept of farmer producer organisations is bulk buying of inputs used in farming like fertilizers, pesticides, seeds, etc. and then distributing it amongst the member farmers. FPOs try to bring small and medium farmers together to reduce the cost of their supply chain in order to increase the benefit from their produce (Chaudhary *et al.,* 2023). Some constraints identified by FPO members and/or office bearers that play a significant part in creating impediments to FPO growth, development, and management based on their priorities are low produce prices, high transportation costs, the nature of products (perishability), and delayed payment (Chauhan *et al.,* 2021). Farm households' participation in FPOs is significantly influenced by the distance to the closest market, the extension contact, the transportation facility, and the intention to extend the scale of activity in the future (Gurung and Choubey, 2022). Few variables such as Age, no. of enterprise, year of enterprise, size of holding, size of homestead land, size of cultivable land, crop yield, livestock yield, income (on-farm and off-farm), family expenditure, marketable surplus and marketed surplus have a critical contribution to transportation cost (Roy and Acharya, 2021).

MATERIALS AND METHODS

The study was conducted in two farmer producer organizations (FPOs) from Ranpur block of Nayagarh district of Odisha. Hundred (100) respondents in total were selected from two FPOs, fifty (50) from each FPO to conduct the study following snowball sampling method. Appropriate operationalization and measurement of the variables have helped the researcher land upon the accurate conclusions. Therefore, the selected variables for this study had been operationalized and measured in the following manner: I) Independent variables II) Dependent variables.

Independent variables selected for the study were age (x_1), education (x_2), no. of enterprise (x_3), year of enterprise (x_4), training exposure (x_5), family size (x_6), mean family education (x_7), material possessed (x_8), size of holding (x_9), size of homestead land (x_{10}), size of cultivated land (x_{11}), size of land under irrigation (x_{12}), no. of fragments (x_{13}), crop yield (x_{14}), livestock yield(x_{15}), cropping intensity (x_{16}), income (x_{17}), family expenditure (x_{18}), marketable surplus (x_{19}), marketed surplus (x_{20}), family labour (x_{21}), no. of male workers (x_{22}) no. of female workers (x_{23}) and dependency ratio (x_{24}).

Dependent variable selected for the study was Expenditure for surplus movement (y). Appropriate statistical tools have been used to carry out the study viz, Correlation coefficient, Multiple regression analysis, Step wise regression analysis and Path analysis with the help of IBM SPSS v26.0.

RESULTS AND DISCUSSION

The subjective information is measured utilizing explicit numerical methodology. Then data analysis i.e. Co-efficient of correlation, multiple regression analysis, stepwise regression analysis and path analysis has been done to evaluate the information.

Table 1 presents the coefficient of correlation between expenditure for surplus movement (y) and 24 dependent variables. It has been found that the following variables viz. education(x_2), number of enterprise (x_3), year of enterprise (x_4), training exposure (x_5), family size (x_6), materials possessed (x_8) and family labour (x_{21}) of FPO members are having negative but significant correlation with the dependent variable. The variables age (x_1), cropping intensity (x_{16}), family expenditure (x_{18}), marketable surplus (x_{19}) and marketed surplus (x_{20}) have recorded positive significant correlation with the dependent variable.

The correlation coefficients revealed that the respondents those who are younger, they are pertaining to higher education category. So, both young and educated respondents have been able to rationalize the cost after transportation. It may so happen that the young age respondents are closely associated with transportation system like small motor vehicles which have become natural for them to access. they are capable of rationalizing cost reduction. incur less expenditure for surplus movement. Also, it has been found that the exogenous variable year of enterprises (x_4) is negatively

Table 1: Coefficient of Correlation (r): Expenditure for surplus movement (y) Vs. 24 Independent Variables (x_1-x_{24})

Independent variables	'r' value	Remarks
Age (x_1)	0.350	**
Education (x_2)	-0.395	**
Number of enterprise (x_3)	-0.402	**
Year of enterprise (x_4)	-0.397	**
Training exposure (x_5)	-0.482	**
Family size (x_6)	-0.333	**
Mean family education (x_7)	0.070	
Materials possessed (x_8)	-0.207	*
Size of holding (x_9)	0.044	
Size of homestead land (x_{10})	-0.115	
Size of cultivated land (x_{11})	0.035	
Size of land under irrigation (x_{12})	0.033	
Number of fragments (x_{13})	-0.121	
Crop yield (x_{14})	-0.145	
Livestock yield (x_{15})	-0.009	
Cropping intensity (x_{16})	0.436	**
Income (x_{17})	-0.137	
Family expenditure (x_{18})	0.202	*
Marketable surplus (x_{19})	0.449	**
Marketed surplus (x_{20})	0.760	**
Family labour (x_{21})	-0.207	*
No of male workers (x_{22})	-0.137	
No of female workers (x_{23})	-0.056	
Dependency ratio (x_{24})	-0.099	

**Correlation is significant at the 0.01 level ; *Correlation is significant at the 0.05 level

significant with the dependent variable. It implies that farmers who have good many years spent on entrepreneurship, they are also good negotiator. They may spend less in transit cost of their farm produce. It has also been found that the variable cropping intensity (x_{16}) have also shown significant association with expenditure for surplus movement (y). The exogenous variables Marketable surplus (x_{19}) and marketed surplus (x_{20}) have been intrigued with the consequent variable. It implies that higher the surplus generated from the farm, then higher will be the cost incurred by the farmers for transporting the farm produce. These significant variables are found to be correlated with access and utilization of various sources of surplus movement by the FPO members and expenditure associated with them respectively.

Table 2 presents the full model of regression analysis between exogenous variable expenditure for surplus movement (y) vs. 24 causal variables. It is found that 24 causal variables together have contributed 71.10 percent of variance in the consequent variable expenditure for surplus movement (y). It has been found that the marketed surplus (x_{20}) has exerted the highest direct effect on expenditure for surplus movement. It is discernible that higher the farm produce more will be their cost of transportation.

Table 3 presents step-down regression analysis. In stepwise regression analysis, it is discernible that the variables marketable surplus (x_{19}), marketed surplus (x_{20}), cropping intensity (x_{16}) and training exposure (x_5) have been retained at the last step. It implies that these 4 variables have significant functional relationship with expenditure for movement of surplus generated by the farmers. In order to improvise the economies of scale of the FPO members, the prime concerns could be to improve cropping intensity. Focus on need-based training for farmer members on proper package of techniques as well as post-harvest handling will result in significant reduction of farm produce waste. The r^2 value being 68%, these 4 variables have together contributed to 95.63 % of 71.10 % total variance of explicated variables to vindicate their distinctive contribution in characterising expenditure for surplus movement.

Table 4 revealed that the variable marketed surplus (x_{20}) has enrooted the highest indirect effect of as much as 13 exogenous variables to impact on the consequent variable. It has got cause and effect relationship. When a farmer produces higher bulk of marketed surplus, significant amount of cost is incurred for surplus movement. Training exposure (x_5) has exerted the highest total effect. It reveals that proper training exposure to farmers has got tremendous impact in accessing different sources for surplus movement. The residual effect been 0.290, it is to conclude that even with the combination of 24 exogenous variables, 29 per cent variance in dependent variable could not be explained. This suggests the inclusion of more numbers of relevant and consistent variables for this framework of study.

Table 2: Multiple Regression Analysis: Expenditure for surplus movement (y) vs. 24 Causal Variables (x_1-x_{24})

Variables	Reg. Coef. B	S.E. B	Beta	t Value
Age (x_1)	-0.040	0.124	-0.040	-0.322
Education (x_2)	0.024	0.126	0.024	0.189
Number of enterprise (x_3)	-0.051	0.134	-0.051	-0.385
Year of enterprise (x_4)	-0.117	0.094	-0.117	-1.240
Training exposure (x_5)	-0.206	0.129	-0.206	-1.596
Family size (x_6)	-0.011	0.106	-0.011	-0.100
Mean family education (x_7)	-0.069	0.087	-0.069	-0.793
Materials possessed (x_8)	-0.035	0.099	-0.035	-0.353
Size of holding (x_9)	0.228	0.546	0.228	0.418
Size of homestead land (x_{10})	-0.047	0.070	-0.047	-0.669
Size of cultivated land (x_{11})	-0.116	0.566	-0.116	-0.204
Size of land under irrigation (x_{12})	-0.013	0.114	-0.013	-0.114
Number of fragments (x_{13})	-0.022	0.097	-0.022	-0.231
Crop yield (x_{14})	0.005	0.087	0.005	0.062
Livestock yield (x_{15})	-0.023	0.071	-0.023	-0.325
Cropping intensity (x_{16})	0.164	0.079	0.164	2.080
Income (x_{17})	0.034	0.077	0.034	0.448
Family expenditure (x_{18})	0.044	0.078	0.044	0.565
Marketable surplus (x_{19})	0.156	0.085	0.156	1.837
Marketed surplus (x_{20})	0.509	0.094	0.509	5.392
Family labour (x_{21})	-0.049	0.091	-0.049	-0.539
No of male workers (x_{22})	-0.033	0.097	-0.033	-0.343
No of female workers (x_{23})	-0.057	0.085	-0.057	-0.672
Dependency ratio (x_{24})	0.017	0.072	0.017	0.240

R square: 71.10%; The standard error of the estimate: 0.618

Table 3: Stepwise Regression Analysis: Expenditure for surplus movement (y) Vs. 24 Causal Variables (x_1-x_{24})

Variables	Reg. Coef. B	S.E. B	Beta	t value
Marketed surplus (x_{20})	0.574	0.068	0.574	8.480
Training exposure (x_5)	-0.211	0.063	-0.211	-3.360
Marketable surplus (x_{19})	0.169	0.063	0.169	2.690
Cropping intensity (x_{16})	0.153	0.063	0.153	2.431

R square: 68.00% ; The standard error of the estimate: 0.577

CONCLUSION

Not more than three per cent of green produces of agri-horticultural production is either value added or processed. This evokes a huge wastage and close to Rs 30,0000 crores of argil produces are wasted due to lack of value addition, supply chain and transshipment to market destinations in India and abroad. The emergence of FPO ecosystems across India incubates new and robust enterprise opportunity and generation of millions of livelihoods. Value addition is the integral part of entrepreneurial growth and dynamics. Value addition starts from innovation and lands on the valley of customers' satisfaction. In between there has been a journey through production, processing, branding supply chain, customer behaviour and commodity acculturation. While farmers are changing their

Table 4: Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Expenditure for surplus movement (y) Vs. 24 exogenous variables (x_1-x_{24})

Variables	Total effect	Direct effect	Indirect effect	Highest indirect effect
Age (x_1)	0.350	-0.040	0.390	0.154 (x20)
Education (x_2)	-0.395	0.023	**-0.418**	-0.146 (x20)
Number of enterprise (x_3)	-0.402	-0.052	-0.350	-0.16 (x20)
Year of enterprise (x_4)	-0.397	-0.116	-0.281	-0.146 (x20)
Training exposure (x_5)	**-0.482**	-0.205	-0.277	-0.170 (x20)
Family size (x_6)	-0.333	-0.010	-0.323	-0.139 (x20)
Mean family education (x_7)	0.070	-0.069	0.139	0.095 (x5)
Materials possessed (x_8)	-0.207	-0.035	-0.172	-0.089 (x20)
Size of holding (x_9)	0.044	0.234	-0.190	-0.122 (x11)
Size of homestead land (x_{10})	-0.115	-0.047	-0.068	-0.052 (x5)
Size of cultivated land (x_{11})	0.035	-0.122	0.157	**0.233 (x9)**
Size of land under irrigation (x_{12})	0.033	-0.014	0.047	0.181 (x9)
Number of fragments (x_{13})	-0.121	-0.022	-0.099	0.104 (x9)
Crop yield (x_{14})	-0.145	0.006	-0.151	-0.054 (x20)
Livestock yield (x_{15})	-0.009	-0.023	0.014	0.042 (x9)
Cropping intensity (x_{16})	0.436	0.164	0.272	0.189 (x20)
Income (x_{17})	-0.137	0.035	-0.172	-0.068 (x20)
Family expenditure (x_{18})	0.202	0.044	0.158	0.176 (x20)
Marketable surplus (x_{19})	0.449	0.156	0.293	0.18 (x20)
Marketed surplus (x_{20})	0.760	**0.509**	0.251	0.069 (x5)
Family labour (x_{21})	-0.207	-0.050	-0.157	-0.085 (x5)
No of male workers (x_{22})	-0.137	-0.034	-0.103	0.061 (x9)
No of female workers (x_{23})	-0.056	-0.057	0.001	0.084 (x9)
Dependency ratio (x_{24})	-0.099	0.018	-0.117	-0.042 (x20)

Residual effect: 0.290; Highest Indirect Individual effect: x_{20} (13)

approaches to agriculture and experiencing a radical change in agricultural pursuits, a change from subsistence farming to enterprising farming, they need more relevant appropriate market driven information to make the venture a successful one. The present study came up with a strong revelation in eliciting the fact that education, size of cultivated land, marketable surplus, marketed surplus, cropping intensity and training exposure are of immense application to make the FPOs a performing business organization to serve the yomen needs of the participating farmers and beyond. Success of FPOs would be more certain and thorough if transit costs were decreased. In order to identify the distinct functional factors influencing the functionality and success of FPOs, these types of studies must be replicated for each of the FPOs. This opens up opportunities for micro-sociological policy delineation which would be of massive utility for FPOs functioning to cover a state like Odisha at large.

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Quality Evaluation and Anti-nutritional Factors of Pearl millet Blended Cake

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ABSTRACT

Pearl millet is one of the most important food crops for the poor farmers especially the tribal people of India. The aim of this study was to evaluate the effect of incorporation of pearl millet flour as a supplement on the quality, anti-nutritional and sensory properties of cake. Six blend ratios of cake *i.e* 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 was developed for refined wheat and pearl millet flour, respectively. Crude fibre, crude fat, ash, phytic acid and polyphenol content in refined wheat- pearl millet flour blended cake increased with the incorporation of pearl millet flour from 0.36 to 1.53, 20.16 to 21.17, 1.77 to 2.51 per cent, 258.58 to 266.81 and 261.85 to 301.18, respectively. Overall acceptability of refined wheat-pearl millet blended cake showed that the blend having 80:20::refined wheat: pearl millet scored the best among all the treatments.

Keywords: Refined wheat, Pearl millet, Blended cake

INTRODUCTION

Millets are the one of the oldest food grains known to mankind and possibly the first cereal grain used for domestic purposes. For centuries, millet has been a prized crop in India and is staple diet for nearly 1/3rd of the world's population. Consequently, there is a global concern to collect, introduce, evaluate and utilize vast array of lesser known, under exploited, alternative crop plants for diversifying agricultural systems. Pearl millet also known as bajra, is one of the major millet crops grown in India. But now, pearl millet is receiving a great interest from food scientists, technologists and nutritionists because of their important contribution to national food security and potential health benefits (Saleh *et al.,* 2013). In western India like Gujarat, Rajasthan and Haryana, pearl millet is an important coarse cereal crop. About 46 per cent of pearl millet produced is used for food, 37.5 per cent for cattle feed, 7.7 per cent for poultry feed, 8.8 per cent for alcohol industry and about 0.4 per cent for seed purpose. The annual production of pearl millet in India is 6.93 million tonnes over an area of 8.61 million hectares (Directorate of millets development, 2020). In India, generally Pearl millet (*Pennisetum glaucum*) is consumed by small segment of the population in the form of *roti*. While, Pearl millet is nutritious but in developed countries, it is underutilized due to non-availability of convenient/ ready to eat form (Obilana, 2002). In developing countries, Pearl millet has great economic and health importance. In Africa, East-Asia and Indian subcontinent, millets are used as staple diet for the underprivileged groups of population (Chandrasekara and Fereidoon 2012). Research studies have found that cereal-based foods have low bioavailability of minerals like iron and zinc that initiate critical problem for infants and young children. Energy content of the pearl millet is greater than other cereal crop like sorghum and equivalent to brown rice due to its rich unsaturated fatty acids and linoleic acid (Jaybhaye *et al*., 2014) but despite this nutritional qualities, anti-nutritional factors (phytate, tannins and polyphenols) are also present in pearl millet. Pearl millet is soothing and easy to digest. Several potential health benefits reported for millets such as preventing cancer and cardiovascular diseases, lowering blood pressure have been attributed to the phenolics.

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Wheat flour is one of the important cereal grain because of its use for the preparation of many baked products. Bakery products are mostly prepared from refined wheat flour with 60-75% extraction rate, which has still lower nutritive value. However, such products can easily be enriched and fortified at lower cost with proteins, fibre, various vitamins and minerals to meet the specific need of the target groups and vulnerable sections of the population who are undernourished and malnourished (Chopra *et al.,* 2013). Cakes are the most popular bakery products worldwide especially among children, they love to eat cakes, cupcakes and biscuits. The incorporation of pearl millet in cake may improve its nutritive value, lower the cost and help in enhancing the utilization of pearl millet.

MATERIALS AND METHODS

For preparation of cake, refined wheat flour was mixed with pearl millet flour in the ratios of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50. Cake was prepared according to the method described by Waring (1988) with some modifications. A cake batter recipe containing 100% refined wheat flour, 100% sugar, 90 g fat, ¼ tsp baking powder, ¼ tsp baking soda, 3 ml vanilla essence. The amount of water added to the batter was 30 per cent of the overall formulation. A refined wheat flour cake was used as control and other cake samples were prepared by replacing refined flour by different levels *i.e.,* 10, 20, 30, 40 and 50 per cent of pearl millet. During preparation of the cake, firstly dry ingredients were mixed thoroughly *i.e.,* refined flour, pearl millet flour, sugar, baking soda, baking powder, fat *etc.* The batter was thoroughly mixed by adding required amount of all ingredients. After mixing, the batter was filled in molds containing pan. The cake pan were placed in baking tray smeared with fat and baked at 180°C for 30 min in baking oven/deck oven. The cakes were allowed to cool, packed in polythene pouches (150 gauge) and then stored for a period of 21 days under refrigerated conditions. The stored product was analyzed for physico chemical changes and sensory characteristics at a regular interval of 7 days. Crude fibre, Crude fat and ash content was estimated as per the procedure described by AOAC (2007). Carbohydrates was calculated from the sum of moisture, crude protein, fat, ash and crude fibre and lastly subtracting it from 100. Phytic acid and polyphenol content was estimated as per the method suggested by Sadasivam and Manickam (2005). A Semi-trained panel of judges was used for the organoleptic evaluation (on 9-point hedonic scale) of the finished product. As per the procedure coined by Amerine *et al.* (1965), score of 5.5 and above was reflected as acceptable. The experiment was laid out in factorial CRD with nine treatments and replicated thrice. The data obtained were statistically analysed as per the procedure of Gomez and Gomez (1987) using OPSTAT software.

RESULTS AND DISCUSSION

Crude fibre: The data pertaining to crude fibre content revealed that there was significant decrease in crude fibre content during storage (Table 1). Incorporation of pearl millet flour, the fibre content increased from treatment T_1 to T_6. At the beginning the highest crude fibre content of 1.72 per cent recorded in treatment T_6 (50:50:: refined wheat flour: pearl millet flour) whereas, the lowest crude fibre content of 0.58 per cent was observed in treatment T_1 (100:00:: refined wheat flour: pearl millet flour). After 14 and 21 days of storage, the maximum crude fibre of 1.45 and 1.33 per cent recorded in treatment T_6 (50:50:: refined wheat flour: pearl millet flour) whereas, the minimum crude fibre of 0.28 and 0.15 per cent was noticed in treatment $T_1$100:00:: refined wheat flour: pearl millet flour). Interaction between treatment and storage was found to be significant. With the incorporation of pearl millet flour; crude fibre increased significantly as fibre content in pearl millet was higher than refined wheat flour (Table 3). Crude fibre is the insoluble fibre that helps in digesting the food particles. The thermal processing significantly reduces the crude fibre content. The decrease in crude fibre content might be due to degradation of hemicelluloses and other structural polysaccharides during storage were reported by Arinola and Adesina (2014). These results are in agreement with the findings of Shende (2016) in pearl millet based sponge cake.

Crude fat: Data in Table 1 revealed that at the beginning, the highest crude fat content of 21.52 per cent registered in treatment T_6 (50:50:: refined wheat flour: pearl millet flour) while the lowest crude fat content of 20.34 per cent was observed in treatment T_1 (100:00::refined wheat flour: pearl millet flour) which decreased to 21.35, 20.95, 20.89 and 20.27, 20.08, 19.95

Table 1: Effect of treatment and storage period on crude fibre and crude fat of blended cake

Treatments	Crude fibre					Crude fat				
Refined wheat:	Storage period (days)					Storage period (days)				
Pearl millet	0	7	14	21	Mean	0	7	14	21	Mean
T_1 (100:0)	0.58	0.46	0.28	0.15	0.36	20.34	20.27	20.08	19.95	20.16
T_2 (90:10)	0.75	0.64	0.50	0.46	0.58	20.90	20.74	20.59	20.46	20.67
T_3 (80:20)	0.98	0.85	0.72	0.58	0.78	21.20	21.15	21.02	20.92	21.07
T_4 (70:30)	1.19	1.15	1.09	1.01	1.11	21.44	21.32	21.00	20.81	21.14
T_5 (60:40)	1.25	1.18	1.13	1.08	1.16	21.16	21.08	20.93	20.88	21.01
T_6 (50:50)	1.72	1.65	1.45	1.33	1.53	21.52	21.35	20.95	20.89	21.17
Mean	1.07	0.98	0.86	0.76		21.09	20.98	20.76	20.65	
CD (5%)										
Treatments			0.49					0.02		
Storage			0.40					0.02		
Treatment x Storage			0.10					0.04		

per cent at 7, 14, and 21 days of storage. As the storage period advanced, crude fat content decreased from 21.09 to 20.65 per cent during 21 days of storage. However, the interaction between treatment and storage was found to be significant. The incorporation of pearl millet flour in different ratios significantly increase in crude fat content in different treatments. The mean values of the crude fat content during storage of 21 days decreased significantly from 21.09 to 20.65 per cent (Table 3). Fats are usually stable during processing but they deteriorate rapidly during storage. The decrease in crude fat content might be due to oxidation of fat in the presence of moisture and oxygen. This leads to oxidative and hydrolytic rancidity and produces off flavours. When lipids get oxidized it produces hydroperoxides and peroxides which react with fat soluble vitamins leading to the depletion of nutrients (Dandago, 2009).

The results are in accordance with the findings of Bhat and Bhat (2013) in pumpkin blended cake and Tanahy *et al.* (2021) in pearl millet flour based cake.

Carbohydrates: A persual of data in Table 2 indicated that the treatments significantly influenced carbohydrates content of cake. Initially, significantly higher carbohydrate content of 60.96 per cent recorded in treatment T_1 (100:00:: refined wheat flour: pearl millet flour) and lowest of 59.85in treatment T_6(50:50:: refined wheat flour: pearl millet flour). After 21 days of storage period the highest carbohydrates content of 60.75 per cent was noticed in treatment T_1 (100:00:: refined wheat flour: pearl millet flour) followed by 60.46, 59.94 and 59.80 per cent in treatment T_2, T_3 and T_4,respectively, whereas, the lowest carbohydrate content of 59.47 per cent in T_6 (50:50:: refined wheat flour: pearl millet flour). The mean value of carbohydrates content decreased from 60.33 to 60.01 per cent during 21 days of storage. However, the interaction between treatment and storage showed significant effect on the carbohydrates content. The changes in carbohydrate content influenced by storage period at ambient temperature. Anu *et al.* (2008) reported similar findings after replacing refined wheat flour with blanched pearl millet flour and green gram flours at 20:70:10 per cent level, respectively to prepare banana enriched sponge cake.

Ash: The statistical results regarding ash content have been presented in Table 2. The results indicated that significantly higher ash content of 2.62 per cent observed in treatment T_6(50:50::refined wheat flour: pearl millet flour) which was followed by 2.55 per cent in treatment T_5(60:40:: refined wheat flour: pearl millet flour) while the lowest ash content of 1.95 per cent recorded in treatment T_1 (100:0::refined wheat flour: pearl millet flour) at initial day of storage. After 21 days of storage, the highest ash content of 2.43 per cent found in treatment T_6(50:50::refined wheat flour: pearl millet flour) while the lowest ash content of 1.62 per cent was recorded in T_1 (100:0::refined wheat flour: pearl millet flour). Treatment, storage and their

Table 2: Effect of treatment and storage period on carbohydrates and ash of blended cake

Treatments	Carbohydrate					Ash				
Refined wheat:	Storage period (days)					Storage period (days)				
Pearl millet	0	7	14	21	Mean	0	7	14	21	Mean
T_1 (100:0)	60.96	60.92	60.88	60.75	60.87	1.95	1.86	1.68	1.62	1.77
T_2 (90:10)	60.75	60.64	60.50	60.46	60.58	2.06	2.01	1.92	1.86	1.96
T_3 (80:20)	60.32	60.26	60.02	59.94	60.13	2.29	2.25	2.12	2.08	2.18
T_4 (70:30)	60.19	60.05	59.92	59.80	59.99	2.40	2.35	2.26	2.21	2.30
T_5 (60:40)	59.94	59.87	59.76	59.68	59.81	2.55	2.48	2.35	2.29	2.41
T_6 (50:50)	59.85	59.70	59.55	59.47	59.64	2.62	2.52	2.49	2.43	2.51
Mean	60.33	60.24	60.10	60.01		2.31	2.24	2.13	2.08	
CD (5%)										
Treatments			0.01					0.02		
Storage			0.01					0.01		
Treatment x Storage			0.01					0.03		

interaction was found to be significant. Ash content increased with the addition of pearl millet flour in various treatments. With the possession of storage period, the ash content decreased significantly from the initial mean value of 2.31 to 2.08 per cent with an increase in storage period. The decrease in ash content might be due to increase in the activities of microorganisms utilizing the minerals for growth. Similar trend of decrease in ash content with an increase in storage period has also been reported by Rathi *et al.* (2004) and Anu *et al.* (2008) in pearl millet rich banana cake.

Phytic acid: Data pertaining to phytic acid in table 3 showed the effect of various treatments and storage on phytic acid content of cake. In treatment T_6 (50:50::refined wheat flour: pearl millet flour) was found maximum phytic acid of 270.12 mg/100 g whereas treatment T_1(100:00:: refined wheat flour: pearl millet flour) showed the minimum iron content of 261.12 mg/100 g at 0 day of storage. However, after 21 days of storage period, treatment T_6(50:50::refined wheat flour: pearl millet flour) recorded highest phytic acid content of 261.78 mg/100 g whereas lowest value of phytic acid content (252.60 mg/100 g) was observed in T_1 (100:00::refined wheat flour: pearl millet flour). Phytic acid content blended of cake was significantly influenced by storage period and the interaction between treatment and storage found to be significant. As the storage period advanced, phytic content decreased from the initial value of 266.35 to 257.07 mg/100 g. It might due to hydrolysis of phytic acid, enzymatically to phytases or chemically to lower inositol phosphates such as inositol Penta phosphate and inositol tetraphosphate. Similar findings were also reported by Sinha and Kawatra (2008) in of pearl millet rich banana cake.

Polyphenols: The data pertaining to polyphenol content of cake in Table 3 depicted a significant increase in polyphenol content with the incorporation of pearl millet flour. Initially, the highest polyphenol content of 310.82 mg/100 g recorded in treatment T_6 (50:50::refined wheat flour: pearl millet flour) whereas treatment T_1(100:00:: refined wheat flour: pearl millet flour) observed the lowest polyphenol content of 267.58 mg/100 g. However, after 21 days of storage period, treatment T_1(100:00::refined wheat flour: pearl millet flour) registered minimum polyphenol content of 257.12 mg/100 g whereas maximum polyphenol content of 288.73 mg/100 g was noticed in T_6 (50:50::refined wheat flour: pearl millet flour). As the storage period advanced, polyphenol content significantly decreased from 284.48 to 273.06 mg/100 g during storage. However, treatment storage and their interaction were found to be significant. With the incorporation of pearl millet flour, polyphenol content increased. This phenomena could be attributed to the oxidization of phenolic compounds present in the cake. Similar results were reported by Dingra and Jood (2001) in different cereal- pulse based bread.

Table 3: Effect of treatment and storage period on phytic acid and polyphenols of blended cake

Treatments	Phytic acid					Polyphenol				
Refined wheat:	Storage period (days)					Storage period (days)				
Pearl millet	0	7	14	21	Mean	0	7	14	21	Mean
T_1 (100:0)	261.12	260.62	259.50	252.60	258.58	267.58	263.46	259.28	257.12	261.86
T_2 (90:10)	263.15	260.08	258.67	254.98	259.34	272.75	271.54	269.52	267.46	270.31
T_3 (80:20)	265.98	262.40	257.09	254.89	260.21	275.98	270.86	268.72	265.48	270.26
T_4 (70:30)	267.90	265.58	260.71	259.04	263.42	284.79	280.95	278.56	272.81	279.27
T_5 (60:40)	269.15	262.08	260.54	258.45	262.67	300.98	298.78	290.03	286.78	294.14
T_6 (50:50)	270.12	269.02	264.85	261.78	266.81	310.82	305.32	299.85	288.73	301.18
Mean	266.35	263.41	260.51	257.07		285.48	281.82	277.66	273.06	
CD (5%)										
Treatments			0.19					0.02		
Storage			0.16					0.02		
Treatment x Storage			0.39					0.05		

Table 4: Effect of treatment and storage period on overall acceptability of blended cake

Treatments	Overall acceptability				
Refined wheat:	Storage period (days)				
Pearl millet	0	7	14	21	Mean
T_1 (100:0)	7.25	7.07	7.00	6.97	7.07
T_2 (90:10)	7.44	7.29	7.17	7.00	7.23
T_3 (80:20)	7.85	7.77	7.63	7.16	7.60
T_4 (70:30)	7.77	7.56	7.50	7.05	7.45
T_5 (60:40)	7.10	6.49	6.26	6.16	6.50
T_6 (50:50)	6.65	6.15	6.20	6.00	6.25
Mean	7.24	7.05	6.93	6.67	
CD (5%)					
Treatments			0.03		
Storage			0.02		
Treatment x Storage			0.06		

Overall acceptability: Overall acceptability of the cake showed a reduction from 0 to 21 days of storage. Highest score of 7.85 and 7.77 recorded in treatment T_3 (100:00:: refined wheat flour: pearl millet flour) whereas the lowest score of 6.65 and 6.15 recorded in treatment T_6 (50:50:: refined wheat flour: pearl millet flour) at initially and 7 days of storage. After 21 days of storage, the highest score of 7.16 was observed in treatment T_3 (80:20:: refined wheat flour: pearl millet flour) while as the lowest score of 6.00 in treatment T_6 (50:50:: refined wheat flour: pearl millet flour) followed by treatment T_5, T_4 and T_2 having values of 6.16, 7.05 and 7.00, respectively. The highest treatment mean score of 7.60 was observed in treatment T_3 (80:20:: refined wheat flour: pearl millet flour) and lowest of 6.25 in treatment T_6 (50:50:: refined wheat flour: pearl millet flour). During storage there was a significant decrease in mean score from the initial value of 7.24 to 6.67 (Table 4). However, the interaction between treatment and storage was found to be significant. The reduced acceptability of cake at 40 and 50 per cent level of incorporation of pearl millet flour may be attributed to the poor flavour contributed by pearl millet flour at higher levels.

Similar results were reported after replacing refined flour with blanched pearl millet flour and green gram flours at 20:70:10 per cent level respectively to prepare banana enriched sponge cake by Anu *et al.* (2008).

CONCLUSION

It can be concluded that the best quality cake can be prepared by using 80 per cent refined flour and 20 per cent pearl millet flour as the optimum proportion to produce the acceptable cake. On the basis of overall acceptability, treatment T_3 (80:20:: refined wheat flour: pearl millet flour) was found to be the best treatment. This investigation will be beneficial in encouraging the utilization of pearl millet, which is still unexploited despite its numerous nutritious and therapeutic benefits. Demand for such pearl millet products will increase in future considering its positive health benefits.

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Tillage and Weed Management Effect on Productivity of Maize in Maize-Wheat Cropping System

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ABSTRACT

A field experiment was carried out at Sher-e-Kashmir University of Agriculture Science and Technology of Jammu during *kharif* season of 2013 and 2014 to investigate the effect of tillage and weed management practices on productivity of maize under maize-wheat cropping system in sub-tropical irrigated conditions of Jammu. Among the tillage treatments, Conventional tillage (CT) preceded by Conventional tillage (CT) resulted in higher Plant height, dry matter, leaf area index, number of grains per cob, 1000-grains weight, grain yield, stover yield and significantly lowered the density and dry matter of weeds which was at par with Conventional tillage (CT) preceded by Zero tillage (ZT). Among various weed management treatments, two hand weeding recorded higher Plant height, dry matter, leaf area index, number of grains per cob, 1000-grains weight, grain yield, stover yield and significantly lowered the density and dry matter of weeds which was at par with Atrazine 1.0 kg/ha.

Keywords: Tillage, Weed management, Conventional tillage, Zero tillage, Maize

INTRODUCTION

Maize (*Zea mays* L.) is the most versatile crop with wider adaptability to varied agro-ecological regions and diverse growing seasons. Besides serving as human food and animal feed, the importance of this crop also lies in its wide industrial applications. In addition, maize is fed to cows, chickens, and pigs, which produce milk, eggs, and bacon, respectively. Responding to its multiple uses, the demand for maize is constantly increasing in the global market. New production technologies, such as improved hybrid cultivars, precision agriculture, herbicide-resistant traits, and biotechnological innovations, such as drought-tolerant maize, offer great promise for increasing maize productivity to meet the growing demand. Traditionally, maize is grown by broadcast seeding or with seed drill after 2–3 tillage operations. The traditional practice of growing these crops is laborious, costly and time consuming. Traditional tillage practices also contribute to the energy and labour cost in crop production system resulting in lower economic returns (Kumar *et al.,* 2013). Repeated conventional tillage coupled with other faulty land-utilization practices have caused large-scale degradation of our soils over the past 50–60 years, and most of the soils have lost up to one-half of their native organic matter content and fauna (Malik *et al.,* 2006). Hence, zero tillage is one of the better options that reduces the problems associated with faulty land-utilization practices to certain extent. However, a combination of zero and conventional options in sequence needs to be standardized for each cropping, soil and microclimatic conditions in order to enhance the sustainability of systems and resource-use efficiency (Stanzen *et al.,* 2016). Excluding environmental variables, yield losses in maize are caused mainly by competition with weeds. Weed interference is a severe problem in maize, especially in the early part of the growing season, due to slow early growth rate and wide row spacing. Weeds compete with the maize plants for resources such as light, nutrients, space, and moisture that influence the morphology and

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phenology of crop, reduce the yield, make harvesting difficult and mar the quality of grains. Furthermore, high weed infestation increases the cost of cultivation, lowers value of land, and reduces the returns of maize producers. In order to realize the yield potential of maize, weed management becomes indispensable.

MATERIALS AND METHODS

The field experiments were conducted during the *rabi* seasons of 2013 and 2014 at the Research Farm of Division of Agronomy, Main Campus, Chatha of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. Jammu which is situated at 320 -40´ N latitude and 740 -58´ E longitude with an altitude of 332 m above mean sea level. The physico-chemical properties of the experimental site revealed that the soil of the experimental site was sandy clay loam in texture, slightly alkaline, low available nitrogen, but medium in organic carbon, available phosphorus and potassium. The experiment was laid down in split-plot design with three replications. The treatments, combination of 4 tillage systems, viz. continuous conventional tillage in maize–wheat (CTCT), continuous zero tillage in maize–wheat (ZT-ZT), zero tillage in maize–conventional tillage in wheat (ZTCT), conventional tillage in maize–zero tillage in wheat (CT-ZT) and 3 weed-management practices, viz. 2 hand weedings at 15 and 30 days after sowing (DAS), weedy check and atrazine 1 kg/ha as pre-emergence application in maize. Maize var. 'Kanchan 517' was sown at row- to -row spacing of 60 cm and plant- to -plant spacing of 20 cm for maize. Maize sown in the first fortnight of June using 20 kg seed/ha, respectively. In each plot, grasses, broad leaves and sedges were counted from 2 randomly selected places in each plot using 0.5 m × 0.5 m quadrate. Weed count was expressed as number/m^2 and subjected to square-root transformation to normalize their distribution. The weeds removed from the selected areas were dried at 65o C to obtain constant weight and the weight was expressed in g/m^2. Benefit: cost ratio was calculated on the basis of prevailing market prices of inputs and produce.

RESULTS AND DISCUSSION

Among the tillage treatments, Conventional tillage (CT) preceded by (pb) Conventional tillage (CT) significantly decreased the density and dry matter of Cyperus rotundus, Cynodon dactylon, Amaranthus viridis and Celosia argentea at 30 DAS, 60 DAS and at harvest which was at par with Conventional tillage (CT) preceded by Zero tillage (ZT) (Table 1). This might have happened due to higher values of weed control efficiencies in these treatments could be attributed to lower weed density and weed biomass owing to delay in emergence of weeds due to the presence of less moisture content in the top layer compare with zero tillage (Chopra and Angairas, 2008). Among various weed management treatments, two hand weeding recorded lowest density and dry matter at 30 DAS, 60 DAS and at harvest which was found to be statistically at par with Atrazine 1.0 kg/ha. Under 2 hand-weeding treatments, the lower density of weeds could be due to removal of two flushes of weeds manually 15 and 30 days after sowing and later on good number of functional leaves might have smothering effect on the third flush of all categories of weeds could be possible reason for decrease in density of weeds at 30 DAS, 60 DAS and at harvest (Bisen and Singh, 2008). On the contrary, little higher weed density under pre-emergence application of atrazine at 1 kg/ha which controls only 1 flush of weeds.

In maize, the highest plant height, dry-matter accumulation and Leaf area index at 30 DAS, 60 DAS and at harvest were recorded in Conventional tillage (CT) preceded by (pb) Conventional tillage (CT) and which were at par with Conventional tillage (CT) preceded by Zero tillage (ZT) (Table 2). In general, overall improvement in waterholding capacity of soil, better root growth and its proliferation, which might have promoted growth of leaves by virtue of enhanced cell-division and increased better interception, absorption and utilization of radiant energy, there by resulting in higher photosynthesis and finally growth parameters (Bisen and Singh, 2008). Among weed-management treatments, the highest plant height, dry-matter accumulation and leaf area index at 30 DAS, 60 DAS and at harvest were recorded with two hand-weedings which was at par with atrazine 1 kg/ha and both proved significantly superior to the weedy check. The better growth parameters were owing to significant reduction in weed density and dry-matter accumulation under treatments of hand-weeding and recommended herbicides in both crops. Singh *et al.* (2010) also reported similar results.

Table 1: Effect of tillage and weed management on weed density (no./m^2) of maize in maize-wheat cropping system. (Pooled data 2 years)

Treatment	*Cyperus rotundus*			*Cynodon dactylon*			*Amaranthus viridis*			*Celosia argenta*		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Tillage												
ZT pb ZT	6.02 (37.61)	6.55 (43.77)	5.83 (35.56)	4.12 (16.83)	4.64 (21.28)	4.13 (16.88)	3.28 (10.39)	3.59 (12.44)	2.8 (7.72)	3.1 (9.22)	3.47 (11.61)	3.41 (11.17)
ZT pb CT	5.86 (35.94)	6.39 (41.94)	5.77 (34.77)	3.87 (15.05)	4.41 (19.28)	4.00 (16.00)	3.18 (9.72)	3.50 (11.88)	2.74 (7.44)	3.00 (8.78)	3.37 (10.94)	3.24 (10.0)
CT pb ZT	5.50 (32.16)	5.96 (37.0)	5.31 (30.28)	3.45 (12.00)	3.9 (15.33)	3.59 (13.00)	3.03 (8.94)	3.42 (11.33)	2.60 (6.83)	2.66 (7.00)	3.12 (9.44)	2.95 (8.39)
CT pb CT	5.39 (31.11)	5.89 (36.22)	5.19 (29.33)	3.26 (10.83)	3.79 (14.39)	3.34 (11.50)	2.98 (8.66)	3.39 (11.11)	2.52 (6.39)	2.56 (6.39)	3.04 (8.89)	2.84 (7.61)
SEm±	0.09	0.06	0.06	0.09	0.06	0.08	0.10	0.07	0.09	0.07	0.06	0.07
L.S.D (P=0.05)	0.32	0.22	0.23	0.33	0.23	0.29	NS	NS	NS	0.23	0.23	0.26
Weed management												
2 hand weeding	4.44 (18.87)	5.08 (25.0)	4.28 (17.5)	2.86 (7.37)	3.46 (11.21)	2.94 (7.87)	2.48 (5.25)	2.92 (7.62)	1.96 (2.95)	2.14 (3.79)	2.65 (6.17)	2.53 (5.54)
Atrazine 1.0 kg/ha	4.65 (20.83)	5.22 (26.41)	4.41 (18.62)	3.11 (8.91)	3.58 (12.08)	3.22 (9.62)	2.66 (6.16)	2.98 (15.83)	2.02 (3.16)	2.35 (4.66)	2.82 (7.04)	2.73 (6.54)
Weedy check	7.99 (62.91)	8.29 (67.79)	7.89 (61.33)	5.06 (24.75)	5.51 (29.4)	5.14 (25.54)	4.22 (16.87)	4.53 (19.54)	4.01 (15.16)	4.00 (15.08)	4.29 (17.46)	4.08 (15.79)
SEm±	0.07	0.04	0.05	0.08	0.07	0.09	0.07	0.06	0.09	0.08	0.07	0.07
L.S.D (P=0.05)	0.21	0.14	0.14	0.26	0.29	0.29	0.21	0.17	0.27	0.24	0.23	0.22

The highest number of grains/cob and 1,000-seed weight were recorded under in Conventional tillage (CT) preceded by (pb) Conventional tillage (CT) and which were at par with Conventional tillage (CT) preceded by Zero tillage (ZT) (Table 3). The possible reason for better yield attributes in CT pb CT maize can be attributed to favourable soil physical conditions for growth and development. Secondly lesser crop-weed competition might have contributed to higher values of yield attributes under tilled treatments which contributed to higher yield. Similar findings were also reported by (Stanzen *et al.,* 2016). Among the Weed-management treatments, two hand-weeding recorded significantly higher number of grains/cob and 1,000-grain weight which was found to be statistically at par with atrazine 1 kg/ha. This improvement in yield-attributing characters of maize might have happened owing to significant reduction in weed biomass and density and consequent reduction in crop-weed competition (Singh *et al.,* 2012).

The highest grain yield and stover yield of maize was recorded under continuous conventional tillage (CT-CT), which was at par with rotated (CT-ZT) in maize-wheat cropping sequence, but was significantly higher over zero tillage in maize and conventional tillage in wheat (ZT-CT) and continuous zero tillage (ZT-ZT) (Table 4). These might be happened due to favourable soil physical conditions for growth and development as well as lesser crop-weed competition owing to CT in present crop which might have contributed to higher values of yield attributes that contributed to higher grain yield (Sarma *et al.,* 2010). The weed-control treatments recorded significantly higher grain yield, stover yields and harvest index than unweeded check. Two hand weeding at 15 and 30 days after sowing produced significantly higher maize grain yield, stover yield and harvest index and statistically at par with Atrazine at 1 kg/ha. Amongst weed management treatments, the highest grain yield of maize was obtained in two hand weeding which was found to be statistically at par with atrazine at 1 kg/ha. The lowest grain yield of maize

Table 2: Effect of tillage and weed management on weed dry matter (g/m²) of maize in maize-wheat cropping system (Pooled data 2 years)

Treatment	*Cyperus rotundus*			*Cynodon dactylon*			*Amaranthus viridis*			Celosia argentea		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Tillage												
ZT pb ZT	2.64 (6.83	5.72 (35.28)	6.32 (47.33)	2.29 (4.50)	4.0 (15.88)	4.25 (17.83)	2.17 (3.94)	4.72 (22.55)	4.37 (19.61)	2.23 (4.27)	5.21 (28.00)	6.76 (47.05)
ZT pb CT	2.62 (6.78)	5.62 (34.39)	6.20 (46.39)	2.15 (3.94)	3.84 (14.83)	4.18 (17.39)	2.14 (3.77)	4.59 (21.33)	4.26 (18.72)	2.15 (3.94)	5.00 (26.00)	6.64 (39.50)
CT pb ZT	2.36 (5.44)	5.31 (31.5)	5.88 (43.22)	1.92 (2.94)	3.48 (12.28)	3.94 (15.44)	1.97 (3.05)	4.37 (19.50)	4.01 (16.83)	1.85 (2.50)	4.70 (23.55)	6.13 (39.50)
CT pb CT	2.30 (4.94)	5.25 (30.89)	5.75 (42.28)	1.87 (2.72)	3.35 (11.39)	3.79 (14.27)	1.94 (2.94)	4.27 (18.72)	3.95 (16.39)	1.82 (2.44)	4.62 (22.17)	6.03 (38.22)
SEm±	0.05	0.05	0.07	0.05	0.06	0.05	0.04	0.06	0.04	0.05	0.06	0.06
L.S.D(P=0.05)	0.17	0.15	0.21	0.16	0.20	0.17	0.13	0.20	0.12	0.16	0.23	0.22
Weed management												
2 hand weeding	1.82 (2.37)	4.03 (15.37)	3.83 (13.83)	1.66 (1.83)	2.92 (7.70)	3.35 (10.75)	1.73 (2.04)	3.61 (12.17)	3.20 (9.33)	1.71 (2.00)	3.82 (13.70)	5.16 (25.87)
Atrazine 1.0 kg/ha	1.91 (2.71)	4.11 (16.04)	3.95 (14.75)	1.76 (2.16)	3.00 (8.12)	3.42 (10.75)	1.81 (2.33)	3.74 (13.04)	3.30 (10.0)	1.76 (2.16)	3.96 (14.79)	5.34 (27.75)
Weedy check	3.72 (12.92)	8.28 (67.62)	10.33 (105.83)	2.74 (6.58)	5.08 (24.95)	5.35 (27.62)	2.62 (5.91)	6.11 (36.37)	5.94 (34.33)	2.57 (5.75)	6.87 (46.29)	8.66 (74.16)
SEm±	0.05	0.05	0.04	0.5	0.06	0.06	0.04	0.05	0.06	0.04	0.05	0.08
L.S.D (P=0.05)	0.15	0.14	0.11	0.16	0.20	0.18	0.14	0.15	0.18	0.13	0.16	0.24

Table 3: Effect of tillage and weed management on plant height, dry matter, leaf area, no. of grains per cob and 1000-grains weight (g) of maize in maize-wheat cropping system (Pooled data 2 years)

Treatment	Plant height (cm)			Dry matter (g)			Leaf area index			No. of grains/ cob	1000-grains wt. (g)
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest		
Tillage											
ZT pb ZT	54.33	115.11	186.45	4.00	43.06	110.89	0.52	2.94	2.84	210.95	163.11
ZT pb CT	55.165	116.28	187.00	4.12	44.06	113.72	0.54	2.95	2.94	212.00	164.28
CT pb ZT	56.89	118.5	189.39	5.56	50.56	123.55	0.57	3.01	3.44	215.23	167.28
CT pb CT	57.67	119.22	190.23	5.83	51.33	125.78	0.58	3.03	3.49	216.12	168.39
SEm±	0.62	0.485	0.70	0.37	0.72	0.64	0.01	0.02	0.03	0.38	0.54
L.S.D (p=0.05)	2.145	1.68	2.42	1.27	2.47	2.21	0.04	0.05	0.11	1.32	1.88
Weed management											
2 hand weeding	58.25	119.665	190.92	5.71	50.13	123.54	0.57	3.01	3.34	217.63	169.63
Atrazine 1.0 kg/ha	55.83	118.585	189.96	5.50	49.54	120.91	0.56	2.98	3.30	217.17	168.21
Weedy check	52.08	113.585	183.92	3.42	42.09	111	0.52	2.96	2.89	182.42	159.96
SEm±	0.48	0.475	0.50	0.43	0.52	1.11	0.01	0.01	0.02	0.45	0.61
L.S.D (p=0.05)	1.43	1.425	1.49	1.29	1.56	3.35	0.02	0.03	0.07	1.34	1.83

Table 4. Effect of tillage and weed management on grain yields, stover yield, harvest index and BC ratio of maize in maize-wheat cropping system (Pooled data 2 years)

Treatment	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)	B:C
Tillage				
ZT pb ZT	2864	8191	25.72	1.43
ZT pb CT	2972	8432	25.90	1.52
CT pb ZT	3311	9106	26.50	1.21
CT pb CT	3485	9478	26.72	1.32
SEm±	62	141	0.08	
L.S.D (p=0.05)	213	488	0.27	
Weed management				
2 hand weeding	3629	9792	26.97	1.23
Atrazine (1 kg/ha	3466	9490	26.69	1.82
Weedy check	2379	7124	24.98	1.06
SEm±	87	218	0.16	
L.S.D (p=0.05)	262	654	0.49	

was noticed in weedy check treatment. The increase were obviously owing to better weed control which rendered favourable conditions like increased availability of nutrients, moisture, light and other to crop plants, which resulted in better growth and higher yields (Jain *et al.,* 2007).

Zero tillage proceed by Conventional tillage (ZT pb CT) fetched the highest benefit: cost ratio which was followed by Zero tillage proceed by Zero tillage (ZT-ZT) proved better than rest of the tillage systems in maize crop of maize–wheat cropping systems. Application of recommended herbicides recorded the highest benefit cost ratio, which was higher over 2 hand-weedings and the weedy check. But highest benefit cost ratio in zero tillage was owing to less cost of cultivation in zero tillage system. Similar findings were reported by Stanzen *et al.* (2016a).

CONCLUSION

Based on the two years of study it is concluded that significantly higher maize yield could be realized when either both the crops are grown with conventional tillage viz. the usual farmer's practice or when the current crop is grown with conventional tillage which was preceded by the previous zero-tilled crop either with two hand weedings or herbicidal weed management (pre emergence 1 kg atrazine). However, it was found to be more economical with respect to B:C when the current crop was grown with zero tillage either preceded by zero or conventional tilled crop in combination with herbicidal weed management.

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Information Processing Behaviour of Rice Growers Under Seed Village Programme in District Baramulla (J&K)

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ABSTRACT

The current investigation of rice growers' information processing behaviour under the seed village programme was conducted in five purposively selected Sub Divisions of the Baramulla district and all have the Seed Village Programme in place for the rice crop. Data were personally collected by researcher through well structured interview schedule. The majority of rice growers in all five sub-divisions had a medium level of information processing behaviour, with the majority in sub-division Pattan (71.42%), followed by Rohamma (70.00%), Baramulla (69.87%), Sopore (68.14%) and sub-division Tangmarg (58.33%). However, rice growers from all five sub-divisions had a medium level of overall information processing behaviour (69.03%).

Keywords: Information, Processing, Behaviour, Rice, Growers

INTRODUCTION

Agriculture is the main source of income for the vast majority of people in most developing countries and it is essential for their economic progress. To boost agricultural production, a variety of data sources are required. Information is the process of exchanging/ transmitting news, views, information and so on in order to reach a common understanding (Sundar and Manjit, 2015). Rice is one of the world's most important food crops, with the second-largest acreage and production. It is consumed as a primary source of food by roughly half of the world's population. Around 11 per cent of the world's agricultural land is dedicated to it. Rice is grown and consumed all over Asia and Asia produces 90 per cent of the world's rice. One of India's most important grain crops is paddy (*Oryza sativa* L.). It has the world's largest land area (43.86 million ha) and in 2014-15, it produced 104.80 million tonnes, second only to China in terms of production.

In Jammu and Kashmir, rice was planted on 0.273 million hectares in 2017-18, yielding 6.641 lakh tonnes at an average yield of 24.27 qts/ha and on 1.35 lakh hectares in Kashmir valley, yielding 3.390 lakh tonnes at an average yield of 24.97 qts/ha (Anonymous, 2020). It signifies that there is a major difference that can be filled by increasing the yield potential of farmer's fields through the use of scientifically validated production technologies. Rice productivity will increase, providing regional food security. With this in mind, the current study was designed to look into the information processing habits of rice growers in the Seed Village Program in the Baramulla District (J&K). The way you think about things is one of the most important aspects of your personality (Ravi Goud and Daya Ram, 2018).

MATERIALS AND METHODS

Although observations had already occurred, the research design used in this study was ex-post-facto. The current study was carried out in the Baramulla district of Kashmir valleys, which was chosen for a seed village programme under rice from 2018 to 2020. There are six Agricultural Sub Divisions in District Baramulla, with five Agricultural Sub Divisions, namely Baramulla, Pattan, Sopore, Rohamma, and Tangmarg, selected from twelve agricultural zones in twenty-five villages. The Seed Village Program included a total of

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310 growers in the study. The information was gathered on a well-organized timetable and the results were analysed using percentages, frequencies, means and standard deviations. Growers' information processing behaviour comprised all behaviours related to data evaluation, storage and utilisation.

The rice farmers information processing behaviour was evaluated by asking them how they reacted to the information they were given. The categories "regularly," "occasionally," "rarely" and "never" were rated 3,2,1, and 0 on a four-point scale, respectively. The respondents were separated into groups based on their total scores.

Information processing behaviour	Score
Low information processing behaviour	Below Mean - SD
Medium information processing behaviour	Between Mean±SD
High information processing behaviour	Above Mean+SD

After combining all of the related response scores together, the final scores for information processing behaviour were determined. Based on their mean and standard deviation, the respondents were categorized into 3 groups.

RESULTS AND DISCUSSION

The majority of rice growers in the Pattan sub-division (71.42%) indicated a medium level of information processing behaviour, according to Table 1 and Figure 2. In 14.29 per cent and 14.29 per cent of rice growers, respectively, low and high levels of information processing behaviour were found. In the Sopore sub-division, 68.14 per cent of rice growers engaged in medium-level information processing, 17.78 per cent engaged in high-level information processing and just 14.08 per cent engaged in low-level information processing. More than half of the rice growers in Tangmarg sub-division (58.33%) had a medium level of information processing behaviour, with 25.00 percent having a high level and just 16.67 per cent having a low level. The majority of rice growers in the Baramulla sub-division (69.87%) had a medium level of information processing behaviour, 16.43 per cent had a high level of information processing behaviour and only 13.70 per cent had a low level of information processing behaviour. The majority of rice growers in the Rohamma sub-division (70.00%) revealed a medium level of information processing behaviour, while the remaining 15.00% revealed low

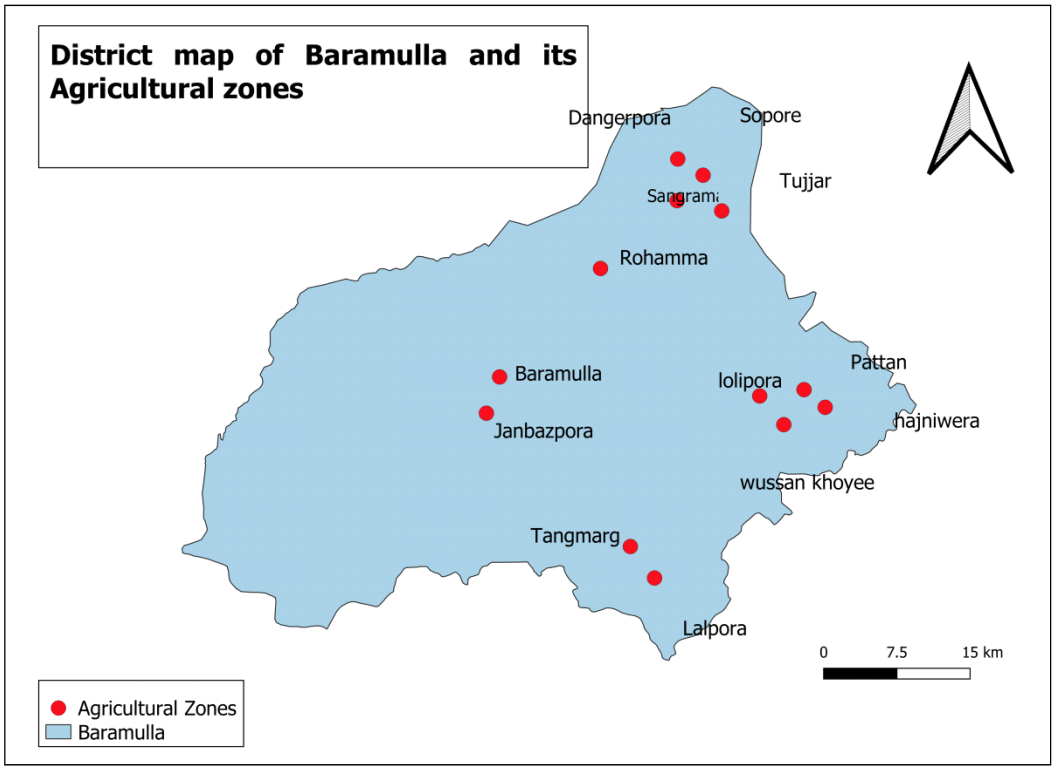

Figure 1: Map of district Baramulla

Table 1: Rice growers are divided into groups based according to how they process information.

Information processing behaviour	Sub-Division					*N*=310
	Pattan (n_1=70)	Sopore ($n_{2=135}$)	Tangmarg ($n_{3=12}$)	Baramulla ($n_{4=73}$)	Rohamma ($n_{5=20}$)	
Low	10 (14.29)	19 (14.08)	02 (16.67)	10 (13.70)	03 (15.00)	44 (14.19)
Medium	50 (71.42)	92 (68.14)	07 (58.33)	51 (69.87)	14 (70.00)	214 (69.03)
High	10 (14.29)	24 (17.78)	03 (25.00)	12 (16.43)	03 (15.00)	52 (16.78)
Mean±S.D	41.43±7.43	39.96±7.65	37.67±5.80	41.16±5.12	39.00±5.82	40.00±6.40
Observed Range	20-61	20-54	29-46	31-56	30-51	20-61

Figures within parenthesis indicate respective percentage

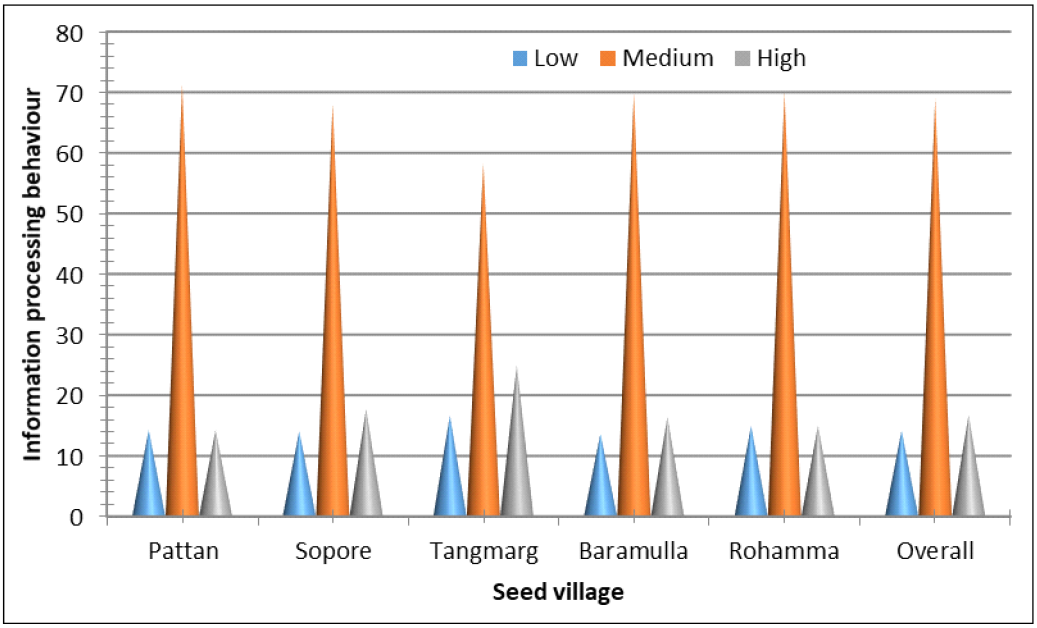

Figure 2: Information Processing Behaviour of rice growers under seed village programme

and high levels, respectively. When it came to overall information processing behaviour among rice growers across all five sub-divisions, the majority (69.03%) had a medium level, followed by 16.78 per cent that had a high level, and only 14.19 per cent that had a low level. This clearly suggests that the majority of growers process information at a medium level.

The pattern could be explained by the fact that when analysing information, respondents regularly analysed messages in light of their personal experiences and looked at the message's technological feasibility. The data was saved through saving and memorising a set of practises, as well as keeping track of technical exchanges with extension officials. Better education, better extension contact, a stronger commercial purpose and a stronger scientific orientation could all play a role. These findings are similar to those of Anwar (2016), Prashanth *et al.* (2012); Ravi Goud and Daya Ram (2018).

CONCLUSION

The findings revealed that the majority of rice growers weighed the messages in light of previous experiences, considered the technological feasibility of the messages and considered the economic and local feasibility of the messages for information evaluation, memorization and information storage package practises. The information is used by the majority of growers to plan the timing of sowing and seed treatment. Apart from that, respondents may be guided toward alternative information processing methods for analysing data on a variety of aspects in order to compare and process data for future use.

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Technological Status of Dairy Farmers Regarding Recommended Dairy Practices in Jabalpur District of Madhya Pradesh

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ABSTRACT

Dairy farming has the ability to provide additional income to people in rural areas, particularly landless agricultural labourers and small and marginal farmers with scarce resources. India had conducted pioneering research in the field of dairy farming. India has the world's largest livestock population. India is continued to remain the largest producer of milk in the world. The investigations took place in the Jabalpur district of Madhya Pradesh. There are 218 villages in the Panagar block of Jabalpur district, eight of which were chosen for having the most dairy farmers. 140 dairy farmers were chosen using a proportionate random sample approach. The results reported that maximum extent of adoption found in healthcare practices have ranked 1st with mean score value 43.00, followed by feeding practices and management practices have ranked 2nd with mean score value 32.00, management practices respectively. Minimum extent of adoption observed in breeding practices have ranked 3rd with mean score value 31.00 and breeding practices have ranked 4th with mean score value 27.00, respectively. Technological gap of 73.00 per cent was found in "breeding practices followed by feeding practices and management practices technological gap was 68.00 per cent and 69.00 per cent regarding recommended dairy practices respectively. Minimum 57.00 per cent technological gap was observed in healthcare practices. The family size, income of the family, land holding, herd size, milk production, milk consumption, milk sale, information seeking behaviour, extension participation, mass media exposure, economic motivation and risk orientation found to have positive and highly significantly correlated with technological gap. Further, remaining attributes of dairy farmers such as age, education and occupation did not establish significant relationship with technological status of dairy farmers regarding recommended dairy practices.

Keywords: Dairy farmers, Recommended dairy practices, Dairy animals, Technological gap

INTRODUCTION

Indian farming is an economic symbiosis between crop and animal husbandry. Dairying, a major constituent of animal husbandry, plays pivotal role in mixed farming of rural areas provides fourfold benefit of nutrition, employment, regular cash as well as draught power and organic manure. India is currently endowed with the largest livestock population 535.78 million in the world with cattle population (192.49 million) whereas buffalo population in the country is 109.85 million (20th livestock census 2018). The importance of dairy, as a subsidiary sector to agriculture, has stressed by the National commission on agriculture. The aim of the national dairy action plan is to improve organised milk yield handling from 20 per cent at present to 40 per cent in 2021-22. The milk handling by cooperatives has been targeted to increase from 10 per cent to 20 per cent and private sector from 10 per cent to 30 per cent.

MATERIALS AND METHODS

In the present research study, an exploratory social research design was utilized. The investigations took place in the Jabalpur district of Madhya Pradesh. In

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the state, the district is located between 23°.10' N latitude and 79°.59' E longitude. There are 218 villages in the Panagar block of Jabalpur district, eight of which were chosen for having the more number of dairy farmers. 140 dairy farmers were chosen using a proportionate random sample approach. A well-thought-out interview schedule was created ahead of time. Information was gathered through personal interviews. The data were analysed by using frequency, mean score and rank. Technological gap was operationalized as the difference between the extent to which the dairy farmers could use the dairy farming technology, if he desire and the actual use of technology.

It is seen from Table 1 that maximum extent of adoption found in healthcare practices have ranked 1st with mean score value 43.00, followed by feeding practices and management practices have ranked 2nd with mean score value 32.00, management practices respectively. Minimum extent of adoption observed in breeding practices have ranked 3rd with mean score value 31.00 and breeding practices have ranked 4th with mean score value 27.00. It is thus, clear that extent of adoption in respect of healthcare practices was more followed by feeding practices, management practices and breeding practices respectively.

RESULT AND DISCUSSION

It was clear from the Table 2 by considering four major practices among dairy farmers, viz; breeding, feeding, healthcare, and management practices of dairy animals. Table 2 and Figure 1 showed distribution of dairy farmers on the basis of technological gap; that maximum 73.00 per cent technological gap was found in "breeding practices" because they were unaware heifers/cow insemination and also unaware about the services to dairy animals 60–90 days postpartum. Minimum 57.00 per cent technological gap was observed in healthcare practices because they followed practices like segregation of animals at the time of the disease and regular Vaccination against diseases that are communicable, such as F.M.D. Rinderpest etc. Whereas in case of "feeding practices" and "management practices" technological gap was 68.00 per cent and

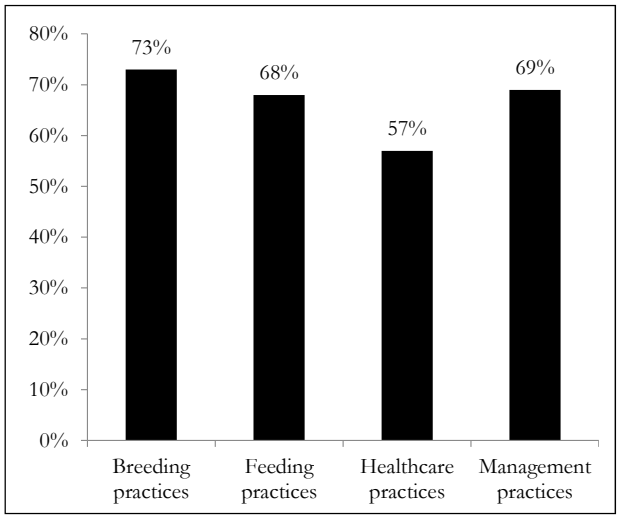

Figure 1: Distribution of dairy farmers on the basis of technological gap

Table 1: Dairy farmer's distribution based on their level of adoption of recommended dairy practises

S.No.	Different recommended dairy practices	Extent of adoption			Mean Score	Rank
		Complete (2)	Partial (1)	Nill (0)		
1.	Breeding Practices	05(3.57)	17(12.14)	118(84.28)	27.00	IV
2.	Feeding Practices	03(2.14)	26(18.57)	111(79.28)	32.00	II
3.	Healthcare Practices	06(4.28)	31(22.14)	103(73.57)	43.00	I
4.	Management Practices	03(2.14)	25(17.85)	112(80.00)	31.00	III

Table 2: Technological gap of dairy farmers regarding recommended dairy practices

S.No.	Different dairy practices	Extent of adoption	Technological gap	Rank
1.	Breeding practices	27.00	73.00	I
2.	Feeding practices	32.00	68.00	III
3.	Healthcare practices	43.00	57.00	IV
4.	Management practices	31.00	69.00	II

69.00 per cent regarding recommended dairy practices. Thus it is clear that the technological gap in respect of breeding practices was more followed by management practices, feeding practices and healthcare practices.

The perusal of data displayed in Table 3 clearly indicates that selected attributes of the dairy farmers viz., family size, Income of the family, land holding, herd size, milk production, milk consumption, milk sale, information seeking behaviour, extension participation, mass media exposure, economic motivation and risk orientation proven to have positive and significant relationship at 0.01 level of significance. Whereas scientific orientation and marketing orientation found to have significant and positive relationship at 0.05 level of significance.

Table 3: Relationship between independent variable and technological status of dairy farmers regarding recommended dairy practices

S.No.	Characteristics	Correlational (r-value)
Independent Variables (X)		
I.	**Socio-personal variables**	
1.	Age (X_1)	-0.05^{NS}
2.	Education (X_2)	-0.22^{NS}
3.	Occupation (X_3)	-0.15^{NS}
4.	Family Size (X_4)	0.54**
II.	**Economic variables**	
5.	Income of the Family (X_5)	0.09**
6.	Land Holding (X_6)	0.23**
7.	Herd Size (X_7)	0.29**
8.	Milk Production (X_8)	0.38**
9.	Milk Consumption (X_9)	0.46**
10.	Milk Sale (X_{10})	0.42**
III.	**Communicational variables**	
11.	Information Seeking Behaviour (X_{11})	0.43**
12.	Extension Participation (X_{12})	0.37**
13.	Mass Media Exposure (X_{13})	0.39**
IV.	**Psychological variables**	
14.	Marketing Orientation (X_{14})	0.32*
15.	Economic Motivation (X_{15})	0.44**
16.	Risk Orientation (X_{16})	0.47*
17.	Scientific Orientation(X_{17})	0.46**

Note: **Significant at 0.01 level of significance; * Significant at 0.05 level of significance; 'NS' indicates for non-significant

Therefore, the null hypothesis was proven to be untrue for these attributes of dairy farmers and concluded that these attributes were significantly correlated with technological status of dairy farmers regarding recommended dairy practices. Further, remaining attributes of dairy farmers such as age, education and occupation did not establish significant relationship with technological status of dairy farmers regarding recommended dairy practices. Hence the null hypothesis accepted with respect to these attributes such as age, education and occupation of the dairy farmers and concluded that these three attributes were not significantly correlated with technological status of dairy farmers regarding recommended dairy practices.

CONCLUSION

The extent of adoption in respect of healthcare practices was more followed by feeding practices, management practices and breeding practices respectively. The technological gap in respect of breeding practices was more followed by management practices, feeding practices and healthcare practices. It can be concluded from these findings that developing and executing appropriate transfer of technology programmes will certainly help in reducing technological gap. The causes responsible for these gaps need to be identified critically and appropriate measures need to be taken to enhance the adoption of recommended dairy practices for dairy farmers. It is essential for dairy farmers to follow scientific practises that will result in greater productivity at the lowest possible cost in order to make dairying a successful and sustainable business.

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Co-management in Pro-poor Aquaculture: Lesson Learnt from Cases in Eastern India

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ABSTRACT

Fisheries co-management secures sustainability of fisheries that also ensures food security of a wide range of stakeholders and eradicates poverty within the poorer section of people, who are basically the primary stakeholders. In this research article, five case studies have been discussed and analysed from the two states namely West Bengal and Tripura, where co-management approaches had been followed with different perspectives to achieve success in pro-poor aquaculture, addressing the issues of vulnerability to a greater extent. These five case studies have highlighted the success of the co-management approaches in pro-poor aquaculture system in five different contexts, namely Beel fishery system of large water body, Marketing of fish seeds, Small individual pond system, Reservoir fishery management and Management of Earthen Pots Makers Association for production of value-added dry fishes. All these five cases critically showed how these co-management pioneers devised their plans, executed those into action, and monitored and evaluated their work in transforming the pro-poor aquaculture.

Keywords: Case studies, Fisheries co-management, Pro-poor aquaculture

INTRODUCTION

Fisheries co-management is an increasingly globalized concept, and a cornerstone of the voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty (Tilley *et al.,* 2019). It can be defined as the sharing of responsibilities and/or authority between the government and local resource users to manage the fishery resource (Amarasinghe *et al.,* 2016). The philosophy behind co-management is that those who are affected by management (e.g., fishers and other resource users) should be involved in making management decisions, thereby improving the legitimacy of the states involvement in fisheries management through more inclusive and transparent decision-making processes (Tilley *et al.,* 2019). Institutional arrangements play a significant role in determining the efficiency and effectiveness of policy for co-management and it can be defined as the set of rights and rules by which a group of resource users and Government organize governance, management and use of resources in collective action situations (Tyagi *et al.*, 2015). When people are well connected in groups and networks, organizations, and when their knowledge is sought, incorporated and built upon during planning and implementation of conservation and development activities, then they are more likely to sustain stewardship and protection over the long-term consequences (Tyagi *et al.*, 2015). Co-management, has several advantages viz. more autonomy, true democracy, active participation, accountable and transparent resource management system; more economical than centralized management system, taking of responsibility by fishers for various managerial functions by active involvement in management; a sense of ownership etc. (Pomeroy, 1998). There is an increasing realization across the world that fisheries co-management/community-based fisheries management shall be considered as an effective alternative to address not only the present challenges

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but also to secure the future for fishing communities and the consumers, especially those who are poor and marginalized. Aquaculture basically seems to be a key player in poverty reduction as well as food security (Belton and Little, 2011).

Pro-poor aquaculture is attributed to multiple usages of the water bodies, higher number of users, improper management of the physical and biological resources, lower productivity and profitability, conflicts over rights and interests among the users, violation of safety norms that leads to threatening concerns for sustainability, and so on. It is cultured in backyard ponds and ditches, community water bodies such as oxbow lakes, canals, roadside ditches, drainage channels, check dams etc., whether they are perennial or seasonal that does not matter. These water resources, may it be manmade or natural, are the source of livelihood of wide range of stakeholders and the primary stakeholders are the poor (Toufique and Belton, 2014).

Co-management or participatory management, as defined above, has emerged as an effective approach in the domain of natural resource management all over the globe (Pomeroy, 1998) and, aquaculture is one of the subsidiaries of this system. To comprehend the process of co-management in pro-poor aquaculture by identifying the vulnerability arising in pro-poor aquaculture and strategies to cope up with it, recognising the factors influencing the management of common property regimes and finally preparing a conceptual framework of approaches and activities of adaptive management in pro-poor aquaculture. In this paper, five case studies have been discussed and analysed where co-management approaches were followed with different perspectives to achieve success in pro-poor aquaculture addressing the issues of vulnerability to a great extent. Cooperatives, Market Committees and Self-Help Groups/Informal User Groups showed the way how poor people can collaboratively resolve their problems, develop their plans, implement and monitor, and finally evaluate their work in the transformation of pro-poor aquaculture were described critically in these case studies. It has also highlighted and recognized the indigenous innovations made in the process and content of the programme.

MATERIALS AND METHODS

The case study method is basically a learning technique in which any particular problem or the case facilitates the exploration of a real issue within a defined context, using a variety of data sources. In general terms, the case study analyzes a defined problem consisting with a real situation and uses real information as methodological tool (Herrera *et al.,* 2016). In the present research the case study method was followed to understand the co-management approaches, being followed by different Cooperatives, Market Committees and Self-Help Groups/Informal User Groups in West Bengal (03 Cases) and Tripura (02 Cases) and ways of transforming pro-poor fisheries and aquaculture were described critically in these case studies. The cases were considered purely on a voluntary basis and their compliance with co-management approaches in fisheries and aquaculture. Figure 1 depicts the location from where the cases were covered.

RESULTS AND DISCUSSION

Case Study I:

Co-management of large water body through fishery cooperative for sustainable and equitable development: Mathura Beel is a large water body, stretching almost 8 km and touching two districts (Nadia and North 24 Parganas) of West Bengal, India. Previously it was a tributary of the Ganges; after its flow started to get blocked, the tributary gave rise to this ox-bow lake. After independence and the political divide of Bengal, a section of refugees from East Bengal started settling around the lake. A large proportion of them were fishermen by occupation. They used to poach in the lake for securing livelihoods. At that time, the lake was under the control of Department of Animal Husbandry, which was later transferred to the Fishery Department of the state. The Kanchrapara Refugee Fishermen's Co-operative Society Limited was founded in the year 1950 under the co-operative act operative at that period; the co-operative got the lake in lease from the Fishery Department. The co-operative started off with 340 members; later 165 members were included to it, resulting in strength of 505 members presently.

The society runs on the basis of West Bengal Cooperative Acts and Rules framed by the Government

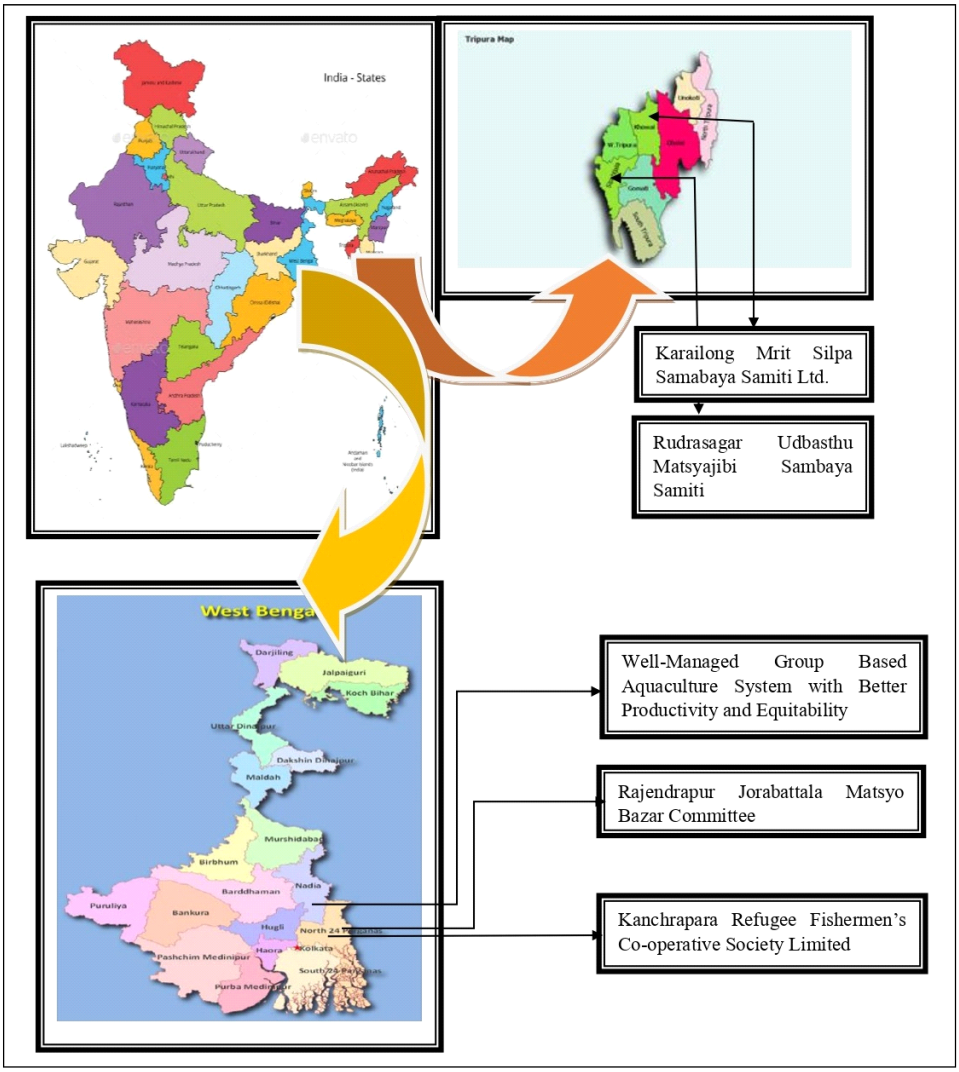

Figure 1: Location of the cases covered

as its core principle and developed its own by-laws as per provision in the said Act and Rules. It holds regular election for electing Board of Directors. Members and Secretary are elected while Chairman and some members are nominated from Government administration and Fishery Department as mediators within the Board of Directors.

In early years, members used to catch fish without replacing them with new fingerlings. The Ganges used to feed the lake in a manner that was sufficient to meet the need of fingerlings. From 1972, however, they started to release new fingerlings into the *Beel*. From the early 80's, the co-operative started to make huge profits out of selling fish. The co-operative, apart from abided by the rules and regulation of the Co-operative Act of the state, has formulated several by-laws matching the situational demands.

However, the profit margin has plunged in recent years. This may be attributed to the silt deposition of the lake, chemical pollutants leaching-in from the adjacent agricultural fields, depletion of water level (3-3.5 ft of average depth of water) due to the intensive cropping pattern in adjacent areas, increasingly depleting the water (Table 1), pollutants coming from railway residential and hospital complex etc.

Factors that influence the management of common property regimes: There are few factors, which influence the management of common property regimes. These factors are Resource Characteristics, Group Characteristics, Resource-Group Relationships, Rules or Institutions and Resource–Rule Relationships. A brief description in line with these factors is given in Table 2.

Table 1: The vulnerability context

Who	What	Effect	Extent of effect	Strategy to cope up with (in relation to the resource in question)
Head of the family	No land/water bodies	Could not cultivate/culture fish	High	Poaching in the water body
Family itself	Lack of other physical assets	Couldn't create asset/start entrepreneurship	High	Gathering and collecting
Male members of the family	Indiscriminate fishing in the water body	Quick depletion of natural resource	Moderate to high	Restrictions/norms for Rehabilitation in the embankment
Family itself	Social alienation	Lack of social capital beyond micro level, psychological setback as departed from motherland	High	Poaching in the water body
Family itself, especially women and children	Lack of scope for sustenance/choosing livelihood options	Food insecurity over the year	High	Formation of informal groups
The community	Settlers were not culturally homogeneous	Lack of cohesiveness within community, groups having vested interests	Moderate to high	

Table 2: Rules or Institutions and Resource–Rule Relationships

Resource character	Large sized (more than 7.5 km long with 280-hectare water body), low mobility, well-defined, water depth changes with season, trend of declining productivity due to pollution and inadequate management intervention.
Group character	Large sized (505 in number), only the family members of the cooperative forms group boundary, no one is allowed to join further.
Resource-group relation	Most of the members stay near the water body, their livelihoods almost completely depend on the lake, and the demand has been moderate for many years as reflected from the restriction maintained on fishing, now the improved standard of living is demanding more from the resource.
Rules	Different by-laws has been formulated and endorsed democratically through the general body meetings by the Board of Directors; these rules are easy to understand, written in local dialect and put before every members notice; the members themselves monitors these rules, the members have been assigned specific jobs in specific hours which is made open by notifications, the management committee is democratically elected and some members of the committee is/are nominated by the government (SDO, Zilla Meen adhikarik, Assistant Director of Fisheries, Kalyani Fish Farm).
Resource-rule relation	Restriction has been maintained on – amount of fishing, species-specific amount of fishing, the minimum weight restriction, restriction on catching fingerlings, restriction of time, restriction on type of nets used etc.

Concepts and approaches contributing to understanding and practicing co-management in Mathura Beel: Several concepts and approaches contribute to the understanding and practicing of co-management of natural resources. For the present case however, no single concept or approach stands fully exploratory. However, one can draw some of these concepts and approaches from all the followings:

- Adaptive management
- Pluralism
- Governance
- Patrimony
- Management of conflicts
- Social communication

Social communication: The society maintains intensive horizontal and vertical communication with the members of the society (Table 4).

The society keeps relation with diverse organisations, institutions and individuals for smooth functioning of the society itself. These include the grassroot level self-governing organisations at different strata (Gram Panchayat, Panchayat Samiti and Zila Parishad), the government administration of different departments at different level, the local branch of Sagar Grameen Bank, West Bengal University of Animal and Fishery Sciences etc. (Table 5).

Table 3: Concept, Approach and Activities of Adaptive Management

Concepts	Approach	Activities
Adaptive management	• Explicit Natural Resource Management (NRM) objectives and explicit hypotheses on how they are to be achieved (including monitoring indicators) • Prompt collection of data on the monitoring indicators • Ongoing evaluation of monitoring data and NRM results • Coherent changes in NRM practice in line with the results obtained and the lessons learned • Appraisal of the NRM situation and problems; generally, in workshops, with several institutional actors • Design of NRM activities; generally, in workshops, on the basis of a comparison of several possible options • Implementation of NRM activities closely following the chosen plan • Monitoring the achievement of the expected results on the basis of indicators drawn up for the expected changes • Evaluation of results to test the effectiveness of the activities implemented • Adjusting activities in line with lessons learned	• Keeping records of the catching of fish by the members over the years. Framing of by-laws as per situations • Testing of water qualities by State Department of Fisheries Scientists-members interactions, group meeting etc. for appraisal of the situation and future plan.
Pluralism	• Recognition that in any society there exist, various actors, interests, concerns and values	• Informal and formal meetings with the members open up multidimensional perspectives of the management of the water body to a great extent.
Governance	• Negotiation • Definition of long-term objectives • Joint selection of tools and establishment of management authorities • Evolution of jurisprudence and adaptation of the law (Including customary law) • Legal principles of reference	• Cooperative society is governed by acts and rules framed by Cooperative Directorate. By-laws can be developed for situation specific management. Board of directors of the cooperative society is elected as per act and rules in regular interval.
Patrimony	• Obligations of owner • Predestination of goods (obligation of use) • Value of use determined by passage of time • Constituent component of owner's identity	• Defined acceptable resource uses, as well as access and control; agreeing on tools, methods, responsibilities and needed technical support.
Management of conflict	• Taking care of disagreements before they generate hostility • Helping the institutional actors to explore a multiplicity of options for agreement and subsequently select an option everyone can live with • Recognising and intervening on the underlying causes of conflict, with a view to preventing them in the future	• Developing commonly agreed upon norms through consensus. • Strong accountability mechanism and transparency in benefit sharing by the members. • Inclusion of senior Government officer in board of Directors of the society who often act as mediator/ facilitator.
Social communication	• Involves exchanging messages (communicating) to create meaning and enrich common knowledge, often in order to face change	• Annual general body meeting, Notification, Mike campaign, Informal meeting, publication etc.

Box 1. By-laws formulated and endorsed by the society regarding catching of fish

Fish weighing between 200 g and 1 kg up to 7 kg @ Rs. 16/- per kg (Rs. 10/- per kg for dead fish)

Catla should be >500g in weight

Silver carp, American rohu and Grass carp weighing >1kg (total 6, two each) @ Rs. 12/- per kg (Rs. 7/- per kg for dead fish)

Any fish 1-2 kg up to 2 in no. @ Rs. 18/- per kg (Rs. 12/- per kg for dead fish)

Any fish >2 kg up to 2 in no. @ Rs. 20/- per kg (Rs. 14/- per kg for dead fish)

For catching filing Rs. 4/- per 200g (for **prawn** Rs. 2/- and for Tangra Rs. 8/-) will have to be given to the society

Fish captured in excess to it will be ceased

Fish can be captured only between 11 p.m. to 6 a.m.

10 men group are proposed by the fish catchers and got endorsed by the society

The member's quota of fish who is working as watchman in night will be captured and sold by the group members

Members will prepare and maintain nursery in addition to keeping watch in return of the increase in commission (Rs. 4/- per kg of captured fish)

Members will be given 2 lit of kerosene per family per month

Society will also provide the members with dry battery for torch

Table 4: Forms of Communication, Frequency and Purposes

Form of communication	Frequency	Purpose
Annual general body meeting	Annually	Accounts, future plans, amendments of rules and regulations
General body meeting	Monthly	Discussion on problems, solutions
Special general body meeting	As and when required	Resolving contingency
Notification	As and when required	Keep members informed regarding by-laws, date and time of fishing/watching for particular group, market responsibilities of members, informing date and time of meeting and fringe benefits
Mike campaign	Weekly	Informing date and time of meeting
Informal meeting	As and when required	Awareness
Publication (Secretarial Commentary)	Annually	Statement of demands for previous financial year, planning for next year, budget of the co-operative

Table 5: Sources of Income and Expenditure Pattern of the Cooperative Society

Sources of income	Major expenditures
Selling of inland major carps (200 gram to 1 kg) Selling of inland major carps (more than 1 kg) Token collection for fishing permission Selling of self-recruiting fish Selling small sized fish and fingerlings	• Purchase of small fingerlings • Commission to the fish catchers • Fingerling production • Remittances to bank loan • Dividend to the members • Tax • Salary of staffs, overtime, bonus etc.

Box 2. Fringe benefit shared by the society

Providing assistance to one family member to continue lifelong study unless failed in any academic session (books are purchased by the society which has to be returned after the student has passed successfully)

Providing treatment cost to the member felling ill due to hard work/accident/otherwise especially during the work as watchman at night

Donation of Rs. 500/- for crematorium if any member expires

SWOT analysis of the society: Strength, Weakness, Opportunity and Threats of the society were assessed by using participatory SWOT analysis. The outcome was self-explanatory and presented below:

Strength	Weakness	Opportunity	Threat
Sufficient resource base (the water body, land) Decent infrastructure (co-operative building, school building) Rich knowledge, experience and skill of members regarding fishing activities Cultural compatibility Effective linkage with nominated members/ Govt. functionaries Conscious members about the rights and privileges	Large area with low protection Lack of up-to-date knowledge regarding natural resource management in general and fishery in particular Absence of women involvement Members are from two adjacent villages; few or no member from other villages by the water body High population pressure over the water bodies Contamination from urban population Weak monitoring of the natural resources in terms of biophysical indicators	Diversification of resource utilisation through promotion of tourism De-siltation of the water body Providing more fringe benefits to the members Biodiversity conservation Promotion of membership among the settlers around the water body Capacity building of the members of the society in terms of monitoring and management of natural resources.	Flood Increasing population Chemical based agriculture adjacent to the water body High cropping intensity depending on irrigation through ground water sources depleting depth of water table Tension created by the politically motivated vested interest groups within the society.

Problems faced by the society: Although the Cooperative is trying hard to resolve the problems within and beyond, still a handful number of problems stand in the way of harvesting its fullest potential (Table 6).

Case Study II:

Co-management initiatives in marketing of fish seeds through market committees: Hatchery enterprise came into prominence in and around Naihati, a small town of North 24 Parganas, District of West Bengal, India in late 1980s. Initially it was some big farmers who were the pioneer in establishing hatcheries of some Indian and exotic carps after being trained by governmental institutes. Their success in terms of technical adaptation and profit generations motivated a large number of medium and small entrepreneurs to join in this endeavour. Very shortly a good number of hatchery entrepreneurs of large, medium and small sized system with different forms of refinements in respects of models and processes were emerged in the adjacent areas of this epicentre. Their combined efforts created a unique space in fish seed production in the national scenario and the state West Bengal itself got the top position over the past decades. In spite of their excellent performance, efforts were private lacking govt. support in respect of technology dissemination, monitoring of qualities and creation of marketing infrastructure. Even the landless and pondless individuals in this locality made them involved in this business by utilizing roadside ditches as their stocking pond for carrying out fish fingerling marketing.

Over the initial years the market was individualistic and the buyer had to reach the growers by themselves and the marketing system was disorganised with middlemen. The product itself suffered set back due

Table 6: Problems Faced by the Cooperative Society

Biophysical problems	Socio-economic problems
Increased siltation and decrease in depth of water Decreasing productivity of fish Pollution from the agricultural lands, residential complexes Depletion of water level due to high cropping intensity around	• Problem of poaching • Conflict among the political factions within the members • Problem of resource maintenance in areas far away from the home of the members • Conflict with the non-member settlers by the side of the water body increasingly claiming stake/share of benefit

to faulty packaging, poor transport services and the growers and the buyers were occasionally exploited in terms of quality, quantity and value due to lack of transparency and specific norms in the marketing system. This backdrop led the growers and the businessman to establish a marketing committee named Rajendrapur Jorabattala Matsyo Bazar Committee with the participation of all the growers and the stock keepers as member of the society. It had created a market place over an acre of open space in prominent location donated by a member. It also built an office building along with rest rooms, medical rooms, and public toilets. The marketing society has presently an enrolment of 650 members in its fold who strictly followed the norms generated out of consensus in the meeting and the norms are:-

- Yearly donation of Rs. 200/-
- Use of standardise measuring system for selling
- Maintenance of proper time of selling
- Fine for irregularities related to offering faulty weight and cheating of customers.

Each and every member enjoys free medical check-ups, access to free toilets, rest room, ambulance facilities. Market committee also monitor pricing of fish seeds over the years. It resolves conflict within the members, and member and clients too.

Case Study III:

Co-management transformed individual inefficient aquaculture system into well-managed group based system with better productivity and equitability: Dakshin Panchpota is a small village of Chakdah Block, West Bengal, India. It is around 65 km away from Kolkata. A total number of 252 families reside in this village. They had migrated from Bangladesh after India's Independence in 1947. The village, erstwhile a low-lying area was later transformed into homestead areas of higher elevation through land shaping activities and the outcome was generation of a good number of domestic ponds around the households. There are 52 ponds out of 252 households and the area of these ponds ranging from 2 to 24 decimal. The average water area is around 6 decimals. Out of 52 ponds, 31 ponds belong to socio-economically backward households.

The aquaculture system prevailing in those 31 ponds was observed precisely and information pertaining to their management was collected from each of the households. The exercise revealed that the pond is basically used for number of domestic purposes like washing, bathing, irrigation etc. and it was under managed as no effort for maintaining of water quality, stocking ratio and density, embank management, fertilizer and manure application had ever been made by the pond owners. The water is rich in organic matter and the owners neglected the ponds, as they had no idea about the economic viability of the water bodies in terms of appropriate aquaculture.

The owners were used to depend on self-recruited fishes mostly and occasionally they grow Indian carps without maintaining the ratio and stocking density. Subsequently, they get poor harvest at the end of the year and the system remains unproductive over the past decades.

When Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Vishwavidyalaya (BCKV) adopted a capacity building initiative with group approach, the facilitator team of scientists faced resistance from the local growers, as the concept of co-management is rather new to them. They have conflicts over the usage of ponds within and beyond the households and were easy prey of the fish fingerling vendors who used to sell poor quality of fish seeds. The capacity building initiative had exposed them to the scientific aquaculture system with the help of proper pond management, identification and purchase of proper fish fingerlings, intercultural operations and marketing. On the other hand, they were offered training on self-help group formation and management for better access to credit and information in respect of purchasing critical inputs like fish fingerlings, fertiliser and manures, net, medicines, etc. on group basis. The groups are linked with the government, departmental machineries in getting policy and project support.

The overall initiatives transform the socio-economically backward pond-owners into self-reliant manager of their aquaculture system with the help of information, credit and programme support to a great extent and the approach of mobilising the individual pond owner in forming and maintaining SHG acted as pivotal factor in the whole process.

Case Study IV:

Co-management initiatives in Rudrasagar lake area by Rudrasagar Udbasthu Matsyajibi Sambaya Samiti: Rudrasagar Lake, located in Melaghar block, Tripura, India, has been identified as one of the wetlands of national importance for conservation and sustainable use, based on its bio-diversity and socioeconomic importance by the Ministry of Environment and Forest, Government of India. A large proportion of the population that resides in this locality is associated with *Rudrasagar Udbasthu Matsyajibi Sambaya Samiti* for their livelihood. This co-operative initiative has started its journey in 1951 with 6 hundred members and a per capita share of 15 rupees in a year, which eventually turned into 2 thousand members and per capita 15 hundred to 20 hundred rupees in a year respectively. Deboprasad Choudhury, Sunatan Das, Upendra Das etc. were the founder members of the society. Among them Mr. Choudhury was the Government administrator, Mr. Das was the president and Mr. Upendra Das was the secretary of that newly formed samiti in 1951. They formed the samiti in 1951 with a drive to ensure livelihood generation for the people of the area as it was very hard to find suitable livelihood options.

After that they realized that use of Rudhrasagar lake area properly can generate livelihood for them. The whole area is divided among the 600 members of that samiti and each one got around 7 to 8 khani(*) land area to cultivate rice during winter season and fish culture during rainy reason, thus they started generating revenue for their livelihood. The samiti is trying to generate revenue being involved in multifarious activities to help the farmers of Rudrasagar area. Among those activities few important ones are (1) Giving lease of agricultural land where about 5200 khani (1 ha=6.2* khani) area is divided into 40 to 50 plots and given to the interested farmers by auction process and total revenue generated from that area is around 40 lakhs rupees per year. (2) Giving 1 day ticket to the fish farmers for catching fish from the rudrasagar lake for their daily livelihood generation and revenue generated from this aspect is around 3 thousand rupees per week. (3) Giving lease of market shops in the Samiti's markets named *Ananda Bazaar-Melaghar Market-1*, *Ananda Bazaar-Melaghar Market-2* and *Melaghar Jute Market* and revenue from each market is 80 thousand, 4 to 5 thousand and 5 to 6 thousand respectively. (4) Revenue generated from *Neermahal, Melaghar Tourism* unit by running small boat service to the Neermahal Palace for the tourist at a cost of 50 rupees per head and in the period between December and January revenue generation from that tourism unit touches its peak by giving picnic spots to the tourist and the earning is around 30 thousand to 40 thousand per month. Other than these months, revenue generation in remaining months is around 3 to 6 thousand. Samiti has 50 numbers of permanent employees to look after the various on-going activities under its purview. These employees are deployed in various unit of that samiti like in main office, market units, tourist unit etc. Salary of these employees ranges from 5 thousand to 7.5 thousand per month.

Towards development, the Samiti does a lot of works, like (1) distribution of clothes to the poorer family of that Melaghar area during Durga puja every year (2) providing financial assistance to the poorer families which had gone through any accidental death or alike misery to bear with the distressed condition (3) extending overall help to the students of needy families for pursuing higher education (4) motivating the meritorious students by giving 2 thousand rupees and memento as a token of appreciation to the students who have secured 60 percentage and above in their respective board exams of 10^{th} and 12^{th}, (5) providing health assistance to the members of Samiti etc.

Under the Blue Revolution scheme, fish farmers cum members of this Samiti, 30 houses were sanctioned in past 2 years, which were allocated equally in 3 panchayats of that *Melaghar* block namely, *Kemtaly, Poangbari* and *Chandanmura Panchayat* and each beneficiary received 1.30 lakhs rupees per unit of house. Apart from this, the farmers received financial aid of 60 thousand rupees from the Department of Fisheries, Govt. of Tripura to purchase 1 net, 1 boat and 1 ice box for each. Apart from these, Department of Fisheries of Rudrasagar provided 17.5 thousand *Pabda* seed, 17 thousand *Shingi* seed and 7 to 8 lakhs Indian Major Carps (IMC) seeds to the farmers for culture.

Case Study V:

Co-management initiative in Karailong Kumbhakar (earthen pots maker) community by Karailong Mritsilpa Samabaya Samiti Ltd.: Karailong, a small hamlet of Tripura, is maintaining its distinct existence and serenity along with its residents

at about 45 km far from Agartala, the state capital. A large proportion of the villagers belong to *Kumbhakar* (earthen-pot makers) family, who have their livelihood through making earthen *matka* (earthen pot) for shidal and subsequently marketing those products in whole Tripura and also outside of the cities like Silchar, Guwahati etc. This whole process gets an overall assistance from a local cooperative society named *Karailong Mritsilpa Samabaya Samiti* Ltd., which is located at Teliamura block, Khowai district of Tripura. This co-operative had started its official journey in 1985 with only nine *Kumbhakar* families with a per capita share of 12 rupees/year, which has been eventually turned into thirteen families and 120 rupees per capita/year respectively. Some eminent personalities have paved the pathway of this initiative namely, Sri Nitinja Bihari Rudra Paul, Smt. Laxmi Rudra Paul, Sri Bihari Rudra Paul, Sri Jagadish Rudra Paul. These pioneers had started to ponder their efforts since 1968, a long way back from the official registration of the *samity* in 1985. In those initial days of the co-operative, when *kumbhakar* community used to face a lot of difficulties in their work starting from the very first step of arranging clay for *matka* making, and then subsequently in receiving order of *matka*, fixation of price, collection of money from market, and even in the last step of distributing the money to the *matka* makers, those persons supported the community. Further, it was felt that the involvement of Government as one of stakeholders in this initiative might ameliorate the functioning of this Smaity. For timely availability of quality clay, inclusion of a section of stakeholder, involved in supply of clay, was also thought of.

Now the scenario has changed in all aspects. The price of one shidal *matka* in 1968 was 1.25 rupees which has reached to 215 rupees per *matka*. Samiti is no longer charging any commission alike the yesteryears when two rupees was used to be charged per *matka* for maintaining multifarious dimensions. Samiti is nowadays having a stable financial condition with a revolving fund of 10 to 15 lakhs rupees for smooth maintenance of the works.

As per the structure of managing committee of the Samiti, there is a provision of one President, one Secretary, one Vice-Secretary, and one Cashier to look after the various on-going activities under its purview. Amongst these positions, only the cashier is a salaried post, who gets a monthly remuneration of 7000 rupees and also takes care of the important works like, accepting order from the market, collecting cash from the market, distributing cash to the *matka* makers and most importantly maintaining all financial records and subsequently presenting those in front of members while discussing in the monthly meeting, usually held during 17th or 18th day of every month.

Every decision is taken on the basis of consensus of every stakeholder in the meeting, be it weekly money collection and distribution, getting new order of *matka* or any seriously challenging issues like Purchasing of clay for making *matka* as this process requires a specific kind of clay. Unitedly Samiti has been able to overcome the adversities so far and to get rid of the specific hurdle of getting quality clay. Samiti has already made its plan and accordingly it has been purchasing clay for the past three years which costs 7 lakh rupees in total and moreover as per altruism investment was done by Samiti itself and later on money was collected from the *matka* makers only after they are able to sell those products within a stipulated span of maximum two years.

Towards the development of the village, the Samiti does a lot of social works, like (1) providing financial assistance to needy families who sought for help after assessing the condition of that family and as per the decision of managing committee (2) conducting social awareness campaign in issues like family planning programme, combat HIV/AIDS disease and etc. in collaboration with the Government. (3) arranging cultural event like *Sanskrit Sandhya Anushtaan* at the village every year (4) celebrating religious events like *Biswakarma puja* (5) helping poorer family to arrange marriage ceremony, funerals or serious medical issues (Table 7).

CONCLUSION

The concept of community-based co-management has gained acceptance among governments, development agencies and development practitioners as an alternative fisheries management strategy to the top-down, centralized government approach to fisheries management. However, co-management may not be an appropriate alternative management strategy for every community or area. The five case studies highlighted the success of the co-management

Table 7: Compliance to different attributes of Co-management

S.No.	Attributes of Co-Management	Kanchrapara Refugee Fishermen's Co-operative Society Limited (Case Study-I)	Rajendrapur Jorabattala Matsyo Bazar Committee (Case Study-II)	Well-Managed Group Based Aquaculture System with Better Productivity and Equitability at Dakshin Panchpota village of Chakdah Block, West Bengal (Case Study-III)	Rudrasagar Udbasthu Matsyajibi Sambaya Samiti (Case Study-IV)	Karailong Mrit Silpa Samabaya Samiti Ltd. (Case Study-V)
1.	Sharing authority and responsibility	The members of Kanchrapara Refugee Fishermen's community, who lived around Mathura Lake/Bill have started sharing authority and responsibility since a long way back in 1950 with 340 members; which eventually turned into 505 members and all are involved in managing of fishery resources in Mathura Lake.	Some major backdrops related to fishery activities led the growers and the businessmen to establish a marketing committee named *Rajendrapur Jorabattala Matsyo Bazar Committee* with the participation of all the growers and the shop-keepers as members of the society. The marketing society has presently an enrolment of 650 members and all shareholder are having equal authority and responsibility towards that and currently they are sharing Rs. 200 per annum. They were gathered to face the problems like set back of Fish fingerling due to faulty packaging, poor transport services and the growers and the buyers were occasionally exploited in terms of quality, quantity and value due to lack of transparency and specific norms in the marketing system.	*Dakshin Panchpota* is a small village of Chakdah Block, West Bengal, India. There are 52 ponds and 252 households and the area of these ponds are ranging from 2 to 24 decimal. The owners were used to depend on self-recruited fishes mostly and occasionally they grow Indian Major Carps without proper maintaining of the ponds and eventually they get a poor harvest at the end of the year. With the help of Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Vishwavidyalaya individual pond owner adopted group-based co-management approach to manage the water bodies, although the facilitator team of scientists faced resistance from the local growers, as the concept of co-management has been rather new to them.	Fisherman community people who lived around in Rudrasagar lake has started sharing authority and responsibility since a long way back in 1951 with 6 hundred members and a per capita share of 15 rupees in a year, which eventually turned into 2 thousand members and per capita share of 15 hundred to 20 hundred rupees in a year respectively to manage fishery in Rudrasagar Lake.	Karailong Kumbhakar (earthen pots maker) community people has started sharing authority and responsibility in since 1985 (on paper) with 9 numbers of Kumbhakar family and per capita share of 12 rupees in a year which eventually turned into13 number of Kumbhakar family and per capita share is 120 rupees in a year to manage and running the earthen pots maker business smoothly.
2.	Participation	Co-operative members are actively participating for electing Board of Directors in regular basis to manage and look after the administration of	*Rajendrapur Jorabattala Matsyo Bazar* ensures participation of all the growers and the shop keepers as members of the society and involves them in	Participation of the members has been the key feature for the success of any adopted management approach and in this regards	Regarding formal participation, *Rudrasagar Udbasthu Matsyajibi Sambaya Samiti* used to conduct general meeting	Karailong mritsilpa samabaya samiti Ltd. use to conduct regular meeting in every month and also ensure everyones, presence which plays a crucial role in terms of

Table 7 contd....

		the Co-operative society. Different laws have been formulated and endorsed democratically through the general body meetings by the Board of Directors; these rules are easy to understand, written in local dialect and put before all member; the members themselves monitor these rules.	any decision-making process, may it be improvement of seed transfer facility or maintaining the transparency among the members of the society.	co-management is not an exception. With the participation of the members, poor individual and inefficient aquaculture system got transformed into a well-managed group-based system with better productivity and equitability.	once in every month and they used to discuss the issues faced by the fisherman community people in general and also, they ensure every members' participation in every sort of activities of the samiti.	formal participation of the member. They discuss mostly how the business is going on and if there is any problem, how to get rid of it. Apart from all these informal participation holds the warmth of relationship within the members in all the occasions.
3.	More social sanction than legal sanction	Most of the members stay near the water body, their livelihoods are almost completely dependent on the lake. Poaching in the water body was the main problem and they realized that legal section can't help much in that so they imposed few restrictions, maintained a system of fishing with consent from all the members, which has improved standard of living to a certain extent while demanding more from the resource.	This committee shows a humane approach towards its members by adopting a friendly strategy related to the process. Committee self monitors pricing of fish seeds over the years. Use of standard measuring system for selling and maintenance of proper time of selling was adopted. It has resolved the conflict within the members and in between the member and the clients too.	Whatever conflicts this farming group has faced was redressed by themselves. They usually discuss the issue with all the members and eventually come up with the most acceptable approach. For an example, conflicts over the usage of ponds within and beyond the households was sorted out with this approach.	The samiti is very keen on being indulged into social issues and on extending their hand in bottleneck situations faced by any of the members may it be need of financial assistance for proper winter clothing, daughters' marriage, providing higher education to children, or medical issues. Moreover, these are sorted out by the samiti itself without looking for outside helps.	This group shows a humane approach towards its members by adopting a friendly strategy related to the process. The biggest issue faced by the samiti in every year while purchasing the particular type of clay for making matka. Initially the money was given by the samiti and later on that is collected from the matka makers. Samiti give a specific time around 1-2 years to the matka makers to return that money to the samiti so that samiti can use that money for further purchasing the clay for the future occasions. In this way, matka makers are dependent on samiti over any other financial institution.
4.	Dependence on Fisheries and allied activities	Maximum people of the *Kanchrapara Refugee Fishermen's Community* are fishermen and their livelihood depends on that Mathura Lake/bill which is open fisheries zone. Culturing and capturing of fish from that lake are the main activities which ensure their livelihood.	All the fish seed growers and the businessmen involved in the *Rajendrapur Jorabattala Matsyo Bazar Committe*e depend on the marketing of fish seed to ensure their livelihoods.	All the members of this group are dependent on fisheries and the capacity building initiatives has exposed them to the scientific aquaculture system with the help of proper pond management, identification and purchase of quality fish fingerlings, intercultural operations and marketing. To realize their needs of	Maximum people of the samiti are fisherman and their livelihood depends on the Rudrasagar Lake which is open fisheries zone. Culturing and capturing of fish from that lake are the main activity which ensure their livelihood.	All the people belong to that Karailong Kumbhakar (earthen pots maker) community are predominantly relied on matka making for their livelihood. Matka making and its marketing is the main activity to ensure their livelihood.

Table 7 contd....

				Fisheries, they were trained on self-help group formation and management for better access to credit and information in respect to purchase of critical inputs like fish fingerlings, fertilizer and manures, net, medicines, etc. on group basis.		
5.	Common resource users	Mathura bill, a large water body stretching almost 8 km and touching two districts (Nadia and North 24 Parganas) of West Bengal, is an open fisheries resource and all the people of *Kanchrapara Refugee Fishermen's* community are dependent on it by catching fishes from that lake which ensure their livelihood.	Each and every member of the *Rajendrapur Jorabattala Matsyo Bazar Committee* enjoys common resources/utility services like free medical check-up facilities, access to free toilets, rest room, ambulance facilities etc.	With the help of Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya individual pond owner adopts group-based co-management approach to manage the water bodies. As group is a collective unit, all the members of the group use common resource and they also depend on that particular resource for their livelihood.	Rudrasagar lake, located in Melaghar, Tripura which is basically an open fishery resource and everyone of that community is using this lake as their earning source.	Mostly the people belong to that Karailong Kumbhakar (earthen pots maker) community use common resource and mostly perform same functions *i.e.,* purchasing of clay for matka making and selling of matka in market.
6.	Homogeneity of resource users	A bias-free atmosphere is maintained where homogeneity prevails at its best in all the activities of the community, it may be regulation on catching fingerlings, restriction of time of fishing, restriction on usage of typical nets etc.	A free atmosphere is maintained where people of the community feel homogeneity in terms of getting equal chance of being trained by governmental institutes to know how to run the hatcheries of Indian and exotic carp, adaptation of technical equipments and how to use it for maximum profit generations. This Rajendrapur Jorabattala Matsyo Bazar Committee ensure equal participation of all the growers and the stock keepers as member of the society in all types of decision-making process.	All the members of the group are treated equally in terms of access to the resources, to the contributed money for maintenance purpose, distribution of profits etc. and that equality approach creates a sense of belongingness and ownership in the group.	All the resource users are mandatorily registered to the samiti and they have to abide by the same process for using that resource. A bias free atmosphere is maintained where homogeneity prevails at its best in every activity of samiti may it be catching fish at lake, providing lease of market shops or agricultural lands to member farmers or samiti-led auction process.	All the resource users are registered to the samiti and they used to go through the same processes for using the resources like clay distribution, matka distribution for selling, contribution to the samiti for its smooth running etc. and in each sphere, equality is must that is to be maintained for obvious.

Table 7 contd....

7.	Competing resource users with other stakeholders	Mathura bill is an attractive place for spectators because of the natural view of that place thus it seems to be competitive with the tourism industry. It has also invited conflicts among the political factions within the members and non-member settlers by the side of the water body who are claiming stake/ share of benefit in enhanced rate.	*Rajendrapur Jorabattala Matsyo Bazar* is a marketing Committee of fish seed so it may compete with the other fish seed suppliers or any other supply agencies in West Bengal.	This group may compete with the other well-managed fisheries stakeholders in the same area as they have to deal with same process for purchasing of quality fish seed, marketing of harvested fishes etc.	Being a very attractive place for spectators because of the presence of Neermahal palace and the natural view of that place, Rudrasagar Lake is an important destiny for tourism. Therefore, conflicts between the tourism industry and Fisheries are common but samiti use to maintain and manage the issues with utmost care.	Clay is generally collected from agricultural land for matka making therefore, conflicts between Kumbhakar (earthen pots maker) community and agricultural community are seen and gradually it is leading towards the increase in price of clay for the Kumbhakar community people.
8.	Access rights	Although Mathura bill is an open fisheries resource and for management of that resource restriction has been imposed on quantity of fishing, species-specific quantity of harvesting, the minimum weight restriction, restriction on catching fingerlings, restriction on time of fishing, restriction on type of nets used etc.	Some of the facilities provided by the *Rajendrapur Jorabattala Matsyo Bazar Committee* can only be accessed by the members only like free medical checkups, rest room facilities, and even using toilets etc.	As individual pond owner adopts group-based co-management approach to manage their water bodies so only owner can use their water bodies. Outsiders may access the same with prior permission.	Although Rudrasagarlake is an open fisheries resource but for using this resource fisherman of that area need to take permission from the samiti as a form of ticket, without that no one is permitted to access this resource. And in terms of accessibility no biasness is there.	The purchased clay can only be used by the Kumbhakar community people for their matka making. If any one wants to use that resource, they have to take permission from the samiti, and have to share some contribution to use the clay for their work.

approaches in pro-poor aquaculture system in five different contexts, namely Beel fishery system of large water body, marketing of fish seeds, small individual pond system, Reservoir fishery management and management of Earthen Pots Makers Association for production of value-added dry fishes. Each of the situation resorted participatory management as core principle for mitigating vulnerability in its own way whether formally or informally. For the first example, dimensions of co-management are prominent due to the fact that they had tried it over decades with different modifications and experimentations and for the two latter cases they are relatively newer in the process, but the outcomes are encouraging for all the cases. In the past, many traditional societies formed relatively closed systems in which natural resources were managed through complex interplays of reciprocities and solidarities. These systems were fully embedded into local cultures and accommodated for differences of power and roles (including decision-making) within holistic systems of reality and meaning. Dialogues and discussions among interested parties on the basis of field experience (presently termed as co-management) were widely practiced in some of these societies and these were made evident from two case studies of Tripura. Common property is available in many localities, and that constitutes a crucial element in the cohesion and sustainability of traditional aquaculture systems mostly. Local knowledge and skills, developed through experiences gained overtime, was another contributory factor. Most importantly, local communities ten ded to *create themselves* around a body of natural resources that they could manage together for their well being. In some societies characterised by large power disparities, the recent development of democratic systems and the state of law allowed a number of social movements, unions, consumer and minority groups to adopt a transparent and accountable mechanism of management, sometimes even in an overtly legal manner. In others, the conditions for this to happen require a gestation period to wait. All these cases may act as food for thought for the policy makers, extension personnel, donors and other stakeholders for mainstreaming elements of co-management in aquaculture for the poor in days to come.

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Agrobacterium-mediated Transformation and Regeneration of Transformants of *Brassica juncea*

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ABSTRACT

A protocol for *Agrobacterium*-mediated genetic transformation was developed using hypocotyl and cotyledonary leaves of *Brassica juncea* varieties RSPR 01 and Varuna. *Agrobacterium* strain LBA4404 used in the study contained a binary plasmid pBI121 having nptII and GUS as marker gene and reporter gene, respectively. In order to optimize parameters that influence transformation efficiency, the explants of both varieties were suspended in bacterial suspension for 20 minutes and inoculated on MS medium (Murashige and Skoog, 1962) supplemented with growth regulators and antibiotics for selection of transformants. Maximum transformation was achieved when the explants were immersed in bacterial suspension having an OD of 0.6 at 600 nm and co-cultivated for 48 hrs. Optimum concentration of kanamycin for selection of transformants was 25 mg/l. Putative transformants were confirmed by histochemical GUS assay. It was observed that hypocotyls displayed better transformation efficiency in comparison to cotyledons. Regeneration of plantlets from transformed calli of Varuna was obtained after 1 month of culture on MS medium augmented with BAP (4 mg/l) and NAA (0.5 mg/l). It was concluded that RSPR-01 showed higher transformation efficiency while Varuna had higher regeneration response.

Keywords: *Brassica juncea*, *Agrobacterium tumefaciens*, Genetic transformation, GUS, Kanamycin resistance

INTRODUCTION

Brassica juncea (L.) also known as Indian mustard is one of the most economically important species of genus *Brassica* (Farzinebrahimi *et al.,* 2012) and is a source of edible oil (Khatri *et al.,* 2005). *Brassica* is a large genus in which *B. nigra, B. rapa, B. oleracea, B. carinata, B. juncea, B. napus* are widely used as forage, oilseeds, condiments or vegetables (Gerszberg, 2018). *Brassica juncea* is an allotetraploid (Gerszberg, 2018) that originated from hybridization between *Brassica rapa* and *Brassica napus* (Khamboj *et al.,* 2015). Mustard has become a key focus for crop improvement due to its large demand as oilseed and being affected by numerous abiotic and biotic stresses which limit crop yield (Grover and Pental, 2003; Dutta *et al.,* 2005). Distant hybridization has been used to transfer some important traits into *Brassica* genotypes, however, this traditional breeding method has several limitations including crossing barriers as well as lack of certain desirable traits in the compatible germplasm including resistance to insect pets, diseases and tolerance to salt stress (Pradhan *et al.,* 1993). In order to improve and sustain mustard production, biotechnological tools are being standardized and applied to developed transgenic plants to overcome the problem of crossing across gene pools.

Genetic engineering has emerged as a potential technology that can be utilized for trait improvement through unconventional means. Reverse genetic approaches like insertional mutagenesis (Xiang *et al.,* 2020), gene knockdown, or RNA interference/RNAi (Luo *et al.,* 2020; Zhang *et al.,* 2020) rely on

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transformation technologies and thus shorten the duration of conventional breeding (Li *et al.,* 2021). *Agrobacterium*-mediated transformation is the most commonly used method for its ease and cost effectiveness for gene transfer to economically important *Brassica* species (Baskar *et al.,* 2016; Ravanfar *et al.,* 2017; Li *et al.,* 2018). Stable and high-efficiency transformations have been conducted by many workers in variety of *Brassica* crops, particularly *B. napus* and *B. oleracea* (Liu *et al.,* 2015; Kowalczyk *et al.,* 2018). This technology has been used to improve *Brassica juncea* in the areas of hybrid seed production (Jagannath *et al.*, 2002), herbicide resistance (Mehra *et al.,* 2000), oil quality (Hong *et al.,* 2002; Sivaraman *et al.,* 2004; Das *et al.,* 2006), aphid resistance (Kanrar *et al.,* 2002; Dutta *et al.,* 2005) and salt tolerance (Zhang *et al.,* 2001). An effective transformation system can prove as an effective tool to verify gene function (Guoliang *et al.,* 2018). Optimization of *in vitro* plant regeneration system is also a key factor following transformation (Baskar *et al.,* 2016). The present study was conducted with the objective to develop an efûcient *Agrobacterium*-mediated genetic transformation system for *Brassica juncea* and optimizing various parameters of transformation.

MATERIALS AND METHODS

The present study was conducted in Plant Tissue Culture Laboratory of School of Biotechnology, Sher-e Kashmir University of Agriculture Science and Technology of Jammu, Chatha, Jammu.

Plant material, Bacterial strain carrying Plasmid construct: Seeds of *Brassica juncea* varieties namely, RSPR 01 and Varuna were collected from School of Biotechnology, SKUAST-J, Chatha, Jammu. *Agrobacterium* strain LBA4404 carrying the binary plasmid pB1121 was obtained from Plant Biotechnology Division, IIIM, Jammu. The plasmid contains a scorable reporter gene GUS (β-glucuronidase) and a selectable marker gene *nptII* encoding for enzyme neomycin phosphotransferase conferring kanamycin resistance. The strain used in the study was maintained on Luria Bertani (LB) agar medium containing rifampicin (25 mg/l), streptomycin (50 mg/l) and spectinomycin (50 mg/l).

Surface sterilization and in vitro seed germination: Seeds of *B. juncea* varieties namely RSPR-01 and Varuna were treated with Tween 20 and a combination of fungicides (Bavistin and Dithane each at 0.1% (w/v) with intermittent shaking for 20 minutes. These were then washed under running tap water to remove detergent. Final sterilization of seeds was performed under laminar air flow by treating the seeds with 0.1% mercuric chloride for 4 minutes followed by thorough washing with autoclaved distilled water. The sterilized seeds were then inoculated on MS basal medium (without growth hormones) for germination. The cultures were kept in the culture room under dark at 25±2°C for germination. After germination the tubes were shifted to 16/8 hours light/dark conditions.

Agrobacterium mediated transformation

Preparation of Agrobacterium culture and infection: A single colony of *Agrobacterium* strain harbouring a binary plasmid pB1121 was freshly streaked on LB agar plates supplemented with streptomycin (50 mg/L), Spectinomycin (50 mg/L) and Rifampicin (25 mg/L); and incubated in dark for 3 days in BOD at 28±2ºC. A loopful of bacterial culture was taken and inoculated in 50ml of freshly prepared LB broth with same antibiotics required for maintenance. The culture vessel was incubated at 28±2ºC in rotary shaker at 150 rpm for 16-22 hrs to obtain optical density (OD) of 0.2 at 600 nm with the help of spectrophotometer. Approximately 2 hrs prior to infection 100 µM acetosyringone was added to *Agrobacterium* culture. In order to optimize the concentration of bacterial growth required for maximum transformation, experiment was repeated with OD 0.4.0, 0.6, 0.8 and 1.0. The *in vitro* germinated seedlings of RSPR01 and Varuna were taken out on petriplate under laminar air flow (LAF) cabinet. The hypocotyls and cotyledonary leaves were cut into segments and were carefully immersed with the cut edge into the bacterial suspension for 20 minutes (separate for each variety). After 20 minutes these explants were taken out from each flask and blotted on sterile filter paper to remove excess of bacteria.

Co-cultivation and selection of transformed explants: The hypocotyl and cotyledonary leaf segments of both varieties were transferred to co-cultivation medium (MS medium) supplemented with BAP (4 mg/l), NAA (0.5 mg/l), $AgNO_3$ (4mg/l) and acetosyringone (100 µM). The cultures were then

incubated in growth room at 28±2ºC with 16 hrs light and 8 hrs dark cycle provided by cool fluorescent lights. The cultures were co-cultivated for 24, 48 and 72 hrs for optimization of co-cultivation period suitable for maximum transformation efficiency. The explants were removed from medium and washed twice with sterile water followed by final washing with autoclaved water mixed with 500 mg/l each of Cefotaxime and carbenicillin to remove *Agrobacterium*. The explants were dry blotted on sterile filter paper and transferred to selection medium (MS medium) supplemented with BAP (4 mg/l), NAA (0.5 mg/l), $AgNO_3$ (4 mg/l), Acetosyringone 100 µM, carbenicillin (250 mg/l) and kanamycin (5-45 mg/l) for two weeks, with a weekly transfer to fresh medium. The optimization of kanamycin concentration was done by using different concentrations varying from 5 mg/l to 45 mg/l.

Histochemical GUS assay: Expression of reporter gene was assessed as per protocol developed by Dutta *et al.* (2005). The hypocotyls and cotyledonary leaf explants were taken out from selection medium and immersed in solution of X-gluc (5-bromo-4-chloro-3-indolyl glucuronide) containing 100 mM phosphate buffer, 100 µM EDTA, 0.5M Potassium ferricynide, 0.5M Potassium ferrocynide and incubated at 37°C for 24-48 hours. The GUS activity of hypocotyls and cotyledonary leaf explants were assessed visually and documented by photographs.

RESULTS AND DISCUSSION

Development of an efficient *in vitro* regeneration system is an effective tool for verification of gene function (Guoliang *et al.,* 2018). Niazian *et al.* (2017) suggested that optimization of various culture parameters of tissue culture and gene transformation are essential for regeneration of transformants. Successful *A. tumefaciens*-mediated genetic transformation depends on susceptibility of a genotype to infections and incorporation of gene of interest into the genome; as well as ability to regenerate plants from transformed cells under *in vitro* conditions. In the present study an attempt has been made to develop a reproducible protocol for transformation of *Brassica juncea* varieties viz. RSPR 01 and Varuna using *Agrobacterium*-mediated transformation. Hypocotyl and cotyledonary leaf explants of 10-15 days old *in vitro* germinated seedlings of *B. juncea* were used for transformation. It was observed that hypocotyl segments of RSPR 01 and Varuna displayed better transformation efficiency as compared to cotyledonary explants when assessed on the basis of histochemical GUS assay performed after transformation as depicted in Figure 1. Similar observations pertaining to better regeneration efficiency of hypocotyls over cotyledonary explants of 4-10 days seedlings has been suggested by Pavlovic *et al. (*2010); Rafat *et al.* (2010); Yi *et al.* (2013); Ravanfar *et al.* (2014) and Gerszberg (2015). However, Munshi *et al.* (2007) and Sharma *et al.* (2014) observed that cotyledon explants showed oragnogenesis superiority over hypocotyl explants. Cardoza and Stewart (2004) reported that explants from 3 to 5 day old seedlings of various *Brassica* spp. gave best regeneration response since the physiological and biochemical status of young explants is very active and the cell wall is not so rigid as

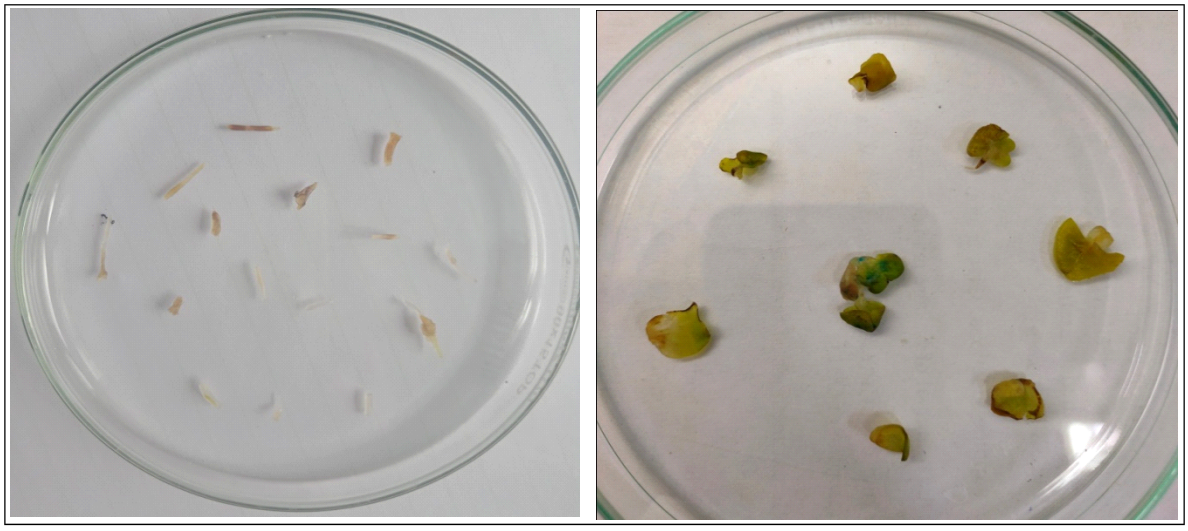

Figure 1: Transformed hypocotyls and cotyledonary leaf segments of *B. juncea*

a result it is more susceptible to the impact of environmental factors. Majority of the researchers (Pavlovic *et al.,* 2010; Ravanfar *et al.,* 2014; Gerszberg *et al.,* 2015; Gambhir *et al.,* 2017a) have preferred to use much older seedlings (7 to 10 day old) as the young explants are too small for convenient manipulation.

Agrobacterium LB 4404 octopine strain was used in present study as it has been successfully used earlier to transfer gene of interest and create transgenic plants of *Brassica* (Dutta *et al.,* 2005; Li *et al.,* 2005; Das *et al.,* 2006; Lei *et al.,* 2006; Min *et al.,* 2007; Hur and Min, 2018). Gerszberg (2018) suggested that this strain is of moderate virulence which results in successful transformation. There are various other factors that need to be optimized for successful transformation. *Agrobacterium* concentration (OD_{600}) is an important factor which influences transformation efficiency to a great extent. Rafat *et al.* (2010); Yi *et al.* (2013) used *Agrobacterium* at concentration of 0.2-0.4 or 1.6-1.8 for transformation of *B. oleracea* var. Capitata. In the present study, *Agrobacterium* concentration (OD_{600}) ranging from 0.2-1.0 has been used for optimization. Maximum transformation efficiency of 53.33 per cent (Varuna) and 66.66 per cent (RSPR01) has been observed when the OD_{600} of bacterial culture was 0.6 followed by 0.4 as shown in Figure 2. These results are in consistence with findings of Vanjildorj *et al.* (2009); Khan *et al.* (2009) and Bhuiyan *et al.* (2011) who reported maximum transformation efficiency at OD of 0.6. However, Kong *et al.* (2009) observed very high transformation efficiency in *B. napus* at OD of 0.8. Baskar *et al.* (2016) reported that bacteria of Brassica transformation are typically grown at OD of 0.8. Besides, Min *et al.* (2007) and Zang *et al.* (2008a) observed promising results of transformation at OD of 1.0.

Addition of phenolic compound such as acetosyringone to bacterial culture has been suggested by Rafat *et al.* (2010) and Gerszberg (2018). It has been commonly used at concentration of 100 µM. In the present study, the explants were suspended in bacterial culture with acetosyringone for 20 minutes. Baskar *et al.* (2016) observed that increasing infection time to more than 35 minutes reduces plant vitality and causes browning of tissue. On contrary, Min *et al.* (2007) observed that transformation efficiency increases with increase in infection time.

Optimization of co-cultivation period is also an important parameter for efficient transformation. The explants of *B. juncea* var. RSPR01 and Varuna were co-cultivated for 24, 48 and 72 hrs and it was observed that maximum transformation efficiency of Varuna (63.3%) and that of RSPR01 (73.33%) was obtained when co-cultivated for 48 hrs followed by reduction in transformation efficiency as depicted in Figure 3. These observations are supported by results reported by Bhuiyan *et al.* (2011); Liu *et al.* (2015); Li *et al.,* 2017), who suggested that 48 hours of co-cultivation was most effective towards transformation. On contrary, Khan *et al.* (2009) observed better results on 72 hours of co-cultivation. Khan *et al.* (2003) observed that longer co-cultivation period may cause explant necrosis as a result of increased bacterial growth.

The explants were transferred to selection medium (MS medium supplemented with 4.0 mg/l BAP, 0.5 mg/l NAA, 4 mg/l $AgNO_3$ after co-cultivation and swelling of explants was observed at the cut ends after

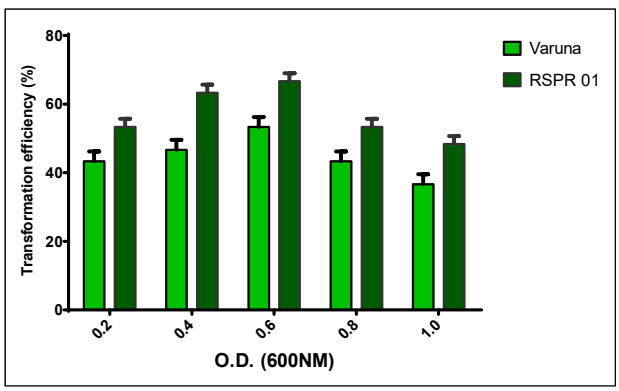

Figure 2: Effect of bacterial concentration (OD) on transformation efficiency of *B. juncea* varieties

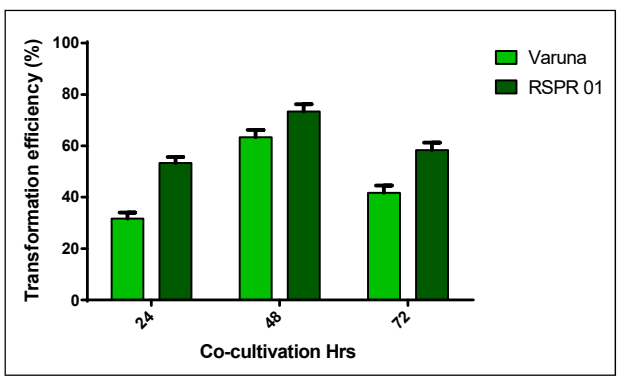

Figure 3: Effect of co-cultivation period on transformation efficiency of *B. juncea* varieties

three weeks of culture. Li *et al.* (2021) also reported that $AgNO_3$ has been commonly used for *Brassica* spp. transformation as it is a potential ethylene inhibitor and could promote adventitious bud formation in tissue culture. The nptII gene conferring kanamycin resistance in the transformed cells has been used in the present study. Kanamycin was added to selection medium for selection of transformed tissue at a concentration higher than the explant tissue's natural tolerance level. Optimization of kanamycin concentration as depicted in Figure 4 indicate that maximum transformation efficiency was observed when Kanamycin was used at concentration of 25 mg/l. Li *et al.* (2021) used a Chinese cabbage orphan gene BraA1000785 with unknown function identified from *B. rapa* reference genomic sequencing (Jiang *et al.,* 2018) for vector construction. The sequence of *BraA1000785* isolated from a Chinese cabbage inbred line 'C-24 and was cloned and inserted into the binary vector pCAMBIA1305.1 that contained hygromycin phospho- transferase (HPT), neomycin phosphotransferase II (nptII) gene conferring kanamycin resistance.

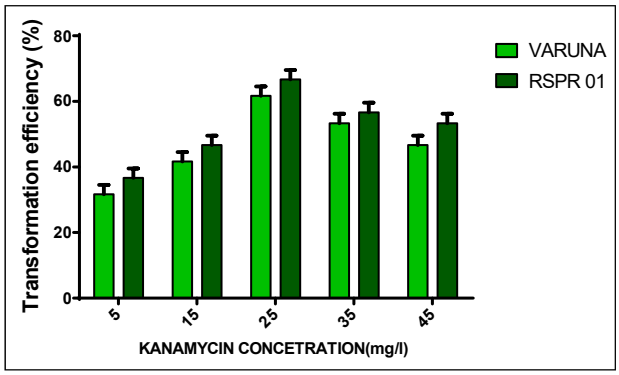

Figure 4: Effect of kanamycin concentration on transformation efficiency of *B. juncea* varieties

The transformation ability of *Brassica juncea* varieties with *Agrobacterium* strain LBA4404 was examined. RSPR 01 showed higher transformation response than Varuna, while, the regeneration response of Varuna was better in comparison to RSPR01 (Figure 5&6). However, both Brassica varieties can be subjected to genetic transformation using *Agrobacterium tumefaciens* for transferring genes of interest.

CONCLUSION

We conclude from our experiments that hypocotyls explants are more responsive in terms of callus initiation and transformation. Results indicate that among different hormonal concentrations and combinations used during this study, 4 mg/l BAP and 0.5 mg/l NAA was the best for initiation of callus in transformed explants. GUS analyses revealed that transformation has successfully occurred in some callus masses. RSPR 01 showed higher transformation response as compared to the variety Varuna.

Figure 5: Regions of transformed callus of *B. juncea* var. Varuna showing green patches for regeneration

Figure 6: Regeneration of plantlet from transformed callus mass of *B. juncea* var. Varuna

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Factors Contributing to Groundwater Consumption of Vegetable Farmers in Nadia District of West Bengal

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ABSTRACT

Groundwater is an important part of the water cycle and is a valuable natural resource that provides a major source of water for the agricultural, household, and industrial applications. The present study portrays different factors, which are responsible for groundwater consumption of vegetable growers in the Nadia district of West Bengal by selecting one hundred and sixty respondents through simple random sampling keeping consideration of homogeneity in the land type, soil type, type of crops, variety, and seasons. The results depict that age, education, topography, farmers' knowledge level, farmers' attitude towards irrigation, production orientation economic motivation, improved water extraction mechanism, and method of irrigation are the major contributing factors in envisaging the amount of groundwater consumption when crop and land situations are constant. Nonetheless, for ensuring proper utilization of groundwater, education, changes in attitude, knowledge, and management aspects of groundwater irrigation of the farmers have to be given due attention during this time. Therefore, proper planning, decision making, and dissemination of relevant knowledge from experts' level to farmers' level through the capacity building are necessary.

Keywords: Farmer's perception, Groundwater, Irrigation, Knowledge, Vegetable growers

INTRODUCTION

Groundwater is an important component of the hydrological cycle and an important geological resource that serves as a key source of water for agriculture, household, and industrial purposes across the world (Treidel *et al.*, 2011; Dhingra and Shah, 2021). It provides over half of all drinking water in the globe, as well as around forty-three per cent of all water used for cultivation (Siebert *et al.*, 2010) and is critical for drinking water and food security, as well as providing a major contribution to human health and the environment (Henriksson *et al.*, 2021). While groundwater has boosted India's self-sufficiency in agriculture, aquifers have been overused in most of the states of the country with unknown consequences for crop productivity.

Groundwater is responsible for approximately seventy-five per cent of dry-season irrigation and nearly all municipal water sources. Most of the irrigated land is irrigated by tapping subsurface water using deep tube wells, shallow tube wells, and dug wells, among other methods. There has seen a significant increase in rice cultivation with the introduction of shallow-tube wells in the late eighties (Fujita, 2013). Although the state has abundant groundwater, intensive cultivation using groundwater leads to chronic depletion of the water table (Sarkar, 2020) which causes widespread arsenic poisoning putting millions of people in danger (Bhowmick *et al.*, 2018). The scarcity of irrigation water leads to an increasing trend toward the use of marginal to low-quality water sources for irrigation (Yasuor *et al.*, 2020) which may reduce the cropping intensity in the upcoming days (Jain *et al.*, 2021). Although there is

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a negative link between the surface irrigated area and groundwater irrigated area at the national level, the same trend may not be observed across all states due to the utilization of various water sources (Narayanamoorthy, 2010). In the current scenario, climate change has a considerable impact on agriculture, though the influence of climate change-induced changes in groundwater levels on agricultural production costs is minor in comparison to other expenses, it might be considered in areas where groundwater levels are rapidly falling (Salem *et al.*, 2018). So, the farmers have to adopt some strategies viz. technical alternative with a 90 per cent inflow cut-off ratio (Kumar *et al.*, 2020), soil-water retention and integrated farming are followed by contingency crop planning, crop diversification, and risk-aversion measures, as well as obtaining help from extension professionals and others to overcome the impact of climate change on crop production (Bharat *et al.*, 2022). The social and economic consequences of heavy groundwater usage are frequently overlooked, although they are critical (Qureshi, 2020). However, in most cases, the impact of groundwater usage is favorable, at least in the short and medium-term, such as enhanced productivity, food security, job creation, livelihood diversification, and general economic and social engagement while in long term it might cause a permanent drop in the water table, degradation of water quality, the creation of an arsenic issue, and an increase in the cost of living (Yasuor, 2020). The present study tried to light on the factors influencing groundwater consumption of the vegetable growing farmers in terms of socio-economic and technological interventions.

MATERIALS AND METHODS

The study was conducted in Nadia district of West Bengal during 2019-2021 focusing on the farmers who use groundwater for irrigation purposes in their crop field. For the study, both purposive and random sampling techniques (Ray and Mondal, 2014) were used, where the district, and block, were purposively selected for the study as the area was under high-intensity agriculture, irrigated, rice, and vegetable-based farming. A score of one hundred and sixty respondents was selected randomly from Haringhata block. Two sets of variables were used to conceptualize the study, factors responsible for groundwater consumption in the selected study location, i.e. (i) independent variables (x_1-x_{13}) and (ii) dependent variable (y). Amount of groundwater extracted (y) is measured using the formula *Running hour x average flow rate (where the average flow rate is 11.36 m^3 per hour for a pump of 5 hp with a 3" diameter of delivery).* The responses are collected using a pretested structured interview schedule and analyzed through quantitative methods viz., Descriptive statistics, Coefficient of Correlation, and, Stepwise Regression with the help of IBM SPSS v24.0.

RESULTS AND DISCUSSION

The relation between the amount of groundwater extraction and thirteen selected socio-personal variables (Table 1) suggests that the variables, topography (x_4), method of irrigation (x_6), improved water extraction mechanism (x_7), economic motivation (x_8), production orientation (x_9), and attitude towards irrigation (x_{13}) has recorded positively significant relationship with the dependent variable.

It is evident that the farmers have high economic motivation and production orientation attitude has shown more groundwater extraction along with other socio-ecological conditions. Whereas the variables education (x_2) and farmer's knowledge regarding

Table 1: Coefficient of correlation between amount of groundwater extracted (y) and selected variables

Independent variables	Pearson correlation (r)	Sig. (2-tailed)
Age (x_1)	0.024	0.760
Education (x_2)	-0.166*	0.035
Soil type (x_3)	-0.043	0.588
Topography (x_4)	0.174*	0.027
Irrigation water management (x_5)	-0.064	0.422
Method of irrigation (x_6)	0.355**	0.000
Improved water extraction mechanism (x_7)	0.171*	0.030
Economic motivation (x_8)	0.569**	0.000
Production orientation (x_9)	0.201*	0.011
Participation in water market (x_{10})	-0.007	0.934
Other sources of irrigation (x_{11})	-0.025	0.758
Knowledge regarding irrigation (x_{12})	-0.625**	0.000
Attitude towards irrigation (x_{13})	0.160*	0.043

**Correlation is significant at the 0.01 level;
*Correlation is significant at the 0.05 level

irrigation (x_{12}) have recorded a negatively significant correlation with groundwater extraction. The farmers are bearing low formal education along with inadequate water extraction mechanisms, which focused that despite having good educational qualifications of the farmers, long-term experience in farming helps them in proper irrigation management activity in the crop field. While a similar finding also suggests that adequate use of water in crop fields can enhance the production as well as income of the farmers (Ojha *et al.*, 2020). Good knowledge of irrigation and ambient soil condition has helped farmers to choose proper water management practices. A similar study also portrayed that farmers in the central plain zone of Uttar Pradesh were found to be using more irrigation water than the optimum amount due to a lack of adequate knowledge and the false belief that water alone might substitute the need for other vital inputs, according to Srivastava *et al.* (2009).

Multiple regression analysis is used to determine the relative contribution of the amount of groundwater extraction among the selected socio-ecological variables, which is depicted in Table 2. The variables soil type (x_3), method of irrigation (x_6), economic motivation (x_8), participation in water market (x_{10}) and knowledge regarding irrigation (x_{12}) have exerted significant contribution in predicting the amount of groundwater extraction. The whole model can explain 57.70 per cent of the variance as the R square value of the model is 57.70 per cent. The study reveals that the farmers' depend on the quantity of groundwater has a causal relationship with the soil water retention capacity, available irrigation facilities, their economic motivation, participation in the water market or water users association, and their overall knowledge regarding efficient irrigation practices. A similar study in the Birbhum district of the same state also reveals that the farmers' participation in both river lifted and groundwater irrigation helps in better water management practices in the presence of the water user association (Ali and Ghosh, 2017).

Table 3 depicts the stepwise regression between amount of groundwater extraction (y) and selected thirteen variables. The variables knowledge regarding irrigation (x_{12}), and economic motivation (x_8) have shown the strongest contribution in predicting the dependent variable in the second step of the analysis. These two variables contribute almost 52.50 per cent out of the total thirteen variables, suggesting that the knowledge of irrigation methods is a key concern in extracting groundwater along with economical sustainability and irrigation methods. The farmers who are knowledgeable about other sources of irrigation and concerned about groundwater depletion are less

Table 2: Multiple regression analysis between amount of groundwater extraction (y) and selected variables

Independent variables	Unstandardized Coefficients		Std. Coef.	t value	Sig
	Reg. coef. B	S.E. B	Beta		
Age (x_1)	2.578	2.842	0.050	0.907	0.366
Education (x_2)	9.712	15.773	0.037	0.616	0.539
Soil type (x_3)	-96.579	38.815	-0.145	-2.488	0.014
Topography (x_4)	-7.917	39.334	-0.012	-0.201	0.841
Irrigation water management (x_5)	-1.694	43.434	-0.002	-0.039	0.969
Method of irrigation (x_6)	146.620	69.010	0.144	2.125	0.035
Improved water extraction mechanism (x_7)	37.918	36.282	0.070	1.045	0.298
Economic motivation (x_8)	150.290	24.811	0.397	6.057	0.000
Production orientation (x_9)	-26.044	19.923	-0.077	-1.307	0.193
Participation in water market (x_{10})	148.434	57.453	0.156	2.584	0.011
Other sources of irrigation (x_{11})	-9.061	36.941	-0.016	-0.245	0.807
Knowledge regarding irrigation (x_{12})	-83.896	10.928	-0.481	-7.677	0.000
Attitude towards irrigation (x_{13})	7.252	15.692	0.027	0.462	0.645

R^2 = 57.70 per cent

Table 3: Stepwise regression analysis between amount of groundwater extraction (y) and selected variables

Independent variables	Unstandardized Coefficients		Std. Coef.	t value	Sig
	Reg. coef. B	S.E. B	Beta		
Knowledge regarding irrigation (x_{12})	-84.011	10.281	-0.482	-8.172	0.000
Economic motivation (x_8)	149.376	22.346	0.394	6.685	0.000

R^2 =52.50 per cent

dependent on using groundwater as the source of irrigation. Similar findings also suggest preventing excessive groundwater extraction, efficient irrigation management strategies such as low water demanding high-value crops, volumetric water charge system, wet and dry irrigation system, farmers' irrigation attitudes, understanding, managerial characteristics and so on may be implemented extensively (Dey *et al.*, 2017; Haque *et al.*, 2021).

Path analysis is used to determine the magnitudes and significance of the causal relationship between the amount of groundwater extraction and selected socio-ecological variables. Table 4 depicts the total effects, direct effects and indirect effects related to the amount of groundwater extraction. The results emphasized that the variable Knowledge regarding irrigation (x_{12}) shows the highest negative total effect and direct effect on the causal variable (y) followed by economic motivation (x_8) and method of irrigation (x_6). While production orientation (x_9), method of irrigation (x_6) and education (x_2) are the highest contributors in terms of indirect effect. The results also indicated that the variable knowledge regarding irrigation (x_{12}) followed by economic motivation (x_8) are the most contributors to the amount of groundwater extraction in terms of the highest indirect effect. Appropriate knowledge of water management is very much crucial for selecting the irrigation schedule for the crops along with the economic motivation of the vegetable growers while the production orientation attribute with the level of education can contribute to the quantity of groundwater extracted for the irrigation. Farmers having their water extraction mechanism are higher groundwater consumers than farmers who purchase from the owners. A similar kind of study also suggests that the farmers who are the buyer of irrigation water have a better water use efficiency and crop management scenario than the owner of the water extraction mechanism (Besra *et al.,* 2018).

Table 4: Path Analysis of decomposing total effect into direct and indirect effect

Independent Variables	TE	DE	IE	HIE
Age (x_1)	0.024	0.050	-0.026	-0.016 (x_6)
Education (x_2)	-0.166	0.038	-0.204	-0.134 (x_{12})
Soil type (x_3)	-0.043	-0.145	0.102	0.062 (x_8)
Topography (x_4)	0.174	-0.012	0.186	0.103 (x_{12})
Irrigation water management (x_5)	-0.064	-0.003	-0.061	-0.084 (x_{12})
Method of irrigation (x_6)	0.355	0.144	0.211	0.153 (x_8)
Improved water extraction mechanism (x_7)	0.171	0.069	0.102	0.079 (x_8)
Economic motivation (x_8)	0.569	0.397	0.172	0.175 (x_{12})
Production orientation (x_9)	0.201	-0.077	0.278	0.124 (x_{12})
Participation in water market (x_{10})	-0.007	0.156	-0.163	-0.072 (x_8)
Other sources of irrigation (x_{11})	-0.025	-0.016	-0.009	0.042 (x_{10})
Knowledge regarding irrigation (x_{12})	-0.625	-0.482	-0.143	-0.143 (x_8)
Attitude towards irrigation (x_{13})	0.160	0.026	0.134	0.056 (x_{12})

TE = Total effect; DE = Direct effect; IE = Indirect effect; HIE = Highest indirect effect; Residual = 0.423

CONCLUSION

Groundwater sustainability is emerging as a priority in maintaining water security. Proper management of readily available groundwater may provide adequate irrigation water around the year for agricultural production, particularly during droughts. Inadequate use of groundwater leads to a decline in water table making it more difficult for farmers to implement maintainable practices which require water conservation and energy-efficient water use techniques. The present study envisaged that awareness about irrigation water plays a significant role in irrigation scheduling as well as managing the source of irrigation. Farmers do not select crops based on water requirements instead, they select crops based on water availability and expected net returns. At this point, changes in farmers' attitudes, understanding, and management aspects of groundwater irrigation must be given appropriate consideration to ensure the long-term usage of groundwater. Proper planning, decision-making, and control operations, as well as capacity building, are necessary concerning groundwater management.

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Models of Khadin Improvement in the Western Rajasthan Based on Assessment of the Knowledge Levels of the Farmers

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ABSTRACT

The Khadin was originally developed a few hundred years ago by the Paliwal Brahmins in Jaisalmer. This system is similar to some irrigation methods used in the Middle East and in Negev desert. The Khadin system is based on the principle of harvesting rainwater on farmland and subsequent use of this water-saturated land for crop production. Three villages i.e. *Rupsi* of Jaisalmer*, Mandawa* of Bhaniyana, and *Utal* of Fathehgarh tehsils have been selected for data collection for Khadin production systems. Among these villages 20 farmers has been selected from each village having Khadin faming system. Thus total 60 farmers of Khadin farming system has been selected and collected information through interview. Scio-economic data of the selected farmers have been collected through the interview schedule in all three selected villages. Five models have been suggested by the researchers. In all five systems farmers have medium level of the knowledge about the crop, vegetable, fruits and livestock by adopting these models production and productivity of these age old Khadins can be increased significantly more over year round income from the Khadins is possible and these models ensures organic nature of the Khadins because animal component provides organic fertilizer and organic stubbles. Among statistical tools mean, median and range has been used for statistical analysis.

Keywords: Khadin, Models of Khadin improvement, Knowledge level

INTRODUCTION

'*Khadin*' is a land-use system developed centuries ago in the Jaisalmer district of Western Rajasthan. It is practiced where rocky catchments and valley plains occur in proximity. The runoff from the catchment is stored in the lower valley floor enclosed by an earthen '*bund*'. Any surplus passes out through a spill-way. The water arrested stands in the *Khadin* throughout the monsoon period. It may disappear below the soil by the first week of November, leaving the surface moist. If standing water persists longer, it is discharged through the sluice before sowing. Wheat or chick-peas are then planted CGWB (2011). These crops mature without irrigation. The soils in the *Khadins* are extremely fertile because of the frequent deposition of fine sediment, while the water that seeps away removes salts. The *Khadin* is, therefore, a land-use system which prevents soil deterioration. The *Khadin* was originally developed a few hundred years ago by the Paliwal Brahmins in Jaisalmer. This system is similar to some irrigation methods used in the Middle East and in Negev desert. The *Khadin* system is based on the principle of harvesting rainwater on farmland and subsequent use of this water-saturated land for crop production. Its main feature is a very long (100-300 m) earthen embankment built across the lower hill slopes lying below gravelly uplands (Blanford, 1901). The size of the *Khadin* is designed on the basis of local rainfall patterns, catchment characteristics and soil type. On an average, the cultivated area under each *Khadin* is 10-14 ha with an average dam size between 1.2-1.7 m high x 1.0-1.5 m wide and 100-300 meters in length, depending upon catchment area and number of land holdings (Kumar, 2016). Other than improving socio-economic conditions of desert dwellers, *Khadins* also have created positive impact on the ecology of the

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region, effectively checking soil erosion and increasing vegetation cover. For efficient agriculture, a minimum of 15:1 ratio of catchment area to crop area is required (Kolarkar *et al.,* 1983) 'A rainfall of 75-100 mm is sufficient to charge the Khadin soils with sufficient soil moisture content to raise a successful local crop. In the Khadin area, the collect runoff percolates into the ground with time recharges the subsoil. Of the total runoff collected only 50-60% of the water is utilised. The construction cost for single Khadin ranges (Blatter and Hallberg, 1918–1921). This construction cost can be repaid back within three to five years. Other than improving socio-economic conditions of desert dwellers, Khadins also have created positive impact on the ecology of the region, effectively checking soil erosion and increasing vegetation cover. There are as many as 500 big and small Khadins in Jaisalmer district, which are productive, even with 40 mm rainfall (Bhandari, 1990). Khadin is a catchment area for eastern Rajasthan desert during rainfall /monsoon this is filled with water later on when water seeds crops like sown in the area, anicut /small door is made to store water in catchment area. This remaining moisture in the field is sufficient for the growth in of the crop Khadin are the best field for growth in the western Rajasthan (Dhiman and Gupta, 2011).

MATERIALS AND METHODS

First of all schedule has been made after taking farmers view after that the schedule has been send to experts for corrections. Suggestions have been incorporated for finalization of schedule. Three villages i.e. *Rupsi* of Jaisalmer, *Mandawa* of Bhaniyana and *Utal* of Fathehgarh tehsils, *gomath* of Pokaran have been selected for data collection for Khadin production systems. Among these villages 20 farmers has been selected from each village having Khadin faming system (Ministry of Rural Development, 2004). Thus total 60 farmers of Khadin farming system have been selected and collected information through interview and filled the schedules. Khadin is a catchment area for eastern Rajasthan desert. During rainfall /monsoon this is filled with water later on when water seeds crops sown in the area, anicut /small door is made to store water in catchment area (Champion and Seth, 1968). This remaining moisture in the field is sufficient for the growth of the crop. Among Obstacles faced by farmers in Khadin it need large area. Labor intensive, heavy initial investment, Among advantages of Khadin system this assures farmers at least one crop. Other than improving socio-economic condition of desert dwellers of Khadins also created positive impact on ecology region. Improvise soil structure, rise of the ground water.

RESULTS AND DISCUSSION

Most of the farmers belong to middle age category, most of the farmers are literate and lower educated most of the farmers possessed large size of land holding and have joint family. In mass media exposure most of the farmers listen radio, T.V. and news paper. Most of the farmers belong to joint family nuclear family rank second, most of the farmers ranked high number of family members (Table 1). Most of the

Table 1: Socioeconomic characteristics of selected farmers

Categories	Number of farmers
Age	
Young (less than 38 years)	10
Middle (38-60 years)	37
Old (more than 60 years	13
Education	
Up to primary	7
Up to Secondary	40
Higher level	13
Cast	
General	40
OBC	12
Others	8
Type of family	
Nuclear	15
Joint	45
Number of family member	
Low	0
Medium	14
High	46
Land holding	
Small-1-2 ha	4
Medium 4-10 ha	6
Large more than 10 ha	50
Entrepreneurship	
Agriculture and dairy	12
Agriculture	38
Agriculture and Job	10

Table 1 contd....

Categories	Number of farmers
Average Income (Annual)	
< 1 Lac	3
1-5 Lac	7
> 5 Lac	50
Social participation	
Low	8
Medium	45
High	7
Number of Livestock	
Low less than 20	9
Medium 20-30	11
High More than 30	40
Milk production Cross bread	
Low less than 5 liter	6
Medium 5-8	10
High more than 5 liter	44

farmers possess agriculture as entrepreneurship while 50 farmers have income more than 5 lacks. Most of the farmers have medium social participation, possess local cow and goat, taken membership from milk production cooperative society similarly most of the farmers have medium livestock as well as most of the farmers have more than 5 liter milk production.

During *kharif* there was no crops grown in lower reach however some crops like Moongbean, moth bean and cluster bean have been grown on upper reach. As soon as water recedes the crops likes' chickpea, cumin and Isabagol were grown in *rabi* season. Among package of practices most of the farmers do not know about the seed treatment while all most all the farmers know right time of the sowing. In Khadin most of the farmers know about the right time of the sowing of the Khadin and the variety to be grown. Khadin farmer also know about the seed rate of the farming system while Khadin farmers does not have good

Table 2: Knowledge level testing of the crops (N=60)

Item	Category	Range	No. of farmers
Name of the high yielding variety of the crops	Low	≤ 0.14	22
	Medium	14-1.12	38
	High	≥ 1.12	0
Seed treatment should be done	low	≤ 0.41	0
	Medium	0.41-1.2	49
	High	≥ 1.2	11
Right time of crop sowing	Low	≥ 0.2	19
	Medium	0.2-1.1	41
	High	≥ 1.1	0
Method of sowing	Low	≥ 5.6	11
	Medium	5.6-6.8	49
	High	≥ 6.8	0
Method of irrigation	low	≥ 0.2	0
	Medium	0.2-0.4	53
	High	≥ 0.4	7
Weed control	Low	-0.94	0
	Medium	-0.94-1.6	19
	High	≥ 1.6	41
Doze of the weedicide	Low	≥ -0.2	52
	Medium	0.2-0.46	8
	High	≥ 0.46	0
Use of insecticide	Low	≤ -0.2	0
	Medium	-0.2-0.46	58
	High	≥ 0.46	2

knowledge about the seed treatment in the Khadin system. All most all the farmers know about the method of sowing. All Khadins of the Jaisalmer are organic by default. Farmers are not using chemical as means of the plant protection. Most of the farmers have good knowledge of the intercultural operation similarly most of the Khadin farmers have good knowledge about the crop storage (Table 2) (Bhattacharya, 2015). Farmers has medium level of the knowledge about high yielding variety of the crops, similarly medium level of the knowledge level found about right time of sowing as well as medium level of knowledge found among farmers about method of sowing, medium level of knowledge exist among farmers about method of irrigation, high level of knowledge exist among the farmers about weed control, low level of the knowledge exist among the farmers about doze of weedicide, while medium level of knowledge found among the farmers about the insecticide (Bhalge and Bhavsar, 2007).

Most of the farmers of the Khadin farming systems are not growing vegetable and fruits however they cultivates vegetable and some fruits on their farm in small area with limited availability of water hence they have some knowledge about the cultivation of fruits and vegetable (Table 3). Most of the farmers possess medium level of the knowledge about the name of the high yielding variety of the vegetable and fruits, Low level of the knowledge exist among farmers about seed treatment. Most of the farmers know about right time of pruning (Bhalge and Bhavsar, 2007).

All most all the Khadin farmers have good knowledge about the animal husbandry technology and good knowledge about the livestock local breeds. Most of the farmers have good knowledge about the symptoms of the animal in heat such as after how many days animals repeats their heat cycle. Most of the farmers have good knowledge about the vaccination, medicine, separation, caring, staff, name of diseases. All most all the farmers have no knowledge about the adoption of the horticulture technology. Among the knowledge level of the livestock there is medium level of the knowledge level exist about the important breeds of the livestock, medium level of the farmers know about the symptoms of the livestock in heat, 50 per cent of the farmers has medium level of the knowledge about A.I. (Table 4) (Bassi and Vendantam, 2013).

CONCLUSION

There are different methods /models for Khadin improvement in the western Rajasthan has been given after the assessment of the knowledge level of the farmers about livestock crops, horticulture plants and socioeconomic traits and problems of the farmers in the Khadin system. Five models have been suggested by the researchers. In all five systems farmers have medium level of the knowledge about the crop, vegetable, fruits and livestock, by adopting these

Table 3: Knowledge level of the of vegetable and fruits (N=60)

Component	Category	Range	No. of the farmers
Name of the high yielding varieties of vegetable and fruits	Low	≤ -0.18	0
	Medium	-0.18-0.54	49
	High	≥ 0.54	11
Seed treatment should be done	Low	≤ 0.52	50
	Medium	0.52 -0.24	10
	High	≥ 0.24	0
Right time of planting	Low	≤ -.26	3
	Medium	-.26- 1.25	57
	High	≥ 1.25	0
Right way of pruning	Low	≤ 0.7	14
	Medium	0.7-1.1	46
	High	≥ 1.1	0

Table 4: Knowledge levels of the livestock (N=60)

Component	Category	Range	No. of the farmers
What are the important local breeds of the livestock	Low	≤ 0.4	12
	Medium	0.4-1.2	48
	High	≥ 1.2	0
Symptoms of the animals in heat	Low	≤ 0.5	7
	Medium	0.5-1.2	53
	High	≥ 1.2	0
When insemination of the animals should be done in heat	Low	≤ -5.393	16
	Medium	5.39-5.407	44
	High	≥ 5.407	0
How many days animal repeats their heat cycle	Low	<41.9	0
	Medium	-41.19-1.24	49
	High	≥ 1.24	11
Do you know about A.I.?	Low	≤ 0.416	10
	Medium	0.416-1.249	50
	High	≥ 1.249	0

models production and productivity of these age old Khadins can be increased significantly more over year round income from the Khadins is possible and these models ensures organic nature of the Khadins because animal component provides organic fertilizer and organic stubbles.

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Job Competence of Teachers of Orissa University of Agriculture and Technology, Bhubaneswar, Odisha

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ABSTRACT

Besides, research and extension, teaching has been regarded as a the vital core in imparting technical knowledge in the field of education of agricultural and allied sciences. Therefore, the in-depth analysis of competency levels can throw light on the current status and thus be guiding force in its further improvement to enhance the level of agricultural education. In this context, the present study was conducted to be aware about the job competency levels of teachers working in the three campuses of university--Bhubaneswar, Bhawanipatna and Chiplima. A total of 90 respondents were selected under ex-post facto research design in which data collection done through personal interview method using questionnaire. From the investigation, the results depicted that 55.55 per cent of teachers accorded to medium level of overall job-competence followed by 16.67 per cent and 27.79 per cent to low and high levels respectively. In terms of self-rating and superior ratings, majority belonged to the medium levels of job competence in the portion of 53.33 per cent and 58.89 per cent respectively. To job competence, the dimension Technical knowledge and Guidance were major contributors but the least ones were creativity, self-development and adaptability which demands of focus and efforts to work out on these for further upscaling the competency levels.

Keywords: Job competence, Teachers, University

INTRODUCTION

The agriculture sector has been held accountable for not only ensuring the food security of the ever increasing population but also contributing to the developing economy of our country. The agriculture itself remained a state subject in our country and that is why the state agricultural university is one of the key stakeholders which shoulders the burden of responsibilities agricultural education and research by imparting technical knowledge and guidance to the undergraduates, post-graduates and the research scholars who would be the future professionals working for the betterment of the farming community of the state. Therefore, the teaching systems of these universities are very vital for the success of university as an organisation in terms of achieving its vision, goal and objectives. Mahra *et al.* (2020) stated that teaching has always been the core of human resource development and is one of the three important mandates of all agricultural universities besides research and extension. It is imperative to maintain quality of teaching-learning in agricultural universities and institutions for preventing the down gradation of the level of agricultural higher education in India. The quality of agricultural higher education should be considered under global perspective (Panda *et al.,* 2019).

Human capital management involves several important and complex issue in the form of multidimensional reciprocity involving viewpoint of employees towards organizational climate, intra-group

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and inter-group relations and leadership relationship. Thus, the main focal point of such management is the pursuit of incessant improvement in the performance of employees working in the organization. It is pre-requisite to know the current level of their skill-set, which can be said as their competency levels and then assessing the scope for further improvement of it in a way to achieve their best.

Job competence can be defined as the potentiality to execute or utilise a cluster of related knowledge, skills and attitudes to carryout functions or task successfully in a defined framework with respect to the duties or roles assigned to concerned job in an organization. Thomson and Strickland (2004) additionally placed building crux competencies and focused capabilities as a key part of building a fit and healthy organization. They expressed that building crux competencies and aggressive capabilities will empower great procedure execution and that maintain the flow of a fitness/ability portfolio, that is refreshed as strategy and outer conditions change, will ensure that an organization is equipped for powerful system execution.

Senthil (1998) concurred that majority (70.00%) of the teaching respondents opinionated to be into the medium category of job competence and citing to the fact of the prevalence of non-significant contrast between Assistant professors and Associate professors working in the University.

Sarvanan (2003) reported that more than half (56.67%) of extension personnel working in the Farm Communication Centres, colloqually known as Raita Samparka Kendra, revealed low job competence whereas one-sixth (16.67%) revealed high levels of job competence. The rest 26.67 per cent belonged to medium level of job competence.

Vijaibabu (2005) concluded that two-third (66.67%) of the agricultural officers had rated themselves into the medium level of job competence followed by 17.65 per cent in low level and 15.68 per cent in high level of the concerned category.

Raut (2006) discovered that majority of the Agricultural Assitants and their immediate superiors have been rated as good in the level of job competence of the Agricultural assistants in the numbers of 72.00 per cent and 48.08 per cent respectively.

Solomon (2013) endeavoured to investigate the dimension of competency winning among the administrators working in public sector units. The consequences of the examination demonstrated that almost half (50%) of the respondents had a moderate dimension of administrative HR and general skills.

The results of the present research investigation put-forward the on-detail interpretation of the levels of job competence of teachers working in the Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. It does aid to give an account of the existing levels of teachers with respect to their competency as needed into their job. Thus, it would be of worthwhile to the concerned policy makers at the top level management, administrators, professional and other miscellaneous personnel who does have direct or indirect stakes in the structural framework and functional operationality of the University, to invent, discover and evolve their prevalent human resource management system for the sake of generating and nurturing a positive compatible and congenial work atmosphere in the way of achieving the goals, aims and objectives of the particular organisation.

MATERIALS AND METHODS

The investigation was conducted in the three campuses of Bhubaneswar, Chiplima and Bhawanipatna of the University. The teaching personnel working for the University in those campuses were considered to be respondents. Under the aegis of Ex-post facto design, 30 respondents from each of the three campuses by following disproportionate random sampling. Therefore, total of 90 respondents were considered for the investigation. The statistical tools like mean, percentage and standard deviation were employed for the on-going analysis.

The Job Competence of teachers was evaluated by using the scale developed by Reddy (1990) with slight modifications. The scale comprised of 10 dimension where under each dimension comprising of six statements and therefore yielding a scale of 60 statements. In the current investigation, the competence was measured in two formats where one was self-rating in which the concerned respondents were asked to rate themselves in the scale of competence and the other was rating by superior where the ratings in the scale on behalf of respondents were produced by the

next superior, in this case, the Head of the concerned departments. The overall job competence of teachers was yielded by considering the arithmetic mean of scores obtained from both self-rating and rating by superiors.

RESULTS AND DISCUSSION

Table 1 inferenced that more than half of teachers (53.33%) accorded to the medium level of job competence whereas 12.22 per cent and 34.45 per cent were found to be in the low and the medium levels of job competence. As per Table 2, the results depicts the ratings provided by the superiors to the teachers working in their department. It was evident that 58.89 per cent of the teachers belonged to the medium level of job competence followed by 18.89 per cent and 22.22 per cent belonged to the categories of low and high level respectively. The results of overall Job competence were depicted in the Table 3. It could be inferenced that majority of teachers (55.55%) pertained to the medium category of job competence whereas in the low and high levels of job competence were 16.66 per cent and 27.79 per cent respectively.

The logical rationality of taking two types of rating- "Self-rating" and "Rating by Superiors" is that no doubt, any well-educated and working individual will be very much aware of her or his strengths and weakness in terms of their skillset, knowledge and attitude forming their behaviour, but there are certain aspects of it that even the concerned individual is not consciously aware of it. Another issue is that it is in the normal human psychology that whenever a person is asked regarding its competency, they would prefer to showcase their strengths as much as possible which is quite contrasting with respect to their weakness because nobody would ever display their own weakness or shortcomings to others publicly. To keep a check on such types of human-induced errors, another rating is being taken from the personnel of their immediate superiority, here it is Head of the Departments, as they have seen the teachers in the real-life action and thus can accurately as well as reliably could convey their real behaviour under the framework of teaching professionalism at the ground level. It is just like looking at the report card of the student and then simultaneously asking the respective class teachers to analyse and determine the actual performance and progress of the concerned student in the class.

The Table 4 represents the in-details investigation of job competence of teachers with respect to its ten sub-components or dimensions that comprises of Technical Knowledge, Guidance, Communicative ability, Adaptability, Self-Development, Creativity, Empathy, Mental Agility, Initiative and Judgement. From both of these, it can be pointed out that the dimension Technical Knowledge and guidance had

Table 1: Job competence of teachers (Self-rating

Extent of job competence	No. of respondents	Per cent	Mean	S.D.
Low (<178.54	11	12.22		
Medium (178.54-193.67)	48	53.33	186.105	15.13
High (>193.67)	31	34.45		

Table 2: Job competence of teachers (Rating by Superiors) (n=90)

Extent of job competence	No. of respondents	Per cent	Mean	S.D.
Low (<162.54)	17	18.89		
Medium (162.54-181.94)	53	58.89	172.249	19.4
High (>181.94)	20	22.22		

Table 3: Overall job competence of teachers (n=90)

Extent of job competence	No. of respondents	Per cent	Mean	S.D.
Low (<170.82)	15	16.66		
Medium (170.82-188.53)	50	55.55	179.177	18.3
High (>188.53)	25	27.79		

Table 4: Job Competence of teachers with respect to their different dimensions (n=90)

S.No.	Dimensions	Number of items	Maximum score	Mean scoreindex (self-rating)	Mean score index (Rating by superior)
1.	Technical knowledge	6	24	90.69	85.13
2.	Guidance	6	24	89.53	85.19
3.	Communicative ability	6	24	87.70	83.24
4.	Adaptability	6	24	86.25	75.32
5.	Self-development	6	24	81.53	81.19
6.	Creativity	6	24	79.12	75.42
7.	Mental ability	6	24	82.35	79.84
8.	Initiative	6	24	81.78	83.05
9.	Judgement	6	24	82.78	77.39
10.	Empathy	6	24	86.52	78.45

received the maximum responses from respondents in both the modes of self-rating and rating by superiors.

This pattern was followed by communicative ability, empathy, adaptability, judgement, mental ability, initiative, self-development and creativity under the category of self-rating whereas it was communicative ability, initiative, self-development, mental ability, empathy, judgement, creativity and adaptability under the category of rating by superiors.

It can be pointed out that the dimensions Technical Knowledge and Guidance proves to be dominant force in terms of their contributions to overall job competence of teachers to be affirmed both by the teachers and their superiors (Head of their respective departments). Another look at this wholesome information reveals that the components contributing least amongst all other components to the job competence of teachers were found to be self-development and creativity in case of self-ratings whereas in case of ratings by superiors, these were found to be creativity and adaptability. Here the low levels of creativity and self-development could be attributed to the strict adherences to old-fashioned syllabus regime, lack of promotional and support avenues and the pressure or burdens of workload from finishing the courses of student in a timebound manner and restricted framework of the University's formal education system. The ratings by superiors have revealed the least contributions by adaptability which speaks of the opinion of concerned Head of the departments with regards to their teacher's inability to adapt to the classroom teaching surroundings in the college campus.

CONCLUSION AND SUGGESTION

The results obtained from the research study gives the impression of predominance of medium level of overall job competence as well as in case of both the self-rating and ratings by superiors. This shows that there is still ample room for progress and improvement in the current level of competency capacity of teachers.

By looking into the dimension-wise analysis of job competence, the component Technical Knowledge and Guidance received maximum responses in both the categories of self-rating and superior rating as well which states their proficiency in acquired knowledge bases for theory-cum-practical classes and their ability to give proper directions to students on their mission of seeking wisdom in the educational field of agriculture and allied sciences. But the components of self-development and creativity were in least contributing sectors to job competence in terms of self-rating which expresses the displeasure over the inability to innovate themselves from out of box and thus affecting their own development eventually. In case of rating by superiors, along with creativity, adaptability was found to be least contributing to job competence which states the concern of Head of the departments about the teachers inability to adapt rapid changes to environment in the University. Therefore, adequate focus must be given to such components on the voyage of improving the job competency levels of teachers.

A solution oriented approach needs to be devised by taking into the policy considerations of all the stakeholders especially the Head of the department and the teachers of the respective department to tackle these issues for the sake of overall betterment of the organization as the State Agricultural University is one of the vital asset of the agriculture and allied sectors of that concerned state.

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Farmers' Perspective on Relevance and Importance of *kisan melas*

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ABSTRACT

Among all the techniques of transfer technology *kisan melas* are considered significant to spread awareness about new technologies to large number of farmers. Punjab Agricultural University (PAU), Ludhiana through its Directorate of Extension organizes *kisan mela* at PAU campus and through a network of Krishi Vigyan Kendras (KVKs) in various agro-climatic zones. The present paper aims at the providing insights into the *kisan mela* organized by PAU, Ludhiana in the year 2019 from the farmers' perspective. A total of 180 farmers who visited the *mela* were interviewed using interview schedule. The data were collected on various parameters and analyzed using appropriate statistical tools. The study indicates that the majority of the respondents visiting *kisan mela* were in the age group of 30 to 50 years, had education up to high school, own medium land holdings and small animal holdings, follow wheat paddy cropping pattern and were the frequent visitor of *kisan melas*. The majority of farmers were satisfied with the latest technical information related to agriculture provided in *kisan mela* through exhibitions. Majority of them were however not satisfied with the arrangements regarding eatables and entertainment. Efforts are required to increase the outreach of monthly magazines of PAU for further timely dissemination of knowledge.

Keywords: *Kisan mela*, Satisfaction, Agriculture technology, Visit

INTRODUCTION

India being an agrarian country the dependency of majority of population on agriculture and allied sector is eminent. There has been a constant improvement in the agriculture based technologies. It is therefore imperative that the improved technologies are disseminated to large number of farmers in short duration of time. A lot of information sources using various communication techniques are used aiming to spread awareness about the new technologies among farmers and to address their problems. Among all the techniques of technology transfer, role of *kisan mela* is significant as this is the key to spread awareness about the new technologies among farmers and to address their problems.

Kisan melas provide farmers an opportunity to witness the latest proven technologies. Exhibitions on the advance technologies provide opportunity for face to face interactions between farmers and scientists. Sale of latest varieties of seeds, plants and vegetable sapling, on the spot technical solutions, demonstrated through visits of experimental sites and information dissemination on latest machinery, banking and other sectors, informal discussions with the scientists, display of success stories are key highlights of *kisan mela*.

These *kisan melas* are organized by the State Agricultural Universities (SAUs) which were established on the pattern similar to that of land-grant universities in US. The Directorate of SAUs organizes *kisan melas* to bridge the gap regarding the technological advances in the field of the agriculture and allied areas and the farmers. Punjab Agricultural University (PAU), Ludhiana which played a vital role in providing the momentum to green revolution which started during the late 1960s and early 1970s in India, through its Directorate of Extension organizes *kisan melas* at PAU campus and through a network of Krishi Vigyan Kendras (KVKs)

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in various agro-climatic zones. *Kisan melas* organized by PAU plays an eminent role in rapid transformation of agriculture during this period due to timely dissemination and adoption of new agricultural technologies.

Although *kisan melas* undoubtedly are important tool of disseminating information to large number of farmers in short duration of time however the success of any extension programme including *kisan mela* depends on the feedback and satisfaction of the clients for whom it is meant. Therefore for better outcome and successful conduct of *kisan melas* the feedback of the visitors regarding the various aspects of *mela* is imperative. The present paper aims at the providing insights into the *kisan mela* from the farmers' perspective and feedback which would be useful for smooth conduct and better utilization of various services provided at the *kisan melas*.

MATERIALS AND METHODS

The present study was conducted in the *kisan mela* organized by Punjab Agricultural University (PAU), Ludhiana in the year 2019. A total of 180 farmers who visited the *mela* were interviewed by using interview schedule method. The data was collected on various parameters including the frequency of visit to *mela,* purpose of visit to *mela*, source of information about the *mela,* amount of money spent on visiting *mela*, satisfaction about the technical information provided in the *mela,* arrangement about eatables, entertainment and subscription of literature of PAU along with various indicators on the socio-economic background of the respondents. The data were tabulated and analyzed using appropriate statistical tools.

RESULTS AND DISCUSSION

Information on the socio-economic characteristics is important to study the social and economic background of the respondents. Data regarding the age, education, operational land holdings, animal holdings and cropping pattern was collected from the respondents. The data in Table 1 revealed that the average age of the farmers visiting the *mela* is 39.8 years. Further seven out of every ten respondents were in the age group of 30 to 50 years while one-fourth of them were relatively young (in the age below 30 years). Das *et al.* (2020) reported that about 68.00 per cent of respondents who visited *kisan mela* organized by Govind Ballabh Pant University of Agriculture and Technology, Pantnagar were from age group of 33-55 years. Education is an important tool in disseminating the technological advances to the farmers. The data from the present study indicate that farmers were formally educated as only 4.5 per cent of the respondents were illiterate while a majority of them (32.2%) had education up to high class. A little more than one-fourth of the respondents had education up to senior secondary and about 15.00 per cent of them were graduates. Similar study conducted by Pratap *et al.* (2019) also points to the fact that formal education

Table 1: Distribution of respondents according to their socio-economic background (n=180)

Category	Frequency	Percentage
Age (years)		
Below 30 years	44	24.4
30-50 years	126	70
Above 50 years	10	5.6
Education		
Illiterate	8	4.5
Primary	26	14.5
Middle	14	7.8
High	58	32.2
Senior Secondary	46	25.5
Graduate	28	15.5
Operational Landholdings (acres)		
Landless	14	7.8
Marginal (< 2.0)	56	31.1
Small (2.0 to 5.0)	36	20
Medium (5.0 to 10.0)	62	34.4
Large (>10.0)	12	6.7
Animal holdings		
No animal	26	14.45
Small (1-5)	102	56.67
Medium (6-10)	38	21.1
Large (> 6)	14	7.78
Cropping Pattern		
Wheat-Paddy	102	56.6
Wheat-Paddy-Vegetables	36	20
Wheat-Paddy- Fodder-Sugarcane	26	14.4
Wheat-Paddy-Sugarcane	16	8.89

has spread in pastoral society. The findings of the present study are in line with the study conducted by Gangil *et al.* (2019).

Land holdings and animal holdings of the farmers are indicative of the economic status of the farmers. In the present study of all the respondents more than one-half were small or marginal farmers having land holdings less than 5 acres, followed by medium farmers (34.4%) with land holdings between 5 to 10 acres. Only a few (6.7%) respondents had land holdings of more than 10 acres. These are in line with the study conducted by Rani and Rampal (2016) which also indicated that majority of the farmers had small and medium land holdings and attributed the small land holdings to the fragmentation of ancestral land from generation to generation. More than 55.00 per cent of farmers had 1 to 5 animals followed by one-fifth who had about 6 to 10 animals (Table 1). The study conducted by Gupta *et al.* (2020) indicated that only 5.3 per cent of the farmers had large animal holdings. More than 56.00 per cent of the respondents had wheat-paddy cropping pattern while one-fifth of them had wheat-paddy and vegetables cropping pattern. Fodder, sugarcane along with wheat and paddy was followed by more than 14.00 per cent of the farmers visiting *kisan mela*. It can thus be concluded that the majority of the respondents visiting *kisan mela* were in the age group of 30 to 50 years, had education up to high school, and had medium land holdings and small animal holdings and follow wheat paddy cropping pattern.

Frequency of visit to *kisan mela* is an indicator of the relevance and popularity of *kisan mela* among the farmers. Majority of the farmers are frequent visitors of *kisan mela* and about seven out of every ten farmers are visitor of both the *kisan melas* organized during March and September (Table 2). While about 14.00 per cent visited *kisan mela* only in September and similar proportion (13.33%) visited *kisan mela* in March only. These findings are in line with the studies conducted by Prasad (2002); Rani and Rampal (2016) and Gangil *et al.* (2019) which indicated that majority of the respondents participated regularly in *kisan mela* conducted in Punjab Agricultural University, Ludhiana twice a year. Further similar results are also reported by Rana and Ansari (2019) who reported that about 96.00 per cent of the rural women visited fairs and festivals within and outside the village. This indicates the popularity of *kisan mela* being conducted twice a year in Ludhiana.

Table 2: Distribution of respondents according to the frequency of visit to *kisan mela* (n=180)

Kisan mela	Frequency	Percentage
March	24	13.33
March-September	130	72.22
September	26	14.45

The publicity of *kisan mela* is done through different modes and channels so that the information reaches the farmers on time. Among the various sources of information KVK, friends, fellow farmers and farm literature such as *change kheti* and progressive farming are most common. Use of internet and WhatsApp group of farmers is latest addition in the channels for providing the information. The data regarding the source of information about the *kisan mela* indicates that more than half of the respondents received information about the *kisan mela* from KVK while more than one-fourth of the respondents got information from internet or WhatsApp (Table 3). Literature such as *change kheti* or progressive farming was source of information in more than 12.00 per cent of the respondents while one in every 10 respondents got the information about the *kisan mela* from friends or relatives. Gupta (2020) in a study conducted regarding the source of information regarding *kisan mela* found that most of the respondents obtained information from one or more than one source of information. This is still relevant as indicated in the present study.

Kisan mela provides an opportunity for the farmers to interact with the scientists and get technical information on the latest advances in agriculture and allied areas through exhibitions, stalls of various departments, latest seeds of various crops, various stalls

Table 3: Distribution of respondents according to the source of information about *kisan mela* (n=180)

Source of information	Frequency	Percentage
KVK	96	53.30
Internet/Whatapp	44	24.45
Friends/relatives	18	10.00
Changi Kheti/Progressive Farming	22	12.20

Table 4: Purpose of visit to *kisan mela*

Purpose	Frequency	Percentage
Technical knowledge through exhibitions	150	83.30
Latest information related to agriculture	130	72.20
Seed purchase	156	86.60
Information related to animal husbandry	110	61.1

(Multi-purpose response)

of private companies, display of latest agriculture related machinery. The purpose of visiting *kisan mela* is indicated in Table 4 which clearly shows that majority of farmers visited *kisan mela* to purchase seed (86.60%) followed by getting technical knowledge through exhibitions (83.30%). More than 72 per cent of the respondents visited *kisan mela* to get latest information related to agriculture. These findings are in line with the findings of studies conducted by Gangil *et al.* (2019) which indicates that the main purpose of visit of farmers to *kisan mela* was to get information about new practices followed by purchase of agriculture/ horticulture/crop/fodder related inputs. Studies conducted by Talwar (2017) also indicated similar findings.

The data from Table 5 indicates that majority of the respondents spent Rs. 500 to Rs.1000 on visit to *kisan mela* while more than one-fourth of them have spent less than Rs. 500 to visit *mela*. A little less than one-fifth spent more than Rs. 1500 to visit *kisan mela*. A majority of respondents (61.10%) spent Rs. 500 to Rs. 1000 on eatable during their visit to *kisan mela*. Only one in every ten respondents spent more than Rs. 1500 on eatables during the *kisan mela*. There are not many studies directly indicating the amount of money spent on visit to *kisan mela* and on eatables but study conducted by Pratap (2019) while indicating the constraints faced by *kisan mela* visitors at SVPUAT, Meerut has pointed that 23.33 per cent *kisan mela* visitors perceived that visit to farmers fare is expensive one in terms of money and it was also time consuming.

Table 5: Amount of money spent on visit to *kisan mela* (n=180)

Amount	Frequency	Percentage
Money spent to visit mela		
Less than Rs. 500	50	27.78
Rs. 500 to Rs. 1000	68	37.78
Rs. 1000 to Rs. 1500	30	16.67
More than Rs. 1500	32	17.78
Money spent on eatables		
Less than Rs. 500	24	13.33
Rs. 500 to Rs. 1000	110	61.10
Rs. 1000 to Rs. 1500	28	15.56
More than Rs. 1500	18	10.00

Satisfaction of the farmers on the various aspects of *kisan mela* was assessed on various indicators such as technical information, arrangement about eatables, arrangement about entertainment and purpose of the visit to *kisan mela* using three-point scale. The data indicated that majority of farmers (82.20%) very satisfied with the technical information provided during the *kisan mela*. The findings of the present study are in line with the study conducted by Shirur (2014) which found that majority of the farmers agreed that they were benefitted with such *melas and goshtis*. Similarly, Gangil *et al.* (2019) which indicates that 82.50% of farmers perceived that these *kisan melas* were beneficial for the rural people. Similarly only 7.78 per cent were not satisfied on this aspect of *kisan mela* (Table 6).

Table 6: Satisfaction regarding various aspects of *kisan mela* (n=180)

Aspects	Frequency	Percentage
Technical Information		
Very much Satisfied	18	10.00
Satisfied	148	82.20
Not satisfied at all	14	7.78
Arrangement about eatables		
Very much Satisfied	46	25.56
Satisfied	110	61.11
Not satisfied at all	24	13.33
Arrangement about entertainment		
Very much Satisfied	38	21.11
Satisfied	94	52.22
Not satisfied at all	48	26.67
Purpose of visiting kisan mela		
Very much Satisfied	22	12.22
Satisfied	142	78.89
Not satisfied at all	16	8.89

The data from the present study further shows that about three-fifths of the farmers expressed their satisfaction regarding the arrangement about eatables and one-fourth of them were very satisfied with the arrangement of eatables. Only 13.33 per cent of the farmers visiting the *kisan mela* were not satisfied at all on this aspect. More than one-half of the farmers were satisfied with the arrangement about entertainment during *kisan mela*. More than one-fourth were not satisfied at all on this aspect while almost same proportion expressed their satisfaction on this aspect. A majority of respondents (78.89%) expressed that they were satisfied regarding the visit to *kisan mela* and their purpose of visit was served while 12.22 per cent were very much satisfied on this aspect (Table 6).

Overall it can be concluded that the farmers expressed their satisfaction on all the aspects while the proportion of farmers who expressed that they were not satisfied with the arrangements regarding eatables and entertainment were on higher side as compared to other aspects. This indicates a scope of improvement on these aspects of *kisan mela*.

Changi Kheti and Progressive Farming, the monthly magazines of PAU provide updated technical information related to agriculture and allied aspects. A majority of respondents (61.11%) expressed that they have not subscribed agriculture literature of PAU (Table 7).

Table 7: Subscription of agriculture literature of PAU (n=180)

Subscription	Frequency	Percentage
Yes	70	38.89
No	110	61.11

CONCLUSION

The findings of the present study indicates that the majority of the respondents visiting *kisan mela* were in the age group of 30 to 50 years, had education up to high school, own medium land holdings and small animal holdings and follow wheat paddy cropping pattern. Majority of the farmers are frequent visitors of *kisan mela* and about seven out of every ten farmers are visitor of both the *kisan melas* organized during March and September. The data regarding the source of information about the *kisan mela* indicates that more than half of the respondents received information about the *kisan mela* from KVK while more than one-fourth of the respondents got information from internet or WhatsApp. A majority of farmers visiting *kisan mela* expressed purchase of seeds and technical knowledge through exhibitions as the purpose of visiting *kisan mela*. Further the data indicate that a majority of respondents spend about Rs. 500 to Rs. 1000 on eatables during their visit to *kisan mela*. Satisfaction about the technical information provided during *kisan mela* was expressed by a majority of the respondents. On the other hand less satisfaction was expressed with the arrangements regarding eatables and entertainment. This indicates a scope of improvement on these aspects of *kisan mela*. Efforts are required to increase the outreach of monthly magazines of PAU for further timely dissemination of knowledge as majority of respondents expressed that they have not subscribed agriculture literature.

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Factors Associated with the Organizational Climate Perception Among Faculty of Farm Universities in Karnataka

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ABSTRACT

The present study was conducted in Karnataka state to measure the perception of organizational climate among faculty of UAS Dharwad, UHS Bagalkot and KVAFSU Bidar and to identify factors contributing to it. It was noticed that majority of faculty in UHS Bagalkot (71.11%), followed by UAS Dharwad (62.22%) and KVAFSU Bidar (60.00%) were moderate level of organizational climate. The correlation results pointed out that out of 11 selected independent variables achievement motivation, and job satisfaction exhibited positive and highly significant relationship at one percent level with the perception of organizational climate among the faculty of all the selected SAUs. Multiple regression analysis revealed that, all the selected 11 variables put together exerted 54.80 per cent contribution for perception of organizational climate in UHS Bagalkot, followed by UAS Dharwad (41.30%), and KVAFSU Bidar (31.20%). Regression coefficient showed that only five independent variables *viz.* professional training acquired, achievement motivation, perceived work load, job satisfaction and organizational commitment contributed towards perception of organizational climate.

Keywords: Achievement motivation, Job satisfaction, Organizational commitment, UAS Dharwad, UHS Bagalkot, KVAFSU Bidar

INTRODUCTION

Organizational climate is multidimensional construct and refers to the individual's perception of work environment. It describes the personality of the organization and influences the motivation and behaviour of the members of the organization. It is the result of interaction among an organization's structure, systems, culture, leader behaviour and employees' psychological needs (Pareek, 1989). Organization climate also have a direct bearing on the job satisfaction of employees and also enhances positive organizational outcomes such as efficiency, productivity, organizational commitment and cohesiveness of co-workers (Ahmad *et al.*, 2010). All these result in lower employee turnover, higher employee productivity and greater organization effectiveness.

Litwin and Stringer (1968) reported that "perception of organizational climate has major influence on satisfaction, motivation, work efficiency and productivity of university faculty members so it is upmost important that an understanding of organizational climate helps faculty to discover how the organization serves as psychological as well as social meaningful environment for its member. Agricultural universities which contribute significantly to agricultural development occupies central position among academic organizations and have main motto for improvement of agriculture, its allied sectors as well as farming communities. These Universities operate on the concept of integration of three basic functions of teaching, research and extension with a large number of specialized disciplines and departments. The technical expertise and commitment of faculty of

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various agricultural universities is of paramount importance which has a direct bearing on the generation and transfer of improved agricultural technology. The congenial organizational climate provides for efficient functioning of the faculties working in these organizations and ultimately helps in achieving the objectives of the organization.

MATERIALS AND METHODS

The study was conducted in the purposively selected three different universities viz. University of Agricultural Sciences (UAS), Dharwad, University of Horticultural Sciences (UHS), Bagalkot and Karnataka Veterinary Animal and Fisheries Science University (KVAFSU), Bidar of Karnataka state. These universities were purposively selected with the objective of comparing the three different organization addressing three dimensions of farming-agriculture, horticulture and veterinary. Since the phenomenon has already occurred the *ex-post facto* research design was used for conducting the proposed study. From the list of faculty working in these three universities 45 faculty members were selected from each university by following random sampling method to form total sample size 135 faculty members.

Perception of organizational climate among faculty of state agricultural universities was measured by using the scale developed by Rajeev (1988) with slight modification. The scale consisted of 25 items representing several organizational climate dimensions, which were assessed on five-point continuum *viz.* for always true, usually true, sometimes true, rarely true and never true with a weightage of 5,4,3,2 and 1, respectively for positive statements and 1,2,3,4 and 5 for negative statements respectively. The responses obtained from the respondents were then multiplied by the scale values of respective items and summed up to obtain the final score of organizational climate perception of individual faculty. The respondents were categorized into three groups based on the mean and standard deviation as follows.

Category	Criteria
Less favourable	Below (mean – 0.425 SD)
Moderate level	Between (mean ± 0.425 SD)
More favourable	Above (mean + 0.425 SD)

The methods followed for operationalization and measurement of independent variables as follows.

Independent variables	Procedure followed
Gender	Procedure followed by Chandargi (1996)
Age	Procedure followed by Petry (2002)
Professional training acquired	Procedure followed by Meti (1992)
Job experience	Procedure followed by Bosco (2000)
Family background	Scoring procedure followed by Manjula (2000)
Marital status	Scoring procedure followed by Ivancevich (1982)
Job stress	Scale developed by Matteson *et al.* (1982)
Achievement motivation	Scale developed by Prasad (1983)
Perceived work load	Scale developed by Meti (1992)
Job satisfaction	Scale developed by Manjula (2000)
Organizational commitment	Scale developed by Matteson and Ivancevich (1982)

The relation between perception of organizational climate by faculty with selected independent variables was studied by applying Pearson's simple correlation coefficients.

RESULTS AND DISCUSSION

The perception of organizational climate as presented in Table 1 revealed that more number of faculty in UHS Bagalkot (71.11%), were noticed in moderate level of organizational climate followed by UAS Dharwad (62.22%) and KVAFSU Bidar (60.00%). Whereas more favourable level of organizational climate perception was noticed comparatively more with the faculty of KVAFSU Bidar (22.22%) followed UAS Dharwad (20.01%) and UHS Bagalkot (15.55%). While incidence of less favourable level of organizational climate perception was noticed comparatively more with the faculty of KVAFSU Bidar (17.78%) followed by UAS Dharwad (17.77%) and UHS Bagalkot (13.34%).

Perception of organizational climate of the respondents of all the three universities together indicated that 64.45 per cent perceived organizational climate as moderate level followed by 19.25 per cent and 16.30 per cent of respondents as more favourable and less favourable respectively. Possession of better achievement motivation, manageable workload, and

Table 1: Distribution of faculty of farm universities according to their perceived organizational climate

Category	UAS Dharwad (n_1-45)		UHS Bagalkot (n_2-45)		KVAFSU Bidar (n_3-45)		Overall (n=135)	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Less favourable	8	17.77	6	13.34	8	17.78	22	16.30
Moderate level	28	62.22	32	71.11	27	60.00	87	64.45
More favourable	9	20.01	7	15.55	10	22.22	26	19.25
Mean	97.95		96.64		99.93		98.18	
SD	8.93		9.19		8.98		9.07	

medium to high level of organizational commitment and satisfaction were the reasons for high incidence of moderate to more favourable organizational climate perception. Similarly, the past research studies conducted by Gogoi and Talukdar (1992); Halakatti and Sundaraswamy (1997) and Sandic (2006) also reported the more incidence of moderate to highly favourable organisational climate perception.

The relationship of selected independent variables with organizational climate of faculty depicted in Table 2 highlighted that out of 11 selected independent variables two variables namely achievement motivation, and job satisfaction exhibited positive and highly significant relationship at one percent level with the perception of organizational climate among the faculty of all the selected SAUs. Whereas organizational commitment shown positive significant relationship at one percent level with the faculty of UAS Dharwad and UHS Bagalkot, but significantly related at five percent level of significance in case of KVAFSU Bidar. Whereas job stress and perceived workload shown negative significant relationship among the faculty of all the three SAUs.

Further the overall distribution revealed the incidence of positive significant relationship of achievement motivation, job Satisfaction and organizational commitment at one percent level with organizational climate, whereas job stress and perceived work load exhibited negative significant relationship. Whereas gender, age, professional training acquired, job experience, family background and marital status did not show any relationship with perception of organizational climate.

It is evident that faculty irrespective of their gender, age, family background strives to achieve and contribute to growth of organization. Similarly, responsibilities and duties of the faculty, similar working conditions,

Table 2: Relationship between independent variables and organizational climate among faculty of farm universities

Independent variables	UAS Dharwad (n_1-45)	UHS Bagalkot (n_2-45)	KVAFSU Bidar (n_3-45)	Overall (n=135)
	r value	r value	r value	r value
Age	0.087^{NS}	0.046^{NS}	0.125 ^{NS}	0.093 ^{NS}
Gender	0.040^{NS}	0.064 ^{NS}	0.056 ^{NS}	0.083 ^{NS}
Professional training acquired	0.080^{NS}	0.140 ^{NS}	0.099 ^{NS}	0.081 ^{NS}
Job Experience	0.102 ^{NS}	0.145 ^{NS}	0.137 ^{NS}	0.098 ^{NS}
Family background	0.054 ^{NS}	0.032 ^{NS}	0.116 ^{NS}	0.054 ^{NS}
Marital status	0.021 ^{NS}	0.057 ^{NS}	0.102 ^{NS}	0.076 ^{NS}
Job Stress	-0.272*	-0.296*	-0.269*	-0.258*
Achievement, motivation	0.498**	0.570**	0.484**	0.505**
Perceived work load	-0.231*	-0.261*	-0.283*	0.236*
Job Satisfaction	0.423**	0.475**	0.354**	0.419**
Organizational commitment	0.427**	0.548**	0.281*	0.428**

Table 3: Multiple regression analysis of independent variables with organizational climate

Independent variables	UAS Dharwad (n_1-45) b value	UHS Bagalkot (n_2-45) b value	KVAFSU Bidar (n_3-45) b value	Overall (n=135) b value
Age	1.087^{NS}	-1.046^{NS}	2.125*	1.093^{NS}
Gender	0.087^{NS}	0.347^{NS}	1.347^{NS}	1.102^{NS}
Professional training acquired	2.087*	3.215*	1.259^{NS}	2.257*
Job Experience	2.394*	0.231^{NS}	1.435^{NS}	1.289^{NS}
Family background	1.229^{NS}	0.279^{NS}	1.389*	1.022^{NS}
Marital status	1.932^{NS}	0.238^{NS}	1.230^{NS}	0.926^{NS}
Job Stress	0.597*	-1.092^{NS}	-0.753^{NS}	-1.347^{NS}
Achievement Motivation	3.356*	6.321**	2.399*	4.124*
Perceived work load	-1.245	-2.342	0.237	1.327*
Job Satisfaction	5.512**	7.412**	4.232**	5.121**
Organizational commitment	4.238**	6.340**	3.263*	4.239**
Coefficient of determination (R^2)	0.413*	0.548*	0.312*	0.456*
F-Value	4.08	3.95	4.52	4.10

willingness and commitment toward job, working morale of faculty, faculty's determination and higher aspirations to excel favoured the situation. These findings were in line with the results of Nagnur (1992); Bosco (2000); Sontakki (1995); Mohan (2000); Manjunath (2004); Nagananda (2005) and Sandic (2006).

Multiple regression analysis was drawn to determine the extent contribution made by different independent variables and identify significant contribution towards perception of organizational climate (Table 3). The study exerted moderate influence on the perception of organizational climate in UHS Bagalkot (54.80%), followed by average influence in UAS Dharwad (41.30%) and KVAFSU Bidar (31.20%).

Six independent variables *viz*. professional training acquired, job experience, job stress, achievement motivation, job satisfaction and organizational commitment contributed significantly towards the variation in perception of organizational climate among faculty of UAS Dharwad. Whereas for the variation in perception of organizational climate among faculty of UHS Bagalkot, independent variables professional training acquired, achievement motivation, job satisfaction, and organizational commitment contributed significantly. But in KVAFSU Bidar the independent variables age, family background, achievement motivation, job satisfaction, and organizational commitment contributed significantly towards the variation in perception of organizational climate.

Further it was revealed that coefficient of determination (R^2) 0.456 of overall faculty members were significant as the value of "F" i.e. 4.10 statistically significant hence all independent variables put together contributed 45.60 per cent of variation in perception of organizational climate by faculty of State agricultural universities. Further the regression coefficient value showed that only five numbers of independent variables *viz*. professional training acquired, achievement motivation, perceived work load, job satisfaction and organizational commitment contributed significantly among twelve independents variables towards perception of organizational climate.

CONCLUSION

The results of the study revealed that majority of faculty were noticed in moderate level of organizational climate perception. Hence, there is scope to improve organizational climate perception by faculty of farm universities by considering determining factors like achievement motivation, perceived workload, job satisfaction and organizational commitment factors.

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The Effectiveness of the Flipped Classroom Method of Teaching on Students' Learning: An Empirical Study

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ABSTRACT

The flipped classroom is an innovative teaching approach that focuses on learner-oriented instruction. This study explores the effect of flipped classroom strategy on academic achievement in seven video tutorials in the course of mass communication and journalism. The study population consisted of all undergraduate second-semester community science students of the HECM Dept, ASPEE College of Home Science and nutrition, SDAU during the years 2018-19 and 2019-20. A whole population was taken as a sample size. A total of 25 students (13 students from the year 2018-19 and 12 students from the year 2019-20) who partook in this study were divided into two study groups: the experimental and control groups. The experimental group consisted of 13 students who taught using a flipped classroom, and the control group was composed of 12 students who taught in a traditional learning environment. To meet the study's objectives, an achievement test and expert session were designed for quantitative assessment, and a student perception survey was used as a qualitative assessment technique. Two samples of independent t-test and correlation were used to analyze the collected research data. The result showed that the students in the experimental group scored higher on the post-assessment test than the students in the control group for both years. A good statistical difference was observed between the flipped format of teaching and the traditional lecture method for six of the seven video tutorials of the course. The majority of the experimental group students expressed their positive perception of implementing the flipped classroom approach, reflecting their acceptance of this method. Positive perception of the experimental group of students strongly correlated to the learning gain. Further, the study recommended that training be imparted to the faculties and university professionals to use the flipped classroom approach for teaching, especially practical content courses, to improve students' academic performances.

Keywords: Achievement, Active learning, Flipped classroom, Lecture method, Video tutorial

INTRODUCTION

To teach is to engage students in learning. Quoted by Christensen *et al.,* engaged pedagogy captures the essence of the state of the art and practice of pedagogy. Educators, researchers, and policymakers consider student participation an essential aspect of meaningful learning (Barkley, 2010; Coates, 2006). Students' involvement in education is primarily the responsibility of the teacher, who becomes less a provider of knowledge and a facilitator of learning occurrences and opportunities.

Traditionally, a lecture is the most common method of teaching. The lecture isn't bad, but the problem with the lecture is a matter of pacing. Some students already know the information, while others may not understand the concepts presented in class. Active learning and student involvement are less in the lecture method. It is also accepted that students cannot continuously absorb new content for an hour as passive learners. Therefore, it is imperative to teach techniques like active and cooperative learning, problem-based learning, team projects, etc., which improve or supplement the traditional lecture method. The flipped

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classroom teaching model is one technique that replaces customary lectures with interactive classes and technologies to encourage audience participation. Technology plays a vital role in students' virtual learning in the present digital age. Students can access learning topics for free through various technology media or online platforms and easily interact with other students and instructors outside of the classroom (Fulton, 2012).

The flipped-classroom model and more simply, the flip is a pedagogical approach that has become something of a buzzword in recent years (Kurtz *et al.,* 2014). In short, "flipping the classroom" means that students are exposed to new material outside of the classroom by first watching lecture videos and then using the class time to do more challenging tasks to assimilate that knowledge through problem-solving, discussion, or debate (Educause, 2012; Alvarez, 2011; Moravec *et al.,* 2010). In the context of Bloom's revised Taxonomy (2001), this means that students are performing lower levels of cognitive functioning outside the classroom (gaining knowledge and comprehension) and higher level of cognitive functioning (application, analysis, synthesis, and/or evaluation) in the classroom, where they have the support of their peers and instructor (Krathwohl and Anderson, 2010). This model differs from the traditional model in that "first exposure" occurs through lectures in the classroom, in which students assimilate knowledge through homework. Hence the term "flipped classroom" is a reversal of traditional teaching which move the content consumption (usually through recorded videos) to out-of-class/independent time and move the exercises to in-class/lecture time; on the theory, it's more valuable to have the instructor involved at that stage than lecturing on the content. Hence the term flipped is also known as an inverted classroom (Halili and Zainuddin, 2015).

Rather than having students memorize factually, the basic purpose of flipped classrooms is to engage students in active learning and focus on applying students' conceptual knowledge. In the electronic age, interactive devices like the internet, video clips, mobile apps, and many other electronic gadgets have a special place in the heart of a remarkable generation (Fu, 2013). Flipped classrooms speak the language of today's students (Bergmann and Sams, 2012) because the availability of internet resources, including audio and video presentations, attracts students to virtual learning. Student-teacher interactions in the flip approach give teachers more opportunities for feedback that improve student learning. Thus inverted classrooms may not just be flipping the class, but the entire paradigm of teaching-where the teacher acts as an instructor rather than a knowledge imparter who carefully observes the students, identifying their learning needs and guiding them to higher learning levels. Therefore, an attempt has been made to develop digital learning content for students and use it in the flipped classroom teaching model. The learning environment has changed with the introduction of computers, the internet, the World Wide Web, ICT and other educational technologies into our lives. The flipped classroom approach boosts these changes into our learning environment where subject matter, instructional material, or content can be taught outside the classroom, at home, or at any additional time and place. These changes must be adopted by those individuals who have an essential role to play, particularly in teaching and learning and contributing to the educational environment by using the flipped classroom. Therefore, an attempt has been made to study the flipped classroom model's effectiveness on students' learning and future teaching.

MATERIALS AND METHODS

The study used an experimental research design to examine active learning between flipped and traditional classrooms. Therefore, the present research work was carried out in three phases: first, the creation of digital learning materials, second, the implementation of the flipped classroom model of teaching, and third, the assessment of the effectiveness of the flipped classroom model of instruction.

I. Creation of Digital Learning Content

Digital learning content is the high-quality academic material delivered through technology. It is what students learn. It includes video tutorials, podcasts, screencasts, slideshows, quizzes, and reference material. The present study used video tutorials/lectures as digital learning content.

The choice to use the flipped classroom teaching model for course HECM 102: Introduction of Mass Communication and Journalism "was made because it was more practical oriented. Out of 15 topics of

the course, seven useful oriented topics (46.66%) were selected for the experiment. After that, relevant content was created by the researcher and reviewed by an expert to make sure of its appropriateness according to the level of the students. The content was modified based on the expert's feedback. An investigator (course teacher) developed seven topics in the form of digital learning content, i.e. video lectures have been developed by an investigator (course teacher) using her real voice and audio-visual representations of materials. So that students would not feel strange and comfortable with known voice, accent, tone and gesture.

II. Implementation of Flipped Classroom Model of Teaching

Study area and sample selection: The study population consisted of all undergraduate second-semester community science students of the HECM Department, ASPEE College of Home Science and nutrition, SDAU during the academic year 2018-19 and 2019-20. A whole population was taken as a sample size. Twenty-five students (13 students from the year 218-19 and 12 students from the year 2019-20) who participated in this study were divided into two study groups: the experimental and control groups. The first group was the experimental group, which taught using a flipped classroom model, and the second was the control group, which led in a traditional learning environment. To achieve the principle of equalization in the two groups, a questionnaire consisting of 20 MCQs related to the HECM course was administered to all students to assess their pre-knowledge level for a subject. Based on total scores obtained by respondents, scores were arranged in descending order and rank them accordingly. Thus, the whole class was divided into two groups. The first group consisted of students of odd rank, known as the experimental group consisting of 13 students. Even rank of the students is known as a control group composed of 12 students.

Comparison of the flipped classroom model with the traditional model of teaching: To analyse the effectiveness of the flipped classroom model of teaching on students' learning, an experiment was conducted to compare a flipped classroom with a non-flipped class. For the flipped classroom teaching model, students of the experiment group watched 15 to 20 minutes of video lectures in a smart classroom that covered a particular topic. Simultaneously, the same teacher taught the students in the control group in the traditional teaching format (lecture) on the same subject. Teaching through the conventional method focused on presenting the unit's lessons by utilizing the textbook as the primary and only resource. The control group was not intervened during the experimental process, while the experimental group was being taught according to the flipped classroom model. Teaching for both study groups was held on the same day for a subsequent hour (i.e. control group was taught immediately after the experimental group). Post assessment was also performed quickly after completing the class for both groups. Flipped students were instructed not to share the provided resources with the control group of students before completion of the teaching and post-assessment process among both the groups.

III. Assessment of Effectiveness of the Flipped Classroom Model of Teaching

Quantitative and qualitative post-assessment techniques were designed and used for data collection in both groups to know the effect of both teaching models (flip and non-flip classroom approach) on student learning and performance and compare the flip approach with the traditional lecture method.

Quantitative assessment: includes achievement test and expert session, which were applied as a post-test to the experimental and control groups at the end of the experimental process.

Achievement test: An achievement test measures the student's ability after presenting educational experiences in a specific subject or a group of subjects. A test included 20 multiple-choice questions on the chosen topics, concepts or ideas that were solved, described, or shown in the videos and in traditional classes. Immediately after completing the teaching part, the Achievement test was administered to both study groups to assess the knowledge gained for related topics. Knowledge gain was measured by student scores in the achievement test, which the researcher prepared.

Expert session: is a session in which two experts have taken individual interviews of students to judge their

learning gained through watching a video or attending an ordinary lecture in class. The experts' session was administered after submitting the achievement test by students of both groups. The questions on a relevant topic prepared for the interviews were presented to two faculty experts in the field beside the faculty member giving the course. In line with the expert views, the necessary arrangements were made. Questions in Dichotomous format prepared with the most common option yes/no dichotomy. In this part, both experts asked ten items about each topic; thus, 20 questions were asked to the students to assess factual knowledge of the relevant text. In the achievement test & expert session, the scoring procedure for multiple-choice and dichotomous questions allocated a score of 1 for the correct answer. The scores were zero for no or wrong answers. At the end of the experimental process, an achievement test and expert session were applied as a post-test to the experimental and control groups.

Qualitative assessments: are based on a student perception survey (SPS). The investigator developed the survey instrument to identify students' perception (experimental group only) of the flipped classroom teaching model, referred to as SPS in the study. A total of 15 questions were asked in SPS to measure students' learning experience and general perception of the flipped classroom approach or use video as a learning tool for the course. Response options for each question are summarized into three categories: "Agree", "Neutral", and "Disagree" with a scoring pattern of 3, 2, 1 respectively. SPS was administered at the end of the study.

Data analysis: Two samples Independent 't' test was employed for analyzing data. This test is the measurement tool used to determine the significant difference when comparing the post-test score of the experimental group with the control group. A T-Test's p-value is used to determine the statistical significance between data sets. A set of data has a very strong statistical significance if it has a p-value less than or equal to 0.001, a strong statistical significance if it has a p-value between 0.001 and 0.05, and a weak statistical significance if it has a p-value between 0.05 and 0.1. Frequency was reported for the student perception survey. A correlation was used to analyse the relationship between post-test scores and perception of the students of the experimental group.

RESULTS AND DISCUSSION

In the present study, video tutorials/lectures were developed as digital learning content. To facilitate these, seven crucial topics from the course HECM 301: Introduction of Mass Communication and Journalism were selected and developed by an investigator (faculty expert) in seven video lectures for the experiment. Videos were designed with an understanding level of students in mind. It was expected that students would watch the videos and take a more active role by working along with the videos. The overview of seven video lectures is presented in Table 1.

Each video was fifteen to twenty minutes long and published on online platforms (YouTube), and shown to the students in the smart classroom. Students were introduced to new material each week; thus, they completed experiments for seven-week by weekly sharing videos. The developed video was implemented during the second semester of the academic year 2018-2019 & 2019-20. Comparing the flipped method of instruction with the conventional way, post-test scores

Table 1: Overview of video lecture for the course "Introduction of Print and Mass Communication."

S.No.	Video Lecture (VL)	Title of The Topic	Online link
1	Video lecture 1	Teaching and Learning	https://youtu.be/05XsJB8nZ4o
2	Video lecture 2	Mass Communication	https://youtu.be/PdTLTUFaFUo
3	Video lecture 3	Mass Media	https://youtu.be/C-cbl8VmXYA
4	Video lecture 4	Newsletter	https://youtu.be/78Z2zrakYGA
5	Video lecture 5	Audio media	https://youtu.be/I9Ilp-enL3U
6	Video lecture 6	Radio script	https://youtu.be/3YwXLuMtD6o
7	Video lecture 7	Camera	https://youtu.be/Bahj7OP5Myo

* The video was developed by the researcher (Subject expert)

of an expert session and achievement test obtained by experimental and control groups were evaluated for the seven video tutorials developed by the researcher. Mean ± Standard Deviation (SD) was used to summarize the scores. An independent sample t-test was used to compare the difference between the learning gain of an experimental and control group. The results of all seven video tutorials have been presented in Table 2.

The data of the expert's session incorporated in Table 2 indicate that there was a significant difference found between average scores of students of experimental and control groups for four, fifth, sixth and seventh video tutorials while no significant difference was observed for first, second, third and fourth video tutorials.

A perusal of data in Table 3 depicts that the respective 't' values regarding the expert's session and achievement test were highly significant at a one per cent level of significance. This value indicates that the flipped classroom has a significant effect on students' academic achievement. Flipped classroom model is more supportive, especially for weaker students; therefore, the whole group's performance was similar. Unlike the traditional lecture, a wide gap in learning gain was prevalent among the control group students. Consequently, it concluded that there was a highly significant difference between the mean scores of the

Table 2: The Difference in post-assessment scores between the experimental and control group regarding seven video tutorials in the flipped classroom teaching model for the year 2018-19

Video tutorials	Post assessment	Group	Mean score ± S.D.	Mean difference	t-value	P-value
First	Expert Session	Experimental Control	12.29 ±1.89 12.17 ±4.49	0.11	0.064	0.950
	Achievement test	Experimental Control	14.00 ±1.41 12.83 ±2.48	1.16	1.063	0.311
Second	Expert Session	Experimental Control	17.57 ±1.90 16.57 ±2.25	0.90	0.786	0.449
	Achievement test	Experimental Control	14.00 ±2.94 12.17 ±3.25	1.83	1.067	0.309
Third	Expert Session	Experimental Control	17.29 ±2.43 15.33 ±1.63	1.95	1.667	0.124
	Achievement test	Experimental Control	15.14 ±1.57 13.33 ±2.94	1.81	1.414	0.185
Fourth	Expert Session	Experimental Control	15.29 ±1.49 13.50 ±1.64	1.78*	2.151	0.050
	Achievement test	Experimental Control	14.43 ±1.13 11.67 ±2.94	2.76*	2.304	0.042
Fifth	Expert Session	Experimental Control	14.71 ±1.49 12.00 ±.00	2.71**	4.416	0.001
	Achievement test	Experimental Control	13.29 ±1.79 09.83 ±0.75	3.45**	4.362	0.001
Sixth	Expert Session	Experimental Control	15.57 ±2.22 11.33 ±2.65	4.23**	3.133	0.010
	Achievement test	Experimental Control	15.71 ±1.97 12.67 ±2.94	3.04*	2.304	0.042
Seventh	Expert Session	Experimental Control	15.43 ±1.90 09.33 ±3.32	3.09*	2.202	0.048
	Achievement test	Experimental Control	15.29 ±1.70 12.83 ±2.04	2.45*	2.363	0.038

*significant at 0.05 level of significance; **highly significant at 0.01 level of significance

Table 3: The Difference in post-assessment scores between the experimental and control group regarding seven video tutorials in a flipped classroom teaching model for the year 2019-20

Video tutorials	Post assessment	Group	Mean score ± S.D.	Mean difference	t-value	P-value
First	Expert Session	Experimental Control	12.17 ±1.32 09.83 ±1.94	2.33*	2.430	0.035
	Achievement test	Experimental Control	14.33 ±1.03 8.33 ±2.87	6.00**	4.811	0.001
Second	Expert Session	Experimental Control	16.33 ±0.81 11.17 ±1.72	5.16**	6.639	Â0.01
	Achievement test	Experimental Control	13.17 ±2.13 9.00 ±1.26	4.16**	4.110	0.002
Third	Expert Session	Experimental Control	14.83 ±1.16 11.00 ±2.28	3.83**	3.664	0.004
	Achievement test	Experimental Control	13.33 ±2.25 9.83 ±2.63	3.50*	2.471	0.033
Fourth	Expert Session	Experimental Control	14.00 ±1.54 9.67 ± 2.25	4.33**	3.884	0.003
	Achievement test	Experimental Control	14.17 ±1.16 8.83 ±2.92	5.33**	4.145	0.002
Fifth	Expert Session	Experimental Control	14.83 ±2.80 9.83 ± 2.13	5.00**	3.810	0.003
	Achievement test	Experimental Control	13.83 ±1.47 08.33 ±2.42	5.50**	4.753	0.001
Sixth	Expert Session	Experimental Control	15.00 ±0.89 8.00 ±2.53	7.00**	6.390	Â0.01
	Achievement test	Experimental Control	13.33±3.38 7.33 ±1.50	6.00**	3.966	0.003
Seventh	Expert Session	Experimental Control	15.00 ±2.28 09.50 ±1.51	5.50**	4.919	0.001
	Achievement test	Experimental Control	15.00 ±.89 7.83 ±2.78	7.16**	5.998	0.001

*significant at 0.05 level of significance; **highly significant at 0.01 level of significance

experimental group and the mean scores of the control group regarding the expert's session and achievement test for all seven video tutorials.

To get an overview of the overall learning outcome of an experimental and control group, overall post-assessment scores (expert session and achievement test) for each video tutorial were summed up for both years 2018-19 and 2019-20. To determine the significance of the difference between the two groups of students, t-test was applied, and the results have been recorded in Table 4 and 5.

The data presented in Table 4 shows that the "t" value was found significant for the fourth, fifth, sixth and seventh video tutorials. However, no significant difference was observed concerning the first, second and third video tutorials. Thus it can be concluded that students' performance of the experimental group in terms of learning gain was higher and better in subsequent video lectures (VL4 to VL7) rather than at the beginning of the video lecture (VL1, VL2 and VL3). It might be because, initially, students found it challenging to learn from video and were uneasy with the teacher's absenteeism. Still, they gradually enjoyed the flipped model and started communicating with their peer group and understanding with interaction, leading to collaborative learning. Flexibility in flipped approach was being able to pause and rewind the videos, take notes and solve example problems while watching the lecture videos. As a result, their learning started growing

Table 4: The difference in overall post-assessment scores among students of seven video tutorials for the year 2018-19

Video tutorials	Post assessment	Group	Mean score ± S.D.	Mean difference	t-value	P-value
First	Expert Session and Achievement test	Experimental Control	26.29 ±1.38 25.00 ±5.69	1.28	.582	0.572
Second	Expert Session and Achievement test	Experimental Control	31.57 ±3.55 28.83 ±5.26	2.73	1.114	0.289
Third	Expert Session and Achievement test	Experimental Control	32.43 ±3.50 28.67 ±4.46	3.76	1.725	0.113
Fourth	Expert Session and Achievement test	Experimental Control	29.71 ±2.43 25.17 ± 4.07	4.54*	2.493	0.030
Fifth	Expert Session and Achievement test	Experimental Control	28.00 ±2.08 21.83 ± 0.75	6.16**	6.846	0.000
Sixth	Expert Session and Achievement test	Experimental Control	31.29 ±3.90 24.00 ±5.36	7.28*	2.831	0.016
Seventh	Expert Session and Achievement test	Experimental Control	27.71 ±3.20 22.17 ±5.30	5.54*	2.325	0.040

*significant at 0.05 level of significance; **highly significant at 0.01 level of significance

Table 5: The difference in overall post-assessment scores among students of seven video tutorials for the year 2019-20

Video tutorials	Post assessment	Group	Mean score ± S.D.	Mean difference	t-value	P-value
First	Expert Session and Achievement test	Experimental Control	26.50 ±2.25 18.17 ±4.70	2.132**	3.909	0.003
Second	Expert Session and Achievement test	Experimental Control	29.50 ±2.88 20.17 ±2.71	1.616**	5.776	Â0.01
Third	Expert Session and Achievement test	Experimental Control	28.17 ±2.92 20.83 ±4.87	2.321**	3.159	0.010
Fourth	Expert Session and Achievement test	Experimental Control	28.17 ±2.13 18.50 ± 4.59	2.068**	4.674	0.001
Fifth	Expert Session and Achievement test	Experimental Control	28.67 ±3.50 18.17 ± 4.49	2.325**	4.516	0.001
Sixth	Expert Session and Achievement test	Experimental Control	28.33 ±4.03 15.33 ±3.98	2.314**	5.617	Â0.01
Seventh	Expert Session and Achievement test	Experimental Control	30.00 ±2.75 17.33 ±2.58	1.542**	8.214	Â0.01

*significant at 0.05 level of significance; **highly significant at 0.01 level of significance

& improving. Therefore, overall, students' learning is more productive with the flipped classroom model of teaching rather than the traditional lecture method.

The data presented in Table 5 shows that the "t" value was found highly significant for all seven video tutorials. Hence, it was proved that there had been a highly significant difference between the post-assessment scores of an experimental and control group of the study. Students' outcomes in a flipped classroom were significantly better than those in a conventional classroom or control class. Flipped students obtained higher post-test scores in all video tutorials and improved their learning and understanding of the learning content at their own pace.

Interestingly, the point to be noted is that the learning gain perceived by each and all experimental

group students was the same. Simultaneously, much variation was found in terms of the post-test score of the control group students. That means the performance of low achievers in the experimental group is positively affected by the flipped model.

Therefore, it can be implied that the flipped classroom approach's learning environments are likely to satisfy students' needs for competence, autonomy, and relatedness and, thus, entice higher levels of intrinsic motivation.

To know the consistency of results in terms of the overall learning outcome of an experimental and control group, overall post-assessment scores (expert session and achievement test) for each video tutorial were compared between both years 2018-19 & 2019-20. To determine the significance of the difference between the two groups of students, t-test was applied, and the results have been recorded in Table 6.

The data presented in Table 6 show no significant differences between the experimental and control groups for the first video tutorial. In contrast, it is worth noting that the t value was highly effective for all six video tutorials.

Therefore statistically, it was proved that for the years 2018 to 2020, there was a highly significant difference between the post-assessment scores of an

Table 6: A pooled analysis of difference in post-assessment scores between the experimental and control group of seven video tutorials in a flipped classroom teaching model for the year 2018-19 and 2019-20

Video tutorials	Post assessment	Group	Mean score ± S.D.	Mean difference	t-value	P-value
First	Expert Session	Experimental Control	12.23 ±1.58 11.00 ±3.51	1.23	1.143	0.265
	Achievement test	Experimental Control	14.15 ±1.21 10.58 ±3.47	3.57**	3.485	0.002
Second	Expert Session	Experimental Control	17.00 ±1.58 13.92 ±3.45	3.08**	2.912	.0008
	Achievement test	Experimental Control	13.62 ±2.53 10.58 ±2.87	3.03*	2.803	0.010
Third	Expert Session	Experimental Control	16.15 ±2.26 13.17 ±2.94	2.98**	2.853	0.009
	Achievement test	Experimental Control	14.31 ±2.05 11.58 ±3.23	2.72**	2.536	0.018
Fourth	Expert Session	Experimental Control	14.69 ±1.60 11.58 ± 2.74	3.10**	3.493	0.002
	Achievement test	Experimental Control	14.31 ±1.10 10.25 ±3.16	4.05**	4.348	Â0.01
Fifth	Expert Session	Experimental Control	14.77 ±1.87 10.92 ± 1.83	3.85**	5.185	Â0.01
	Achievement test	Experimental Control	13.94 ±1.61 05.08 ± 1.88	4.45**	6.373	Â0.01
Sixth	Expert Session	Experimental Control	15.31 ±1.70 9.67 ±3.02	5.64**	5.807	Â0.01
	Achievement test	Experimental Control	14.62±2.87 10.00 ±3.56	4.61**	3.576	0.002
Seventh	Expert Session	Experimental Control	13.62 ±2.39 09.42 ±2.46	4.19**	4.313	Â0.01
	Achievement test	Experimental Control	15.15 ±1.34 10.33 ±3.49	4.82**	4.618	Â0.01

*significant at 0.05 level of significance; **highly significant at 0.01 level of significance

experimental and control group of the study. Thus, the pooled data analysis in the Table indicates that the experimental group's learning outcome for both years is higher than the control group for the six video tutorials. Thus; it can be proved that a flipped classroom model of teaching is valid and is helpful in mutually enhancing students' learning.

A students' perception survey (SPS) was used to identify the perception of students' toward the flipped classroom model of teaching. All 13 experimental group students responded to the study with 15 perception statements. The response to each perception statement for the flipped classroom method was summarized in Table 7. The data were collected on three response groups, viz. Agree, Neutral and Disagree with the weightage 3, 2 and 1 assigned, respectively, and the results in frequency and percentage are presented hereunder:

In response to the first and second perception statements, "The flipped classroom method promotes active learning" and "The video lecture helps me to learn the complex concept more effectively and quickly than the traditional lecture method", the large majority of the students (92%) were agreed. A higher proportion of the students (85%) "Liked the daily routine of the flipped class". They commented that the flipped format was very engaging and interactive, and they enjoyed learning with the video lectures. However, the majority of the students (85%) also believed that "The duration of the video is too long" and "Technical issue to view video effect continuity of learning". To overcome the technical issue, downloading the video is better than streaming.

Further, 84 per cent of students felt that a "flipped classroom provides an enjoyable and interacting learning environment" and agreed that they "prefer video rather than having a traditional lecture method for this course". They learned the material more effectively by viewing the online recorded lecture rather than a traditional lecture. Most of the students (84%) expressed that they "want the flipped class to be implemented in future classes or other courses".

Interestingly, students were more likely to suggest a flipped classroom to their other friends and students

Table 7: Students' perception of a flipped classroom teaching model

S. No.	Perception Statements	An (%)	Nn (%)	Dn (%)
1	The flipped classroom method promotes active learning.	12 (92%)	1 (8%)	–
2	The video lecture helps me learn the complex concept more effectively and quickly than the traditional lecture method.	12 (92%)	–	1(8%)
3	The flip approach required more work and time.	9 (69%)	–	4(31%)
4	Video offers flexibility in learning at my own pace	8(62%)	3 (23%)	2 (15%)
5	I felt disconnected in a virtual online class due to the teacher's absence.	6(46%)	1 (8%)	6(46%)
6	Flipped classroom provides an enjoyable and interacting learning environment	11(84%)	1 (8%)	1 (8%)
7	Flipped model is more appropriate for practical application of knowledge	10(77%)	1 (8%)	2(15%)
8	Flipped teaching method breaks the monotony in study	9(69%)	3(23%)	1 (8%)
9	Flipped approach improve my understanding of the learning material	10(77%)	2(15%)	1 (8%)
10	I like the daily routine of flipped class (electronic content delivery, in-class discussion with a classmate, assessment test etc.)	11(84%)	2(15%)	–
11	Some part of the content of the video is difficult to understand.	9 (69%)	–	4(31%)
12	The duration of the video is too long	11(84%)	–	2(15%)
13	Technical issue (downloading from another device) to view video effects continuity of learning.	11(84%)	–	2(15%)
14	I prefer video rather than having a traditional lecture method for this course.	11(84%)	1(8%)	1(8%)
15	I want the flipped class to be implemented in future classes or other courses.	11(84%)	1(8%)	1(8%)

A= Agree, N= Neutral, D= Disagree

teaching by the general lecture method. Approximately three-fourths of students (77%) reported that the "Flipped model is more appropriate for practical application of knowledge" and "flipped approach improves my understanding of the learning environment". As flipped require a lot of student engagement, they learn more when actively involved in learning. Furthermore, 69 per cent of students appeared to agree that Flipped teaching method breaks the monotony in the study. The Table further expressed that 69 per cent of students perceived that "Flip instruction and learning required more work and time" and "Some part of the video's content is difficult to understand" whereas 31 per cent of students disagreed. Flipping may be an entirely new approach to learning and teaching that students have never experienced before. In the fifth statement of perception, there is a 50-50 split between Agree and Disagree. Half of the students (46%) agreed, while half of the students (46%) disagreed that "In a virtual online class, I felt disconnected due to the teacher's absence". Almost two-thirds of the students (62%) appreciated that "Video offers flexibility in learning at my own pace" which was extremely helpful. Far more students commented that it was conducive to rewatching lectures, pausing when I needed to, and allowing me to take notes at a slower pace.

Thus, from the above findings, it can be deduced that a vast majority of students positively perceive the flipped classroom model. The most commonly valued reasons for this were that the students appreciated learning through using video material, studying at their own pace, flexibility and mobility brought about by accessible video lectures, and learning is more comfortable and practical within the frame of the flipped classroom. The students' response to some of the statements determined their negative perception of the flipped model. These disadvantages included technical flaws, the need for more computer knowledge and skills and the availability of full-fleshed internet facilities. The correlation coefficient method was used to measure the association between test group scores and students' perception of the experimental group. The correlation ($r=0.811^{**}$) between post-test scores and the overall perception of the students was found to be highly significant ($p<.001$). It can be interpreted that the student's positive perception was associated with learning gain. If the learning gain of students is high, their perception was also positive towards the flip approach.

CONCLUSION

In conclusion, this study revealed that the experimental group students obtained higher scores in the post-assessment test than the control group students. A strong statistical difference was observed between the flipped format of teaching and the traditional lecture method about seven video tutorials of the course "Introduction of Mass Communication and Journalism". Thus, a flipped experiment was more successful in improving student performance in the selected course. Out of seven video tutorials, the sixth video tutorial" Radio Script" was found to be the most effective lecture with the highest t value. While the first video tutorial, "Teaching and learning" was found with the lowest t value. Therefore, the experimental group's learning gain performance was higher and better in subsequent video lectures (VL6, VL7, VL5 and VL4) rather than at the beginning of the video lectures (VL1, VL2 and VL3). The majority of the experimental group students expressed their positive perception of implementing the flipped classroom approach, which reflects their acceptance of this method. Positive perception of the experimental group students strongly correlated to the learning gain.

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A New Series of Efficient Partially Balanced Incomplete Block Designs with Minimal Replications

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ABSTRACT

In this study, a new series of three associate class partially balanced incomplete block (PBIB) designs in two replicates have been proposed, along with their underlying association scheme. General expressions for average variance and for canonical efficiency factors have been derived for this class of designs. The efficiencies of these designs are observed to be quite high in comparison to an orthogonal block design. A list of designs has been prepared for various parametric combinations. As treatments require minimum number of replications in these designs, they can be advantageously used when there is scarcity in resources.

Keywords: Association scheme, Canonical efficiency factor, Partially balanced incomplete block designs

INTRODUCTION

Replication is an integral component in planning and designing any scientific experimentation, along with randomization and local control. Majority of the trials in experimental stations are conducted under block design set up. Many a times, experiments are conducted with serious resource crunch situations. Scarcity in the availability of the treatments under examination intensifies the problem of the researchers. Minimally replicated block designs, *i.e.,* treatments replicated only twice, can provide a quick solution to this problem. Three associate class partially balanced incomplete block (PBIB) designs in two replicates can be advantageously used when there is scarcity of resources as these designs optimize the resource use by employing minimum number of replications.

A general definition of PBIB designs was first given by Bose and Nair (1939). Most of the incomplete block designs employed in practice are either balanced incomplete block (BIB) designs or two-associate class PBIB designs, which have been widely explored in the literature. The class of PBIB(3) and PBIB(4) designs are useful alternatives to these designs since they can be utilized in situations where BIB and PBIB(2) designs are either unavailable or require a large amount of resources. The PBIB(3) designs are extensively studied in the literature with distinct treatment structures including cubic designs (Raghavarao and Chandrasekhararao 1964), nested group divisible designs (Roy 1953), extended triangular designs (John 1966); Sharma *et al.* (2010); Rao (1956); Varghese and Sharma (2004); Garg *et al.* (2011); Jha *et al.* (2022) developed some PBIB designs in two-replicates.

The present work describes a general method of constructing PBIB(3) designs and their related association schemes. The characterization properties of the proposed series of designs have been studied. General expressions for computing the variance of estimated elementary contrasts pertaining to the treatment effects and the canonical efficiency factors of the designs has been derived. A catalogue of the new series of PBIB(3) designs has been prepared for $v \leq 400$ (Table 1).

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Table 1: List of proposed series of PBIB(3) designs for v ≤ 400

S.No.	p	v	b	r	k	λ_1	λ_2	λ_3	$\frac{\overline{V}(\widehat{\tau_i-\tau_j})}{\sigma^2}$	Canonical efficiency factor
1	2	20	5	2	8	2	1	0	1.1263	0.8879
2	3	30	5	2	12	2	1	0	1.0828	0.9236
3	4	40	5	2	16	2	1	0	1.0615	0.9420
4	5	50	5	2	20	2	1	0	1.0490	0.9533
5	6	60	5	2	24	2	1	0	1.0407	0.9609
6	7	70	5	2	28	2	1	0	1.0348	0.9664
7	8	80	5	2	32	2	1	0	1.0304	0.9705
8	9	90	5	2	36	2	1	0	1.0270	0.9737
9	10	100	5	2	40	2	1	0	1.0242	0.9763
10	11	110	5	2	44	2	1	0	1.0220	0.9785
11	12	120	5	2	48	2	1	0	1.0202	0.9802
12	13	130	5	2	52	2	1	0	1.0186	0.9817
13	14	140	5	2	56	2	1	0	1.0173	0.9830
14	15	150	5	2	60	2	1	0	1.0161	0.9841
15	16	160	5	2	64	2	1	0	1.0151	0.9851
16	17	170	5	2	68	2	1	0	1.0142	0.9860
17	18	180	5	2	72	2	1	0	1.0134	0.9868
18	19	190	5	2	76	2	1	0	1.0127	0.9875
19	20	200	5	2	80	2	1	0	1.0121	0.9881
20	21	210	5	2	84	2	1	0	1.0115	0.9886
21	22	220	5	2	88	2	1	0	1.0110	0.9892
22	23	230	5	2	92	2	1	0	1.0105	0.9896
23	24	240	5	2	96	2	1	0	1.0100	0.9901
24	25	250	5	2	100	2	1	0	1.0096	0.9905
25	26	260	5	2	104	2	1	0	1.0093	0.9908
26	27	270	5	2	108	2	1	0	1.0089	0.9912
27	28	280	5	2	112	2	1	0	1.0086	0.9915
28	29	290	5	2	116	2	1	0	1.0083	0.9918
29	30	300	5	2	120	2	1	0	1.0080	0.9920
30	31	310	5	2	124	2	1	0	1.0078	0.9923
31	32	320	5	2	128	2	1	0	1.0075	0.9925
32	33	330	5	2	132	2	1	0	1.0073	0.9928
33	34	340	5	2	136	2	1	0	1.0071	0.9930
34	35	350	5	2	140	2	1	0	1.0069	0.9932
35	36	360	5	2	144	2	1	0	1.0067	0.9934
36	37	370	5	2	148	2	1	0	1.0065	0.9935
37	38	380	5	2	152	2	1	0	1.0063	0.9937
38	39	390	5	2	156	2	1	0	1.0062	0.9939
39	40	400	5	2	160	2	1	0	1.0060	0.9940

MODEL AND EXPERIMENTAL SET-UP

The proposed PBIB(3) designs can be analysed as standard PBIB designs by considering the following linear model:

$$y_{ij} = \mu + \tau_i + \beta_j + e_{ij}$$

where, i = 1, 2, ..., v and j = 1, 2, ..., b. Here, y_{ij} is the response on plot i in block j, μ is the general mean, τ_i is the effect of the i^{th} treatment and β_j is the effect of j^{th} block. e_{ij} are independently, identically and normally distributed random errors with mean zero and variance σ^2.

The reduced normal equation pertaining to treatment effects for this model is: $C\hat{\tau} = Q$ with $q'\hat{\tau} = 0$, where, C is the information matrix and Q is the vector of adjusted treatment totals. The normal equation can be solved to get $\hat{\tau} = C^{-}Q$, where C^{-} is generalized inverse of C. The BLUE (Best Linear Unbiased Estimator) of $q'\hat{\tau}$ is $q'C^{-}Q$ with $\text{Var}(q'\hat{\tau}) = \sigma^2 q'C^{-}q$.

MATERIALS AND METHODS

Consider a star polygon with five distinct edges and the points of intersection of the edges as the vertices. Arrange v = 10p ($p \geq 1$) treatments on the vertices so that each vertex has p distinct treatments. Each edge of the star polygon will form a block with 4p entries corresponding to the four vertices on a particular edge. Obtain the remaining blocks from the remaining four edges in a similar manner. The resulting design so obtained will be a PBIB(3) design with parameters: v = 10p, b = 5, r = 2, k = 4p, $\lambda_1 = 2$, $\lambda_1 = 1$ and $\lambda_1 = 0$.

The information matrix (**C**- matrix) pertaining to the treatment effects for this class of designs is:

$$\mathbf{C} = (r - a_0)\mathbf{I}_v - a_1\mathbf{A}_1 - a_2\mathbf{A}_2 - a_3\mathbf{A}_3.$$

Here, $\mathbf{I}_v$ is the identity matrix of order v. $\mathbf{A}_i = \{x_{\alpha\beta}\}$, where, $x_{\alpha\beta} = 1$ if α^{th} and β^{th} treatments are i^{th} (i = 1, 2, 3) associates and 0, otherwise with $a_0 = \frac{r}{k}$, $a_1 = \frac{\lambda_1}{k}$, $a_2 = \frac{\lambda_2}{k}$ and $a_3 = \frac{\lambda_3}{k}$. The inverse of the **C**-matrix is obtained as:

$$\mathbf{C}^{-} = z_0\mathbf{I}_v + z_1\mathbf{A}_1 + z_2\mathbf{A}_2 + z_3\mathbf{A}_3,$$

where, $z_0 = \frac{50p + 7}{100p}$, $z_1 = \frac{7}{100p}$, $z_2 = \frac{-3}{100p}$ and $z_3 = \frac{-13}{100p}$.

The general expressions for variances of estimated elementary contrasts between two treatment effects are:

$$V(\hat{\tau}_i - \hat{\tau}_{i'}) = \begin{cases} V_1 = \sigma^2, \text{ if i and i' are the first associates;} \\ V_2 = \left(1 + \frac{1}{5p}\right)\sigma^2, \text{ if i and i' are the second associates and} \\ V_3 = \left(1 + \frac{2}{5p}\right)\sigma^2, \text{ if i and i' are the third associates.} \end{cases}$$

The average variance ($\bar{V}$) of the elementary contrast between two estimated treatment effects is computed as:

$$\bar{V} = \frac{2(50p + 7)}{5r(10p - 1)}\sigma^2.$$

The eigen values of information matrix of the proposed designs are 2 and 1.25 with multiplicities 5(2p-1) and 4, respectively. The canonical efficiency factor of the proposed class of designs in comparison to an orthogonal design can be calculated by working out the harmonic mean of $\left(\frac{1}{r}\right)$ times the non-zero eigen values of **C** (Dey 2008), where r represents the number of replications of the treatments in the design and is given as:

$$\varphi = \frac{50p - 5}{50p + 7}$$

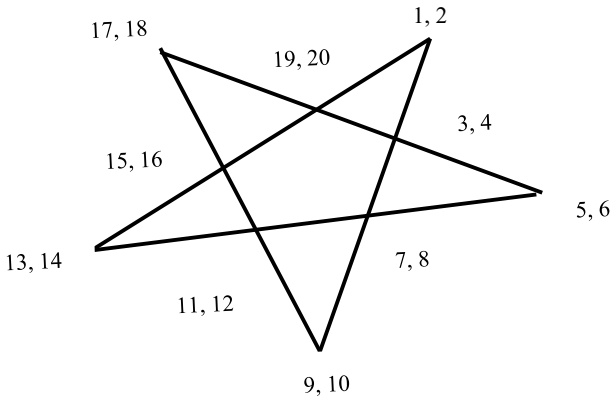
***Association Scheme*:** Consider the arrangement of v = 20 treatments as described above. For a given treatment α:

- other treatments appearing in the same vertex of α are first associates,
- treatments lying on the two edges passing through the same vertex of α are second associates and
- the rest are third associates.

The parameters of the association scheme are: v = 10p, $n_1 = p-1$, $n_2 = 6p$, $n_3 = 3p$,

$$\mathbf{P}_1 = \begin{bmatrix} p-2 & 0 & 0 \\ 0 & 6p & 0 \\ 0 & 0 & 3p \end{bmatrix}, \mathbf{P}_2 = \begin{bmatrix} 0 & p-1 & 0 \\ p-1 & 3p & 2p \\ 0 & 2p & p \end{bmatrix} \text{ and } \mathbf{P}_3 = \begin{bmatrix} 0 & 0 & p-1 \\ 0 & 4p & 2p \\ p-1 & 2p & 0 \end{bmatrix}.$$

***Illustration*:** Let v = 20(= 10 × 2). The arrangement of 20 treatments with p = 2 treatments on each of the vertices of a star polygon is as follows:



For the arrangement of 20 treatments over the 10 vertices of a star polygon as shown above, we have the following PBIB(3) design with parameters v = 20, b = 5, r = 2, k = 8, $\lambda_1 = 2$, $\lambda_2 = 1$ and $\lambda_3 = 0$ as shown:

Blocks	**Treatments**							
B1	1	2	3	4	7	8	9	10
B2	5	6	7	8	11	12	13	14
B3	9	10	11	12	15	16	17	18
B4	13	14	15	16	19	20	1	2
B5	17	18	19	20	3	4	5	6

For the design given in Illustration, the information matrix and its inverse are: $\mathbf{C} = 1.75\mathbf{I}_{20} - 0.25\mathbf{A}_1 - 0.125\mathbf{A}_2 - 0\mathbf{A}_3$ and $= 0.535\mathbf{I}_{20} + 0.035\mathbf{A}_1 - 0.015\mathbf{A}_2 - 0.065\mathbf{A}_3$, respectively. Here, $\mathbf{I}_{20}$ is an identity matrix of order 20, $\mathbf{A}_1$, $\mathbf{A}_2$, $\mathbf{A}_3$ and $\mathbf{A}_4$ are symmetric association matrices as defined earlier. The variances of elementary contrast between two estimated treatment effects are $V_1 = \sigma^2$, $V_2 = 1.1\sigma^2$, $V_3 = 1.2\sigma^2$ and the average variance is $\overline{V} = 1.1263\sigma^2$. Further, the canonical efficiency of this particular design is computed as 0.8878.

Here, the treatments follow the association scheme as defined earlier. The first, second and third associates of few of the treatments are shown here. Associates for rest of the treatments can be obtained in a similar manner.

Treat-ments	**1st associate**	**2nd associates**	**3rd associates**
1	2	3, 4, 7, 8, 9, 10, 13, 14, 15, 16, 19, 20	5, 6, 11, 12, 17, 18
2	1	3, 4, 7, 8, 9, 10, 13, 14, 15, 16, 19, 20	5, 6, 11, 12, 17, 18
3	4	1, 2, 5, 6, 7, 8, 9, 10, 17, 18, 19, 20	11, 12, 13, 14, 15, 16
5	6	3, 4, 7, 8, 11, 12, 13, 14, 19, 20, 17, 18	1, 2, 9, 10, 15, 16

The **P**- matrices for the particular design are:

$$\mathbf{P}_1 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 12 & 0 \\ 0 & 0 & 6 \end{bmatrix}, \mathbf{P}_2 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 6 & 4 \\ 0 & 4 & 2 \end{bmatrix} \text{ and } \mathbf{P}_3 = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 8 & 4 \\ 1 & 4 & 0 \end{bmatrix}.$$

CONCLUSION

A new series of three associate PBIB designs with treatment structure v = 10p and two replications has been developed which are useful in situations where there is crunch in resources. The association scheme of the proposed designs has been studied and a general form of average variance has been derived for this class of designs. The expression for canonical efficiency factors has also been derived. A list of parameters along with their efficiency factors has been prepared. It is observed that the designs are quite efficient, which will encourage the researchers for adoption of these designs, thus enhancing their application potential.

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Self Help Groups : A Ray of Hope in Challenging Times

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ABSTRACT

The purpose of the Self Help Group is to obtain microcredit from banks with encouraging members to save and to lend money for their members. In an informal setting, the women learn basic financial skills. They begin with minimal contributions; learn to inter-loan, and keep records. The purpose of this is to classify the social and economic factors which impact the involvement of women in self-help groups (SHGs) for their economic as well as social empowerment. It's human nature to search for a silver lining even during pandemic COVID-19. Humans need hope. Some sectors have proved resilient even in these challenging times. The most prevalent among these is the self-help group (SHG) movement in India, which is one of the most powerful incubators of female strength and entrepreneurship in rural areas. It is a powerful channel for altering the social construct of gender in villages. Women in rural areas are now able to create independent sources of family income. Self-help groups are groups of 8–20 women engaged in entrepreneurship activities. SHGs are formed for a variety of reasons, yet their primary purpose has been to economically empower women and communities through saving/lending activities and bank-linkage programs to access loans and capital. Through taking the SHG concept to scale, the Indian government along with non-governmental organizations (NGOs) and funding agencies, is increasingly developing SHGs by layering thematic interventions onto entrepreneurial activities. While there were many young literate, semi-literate and skilled women who have home-grown skills, the absence of capital prevents them from taking a full plunge in any decision-making role and setting up their own independent business. Self Help Group is an innovative organizational setup for the women upliftment and welfare. Today, the self help group movement is increasingly accepted as an innovation. There is need to impart skill developed training to the women to form a Self Help Group for becoming entrepreneur and a skilled worker. All India Coordinated Research Project, Family Resource Management is imparting skill based training to rural unemployed youth, the impact of these trainings can only be realized if the skilled resource rural women engage themselves and form a Self Help Group and also start an enterprise. These Self Help Groups can become a ray hope for those rural poor families which merely depend upon daily wages for their livelihood.

Keywords: Self Help Group, Challenges, Hope

INTRODUCTION

Self-help groups are informal groups of people who come together to address their common problems. In an informal setting, the women learn basic financial skills. They begin with minimal contributions; learn to inter-loan, and keep records. It's human nature to search for a silver lining even during pandemic COVID-19. Humans need hope. Some sectors have proved resilient even in these challenging times. The most prevalent among these is the self-help group (SHG) movement in India, which is one of the most powerful incubators of female strength and entrepreneurship in rural areas. It is a powerful channel for altering the social construct of gender in villages. Women in rural areas are now able to create independent sources of family income. Self-help groups (SHGs), groups of 8–20 women engaged in entrepreneurship activities, have come to dominate the development landscape. SHGs are formed for a variety of reasons, yet their primary

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purpose has been to economically empower women and communities through saving/lending activities and bank-linkage programs to access loans and capital. In India, the central government has catalyzed the spread of SHGs since 2011 through the National Rural Livelihood Mission (NRLM). Through taking the SHG concept to scale, the Indian government along with non-governmental organizations (NGOs) and funding agencies, are increasingly developing SHGs by layering thematic interventions onto entrepreneurial activities. While there were many young literate, semi-literate and skilled women who have home-grown skills, the absence of capital prevents them from taking a full plunge in any decision-making role and setting up their own independent business. Self Help Group is an innovative organizational setup for the women upliftment and welfare. Today, the self help group movement is increasingly accepted as an innovation. There is need to impart skill developed training to the women to form a Self Help Group for becoming entrepreneur and a skilled worker. All India Coordinated Research Project, Family Resource Management is imparting skill based training to rural unemployed youth, the impact of these trainings can only be realized if the skilled resource rural women engage themselves and form a Self Help Group and also start an enterprise. These Self Help Groups can become a ray hope for those rural poor families which merely depend upon daily wages for their livelihood. Keeping in view following objectives were kept for the study.

1. To analyse the economic benefits gained by the members after joining the SHGs.
2. To examine the social benefits derived by the members.
3. To analyse the operating system of SHGs for the management of group funds, repayment of loan and economic activities of the SHGs.

MATERIALS AND METHODS

The present study is based on a sample of 200 women SHGs drawn from Ludhiana district of Punjab. These SHGs are being run block-wise in the district Ludhiana. The saving and lending groups were selected through stratified random sampling from the lists provided by the district agencies and then mapped across the villages in different blocks. Two women were selected from each SHG. Of these two women, one was purposively selected from the office-bearers and the other one was randomly selected from the remaining members. Thus, in all 200 women were selected to get their responses. A structured schedule was administered on the respondents. Besides, a range of methods like observation, interviews, group discussion, and maintenance of field diary were used to collect primary data.

RESULTS AND DISCUSSION

The average age of SHG members in the study area is presented in Table 1 it is observed that the average age of SHG members was 36.2 years, lowest being 34 years in Sudhar village and highest being 40 years in Bhagwanpura village district Ludhiana. Regarding the caste profile of SHG members, the table shows that majority of members belong to rural families. Educational background of the SHG members shows that most of them are illiterate. Only 7 per cent of them have studied up to primary level. So far as the occupation of the members are concerned, majority of them are engaged in agricultural activities. As regards

Table 1: Profile of SHG Members

Item	Sudhar	Bhagwanpura	Kotala	Boparai Kalan	Powat	Overall
Age (years)	34	40	35	35	37	36.2
Percentage of SCs	90	07	46	97	77	62.2
Percentage of STs	10	39	03	03	17	14.4
Percentage of Other Castes	34	24	48	12	10	25.6
Literacy (%)	5.11	11.23	13.26	3.69	3.88	7.43
Occupation Agriculture (%)	71.89	36.55	38.89	69.89	62.57	47.41
Others	28.11	63.45	61.11	30.11	37.43	53.59
Income (Average)	9223	10,104	10057	6582	5861	8,365.4

Table 2: Purpose of Credit Demanded and Utilised and Structure of SHGs

Item	Sudhar	Bhagwanpura	Kotala	Boparai Kalan	Powat	Overall
Membership average (No.)	18.00	16.78	17.00	15.86	16.00	16.72
Savings per SHG (Rs.)	14517	16125	13633	7093	2097	10,693
Loan (Avgerage) (Rs.)	18725	19200	10040	6000	2000	11,193
Frequency of group meeting (%)						
Weekly:	15	25	13	1	1	11.0
Fortnightly	65	68	72	35	28	53.6
Monthly	11	12	6	8	8	9.0

to average income per SHG, it was around Rs. 8365. It was highest in Bhagwanpura (Rs.10,104) followed by Kotala (Rs. 10,057) and lowest in Powat (Rs. 10,057).

Table 2 shows that after every six months operation of savings account, the saving is pooled and used for internal lending among the members. The amount of loan and number of loans are decided by the members themselves after conducting a meeting depending on their need and emergency. Members of Bhagwanpura village has maximum savings as they save at least 16,125 Rs per month to repay their loan. Moreover, most of the SHG's conducted fortnightly meetings in a year followed by weekly and monthly meetings.

The purpose-wise credit demanded by the SHG members from the SHGs is given in Table 3. It is observed that most of the members have demanded credit for domestic consumption purposes. It is highest in Bhagwanpura (58.66%) followed by Kotala (47.57%). Reasonable proportion of SHG members have demanded credit for other purposes. This percentage is highest in Bhagwanpura (25%) and lowest in Boparai kalan (5.68%). About 11.56 per cent of credit is demanded for investment purposes. A proportion of credit was demanded by the SHG members for payment of old debts. A less proportion

of loan is demanded for festival and health purposes. From the table it is clear that a larger share of credit demanded by SHG members is being utilised for domestic consumption purposes followed by repayment of debts and others.

Table 4 reveled that most of the SHG members are engaged in the collection and preparation of products. These products include stitching bags, quilts, designer bed sheet, pillow covers, cushions, tote bags school bags, processing of fruits and vegetables etc. Some of the members are engaged in individual businesses like preparing pickle, haldi powder, making bags, vegetable business, tailoring etc. Some are engaged in other activities. They earn about Rs. 3,000

Table 3: Purpose for Credit Demanded by SHG Members

Purpose	Sudhar	Bhagwanpura	Kotala	Boparai Kalan	Powat	Overall
Domestic consumption	34.16	58.66	47.57	17.23	17.09	34.94
Health	3.22	6.87	9.50	4.44	2.27	5.26
Festivals	8.11	10.78	8.71	3.39	4.18	7.03
Repayment of debts	15.67	25.00	11.52	5.68	6.10	12.79
Other Investments	10.89	12.57	11.66	14.05	8.67	11.56
Others	34.10	47.21	43.04	11.34	18.40	30.81

Note: Figures in the table indicate percentages.

Table 4: Economic Activities done by the SHG Members

Item	Sudhar	Bhagwanpura	Kotala	Boparai Kalan	Powat	Overall
Collection and marketing of products	75	55	40	70	60	60.00
Individual business	5	10	25	10	5	11.00
Goatery	10	12	10	15	15	12.4
Dairy	10	18	10	5	15	12.6
Others	5	5	15	5	5	7.00

Note: Figures in the table indicate percentages.

to Rs. 10,000 per month through these activities. There is a bank linkage programme established to SHGs. The SHG members opened their accounts in various nationalised banks such as cooperative banks, State Bank of India, Indian Bank, Bank of Baroda etc. SHG members are getting both internal loans and external loans. They are also maintaining cashbook, membership register, loan register, individual passbook register etc. They are taking loans for both production and consumption purposes. Cooperative banks has advanced loans of Rs. 3 lakhs to Samrala block village Bhagwanpura. So far as loan repayment is concerned, the SHG members of Bhagwanpura and Kotala have repaid 100 per cent of their loans. But in Sudhar block, though they are urban based, the repayment position is not encouraging. In these two blocks the members repaid only 20 per cent of their loans (Table 5).

Table 5: Loan Support to SHGs

Name of the Block	Total SHGs	Loan availed	Loan repayment
Sudhar	10	Rs. 2,96,428	-
Bhagwanpura	10	Rs. 2,66,611	100%
Kotala	10	Rs. 2,00,000	30%
Bopa Rai Kalan	10	Rs. 1,30,000	-
Powat	10		-

Variety of benefits is derived by the members of SHGs as presented in Table 6. One of the outstanding benefits reported by all the members is the development of self-confidence (80.30) ranked first, followed by social cohesion (75.91%), self satisfaction (75.2%), habits of saving (73.99%), economic independence (73.69%), freedom from debt (63.36%) and employment to others (38.60%).

CONCLUTION

Considering the findings of the study, the following suggestions were prescribed.

- Training regarding legal documentation, their rights and gender awareness are important complements to micro-credit for the empowerment of women. The members should be given necessary training & guidance for the successful operation of the group.
- Literacy and skill development trainings are needed for the rural women to benefit from the credit schemes.
- Marketing facilities at different platforms for the sale of products of SHG may be created.
- Time to time exhibitions at block and district level may be organised where the products of SHG can be displayed.

Table 6: Benefits Derived by SHG Members (Multiple Responses)

Benefits	Sudhar	Bhagwanpura	Kotala	Boparai Kalan	Powat	Overall
Habit of Savings	72.12	81.11	72.18	72.66	71.89	73.99
Economic independence	75.10	82.16	78.21	66.81	66.20	73.69
Self-confidence	81.00	88.21	82.10	75.00	75.20	80.30
Self Satisfaction	88.00	90.00	76.00	60.00	62.00	75.2
Social cohesion	70.00	80.22	84.11	67.11	78.11	75.91
Freedom from debt	48.00	85.00	82.18	28.00	26.21	53.87
Employment to others	12.10	62.80	58.60	38.10	21.16	38.60

Note: Figures in the table indicate percentages.

- The members of the SHG should be more active, enthusiastic and dynamic to mobilise their savings. In this process NGOs should act as a facilitator and motivator.
- The leaders of the groups should be given nominal financial benefits, which will enable them to be more involved in the activities of the Group.
- The bank should give advance adequate credit to the SHG according to their needs.
- Uniformity should be maintained in formation and extension of financial assistance to them by banks.
- Meeting, Seminars and awareness campaigns may be organised where the members will get a chance to exchange their views and ideas and be able to develop their group strength by interactions.
- Active intervention by block and district administration, professional bodies & voluntary organisations is precondition for the successful enterprises in terms of skill training, designing products, providing new technology and access to market.
- The procedure of the banks in sanctioning credit to SHG should be simple and quick.

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Comparative Analysis of Plant Protection Measures in Conventionally Planted and High Density Planted Kinnow

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ABSTRACT

Fruits are of great importance in human diet. India is the 2nd major producer of the vegetables and fruits in all over the world Citrus is significantly grown in arid irrigated and sub-mountain zone of the Punjab state. Kinnow, Lime, Lemon and Sweet orange are most commonly grown varieties of citrus crop. The common insects such as citrus psylla, aphids, leaf minor, white fly, thrips and mites were found in present study. *Plant Protection* continues to play a significant role in achieving targets of crops production by controlling these insects. Keeping this in view, the study was conducted among kinnow growers of sub-mountainous zone of Punjab to know the plant protection measure followed in Kinnow cultivation for management of this insect pest management. Findings of the study revealed majority of the farmers were in medium category of innovativeness (40%), risk bearing capacity (82.5%) and scientific orientation (40.8%) respectively. Furthermore it was found that 85 per cent of the respondents used recommended insecticides in high density planting while in conventional planting, all of the respondents used recommended insecticides for control of aphids. Leaf minor was controlled with recommended insecticides by 27.5 per cent of high density planting kinnow growers while 57.1 per cent of conventional planting growers used recommended insecticides.

Keywords: Psychological traits, Kinnow growers, Insecticide

INTRODUCTION

Fruit cultivation in India is one such major commercial and business for exporting, merchandise and shipping from which much of the international revenue is incurred. Citrus fruits are native to the tropical and sub-tropical regions of the world. Citrus fruits cultivated all over the world in more than 140 countries. India occupies 6th position in citrus fruit cultivation (Sanofer, 2014). The total area under fruits cultivation in Punjab was 90416 hectares with production 1941137 million tons in 2019-20. Among these citrus crops, Kinnow is the leading citrus fruit with 55.47 thousand hectares in terms of the area and 1312.4 million tons in terms of production during 2019-20 in the state (Anonymous, 2020). The study conducted by Kumar (2019) reported, that the majority of respondents used less than recommended doses of farm yard manure, with adoption rates of 1.8, 6.6 and 33.4 per cent for 1-3 year, 4-7 year, and more than 8 year old plants, respectively. For nitrogenous fertilizer respondents used less than suggested, with 1.6, 3.0 and 25.3 per cent adoption rates for 1-3 year, 4-7 year, and more than 8 year old plants, respectively. For phosphorus application, the majority of respondents used the recommended doses, with adoption rates of 7.1 and 24.4 per cent for 4-7 year and more than 8 year old plants, respectively. In general, respondents used suggested insecticides at the appropriate times to control insects (Citrus psylla, Aphids, Leaf minor, White fly and Mites). The majority of respondents used recommended fungicides on time to manage Citrus canker and Gummosis/foot rot. Kumar and Kumar (2020) in their study found that more than half of the respondents applied recommended insecticides (Actara 25 WG, Confidor 17.5 SL, Fosmite 50 EC and Fosmite 30 EC) for control of *Citrus psylla* (59.60%), aphids

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(66.23%), leaf miner (57.77%), whitefly (58.54%) and mites (57.14%) and most of the respondents applied non recommended insecticides for control of mealybugs and thrips.

MATERIALS AND METHODS

The Study was conducted in the sub-mountainous zone of Punjab state. A compiled list of 795 Kinnow growers who were practicing high density planting as well as conventional planting of Kinnow from all six districts of sub-mountainous zone viz. Hoshiarpur, Ropar, Nawanshahr, Gurdaspur, SAS Nagar Mohali and Pathankot was obtained from Horticulture Development Officer of Department of Horticulture, Punjab. An interview schedule was prepared to obtain the data from the respondents following high density planting and conventional planting of Kinnow. The data was gathered by conducting personal interviews with the respondents using an interview schedule for the investigation. Every effort was made to clarify the questions in local language to get accurate responses from the respondents. The collected data from the growers were tabulated and analysed with the help of appropriate statistical tool i.e. frequency, percentages, mean score, range method etc.

RESULTS AND DISCUSSION

The information related to Psychological characteristics of respondents has been furnished in Table 1. The Psychological characteristics include Innovativeness, Risk Bearing Capacity and Scientific Orientation. All these variables were taken as independent variables for the study.

Table 1: Distribution of the respondents according to the psychological traits of the respondents (n=120)

Psychological trait	Categories	Frequency	Percentage
Innovativeness	Low (11-14)	45	37.5
	Medium (15-18)	48	40
	High (19-22)	27	22.5
Risk bearing capacity	Low (13-14)	14	11.6
	Medium (15-16)	99	82.5
	High (17-18)	7	5.8
Scientific orientation	Low (9-12)	41	34.1
	Medium (13-16)	49	40.8
	High (17-20)	30	25

It can be seen from the Table 1 that 40.0 per cent of respondents had medium level of Innovativeness followed by 37.5 per cent of the respondents had low level innovativeness. About 22.5 per cent of the respondents were highly innovative. These findings were approximately in line with the findings of Pawar (2020).

The data in Table 1 indicate that a majority of farmers (82.5%) were medium while 11.6 per cent farmers were low risk bearing capacity. Only 5.8 per cent of farmers were having high risk orientation. These findings were approximately in line with the findings of Singh *et al.* (2019) and Pawar (2020). The study by Sharma *et al.* (2022) reported that decision making pattern about Input management of horticultural crops production mean score was minimum in case of plant protection measure (1.65).

It is evident from the data in Table 1 that 40.8 per cent farmers were in medium category, followed by low level category with 34.1 per cent in scientific orientation whereas 25.0 per cent of farmers were highly scientific oriented.

A perusal of Table 2 explicated that 57.5 per cent of the respondents had observed the attacks of citrus psylla in densely planted orchard and out of this majority (53.3%) used recommended insecticides and only 4.2 per cent used non-recommended insecticides whereas it was observed by 57.1 per cent of the respondents in widely spaced orchard out of which all the respondents applied recommended insecticides and none of the respondents used non-recommended insecticides. All the respondents applied insecticides at recommended time in both cases. Ghadge and Bhople (2022) in their study found that 60.83 per cent of the respondents had knowledge about management of citrus psylla pest management.

Further, 39.2 per cent of respondents applied recommended doses followed by 11.7 per cent of respondents applied more than recommended doses and 2.5 per cent of the respondents applied less doses than recommended in high density planting. Whilst in conventional planting, maximum (42.8%) number of respondents applied recommended doses followed by 14.3 per cent of respondents applied less doses than recommended and no one exerted more than required doses of insecticides. The results were in contradiction with the findings of Gill (1996).

Table 2: Distribution of the respondents according to different plant protection measures followed for insect-pest management in Kinnow cultivation

Insect	f (%)		Recommended		Dose					
	n=120	n=7	TOA f (%)		HDP f(%)			CP f(%)		
	HDP	CP	HDP	CP	LR	R	MR	LR	R	MR
1. Citrus psylla										
Recommended insecticide	64(53.3)	4(57.1)	64(53.3)	4(57.1)	3(2.5)	47(39.2)	14(11.7)	1(14.3)	3(42.8)	-
Non-recommended insecticide	5(4.2)	-	-	-	-	-	-	-	-	-
2. Aphids										
Recommended insecticide	102(85)	7(100)	102(85)	7(100)	6(5)	80(66.7)	17(14.2)	1(14.3)	6(85.7)	-
Non-recommended insecticide	6(5)	-	-		-	-	-	-	-	-
3. Leaf Minor										
Recommended insecticide	31(25.8)	4(57.1)	31(25.8)	4(57.1)	-	26(65)	5(4.2)	-	4(57.1)	-
Non-recommended insecticide	2(1.7)	-	-	-	-	-	-	-	-	-
4. White fly										
Recommended insecticide	2(1.2)	-	2(1.2)	-	-	1(0.9)	1(0.9)	-	-	-
Non-recommended insecticide	33(27.5)	-	-	-	-	-	-	-	-	-
5. Thrips										
Recommended insecticide	11(9.2)	-	11(9.2)	-	-	11(9.2)	-	-	-	-
Non-recommended insecticide	3(2.5)	-	-	-	-	-	-	-	-	-
6. Mites										
Recommended insecticide	27(22.5)	2(28.6)	27(22.5)	2(1.7)	-	23(19.2)	4(3.3)	-	2(28.6)	-
Non-recommended insecticide	8(6.7)	1(14.3)	-	-	-	-	-	-	-	-

In HDP in the case of aphids, majority (90%) of the respondents reported the infestation and 85 per cent of the respondents used recommended insecticides and most of them (66.7%) administered the recommended doses followed by 14.2 per cent those applied more than required doses and only 5 per cent of the respondents exerted less than required doses of insecticide. On the contrary in conventional planting, all of the respondents used recommended insecticides and also applied them on right time. Majority (85.7%) of them employed recommended doses followed by only 14.3 per cent of those who applied less than recommended doses and none of them administered more than required doses of insecticides for the control of aphid. The results were almost in conformity with the findings of Suraj (1996).

Infestation of leaf minor was reported by 27.5 percent of high density planting kinnow growers out of which 25.8 per cent respondents used the suggested insecticides for the control of it. Although it was reported by majority (57.1) in widely spaced orchards and all of them applied it timely. All of the respondents in conventional planting applied recommended doses and none of them applied less than or more than required doses whereas in densely planted orchard, majority (65%) exerted the required doses and only 4.2 per cent of respondents applied more than recommended doses. None of them applied less than required doses for the control of leaf minor.

The infestation of white fly was observed in 28.7 per cent of densely planted orchard and only 1.2 per cent of respondents applied recommended insecticides and 27.5 per cent of the respondents used non-recommended insecticides. All of the respondents those administered recommended insecticides applied it on suggested time of application and half of them applied required doses and the other half exerted more than specified doses of insecticides. There was no infestation of white fly reported by widely spaced kinnow orchard growers. Ghadge and Bhople (2022) found that 63.33 per cent of the respondents didn't have knowledge about soil white fly control. Contrarily Kumar and

Kumar (2021) reported that 55.83 per cent had knowledge regarding recommended insecticide for controlling whitefly.

There was no infestation of thrip attack was reported by conventional planting kinnow growers. But on the other hand it was observed by 11.7 per cent of high density planting kinnow growers and 9.2 per cent of respondents applied recommended insecticides. All of the respondents followed recommended time of application and required doses for the control of thrip attack.

In concern of mites attack 29.2 per cent of high density planting and 42.9 per cent of conventional planting kinnow growers reported the infestations. Recommended insecticides were administered by 22.5 per cent in closely planted and 28.6 per cent of respondents in widely spaced kinnow orchard. Recommended time of application was followed by all of the respondents in both planting methods. In high density plantation 19.2 per cent of respondents applied recommended doses followed by 3.3 per cent of respondents applied more than recommended doses and none of them applied less than recommended doses. All of the respondents applied recommended doses in conventional planting system. Almost similar trends were presented by Suraj (1996) and Kumar (2019).

In case of insect pest management, majority of orange growers had knowledge about management of bark eating caterpillar (75.42%), management of fruit sucking moth (71.25%) and citrus psylla pest management (60.83%). While 63.33 per cent orange growers didn't have knowledge about soil white fly control.

A scrutiny of data in Table 3 elucidated that 53.3 per cent of respondents in high density and 57.1 per cent of respondents in conventional planting applied the recommended insecticides to control citrus psylla *i.e.* Actara 25 WG and Confidor 17.5 SL. In densely planted orchard, 26.6 per cent of the respondents applied recommended doses followed by 7.5 per cent exerted more than required and 2.5 per cent of the respondents applied less than recommended doses of Actara 25 WG. For Confidor 17.5 SL application about 12.5 per cent of the respondents used recommended doses followed by 4.2 per cent and 1.6 per cent of the respondents applied more than recommended doses and less than recommended doses respectively. While in conventional planting, actara 25 WG was administered by half of the respondents with recommended doses and the other half applied less than recommended doses, none of the respondents applied more than recommended doses. All the respondents applied recommended doses of Confidor 17.5 SL insecticide.

For control of aphid, majority (85%) of respondents applied recommended insecticides *i.e.* Actara 25 WG and Confidor 17.5 SL in densely spaced orchard in which Actara 25 WG was administered by 43.3 per cent of the respondents as per recommendations followed by 5 per cent and 4.2 per cent of the respondents applied less than recommended and more than recommended doses respectively and Confidor 17.5 SL was applied more than required by 18.3 per cent and 14.2 per cent of the respondents applied recommended doses. None of the respondents applied less than required doses. Nonetheless in widely spaced orchard Actara 25 WG was applied as per recommendation by more than half (57.1) of the respondents, followed by 14.3 per cent of the respondents those applied less than recommended doses, none of the respondents applied more than recommended doses. For Confidor 17.5 SL application all the respondents applied recommended doses of insecticide.

The Table further portrayed that for management of leaf minor, 25.8 per cent in high density and 57.1 percent of the respondents in conventional planting method applied recommended insecticides *i.e.* Actara 25 WG and Confidor 17.5 SL. In conventional planting, for Confidor 17.5 SL application all the respondents applied recommended doses. None of the respondents used Actara 25 WG for the control of leaf minor. Whereas in high density planting,

for Actara 25 WG application 12.5 per cent of the respondents applied recommended doses and only 2.5 per cent of the respondents administered more than recommended. Confidor 17.5 SL was administered by 9.2 per cent of the respondents as per recommendations and only 1.7 per cent of the respondents applied more than recommended doses.

Table 3: Distribution of the respondents according to dose of insecticide for insect-pest management

Name of insect and insecticides used	Dose used	f (%)	
		HDP (n=120)	CP (n=7)
1. Citrus psylla			
a. Actara 25 WG	Less than recommended (100-130g/500L)	3(2.5)	1(14.3)
	Recommended (160g/500L)	32(26.6)	1(14.3)
	More than recommended (180-300g/500L)	9(7.5)	-
b. Confidor 17.5 SL	Less than recommended (150-180 ml/500L)	2(1.6)	-
	Recommended (200ml/500L)	15(12.5)	2(8.6)
	More than recommended (230-300 ml/500L)	5(4.2)	-
2. Aphida			
a. Actara 25 WG	Less than recommended (120g/500L)	6(5)	1(14.3)
	Recommended (160g/500L)	52(43.3)	4(57.1)
	More than recommended (200-300 g/500L)	5(4.2)	-
b. Confidor 17.5 SL	Recommended (200ml/500L)	17(14.2)	2(28.6)
	More than recommended (250-300ml/500L)	22(18.3)	-
3. Leaf Minor			
a. Confidor 17.5 SL	Recommended (200ml/500L)	11(9.2)	3(42.8)
	More than recommended (250-300ml/500L)	2(1.7)	-
b. Actara 25 WG	Recommended (160g/500L)	15(12.5)	-
	More than recommended (250g/500L)	3(2.5)	-
4. White fly			
a. Fosmite 50 EC (Ethion)	Less than recommended (500ml/500L)	1(0.8)	-
	Recommended (1000ml/500L)		
5. Mites			
a. Fosmite 30 EC (Ethion)	Recommended (1000ml/500L)	23(19.2)	2(28.6)
	More than recommended (1500ml/500L)	4(3.3)	-
6. Thrips			
a. Fosmite 50 EC (Ethion)	Less than recommended (500ml/500L)	2(1.6)	-
	Recommended (1000ml/500L)	9(7.5)	-

In case of white fly infestation, there was only 1.2 respondents used recommended insecticide *i.e.* Fosmite 50 EC (Ethion). Half of the respondents applied doses as recommended followed by other half of the respondents applied less than recommended doses in high density planting. There was no insecticide used in Kinnow orchard grown in conventional planting method for the control of white fly.

For management of mites, 22.5 percent of the respondents applied recommended insecticide *i.e.* Fosmite 30 EC (Ethion) in high density planting orchard and 19.2 per cent of the respondents applied doses as recommended followed by 3.3 per cent of the respondents applied more than recommended doses and none of them used less than required doses for control of mites. In conventional planting only 6.7 per cent of the respondents applied recommended insecticide and also applied it as per recommendations. In conventional planting method there were no insecticide used for the control of thrips. Although in densely planted orchard 9.2 per cent of the respondents applied recommended insecticide *i.e.* Fosmite 50 EC (Ethion). About 7.5 per cent of the respondents applied recommended doses followed by 1.6 per cent of the respondents applied less than recommended doses. None of the respondents exerted less than more than required doses of recommended insecticide.

CONCLUSION

Kinnow is one of the most important fruit crops of Punjab. There is always the risk of pests attack on kinnow orchards. For the management of different pests like psylla, aphids, leaf minor, white fly, thrips and mites chemical control methods were most prevalent among kinnow growers. Although, most of the kinnow growers used recommended pesticides a considerable deviation from recommended doses and time of application was noticed. Therefore it is suggested that extension strategies like awareness training programmes should be organized for proper management of insect-pest attack.

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'*Mann Ki Baat*' and Mobile Based Extension Agro-advisory Services: Insights on Farmers' Perception and Lessons Learned

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ABSTRACT

Mann Ki Baat programme, a new initiative by Government of India started on 3rd October 2014, aims to sensitize the society about the positive and innovative approaches for excellence in endeavours towards well-being. Episodes on digital tools and mobile phones assumed significance in context of agriculture and farmers' welfare. Increasing penetration of mobile phones in farming community can be a game changer in agriculture sector. Mobile based extension agro-advisory services (MEAS) have the potential to improve the agricultural practices and increase productivity at field level through enabling farmers for quality and timely decision making. Although, the beneficial effect of these services is acknowledged, there is a gap in documented empirical based evidences of the actual effect at the field level on important aspects. This study aimed assess the effect of *Mann Ki Baat* on MEAS and the factors influencing the effect. qualitative estimate of how the MEAS initiative have affected farmers in innovation decision process. The findings suggested that MEAS had significant influence on farmers' perception about MEAS and increase in farmers' level of awareness and knowledge about the critical aspects of agriculture. Significant effect was also observed in the level of adoption of technology, yield enhancement and availability of market information. The study suggests that strengthening of the MEAS can bring about desirable changes in agriculture and farmers' livelihoods.

Keywords: Agro-advisory, *Mann Ki Baat*, Perception, Effectiveness, Knowledge creation, Social learning

INTRODUCTION

Agriculture is the backbone of economy in developing countries where a significant percentage of the population is engaged in farming. Extension system and delivery method has effect on timely delivery of the agricultural information among the farmers that ultimately affects the farm productivity. In India, extension worker to farmer ratio is very wide i.e. 1:5000 (Davis *et al.*, 2010) hampering farmers access to agricultural technology timely. As a result, farmers face several challenges related to access of information, technology, and resources, which hinder their productivity and profitability (Ragasa *et al.,* 2013; Burman *et al.,* 2015). In recent years, mobile-based extension agro-advisory services (MEAS) have emerged as a potential solution to address these challenges by providing farmers with timely and relevant information and guidance on farming practices, pest and disease management, weather forecasts and market trends, among others. *mKisan* platform is one such notable example of mobile-based extension agro-advisory services, launched by the Ministry of Agriculture and Farmers Welfare (Government of India) which provides farmers with information on a range of agricultural subjects (MoA&FW, 2022) and covered ~53 million Indian farmers. According to a report by the Internet and Mobile Association of India (IAMAI) (2019), mobile-based agriculture advisory services have the potential to reach up to 90 million farmers in India. These initiatives have also been found to have a positive impact on farmers' income and livelihoods (Pratap and Mehta, 2020). The use of mobile phones and internet technology has made it possible for farmers in the remote areas to access information on farming practices, crop management, weather updates, and market prices in real-time, leading

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to significant improvements in productivity and income. For instance, a study conducted by Katuramu *et al.* (2019) found that farmers who received mobile-based agro-advisory services had a higher yield and income than those who did not. Similarly, a study by Maumbe *et al.* (2020) found that mobile-based agro-advisory services have a positive impact on the adoption of sustainable farming practices.

The *Mann Ki Baat* programme is a regular broadcasted programme by the Hon'ble Prime Minister of India, where he addresses the nation on a range of topics including agriculture since its launch in 2014. The messages under *Maan Ki Baat* were able to reach a large section of the population including, rural areas through various channels, including radio, television, social media, and mobile applications. In recent years, the programme has been increasingly used as a platform to promote agricultural development and disseminate agricultural information among farmers. Mobile-based agro-advisory services have emerged as an effective means to reach farmers with timely and relevant information, and *Mann Ki Baat* has played a significant role in promoting the use of such services among farmers. For instance, a study conducted by Banerjee *et al.* (2020) found that the programme has significantly increased the usage of mobile-based agro-advisory services among farmers in rural India. Similarly, another study by Sharma and Singh (2021) found that the programme has had a positive impact on the awareness and motivating farmers to adopt mobile-based agro-advisory services by farmers. Overall, the literature suggests that *Mann Ki Baat* has emerged as a powerful tool for promoting agricultural development and dissemination of agricultural information among farmers through mobile-based agro-advisory services.

Despite the potential benefits of mobile-based extension agro-advisory services, it is crucial to understand the factors that influence farmers' adoption and usage of such services and the effect of these services on farmers' productivity, income, and well-being. This paper aims to assess the effect of *Mann Ki Baat* on mobile-based extension agro-advisory delivery and its accuracy considering the existing literature and empirical evidence. The paper also try to contextualise the factors those influencing farmers' adoption, and the challenges that need to be addressed. Furthermore, the paper seeks to assess the influence of *Mann Ki Baat* on farmers' perceptions of mobile-based extension agro-advisories and their motivation. Finally, the paper provides suggestions for increasing the significance of mobile-based extension agro-advisories, which are influenced one way or other by the *Mann Ki Baat* programme.

CONCEPTUAL FRAMEWORK

Effect of mobile-based extension agro-advisory services development and implementation has influence in the process of the farmers learning and its transfer among the peers which can be attributed to various communication theories. A combination of the theories is used to demonstrate effect of mobile based extension agro-advisory (Figure 1). The diffusion of innovation theory (Rogers, 2010) explains how new ideas, products, or services spread through a social system. In the context of mobile-based extension agro-advisory services, this theory can be used to understand the factors that influence the adoption and use of these services by farmers. Theory of change shows farmers readiness to change in their status in the adoption behaviour. Mobile phone mediated agro-advisory services may help in changing the adoption behaviour of farmers on a particular technology (Abdel Ghany, 2014; Bhaskar *et al.,* 2022).

According to the Unified Theory of Acceptance and Use of Technology (UTAUT, 2003), the actual use of technology is determined by behavioural intention. The perceived likelihood of adopting the technology information is dependent on the direct effect of four key constructs, namely performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy refers to the degree to which farmers believe that using mobile agro-advisory will help them improve their agricultural practices and increase their productivity. Effort expectancy refers to the ease of using technology and the perceived ease in learning to use it. Social influence refers to the impact of external factors, such as the opinions of family, friends, or other farmers, on a farmer's intention to use the technology. Facilitating conditions refer to the availability of necessary resources, such as access to mobile phones and internet connectivity, to use the technology effectively (Venkatesh *et al.,* 2003).

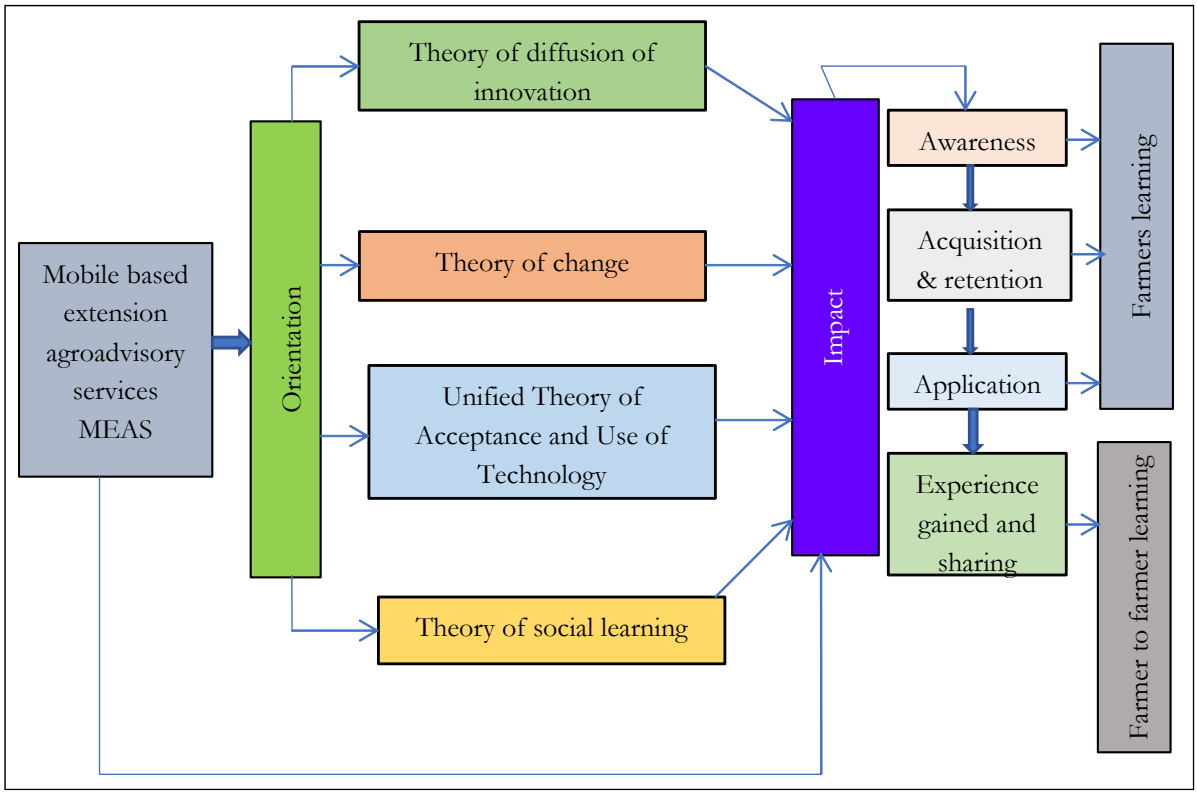

Figure 1: Conceptual framework developed for the study

To encourage farmers to use mobile agro-advisory services, it is important to address these four central determinants of technology adoption. Service providers should ensure that the technology is easy to use, accessible, and provides significant benefits to the farmers. Additionally, promoting positive social influence through farmer-to-farmer learning can be beneficial in increasing acceptance and adoption of the technology. In the context of mobile-based extension agro-advisory services that was emphasized in *Mann Ki Baat*, social learning can occur through interactions with peers, extension workers, or through online platforms (Bandura 1977). By creating opportunities for social learning, service providers can help farmers to develop the skills and knowledge needed to adopt and use these services effectively.

MATERIALS AND METHODS

The framework for this study is based on the combination of communication theories mentioned in the conceptual framework (Figure 1). The study primarily focusses on understanding the effect of mobile-based extension agro-advisory services on the process of farmers learning and its transfer among the peers. In order to achieve this objective, the following steps were undertaken:

The study aimed to understand the factors that influence the adoption and use of mobile-based extension agro-advisory services (as emphasized in *Mann Ki Baat* messages) by farmers in context of diffusion of innovation theory. The study further employed the Theory of Change to understand farmers' readiness to change their status in the desired behaviour as a influence from *Maan Ki Baat* directly or indirectly. The focus was on how mobile phone-mediated agro-advisory services changed farmers' behaviour to adopt agricultural technology.

In this study, Unified Theory of Acceptance and Use of Technology (UTAUT) was used to understand the actual use of mobile-based extension agro-advisory services by farmers. Examined the impact of four key constructs, namely performance expectancy, effort expectancy, social influence, and facilitating conditions, on the farmers' intention to use the technology from MEAS. Social learning theory was used to understand the effect of farmer-to-farmer learning on the adoption and use of mobile-based extension agro-advisory

services by farmers. It examined how creating opportunities for social learning can help farmers to develop their skills and knowledge needed to adopt, and use these services effectively.

Data: Primary data were collected by administering a well-structured and pre-tested interview schedule to the key informant (farmers) who listened *Mann Ki Baat* messages. Information was collected on demographic characteristics of the respondent farmers, farm specific characteristics, including ancillary activities; farmers' source of obtaining information on *Mann Ki Baat* initiatives; their perception of functioning of mobile-based extension agro-advisory services; effect of such services had on these farmers and also their suggestions on improving these services.

Sampling frame: The study was carried out in 72 districts in India, spanning across selected 29 states/ union territories of the country. The study area thus covered all the agro-climatic zones of India, as specified by Planning Commission (1982) and also all the geographical regions. The districts for the study were selected based on number of '*Mann Ki Baat*' events facilitated by respective KVKs of these districts both 'on-campus' and 'off-campus'. A list of the farmers who had participated in the '*Mann Ki Baat*' programmes were prepared and minimum 20 farmers, were selected randomly from each of the district. Besides, in some districts, KVKs have captured data more than twenty farmers. Given the above sampling plan and availability of farmers during the survey period and after data cleaning and smoothing, the final data set comprised information for 1509 farmers.

Analytical framework

Descriptive analysis: Descriptive statistics, in the form of means and proportions, were used to analyze farmers demographic features, their perceptions regarding the functioning of MEAS and their effectiveness. Z-test for two sample test for proportions were performed to check for significance of difference in proportions across different parameters measuring the underlying construct (like effectiveness, usefulness, etc.). For mean values, one-way ANOVA was used to test for significance of differences in the means of more than two groups across such parameters. Data were analyzed using statistical package STATA version 12 licenced (ICAR-NIAP, New Delhi).

Binary choice logistic regression: For assessing the influence of MEAS on specific parameters, farmers in this study mostly replied on dichotomous choices presented before them; i.e. '*Yes*' or '*No*'. For assessing the factors significantly influencing the likelihood of farmers' response being 'yes', we fitted binary choice logistic regression model. The model used in the form:

$$\text{Ln}\ (P_i\ /1-\ P_i) = \alpha + \Sigma\beta_i X_i + e_i$$

Where X is the vector of independent variables and β_i's is the coefficients to be estimated.

The e^{β} were calculated, which gave the odds ratio (OR) associated with change in the independent variable. The odds mean the ratio of probability of happening of an event to probability of not happening of that event. The odds are expressed as single number to the ratio to 1. The odds ratio gives a measure of degree of influence of a variable on the likelihood of event happening. The odds of 2 associated with a variable means that with one unit increase in the independent variable, the likelihood of the even happening doubles.

Ordered logistic regression: The data obtained in this study was qualitative in nature, mostly measured on Likert scale (3 or 5-point continuum) when we were analyzing farmers' perception towards the functioning of MEAS. As such to carry out a relational analysis to identify the significant factors influencing farmers' responses, we used ordered logistic regression (Fullerton, 2009). Ordered or Ordinal logistic regression has wide applications in social science research (Das and Rahman, 2011). As mentioned above, in our case the outcome variable is polychotomous. Examples of such or multiple-ordered response categories include opinion surveys with responses ranging from 'strongly agree' to 'strongly disagree'; etc. Ordered logit can be derived from a latent variable model, similar to the one from which binary choice logistic regression can be derived.

RESULTS AND DISCUSSION

All the farmers in this study were those who have participated in *Mann Bi Baat* programme, either off-campus or on-campus mode facilitated by the Krishi

Vigyan Kendras (KVKs). A majority of the farmers (58.12%) have reported that they have participated in on-campus (within the premises of KVKs), followed by at their own places (34%) and 7.75 per cent other places. Vast majority (86%) of respondents reported that they received the information regarding the *Mann Ki Baat* events from KVKs (Table 1). The other notable institutional source of information was the State Departments (23%). Progressive farmers and neighbouring farmers were the major non-institutional sources of information about the said event. State Agricultural Universities (SAUs) and Gram Panchayat bodies have also played, to some extent, their important role in providing the information on such events (10% and 15%, respectively).

Socio-economic and farm-specific characteristics: Highest proportion (95%) of respondents who have participated in *Mann Ki Baat* programme, were found to grow the field crops in their fields (Table 2). Relatively lesser proportions of respondents grow horticultural crops (51%) or rear livestock/poultry (53%) for source of income. Within the livestock rearing farmers, majority (71%) pursue dairying, followed by poultry (36%) and small ruminants rearing (27%). Pigs were reared by relatively lesser number of farmers (11%). Eleven per cent of farmers pursue agri-based enterprises, viz. bee-keeping, mushroom, etc. on their farms as supplementary source of income. About nine per cent of farmers has at least one non-farm income source, primary source being government/private service (67%) followed by non-agri based enterprises. Agricultural labour is source of income for only 5 per cent of the sample farmers. Farmers heads are mostly males (85%); the average age of farmers across all sample farmers being 45 years. Majority (63%) belonged to middle-income category. Social category wise, ~34.0 per cent farmers belonged to OBC or general (32%) categories, followed by tribal respondents (21%).

Table 1: Source of information for participation in PM's *Mann Ki Baaat*

Items	(% of farmers)
KVK	85.88[a]
ATMA	17.63[b]
State Department	23.26[c]
SAU's	10.34[d]
Gram Panchayat	15.44[b]
NGO's	6.96
Progressive farmers	26.84[b]
Farmers Producer Organization's (FPOs)	9.34
Shelf Help Group's (SHG's)	7.42
Joint Liability Group's (JLG's)	1.79
Input dealers	2.85
Neighbouring farmers	16.17[b]

Figures with different superscripts are significantly different at least 5% level of significance

Table 2: Socio-economic and farm-specific characteristics of sample respondents

S.No.	Particulars	Proportion of farmers
A	*Sources of Income*	
1	Field Crops	94.83
2	Horticulture	51.42
3	Animal Husbandry/Poultry	53.41
3.1	Dairying	71.22
3.2	Small ruminants	26.92
3.3	Poultry	35.98
3.4	Piggery	11.54
4	Agri-based enterprises	10.87
5	Non-Farm Income	8.81
5.1	Non-agri based enterprises	27.82
5.2	Service (Govt./Pvt.)	66.17
5.3	Industrial labour	8.27
6	Agricultural labour	5.17
B	*Annual Income*	
1	Low (<Rs. 1 lac)	22.86
2	Medium (Rs.1-2 lacs)	34.26
3	High (Rs. >2 lacs)	38.17
C	*Gender*	
1	Male	84.49
2	Female	15.51
D	*Age*	
1	Young (<33 yrs.)	17.16
2	Middle-aged (>=33 <=56 yrs.)	62.62
3	Old (>56 yrs.)	20.21
E	*Poverty Status*	
1	Above poverty line	71.64
2	Below poverty line	28.36
F	*Education category*	
1	Illiterate	4.17
2	Primary	21.07
3	High school	25.18
4	Intermediate	23.66
5	Graduate	20.74
6	Post graduate	5.04

Table 2 contd...

S.No.	Particulars	Proportion of farmers
G	*Landholding category*	
1	Landless	0.40
2	Marginal (<1 ha)	29.36
3	Small (>=1 to <=2 ha)	39.03
4	Medium (>2 to <=4 ha)	15.97
5	Large (>4 ha)	15.24
H	Proportion of land irrigated	
1	Marginal (<1 ha)	49.27
2	Small (>=1 to <=2 ha)	69.14
3	Medium (>2 to <=4 ha)	68.92
4	Large (>4 ha)	69.70
I	*Family size*	
1	Small (<3 HH members)	8.56
2	Medium (>=3 to<8 HH members)	78.99
3	Large (>= 8 HH members)	12.46

A majority (72%) of respondents were found to belong to above-poverty line as denoted by their ration cards they hold. Significant proportion of farmers were well-educated (25% high school, 24% intermediate and 21% being graduates). Average landholding size of Mann Ki Baat listeners was 2.47 ha, with the highest proportion of farmers belonging to small (>=1 ha to <=2 ha) landholding size category (39%), followed by marginal (<1 ha) landholders (29%). Sixty three per cent of total cultivable land area that farmers has, was recorded to be irrigated, with the marginal farmers having the lowest level of irrigation (49%).

Farmers' perception of functioning of MEAS

Effectiveness

"मोबाइल कृषि–सलाह से फसल संबंधी समस्या की त्वरित और सही जानकारी मिलती है।"

"Mobile agro-advisories provides quick and accurate solutions of crop-related problems."

(*Respondent-A*)

Such local perception of farmers could reflect the swiftness and easiness in access of appropriate resources being enabled by mobile led agroadvisory. Three items were before the sampled farmers to elicit their responses on a 3-point continuum on the 'effectiveness' parameter. Vast majority of farmers rated each of the items on agriculture (perceived to be inspired from *Mann Ki Baat* messages), viz. 'relevance to farming needs', 'correctness of contents' and 'timely availability of information' (73%, 70% and 71, respectively) very highly (Table 3a). However, statistically differences among these were not significant in the proportions of farmers rating these three items. Overall, on the basis of total scores for each farmer across these three items, 74 per cent of them gave high ratings to the effectiveness of the MEAS in general.

Awareness creation

"मोबाइल कृषि–सलाह से मिली जानकारी, मैं अपने साथी किसानों से साझा करता हूँ।"

"I share the information received through mobile agriculture advisory with my fellow farmers."

(*Respondent-B*)

This local quote of a farmer indicated how the information being received on agroadvisory helps in developing knowledge exchange mechanisms.

In case of the parameter regarding 'awareness creation' led by the *Mann Ki Baat* programme (multiple influence from other sources too), higher proportion of farmers rated all the items presented before them for rating as 'always' as compared to the same for the rating on 'sometimes' (Table 3b). Proportion of farmers rating awareness creation regarding time of sowing was significantly higher than the same for all other items. This is followed, in order of extent of awareness creation, awareness about weather forecast, horticultural crops and vaccination of animals.

Knowledge creation

"मोबाइल कृषि–सलाह हमें उन्नत तकनीकों को अंगीकृत करने का अवसर देता है।"

"Mobile agro-advisories provides opportunity to adopt improved technologies."

(*Respondent-C*)

As perceived locally, the process of getting new information through mobile-led agroadvisory also inculcate interest to try and adopt the new innovations in agriculture. The farmers covered under this study were recipient of technical information from mobile phones through various sources and they were using it differently in their farming but after listening *Mann Ki Baat* and getting the importance of mobile-based agro-advisory from Honorable Prime Minister side, they were encouraged to get deep into it for its proper

Table 3a: Perceived valuation of different attributes of MEAS in regard to their effectiveness (% of respondents)

Items	Always	Sometimes	Never
Relevance of MEAS to farming needs	73.09	26.04	0.86
Correctness of MEAS in terms of content	70.31	29.22	0.46
Timely availability of MEAS	71.11	26.91	1.99
Overall perceived effectiveness*	High	Medium	Low
Percentage of farmers	74.16	24.32	1.52

Table 3b: Awareness creation through MEAS (% of respondents)

Awareness about	Always	Sometimes	Never
Right time of sowing of crops	64.15[a]	34.79	1.06
Weather forecast	57.26[b]	36.38	6.36
Horticultural crops	54.08[c]	40.09	5.83
Time & frequency for vaccination	41.02[d]	44.80	14.18
Overall perceived awareness*	Completely	Partially	Not at all
Percentage of farmers	72.70	21.67	5.63

Figures with different superscripts are significantly different at least 10% level of significance

Table 3c: Knowledge creation though MEAS (% of farmers)

Items	Always	Sometimes	Never
Knowledge about right amount of use of bio-fertilizers and bio-pesticide	39.89[a]	50.50	9.61
Knowledge about insect and pest affecting the crops	43.94[b]	52.22	3.85
Knowledge about proper quantity of pesticides application	45.20[b]	46.06	8.75
Overall perceived awareness*	Completely	Partially	Not at all
Percentage of the farmers	41.75	43.67	14.58

Figures with different superscripts are significantly different at 5% level of significance

understanding and utilization. In this study, knowledge creation refers to measurement of the degree of MEAS after inspiring from *Mann Ki Baat*, in contrast to the earlier two parameters (Table 3a & 3b), higher proportions of respondents rated all the three items on 'sometimes' scale as compared to 'always'. Significantly higher proportion of respondents gave highest rating to the item pertaining to knowledge about pesticides, followed by insect and pest affecting crops and bio-fertilizers and bio-pesticides (Table 3c).

The usefulness of MEAS and motivation about MEAS was measured on a 5-point continuum i.e. strongly agree, agree, undecided, disagree and strongly disagree (Table 3d & e). The results showed that the farmers gave 'simplicity and applicability' the highest rating (1.24 mean score) followed by availability of sufficient information related to agriculture (1.18 mean score) and resolution of doubts related to agriculture (1.01 mean score) and significantly differed from each. However, regarding perception on motivation received due to MEAS, highest rating was given to motivation to increase yield (1.16 mean score), followed by motivation to adopt new technology (1.08 mean score) and to become successful in agriculture by maximize profits (1.10 mean score). These differed significantly from each.

On overall basis, 67 per cent of the farmers belong to the category of medium level of motivation level from MEAS followed by large (19.55 %) and low (13.59%) motivation level (Figure 2).

Factors significantly influencing the farmers' responses

The results of the ordered logistic regression, eliciting the variables significantly influencing the ratings of farmers on all three parameters, viz. 'effectiveness', 'awareness creation' and 'knowledge creation' are presented in appendices (1, 2, and 3). Among the significant variables, the value of odds ratio for gender reveals that being a male increases the perceived

Table 3d: Usefulness of MEAS

Items	Mean scores
Availability of sufficient information related to agriculture in MEAS	1.178[a](0.173)
Simplicity and applicability of MEAS	1.236[b](0.017)
Resolution of doubts related to agriculture through MEAS	1.010[c](0.020)

Figures with different superscripts are significantly different at 5% level of significance

Table 3e: Motivation about MEAS

Items	Mean scores
Motivation on increase yield	1.162[a](0.018)
Motivation to maximize profit and become successful in agriculture	1.084[b](0.018)
Motivation to adopt new technology	1.100[c](0.018)

Figures with different superscripts are significantly different at 5% level of significance

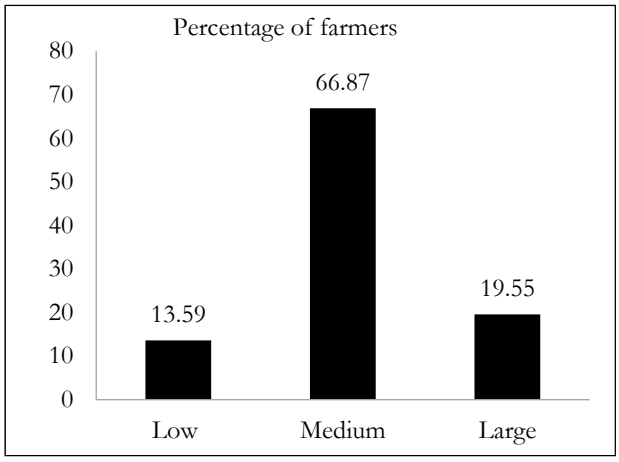

Figure 2: Overall motivation level from MEAS

valuation regarding effectiveness by 72 per cent (P <0.01) (Appendix 1), implying some level of differential effect on female farmers. With one year of increase in farmers age, the likelihood of favourable valuation by 1.6 per cent (P <0.01). Belonging to a SC (P <0.10) and general (P <0.05) category farmers increased the likelihood of favourable perception by 1.5 times in case of both. Being higher educated, the probability of favourable perception of effectiveness increases significantly. For example, a post-graduate farmers is 2.5 times more likely, than his counterpart having no education, to have favourable perception (P <0.05). Having ancillary income source like horticulture, animal husbandry, agri-based enterprises also increase the likelihood of perception in favour of MEAS effectiveness.

In case of the parameter, 'awareness creation', low income category farmers had more favourable perception towards MEAS, as belonging to middle income and high income category farmers reduces the likelihood of having favourable disposition by 35 per cent (P <0.01) and 40 per cent (P <0.01), respectively (Appendix 2). As in case of 'effectiveness' parameter, in case of 'awareness' also, increase in farmers age and belonging to SC and general category farmers increases the likelihood of having a favourable disposition. Increase in education, also increases the likelihood of possessing a favourable perception. Also, having an ancillary income source increases the probability of favourable disposition, while non-farm income does not exert and significant influence on the outcome variable. Being a male also significantly influences the likelihood of having a favourable disposition.

In case of 'knowledge creation', the same factors are identified to significantly influence the outcome variable as for in the case of 'effectiveness' parameter; with the exception that gender does not exert any significant influence and only one ancillary activity, viz. Agri-based enterprises, was significant in its influence (Appendix 3).

Effect of MEAS on farmers and influencing factors

"मोबाइल आधारित कृषि सलाह हमारी फसलों की उत्पादकता और गुणवत्ता बढ़ाने में मदद करती है।"

"Mobile agro-advisories helps in increasing the productivity and quality of our crops."

(*Respondent-D*)

Such a local perception of farmers indicated that MEAS could play a valuable role in obtaining

information that help in moderating crop husbandry which enhances the productivity and quality of related produce. The perusal of data presented in the Table 4 shows that vast majority of respondents reported significant and favourable effect of MEAS on parameters like 'yield increase' (88%), 'information on new agricultural technology' (90%), 'obtaining market information' (71%) and 'obtaining information on government schemes' (81%).

Table 4: Percentage % of farmers reporting favourable effect on relevant parameters

Items	Yes	No
Yield increase	87.74[a]	12.26
Information of new agricultural technology	90.26[b]	9.74
Market information	71.11[c]	28.89
Government schemes	80.98[d]	19.10

Figures with different superscripts are significantly different at least 5% level of significance

Table 5 elicits the factors significantly influencing the likelihood of increases yield and income. Belonging to medium and high-income category farmers significantly influences the likelihood of yield increase, pointing towards a bias against economically weaker farmers. This is further corroborated by the fact that increase in landholding is also significantly associated with likelihood of increasing income. Farmers with rich experience were found to have fair chance of increasing crop yield using MEAS influenced from *Mann Ki Baat*. On the other hand, SC and OBC categories are more likely to increase yield than their ST counterparts. Farmers, with higher level of education are more likely to have a favourable disposition to increasing their income.

Farmers, with ancillary source of income, like animal husbandry and horticulture, are more likely to increase their income. Also, farmers with at least one non-farm income source are also more likely to have a favourable disposition towards increasing income.

Table 5: Factors influencing likelihood of increasing yield and income due to MEAS (Results of Logit regression)

Logit yield increase		Odds Ratio	Std. Err.	z	P>z
Medium income category		1.503792	0.3210306	1.91	0.056
High income category		1.611207	0.3830232	2.01	0.045
Gender category		1.364899	0.2994192	1.42	0.156
Age		1.031561	0.0084164	3.81	0.000
Poverty category		1.117588	0.2208182	0.56	0.574
Primary		1.89571	0.6932673	1.75	0.08
High School		1.688492	0.6259326	1.41	0.158
Intermediate		2.314575	0.884172	2.20	0.028
Graduate		2.936424	1.208344	2.62	0.009
Post Graduate		1.949868	0.9956071	1.31	0.191
Family size		1.003746	0.0310584	0.12	0.904
Total landholding (ha)		0.8840019	0.0200672	-5.43	0.000
Proportion of land irrigated		1.309778	0.3017536	1.17	0.241
Horticulture Income Source		1.915801	0.3669667	3.39	0.001
AH Poultry Income source		1.354519	0.2456524	1.67	0.094
Agrienterprises including apiary		1.482683	0.501013	1.17	0.244
Non Farm Income Source		2.633435	1.107921	2.30	0.021
Agricultural labour Income Source		0.692628	0.2301921	-1.11	0.269
_Cons		0.2406464	0.1322211	-2.59	0.01
Particular	LR $chi^2(21)$	126.24			
	Prob > chi^2	0			
Log likelihood = -498.3319	Pseudo R^2	0.1124			

Table 6: Percentage of farmers reporting suggestions for improving MEAS

Number of agro-advisories received in a week should be	Three	Four	Five	More
	53.88	22.53	8.42	15.18
Language for receiving agro-advisories	Hindi	English	Local language	Others
	41.35	7.09	51.56	—
Need for MEAS for other subjects	Yes		No	
	89.46		10.54	

Suggestions for improving MEAS: Table 6 presents the results for suggestions given by the farmers for improving the effectiveness of MEAS. Majority (54%) of the farmers prefer to have three agro-advisory services per week, even though 22 per cent of the farmers reported they will prefer four agro-advisory services per week. Majority (51%) of the farmers prefer to receive the services in local language, followed by Hindi (41%). Vast majority of the farmers also elicited that they will prefer that the agro-advisory services also extend to other subjects beyond agriculture.

CONCLUSION

The present study focused on effect of *Mann Ki Baat* programme on functioning and application of mobile-based extension agro-advisory service (MEAS) by the farmers in their farming practices for improving their technology uptake for enhancing their income and securing their livelihood. The findings also suggested that MEAS (further strengthened by *Mann Ki Baat*) has significant effect on farmers' perception of its functioning, viz. effectiveness in regard to farmers' needs, and creation of awareness and knowledge about critical aspects of agriculture. Also, favourable and significant impact of the initiative was also observed on yield enhancing potential of farmers, their adoption of technology and getting market related information. The study also indicated that simplicity and applicability of MEAS is making highly useful for the farmers and increase in yield is the motivation factor for application of MEAS in their situation.

Further, it was also observed that the accrued benefits of MEAS found heterogeneous which may be due to scale bias, with richer farmers with larger landholdings, male farmers, and farmers with higher level of education benefiting the most. Thus, more focus needs to be given on marginal and small landholders, female farmers and farmers with lesser education level, to make the initiative more inclusive. The study also established the role of ancillary agricultural activities, mostly horticulture and animal husbandry in increasing the income potential of the farmers. Thus, any effort aimed towards enhancing farmers' welfare need to give maximum focus on these ancillary activities. The study also established the beneficial effect on farmers with non-farm income source.

The regular interaction and consultation of the farmers enhancing their inquisitiveness about new technology/practice, methods, tools, techniques etc., in their farming activity which ultimately leading to the positive attitude and right perception towards farming business as a profitable venture. Moreover, it has been experienced that farmers equipped with latest technological information are prone to be entrepreneurial and also supporting the fellow farmers in accepting and adopting the new agricultural innovations and improved practices. Thus, we can say that though *Mann Ki Baat* may have only sparked the agro-advisory, however it has lasted into high confidence level among the farmers leading to empowered farming community.

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Ethical statement: Respondents gave their informed consent for inclusion before they participated in the study. Informed consent was obtained from respondents for information published in this article.

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Appendix 1: Factors influencing perceived valuation of effectiveness of MEAS (Results of Ordered Logistics regression)

Effectiveness category	OR	S.E	P>z
Medium income category	0.810	0.126	0.178
High income category	1.231	0.223	0.251
Gender category	1.721	0.275	0.001
Age	1.016	0.005	0.004
Poverty category	1.154	0.168	0.325
Primary	1.247	0.370	0.457
High School	1.373	0.415	0.295
Intermediate	1.836	0.568	0.05
Graduate	1.760	0.570	0.08
Post Graduate	2.494	1.090	0.037
Family size	0.974	0.024	0.291
Total landholding (ha)	1.011	0.023	0.62
Proportion of land irrigated	1.128	0.187	0.467
Horticulture _Income Source	1.637	0.225	0.000
AH Poultry_Income source	1.336	0.175	0.027
Agrienterprises including apiary	1.892	0.475	0.011
Non FarmIncome Source	0.741	0.158	0.162
Agricultural labour Income Source	1.643	0.476	0.087
/cut1	-1.963	0.469	
/cut2	1.272	0.433	
LR chi^2 (21) = 116.5			
Prob > chi^2 = 0.0000			
Pseudo R^2 = 0.0613			

Appendix 2: Factors influencing perceived awareness associated with MEAS (Results of Ordered Logistics regression)

Awareness category	Odds Ratio	Std. Error	z	P>z
Medium income category	0.6497089	0.1041425	-2.69	0.007
High income category	0.59951	0.1089395	-2.82	0.005
Age	1.025759	0.0058508	4.46	0.000
Poverty category	1.117054	0.1599048	0.77	0.439
Primary	1.986839	0.5744547	2.37	0.018
High School	1.968098	0.5776785	2.31	0.021
Intermediate	2.280455	0.6805764	2.76	0.006
Graduate	2.454177	0.7661458	2.88	0.004
Post Graduate	4.974196	2.226414	3.58	0.000
Family size	1.007366	0.0258733	0.29	0.775
Total landholding (ha)	1.007463	0.0231146	0.32	0.746
Proportion of land irrigated	2.002699	0.32549	4.27	0.000
Horticulture Income Source	1.657671	0.2238855	3.74	0.000
AH Poultry Income source	1.551393	0.1997601	3.41	0.001
Agrienterprises including apiary	2.18124	0.5347209	3.18	0.001
Non Farm Income Source	1.332839	0.295484	1.30	0.195
Agricultural labour Income Source	2.946798	0.9976353	3.19	0.001
Gender category	1.433563	0.2296573	2.25	0.025
/cut1	0.4113854	0.4319445		
/cut2	2.391743	0.4335639		
LR chi^2 (21)	157.42			
Prob > chi^2 = 0				
Log likelihood = -1015.6558				
Pseudo R^2 = 0.0719				

Appendix 3: Factors influencing perceived knowledge with MEAS (Results of Ordered Logistics regression)

Usefulness category	Odds Ratio	Std. Error	z	P>z
Medium income category	0.75428	0.1004708	-2.12	0.034
High income category	0.838152	0.1214237	-1.22	0.223
Gender category	0.9751527	0.1392094	-0.18	0.860
Age	1.02073	0.0046904	4.47	0.000
Poverty category	1.13435	0.1387945	1.03	0.303
Primary	0.9576131	0.2571123	-0.16	0.872
High School	1.000417	0.2706663	0.00	0.999
Intermediate	1.000502	0.2737424	0.00	0.999
Graduate	1.064957	0.3008951	0.22	0.824
Post Graduate	1.323037	0.4561608	0.81	0.417
Family size	1.030085	0.0221386	1.38	0.168
Total landholding (ha)	0.9830181	0.0165056	-1.02	0.308
Proportion of land irrigated	2.19307	0.3054319	5.64	0.000
Horticulture Income Source	1.123728	0.1254347	1.05	0.296
AH Poultry Income source	1.179073	0.1266355	1.53	0.125
Agrienterprises including apiary	1.55313	0.2576778	2.65	0.008
Non Farm Income Source	0.9007797	0.1617929	-0.58	0.561
Agricultural labour Income Source	0.7051289	0.1623108	-1.52	0.129
/cut1	0.1485427	0.3694412		
/cut2	2.392682	0.3752557		

LR chi^2 (21) = 126.89

Prob > chi^2 = 0

Log likelihood = -1456.4449

Pseudo R^2 = 0.0417

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Knowledge Level of Rural Women Regarding Safe and Judicious use of Chemicals at Household Level

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ABSTRACT

Rural women are processors, consumers, producers and protectors of farm produce, they are constantly in contact with chemicals. Thus they may become vulnerable to chemicals related health risks. The role of women in chemical usage and consumer safety is of special significance. So, it is very important to assess their knowledge related to use of these chemicals safely at household level. Keeping this in view, the study was conducted on safe and judicious use of chemicals at household level on 100 rural women of Ludhiana District of Punjab State. After consulting the literature, 17 practices were finalized for knowledge test. All the items had a score of one for each correct response and zero for incorrect response. Total scores of each respondent on the knowledge test were calculated. The level of knowledge was categorized into low, medium and high. Fifty four per cent of the respondents had medium knowledge level and 45 per cent had low knowledge level. Only one per cent had high level of knowledge. Education, occupation and family type had significant association with knowledge level of rural women. There is need to create awareness and impart knowledge to rural women regarding safe and judicious use of chemicals at household level through different media.

Keywords: Chemical, Household level, Judicious, Knowledge level, Rural women

INTRODUCTION

Chemicals have become an integral part of our daily life. Many household chemicals are being used in performing different activities. Household chemicals are non-food chemicals, which are used for cooking, storage, cleaning, maintenance and hygiene like air freshener, bleach, conditioner, deodorant, insect-repellent, disinfectants, etc. These exist in the form of solids, liquids, gas, and plasma. If they not properly used or stored, these chemicals could cause minor to serious health problems. About 4.3 million people die every year due to the pollution of indoor household chemicals (Apte and Salvi, 2016). The rural women play a dynamic role in India's agro-based economy and household chores (Tripathi and Selvan 2016). The role of women in chemical usage and consumer safety is of special significance. So, it is very important to assess their knowledge how to use these chemicals safely at household level.

MATERIALS AND METHODS

The study was conducted on 100 rural women of Ludhiana District of Punjab state. A search on literature was made to identify the practices for safe and judicious use of chemicals. For this, past research studies, booklets, articles in different newspapers and magazines and books on chemicals were consulted with reference to residual effects of chemicals on health and health hazards caused due to these chemicals. After consulting literature, 22 practices were finalized for knowledge test. The test constituted multiple choice questions. All the items had a score of one for each correct response and zero for incorrect response. Knowledge test was pre-tested on sample of 20 rural women from non-sampled area. Items analysis including item difficulty and item discriminating power index was worked out (Parkash and Peshin, 2018). Out of 22 items, 17 items were finalized. Data were collected through interview

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schedule. Total scores of each respondent on the knowledge test were calculated out of a maximum score of 17. Score range was fixed between 1-17. The level of knowledge was categorized into low, medium and high as follows:

Knowledge level	Score range
Low	1–6
Medium	7–12
High	13–17

RESULTS AND DISCUSSION

Table 1 highlights that highest percentage of the respondents (61%) had a knowledge regarding safe coagulant for *paneer* making followed by 53 per cent for using of clay made utensils for safe cooking. Thirty per cent knowledge was observed in using natural colours in food whereas lowest percentage (29%) of the respondents was having knowledge for avoiding the use of *ajinomoto* in food. Reason for low knowledge may be that they were not aware about *ajinomoto* and artificial food colours.

In Table 2, the data showed that among all cleaning practices, 49 per cent of the respondents were having knowledge for using organic toilet cleaners followed by 31 per cent regarding the safe method of painting walls by brushing. Lowest percentage i.e. 28 per cent of the respondents had knowledge in spraying the pesticides/chemicals at night time in the kitchen. Among all storage practices, 39 per cent of the respondents had knowledge regarding storage of clothes with organic material followed by 37 per cent for wrapping the food in cotton cloth. Storage of food in glass jars had lowest knowledge i.e. 27 per cent.

Table 2: Knowledge of rural women regarding safe cleaning and storage practices at household level (n=100)

Cleaning practices	Knowledge level (%)
Spray the insecticides/chemicals at night time in the kitchen.	28.00
Paint the walls with brush.	31.00
Use organic toilet cleaners.	49.00
Storage practices	
Store the clothes with newspaper, dried mint and *neem* leaves.	39.00
Store food in glass jars.	27.00
Wrap the food in cotton cloth.	37.00

Table 3: Knowledge of rural women regarding safe hygiene and grooming practices at household level (n=100)

Safe hygiene and grooming practices	Knowledge level (%)
Avoid the frequent use of hair spray.	34.00
Use the organic material like *mehandi,* freshly brewed tea and coffee to dye hair.	43.00
Use the bathing soaps instead of shaving gels.	44.00

Table 3 depicted that 44 per cent of the respondents were having knowledge for using the bathing soaps for shaving whereas 43 per cent was noted in use of organic material to dye hair. Only one-third of the respondents knew about the avoidance of frequent use of hair spray.

The data regarding level of knowledge were presented in Table 4. The data revealed that 54 per cent of the respondents had medium knowledge level and 45 per cent had low knowledge level. Similar results

Table 1: Knowledge of rural women regarding safe and judicious use of chemicals in cooking practices at household level (n=100)

Practices related to safe and judicious use of chemicals during cooking practices	Knowledge level (%)
Avoid using the canned foods because it has fewer nutrients as compared to fresh foods.	48.00
Cooking in clay made utensils is the best for chemical free food.	53.00
Use natural colours in food because artificial colours cause cancer.	30.00
Avoid the use of *ajinomoto* in food.	29.00
Use safe coagulant like Lemon juice/Citric acid for *paneer* making because it is safe.	61.00
Store deep frying oil in airtight container immediately after cooling and use it once for refrying.	35.00
Avoid reuse of frying oil for deep frying for more than once.	43.00
Boil milk by simmering method. It kills bacteria.	45.00

Table 4: Overall knowledge level of respondents regarding safe and judicious use of chemicals at household level (n = 100)

Level of knowledgeScore range (1-17)	Knowledge level (%)
Low (1 – 6)	45
Medium (7 – 12)	54
High (13 – 17)	1

were also represented by Kumar *et al.* (2018) that majority of dairy owners of Roorkee block of Haridwar District (Uttarakhand) had low level of knowledge regarding improved animal husbandry practices. Only one per cent had high level of knowledge.

The data presented in Table 5 measured the relationship of the personal and socio-economic profile with knowledge and it was found that age, annual family income and land holding of the respondents had non-significant relationship with knowledge. But annual family income and land holding of the respondents were negatively related with knowledge whereas positive and non-significant relationship was also observed between age and knowledge score of rural women.

Table 5: Relationship of personal and socio-economic characteristics of the respondents with knowledge score (n=100)

Variables	'r' value (Knowledge score)
Age	0.070^{NS}
Annual family income	-0.116^{NS}
Land holding	-0.052^{NS}

The data with respect to education, occupation and family type of the respondents were discrete in nature and thus were subjected to chi-square test for the purpose of knowing their association with knowledge. Table 6 indicated that education, occupation and family type had significant association with knowledge.

CONCLUSION

Rural women had lowest knowledge score regarding use of *ajinomoto*, proper storage of deep frying oil and storage of food in glass jars. Lowest knowledge was also observed for avoiding the frequent use of hair spray. Only one per cent of the respondents had high level of knowledge. So, there is need to create awareness and impart knowledge to rural women regarding safe and judicious use of chemicals at household level through different media.

Table 6: Association of personal and socio-economic characteristics of the respondents with level of knowledge (n = 100)

Variables	Knowledge level				χ^2 value
	Low	Medium	High	Total	
Education					
Illiterate	9	6	-	15	60.089**
Primary	6	22	-	28	
Middle	-	13	-	13	
Matric	1	5	3	9	
Higher secondary	-	5	2	7	
Diploma holder	-	12	6	18	
Graduation	-	4	1	5	
Post graduation	-	1	4	5	
Occupation					
Housewife	20	56	4	80	5.582**
Enterprise at household level	-	7	1	8	
Govt. service	1	11	-	12	
Family type					
Nuclear	12	39	-	51	4.51**
Joint	9	36	4	49	

Significant at 1% level of significance

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Sericulture–An Supplementary Income Activity

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ABSTRACT

The term "sericulture" broadly includes plant cultivation for feeding the silkworms, its rearing for silk cocoon production, reeling the cocoons for unwinding the silk filament, yarn making, weaving and fabric making. In India, sericulture is not only a tradition but a living culture and is spread over 22 states. It plays a very significant role in the use of natural resources effectively for socio-economic upliftment with livelihood, employment and income generation to rural people. The profits are of Rs. 35000–40000 per cycle for about 2 quintals of cocoons from 200–250 DFLs and with around 7 to 8 cycles in a year, the total income can be up to Rs. 2.45–3.20 Lakhs per annum and monthly income of Rs. 20400–26500. The commonly grown crops like paddy and maize when grown twice in year give profits of Rs. 45000–60000 and monthly income of Rs. 3750–5000 whereas maize gives profits of 75000–84000 and monthly income of Rs. 6250–7000. Similarly for chilli, cotton and sugar cane grown once in a year, the profits are Rs. 90000–100000, 28500–35000 and 55000–65000 respectively. Each month, the income from these crops can be Rs. 7500–8300, 2350–2900 and 4600–5400 respectively. All the profits and monthly amounts presented are for one acre of land cultivated.

Keywords: Chilli, Cotton, Income generation, Maize, Mulberry leaves, Paddy, Sericulture, Silkworm rearing, Sugar cane

INTRODUCTION

The word "Sericulture" was derived from the word "Su" (Si) meaning silk (Shrivastav, 2005). It was used to denote both the industry concerned with silkworm rearing and the science with technical basis for the industry. Sericulture broadly comprises of inter-linked activities that include plant cultivation for feeding the silkworms, its rearing for silk cocoon production, reeling the cocoons for unwinding the silk filament, yarn making, weaving and fabric making (Ahmed and Rajan, 2011). There are 10 million silkworm rearers and 0.5 million related industrial workers in the world (Seidavi *et al.,* 2005).

Asia is the top producer of silk in the world contributing 95 per cent of total global output. There are 58 countries on the world map of silk with bulk being produced in China and India, followed by Japan, Brazil and Korea (Nagaraju, 2008).

In India, sericulture is not only a tradition but a living culture (Dewangan *et al.*, 2012). India is home to a vast variety of silk secreting fauna including an amazing diversity of silk moths. The cultivation is spread over 22 states covering about 172000 hectares (Dewangan *et al.,* 2011b). India is uniquely distinct country in the world producing all five kinds of silk that include Mulberry, Eri, Muga, Tropical Tasar and Temperate Tasar with 87.0 per cent. Indian domestic silk market being multivoltine mulberry silk oriented (Jayaram and Indumati, 2008).

About 1.5 lakh tribal population in the states of Jharkhand, Chhattisgarh, Orissa, Madhya Pradesh, Uttar Pradesh, West Bengal, Maharashtra and Andhra Pradesh practice Tasar sericulture (Shetty *et al.,* 2007). Despite the availability of vast tasar food plants spread in 111.68 lakh hectares in the tropical belt of India. Tasar production is only 1.5 per cent of total silk production

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contributing to 16.5 per cent of non-mulberry silk production in the country (Dewangan *et al.,* 2011b). Tasar sericulture is a labour-intensive industry at all phases and can generate employment up to 11 persons for every kilogram of raw silk produced (Ramalaxmi, 2007). The five states of Andhra Pradesh, Karnataka, Tamil Nadu, Jammu and Kashmir along with West Bengal are considered traditional mulberry sericulture states accounting for 97.0 per cent production (Eswarappa, 2011).

Sericulture production is still limited to a few pockets in the country and decline in areas under cultivation of silkworm food plants is a matter of concern. The current production of about 28708 MT during 2014–15 was not adequate to meet the demand for silk in the country. This industry is struggling to cope with competition from countries like China and Japan (Handique *et al.,* 2016).

This sector plays a very imperative role in the utilization of natural resources effectively for socio-economic upliftment with livelihood, employment and income generation to rural folks (Malik *et al.,* 2008). It requires low investment and offers high profit fetching regular income to farmers throughout the year unlike most of the agricultural crops. The vital role in flow of income is from urban rich to rural poor as demand for silk is largely from the higher income group of the society (Dewangan *et al.,* 2011a).

Indian rural sector is one of the biggest in the world after China with over 76.3 per cent population living in rural areas and 68.8 per cent dependent on agriculture (Kasi, 2009). In India, more than 90.0 per cent of labour force are employed in unorganized sector with no social security and other benefits of employment as in the organized sector (Rani, 2007). Sericulture is a potential sector of agriculture to raise economic status of farming community and earn foreign revenue (Thapa and Shrestha, 1999). The sericulture related activities ensure livelihood security to over six million families and earned valuable foreign exchange for the country of Rs. 3.34 thousand crores during 2006-07 (Gangopadhyay, 2008).

The two significant problems involved in the commercial aspects of sericulture include breeding of a silkworm strain with high productivity and prevention of silkworm diseases (Horie, 1980). The bulk of silk produced in the country is reared from cross breed cocoons and are more suitable for handloom sector. The power loom weavers and exporters in India prefer Chinese silk as it has more uniformity, less winding breaks and low degumming losses compared to domestic Indian silk. As the quality and productivity of silk derived from traditional crossbreed cocoons is less, switching over to bivoltine sericulture in the country is imperative to achieve competitiveness (Jayaram and Indumati, 2008).

The earlier phase of development of sericulture in India targeted on replacing low yielding mulberry varieties with improved robust yielding one followed by replacement of the traditional multivoltine silkworm races with bivoltine races. The conditions prevailed in rearing silkworm are very unhygienic because of absence of separate rearing houses for silkworm rearing with majority of farmers. The unhygienic conditions of silkworm rearing can increase the outbreak of diseases and this can be a major setback to silk cocoon production due to poorer yields and thereby harming the productivity level (Jayaram and Indumati, 2008).

Women constitute more than 50.0 per cent of the world's population with one third of the labour force performing nearly two thirds of all working hours. It is estimated that India is the home to 12.7 crores working women and 90.0 per cent of them are working in the unorganized sector (Dewangan *et al.,* 2011). Sericulture provides ample opportunities of income for these women in rural areas particularly in silkworm rearing and reeling activities. The involvement of women in different activities of sericulture is about 53.0 per cent. Raw silk production is the most appropriate tool to provide gainful employment to the poorer sections of society. It is estimated that sericulture can generate employment 11 man-days per one Kilogram of mulberry raw silk production with both on and off farm activities throughout the year along with helping to stop interstate migration (Gangopadhyay, 2008).

In view of its potential to help in improving the economic levels of farmers, the present study was taken up by Krishi Vigyan Kendra, Wyra in Khammam district.

MATERIALS AND METHODS

The farmers / farm women in the age group of 35–55 years were considered for the study who are taking up sericulture along with growing regular farm crops common to Khammam district like paddy, chilli, cotton and maize. A detailed questionnaire was developed to compare the income generation through sericulture with other crops. The data collected was consolidated and present.

RESULTS AND DISCUSSION

The comparison between cultivation of different crops with sericulture is shown in Table 1. The commonly grown crops in Khammam district include paddy, chilli, cotton, maize and sugar cane to a certain extent.

The usual duration for paddy is 120 to 150 days depending on the variety selected and 1 to 2 times in a year. The profits per annum range around Rs. 45000–60000 when grown 2 times with income per month of Rs. 3750–5000. Next is chilli, another popular crop in this district which fetches around Rs. 90000–100000 per season of 7 to 8 months with income per month of Rs. 7500–8300. Next crop is cotton which gives an income of Rs. 28500–35000 per annum with income per month of Rs. 2350–2900. Maize is also grown 1 to 2 times in a year with annual profit of Rs. 75000–84000 when grown twice in a year and then monthly income can be Rs. 6250–7000.

Sugar cane is another cash crop grown in pockets of Khammam district with sericulture by few progressive and they harvest about 340–400 quintals (34 to 40 tons) per season lasting 9 to 11 months for early harvest varieties. It can fetch profits of Rs. 55000–65000 per time with monthly income of Rs. 4600–5400. The crop can be grown in regions nearer to sugar processing units as cost of transportation is quite high. All the profits and monthly amounts presented are for one acre of land cultivated.

Coming to sericulture as an important source of income, in about 1½ - 2 acres of land around 7750–11000 mulberry plants can be grown. Initially for transplanting each of the plant, Rs. 2 is charged. Once done, it takes about 3 months to reach a height of 4 feet from when cuttings can be done. The cuttings can be done almost daily and last between 10–15 years. Later the crop should be changed otherwise problems

Table 1: Comparison between sericulture and different crops cultivated per acre in Khammam district

Parameter	Sericulture	Paddy	Chilli	Cotton	Maize	Sugar cane
Duration of crop	DFLs–26 to 28 days Chawki–18 days	120 to 150 days	7 to 8 months	5 to 6 months	110–120 days	9 to 11 months
No. of times per annum	7 to 8	1 to 2	1.0	1.0	1 to 2	1.0
Yield of crop per acre in quintals	2.0	25–30	25–30	10–12	35–40	340–400
Cost of cultivation in Rs.	19000–21000	23000–25000	1.4–1.6 Lakhs	25000–28000	24000–28000	50000–60000
Profits generated in Rs. for one time	35000–40000	22500–30000	90000–100000	28500–35000	37500–42000	55000–65000
Profits generated in Rs. per annum	2.45–3.2 Lakhs	45000–60000	90000–100000	28500–35000	75000–84000	55000–65000
Amount of income in Rs. per month	20400–26500	3750–5000	7500–8300	2350–2900	6250–7000	4600–5400

of root rot may arise. The cost of setting up the shed is around Rs. 7 to 8 lakhs which is the initial investment. Previously government used to provide subsidy for setting the shed whereas now there is no subsidy. The shed too last for around 15 to 16 years with minimum maintenance.

Initially DFLs (Disease free laying) or chawkis can be obtained. DFLs take around 26–28 days to grow into silk cocoons with 100 DFLs costing Rs. 400–500 whereas and chawkis take around 18 days into silk cocoons costing Rs. 2500–2800 as they are already reared before purchased by farmer. From 1 acre land, around 200 to 250 DFLs can be reared and can again reared once the mulberry plants grow. But, with 1½ - 2 acres of land having mulberry plants, 7 to 8 cycles can be done. With careful planning, the number can be increased to 10 times also. Usually during the months of May and June there will be no rearing of silk worms due to vagaries in temperature and onset of monsoons.

The usual profits are of Rs. 35000–40000 per cycle with 2.0 quintals of cocoons obtained from 200–250 DFLs. With around 7 to 8 cycles in a year, the total income can be up to Rs. 2.45–3.2 Lakhs per annum and monthly income of Rs. 20400–26500. Another interesting factor is that there are no losses incurred usually but the profits are cut down and farmer may get around Rs. 20000 to 22000/- only. Even if the profits are reduced, the income from 7 to 8 cycles can be around Rs. 1.4–1.75 per annum. The initial investment on shed is quite high and hence to reach the break even point, it can take around 3 to 4 years if larvae are grown 7 to 8 times in a year.

The materials like plastic sheets and ant wells are provided free of cost with DFLs or chawkis. The larvae also called the caterpillars or the silkworms are stored in clean bamboo trays along with freshly chopped mulberry leaves. The caterpillars feed on these leaves day and night and grow enormously in size. Humidifiers during summer months and heaters during winters can be used to maintain optimum growing temperatures of 24–28°C. Locally available mud pot charcoal fire place can be used to reduce the cost of electricity run heaters.

The frequency of feeding for chawkis is done at least four times a day. The rearing beds are kept covered with paraffin paper. To maintenance the humidity in rearing beds foam rubber pads or paper soaked in water are used. Silkworms are fed with large quantity of mulberry leaves than their eating capacity and the unused leaves are unfit for consumption as feed by the worms. Along with this, excreta of worms form a thick bed as out of the total weight of leaf taken as food, three fifth is excreted out and only two-fifth assimilated by the chawkis. The pilling of unconsumed leaves on moist beds can result in fermentation there by releasing harmful gases and favour multiplication of pathogens that affect the chawkis. Hence, removal of unused mulberry leaves, fecal waste from silkworms, cast out skin, dead or unhealthy worms from the rearing bed is very much essential.

The minimum sales price and compensation for crop loss to regular produce like paddy, chilli, cotton and maize in times of unpredictable climatic conditions, global warming, greenhouse gases and single crop farming is adversely affecting the economic status of farmers and in India, still 60 to 70 per cent population are dependent on agriculture. In this scenario, the encouraging of silk worm rearing can be helpful as each Kilogram of cocoons are sold at Rs. 350–450 with Rs. 75/- given by government. Sericulture is good option for additional income generation and can provide employment locally for longer months than the regular agriculture activities. Apart from improving the economic status of farmers, migration in search of employment and displacement from native places can be reduced.

The other side of the coin is that the use of mechanical sprayers in regular crop fields is causing drifting pesticides to nearby mulberry fields and once the pesticide infested mulberry leaves consumed by the larvae is affecting their survival rates causing losses which are otherwise not seen in silkworm rearing. It is also adversely influencing the growth of sericulture as an additional income generating activity among farmers.

CONCLUSION

Sericulture is the source of additional income generation. The availability of land, labour, good silkworm hybrids, low investment, short gestation period, easily adoptable technologies with requirement of minimal skills and strong domestic demand-pull are strengths of sericulture. The reduction in seasonal out-migration and improvement in living conditions

among farmers adopting it can be popularised. This sector highly succeeds as an appropriate agro-based cottage industry for rural development, environment protection and rejuvenation. It is important for generating rural employment and preventing rural migration

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Impact of IFS Models on Economic Status of Rural Women

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ABSTRACT

The present study was planned to study the impact of IFS models on economic status of rural women. The study was conducted in *Gudli* village of Udaipur district of Rajasthan. The AICRP on Home Science has promoted two IFS model viz. crop + horticulture and crop + poultry in the adopted village of MPUAT, Udaipur. From the selected village, 50 respondents for crop + horticulture model and 60 respondents for crop + poultry model were selected for the study. For accomplishing the present investigation, interview technique was used to collect information from the rural women beneficiaries. After data collection, data were analyzed using frequency, percentage, mean per cent score and paired t-test. Overall impact of both IFS models in relation to income generation was found to be good. For calculating the difference between the two means of income generation before and after the adopting both IFS model, t test was applied. The calculated value was found highly significant at 1 per cent level of significance.

Keywords: Economic status, IFS models, Rural women

INTRODUCTION

Integrated Farming System (IFS)is a sub system of a high-level land use system like a village or a watershed which includes crop production, raising livestock, fishery, poultry, beekeeping on a particular farm with an objective of higher profitability without altering ecological and socio-economic balance on one hand and to meet the national goals on the other hand (www.agri-bsc.kkwagh.edu.in).

The Integrated Farming Systems (IFS) therefore assumes greater importance for sound management of farm resources to enhance the farm productivity and reduce the environmental degradation, improve the quality of life of resource poor farmers and maintain sustainability. It utilizes wastes as resources, we not only eliminate wastes but we also ensure overall increase in productivity for the whole agricultural systems (CARDI, 2010). In order to sustain a positive growth rate in agriculture, a holistic approach is the need of the hour. This involves the adoption of scientific agronomic practices and technologies which promise an augmentation of the productive capacity of traditional agricultural systems. Agronomic practices such as the liberal use of inorganic pesticides and fertilizers during the twentieth century enhanced productivity significantly but undesirable environmental degradation accompanied by increased operational costs in agriculture raised concerns about economic feasibility and sustainability. IFS is a multidisciplinary whole farm approach and very effective involving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holding by integrating various farm enterprises and recycling crop residues and by products within the farm itself.

In another way Integrated farming system (IFS) is one of the best solutions for the stability of income and improvement of nutrition for the small and marginal farmers with limited resources. Channabasavanna and Biradar (2009) stated that IFS approach recorded 26.3 and 32.3 per cent higher productivity and profitability respectively over conventional system in rice ecosystem. Integration of different enterprise with crop activity will provide ways to recycle products and waste materials of one component as input through another linked

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component and reduce cost of production of the products which will finally raise the total income of the farm.

The "All India Coordinated Research Project on Home Science" carried the project on "Scoping IFS Models from Gender Perspective with Focus on Enhancing Farm Income" in year 2017-20 with the objectives to document region specific tested IFS models for enhancing farm income, to screen the selected models from gender perspective and to diffuse the learnings/lessons from identified models in the adopted village. Under the project the information was collected about suitable IFS models for Rajasthan state from AICRP on IFS, Rajasthan College of Agriculture, MPUAT. According to their study four models are suitable for Rajasthan. Out of four models, two models were established at farmer's field in the adopted villages of AICRP on Home Science before establishing the models, technological interventions were given to the farm women related to Crop + Horticulture model and Crop + Poultry models. Since the project has completed three years of its implementation therefore, it is apt time to frame a systematic study on impact of IFS models on economic status of rural women.

MATERIALS AND METHODS

The present study was conducted purposively in *Gudli* village of *Mavli* panchayat samiti of Udaipur district in Rajasthan state as the researcher was well acquainted with the socio-economic conditions of the place which facilitated and smoothened the data collection process. Another reason was that AICRP – Home Science has adopted the village and promoted various IFS models in the village. The AICRP on Home Science has promoted two IFS model viz. crop + horticulture and crop + poultry in the adopted villages of MPUAT, Udaipur. For selection of sample, IFS model wise list of women was procured from AICRP on Home Science. From the list, it was observed that crop + horticulture and crop + poultry IFS models were promoted among 50 and 60 respondents, respectively. Thus there were total 110 rural women and all were included in the study. For accomplishing the present investigation, interview technique was used to collect information from the rural women beneficiaries. For this purpose, interview schedule was developed by the investigator by consulting review of literature. The schedule section included information about the impact of IFS models on economic status of rural women in terms of income of the respondents before and after adopting IFS models.

The respondents were contacted individually and interviewed at their homes and farms. The questions were asked in local dialect (*Mewari*), which helped them to understand the questions more clearly.

Analysis of data: In the present study, adoption is referred to the acceptance and practice of different IFS modules by the farm women. To know the extent of adoption of IFS modules an attempt was made as detailed below. The information pertaining to adoption of different technologies were recorded on a three point continuum namely always, sometimes, never with scores 2, 1 and 0 respectively. Further adoption index developed by Singh and Singh (1981) was used to quantify the adoption behaviour of the respondents. It is given below:

$$A.I. = (E / P) \times 100$$

Where, A.I. = Adoption index
E = Extent of adoption of a given practice
P = Potentiality of adoption of a practice

RESULTS AND DISCUSSION

Impact of IFS model was seen in terms of extent of income generation after adopting the activities which is one of the driving forces for rural women to carry the model successfully. It can directly influence the sustainability of any activity and in long terms it could be turns up to IFS models. If one is not getting adequate returns from the investments, then the efforts are meaningless, and it can hamper their progress. Thus, the present objective attempts to know the impact of IFS model on economic status of rural women.

Data in Table 1 show the monthly income before and after adopting the horticulture IFS model. It indicates that 40 per cent respondent's monthly income before starting the activity was ranging between Rs. 5000-10000 followed by 36 per cent monthly income was up to Rs. 5000, 14 per cent respondents income was in the category of Rs. 10000-15000 and only 10 per cent respondents income were in the category of 15000-20000. After adoption of IFS model, 50 per cent respondents' monthly income falls in the range of

Table 1: Distribution of the respondents by their income before and after adopting the crop + horticulture IFS model (n=50)

Income Categories	Before		After		Percentage change	
(rupees)	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Nil	0	0	0	0	0	0
Up to Rs. 5000	18	36	5	10	13	26
Rs. 5000 - Rs. 10000	20	40	25	50	5	10
Rs. 10000 - Rs. 15000	7	14	12	24	5	10
Rs. 15000 - Rs. 20000	5	10	8	16	3	6
Rs. 20000 - Rs. 30000	0	0	0	0	0	0
Above Rs. 30000	0	0	0	0	0	0

Rs. 5000- 10000 whereas 24 per cent of the respondents earned monthly income up to Rs. 10000-15000 and 16 per cent of the respondents monthly income ranges between Rs. 15000-20000. Ponnusamy and Devi (2017) studied impact of integrated farming system approach on doubling farmers income with 150 farmers and revealed that incremental net benefit of adopting different enterprise combinations with improved management practices increased by INR 7880 for crop + dairy, INR 12680 for crop + dairy + poultry, INR 57530 for crop + dairy + poultry + fishery and INR 35840 for crop + dairy + poultry + sheep/goat.

Mukherjee (2015) in a study reported the similar results that in mid hill regions of West Bengal, India, farming system involving crop + Poultry + dairy + piggery IFS models had positive advantage in terms of economic returns. It has high gross income (Rs. 101482/ha), net returns (Rs. 24935/ha) and sustainability index (88.5%) in comparison with crop alone component's (gross income Rs. 57589/ha, net returns Rs. 14002/ha and sustainability index 44.8%). An effort was made to find out the significance of gain in income of the respondents. This gain was found to be highly significant as indicated by the 't' value.

Table 2 shows overall impact of horticulture IFS model in relation to income generation. For calculating the difference between the two means of income generation before and after the adopting crop + horticulture IFS model, t test was applied. The calculated value was found to be highly significant at 1 per cent level of significance. Kumar *et al.* (2012) reported the similar findings with the net income (Rs. 159485/year) and employment generation (752 man days/year). Employment generation and marketing behaviour were also found significantly correlated with the total income due to the proper engagement of family labour and immediate returns from sale of crop output, vegetable production and dairy products for meeting the urgent expenses.

Table 2: Significance of difference in income of the respondents before and after adopting crop + horticulture IFS model

Categories	Mean percent scores	t value
Before	8250	7.23**
After	11180	

** Significant at 1 per cent level of significance

In case of poultry IFS model, Table 3 shows that majority of the respondent's (66.66%) monthly income was ranging upto Rs. 5000 before adopting the IFS model followed by 20 per cent respondents' monthly income was ranging Rs. 5000-10000 and 13.33 per cent respondents' income was in the category of Rs. 10000-15000 before taking up the activity. Prasad *et al.* (2021) conducted a study on integrated farming system in *Chickballapura* district- a method to improve livelihood security of farmers with 271 respondents and reported that the average yield of ragi increased by 46.16 per cent, groundnut increased by 33.33 per cent.

Regarding income level after adopting IFS model, 58.33 per cent of the respondents earned up to Rs. 5000-10000 per month, 20 per cent respondents monthly income falls in the category of Rs. 10000-15000, 16.66 per cent respondents income was up to 5000 and 5 per cent respondents were earning income in the range of Rs. 15000-Rs 20000, shows a good increment in monthly income of respondents after adopting the poultry + crop IFS model.

Table 3: Distribution of the respondents by their income before and after adopting the crop + poultry IFS model (n=60)

Income Categories (rupees)	Before		After		Percentage change	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Up to Rs. 5000	40	66.66	10	16.66	30	50
Rs. 5000 - Rs. 10000	12	20	35	58.33	23	38.33
Rs. 10000 - Rs. 15000	8	13.33	12	20	4	6.66
Rs. 15000 - Rs. 20000	0	0	3	5	3	5
Above Rs. 20000	0	0	0	0	0	0

Table 4: Significance of difference in income of the respondents before and after adopting crop + poultry IFS model

Categories	Mean percent scores	t value
Before	5925	6.53**
After	8425	

** Significant at 1 per cent level of significance

Table 4 shows overall impact of poultry IFS model in relation to income generation. For calculating the difference between the two means of income generation before and after adopting IFS model, t test was applied. The calculated value was found to be highly significant at 1 per cent level of significance.

Regarding socio economic status perceived by respondents after adopting horticulture model, Table 5 shows that more than half of the respondents (52%) strongly agreed that their socio-economic status have been increased whereas 36 per cent of the respondents agreed regarding increasing of socio-economic status after adopting IFS model. It is further evident from the table that 8 per cent respondents had neutral reaction with blank statements as they were mentally confused or in dilemma whether the economic status increased, or it was same as earlier, followed by 4 per cent respondents showed their disagreement that there was no increment in socio economic status of the respondents.

In case of poultry, majority of the respondents (63.33%) were strongly agreed regarding changes in socio economic status whereas 26.66 per cent rural women reported that they were agreed as their socio-economic status have been raised after adopting of IFS model and 10 per cent respondents had neutral reaction with blank statements as they were mentally confused or in dilemma whether the economic status increased, or it was same as earlier (Table 5).

The findings of the study were in consonance with Aklilu *et al.* (2008) reported that farmers described Poultry as a source of self-reliance for rural women. Poultry and egg sales are decided by women and therefore provide them with an immediate income to meet household expenses (e.g., food items) instead of expecting men to provide the cash.

CONCLUSION

The adoption of multiple farm enterprises in an integrated manner can ensure a substantial income generation to sustain the livelihood of farm women over the meagre income from self-standing enterprises as revealed from this study. Thus, we can conclude that adoption of integrated farming systems improves

Table 5: Distribution of the respondents regarding change in socio-economic status after adoption of IFS model

Responses	Horticulture (n=50)		Poultry (n=60)	
	Frequency	Percentage	Frequency	Percentage
Strongly Agree	26	52	38	63.33
Agree	18	36	16	26.66
Neutral	4	8	6	10
Disagree	2	4	0	0
Strongly Disagree	0	0	0	0

the profitability and achieve sustainable production by effective recycling of natural resource in addition to meeting family needs. The adoption of IFS is the right approach in this direction and should be supported through institutional, extension, policy and marketing interventions in a system approach.

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Assessing Drivers of Adaptation Strategies of Climate Change in Kymour Plateau and Satpura Hills of Madhya Pradesh

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ABSTRACT

Climate change is threatening the food and nutritional security of the world. The increasing temperature, decreasing rainfall and increasing concentration of carbon di oxide impacting production and productivity of the farm ultimately affecting the farmers income and their livelihoods. Adjustment or alteration in the present farming situation in response to changing climate scenario will mitigate the negative impact of climate change. Thus, the present study was conducted in the Jabalpur district of Madhya Pradesh to assess drivers of the adaptation for climate change. The study reveals that age, occupation, credit access, mass media exposure, information seeking behaviour, innovative proneness, decision making ability and risk preference were the main drivers of the adaptation for climate change in the study area. The planners, policy makers and researchers have to give more focus on these attributes of the farmers to enhance climate resilience by adaptation of suitable measures for climate change and secure farmers income and livelihood.

Keywords: Socio-personal, Agro-economic, Climate change, Adaptation strategies, Drivers

INTRODUCTION

Agriculture has been considered as the most vulnerable sector to climate change. In India, it plays important role in social and economic upliftment of people, though 65 per cent of the cropped area is rain-fed. It is projected that by the end of 21st century, the mean annual temperature will be increased by 3-4°C and rainfall by 15-40 per cent in India (NATCOM, 2004). Such climatic variability leading to global warming has considerable fluctuations in food production also. In fact, losses will be more with increase in temperature. The productivity of most crops decreases 10-40 per cent due to increase in temperature and rainfall as well as decrease in irrigation water by 2100 (Shrivastava, 2016). In the recent years, extreme weather events like excessive and deficit rainfall, flood, severe frost, temperature and drought are occurring more commonly affecting agricultural production and productivity which leads to decreasing farmer's income (Bhan *et al.,* 2014).

Madhya Pradesh has sub-tropical climate with average annual rainfall about 1300mm. About 75 per cent of the total population of Madhya Pradesh is living in rural areas which are directly or indirectly engaged in agriculture related activities thus agriculture is most-important sector in Madhya Pradesh (Mishra *et al.,* 2016). Further, rice-wheat is main cropping system in Jabalpur district and it has been observed by the scientists that in rice-wheat cropping system, rice crop suffers from drought condition while wheat crop is exposed to the higher temperature during grain filling stage, which ultimately causes low production and reduces the quality of grain too. Hence, it is being tried that rainfed agriculture system must be more resilient in order to fulfil the need of growing population and stabilize yield and income of the farmers.

Alam *et al.* (2017) reported that adaptation strategies are crucial to help the farmers to cope with extreme weather conditions and associated climatic variations. Moreover, adaptation is the process of adjustments or moderation in natural or human systems

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in response to actual or expected climate change as well as taking advantage of beneficial opportunities (IPCC, 2001; Elum *et al.,* 2017). And, adaptation strategies are implemented to mitigate potential adverse effects and take advantage of the potential benefits of changing climate and variability (Ndamani and Watanabe, 2016).

Therefore, it is advised to plan strategies for adaptation and mitigation on the basis of the assessment of changes observed and their future projections of climate change, keeping in view the uncertainties involved. The impact of climate change is the foremost thought in many developing countries, due to greater vulnerabilities and limited ability to mitigate the adverse effect of climate change for sustainable crop production (Ali *et al.,* 2017). The economy of most developing countries is based on agriculture; while agricultural sector is fully dependent on nature (IPCC, 2012; Iqbal *et al.,* 2014).

This paper aimed to highlight the drivers of the adaptation strategies particularly in the agro-climatic zones- Kymour Plateau and Satpura Hills of Madhya Pradesh state so that farming community could be supported in saving their crops and animals from the ill-effects of the climatic vulnerable situations.

MATERIALS AND METHODS

Conceptual framework: Behavioral theories describe about the adaptation strategies through various perceptual and socio-cognitive processes. Adaptation for climate change has base of theories i.e., Theory of Planned Behaviour (TPB, Ajzen, 1985). The theory of planned behaviour is extension of Theory of Reasoned Action (TAR, Fishbein and Ajzen, 1975). TAR and its extension TPB focus on attitudes, subjective norms and intentions of the personal. In adaptation strategies for climate change, the farmers found those strategies positive and significant for farming situation are intended to perform the behaviour (strategies). TPB refers to the degree which farmers believes that he or she can adapt a given strategies in perception of the climate change. It leads to their behaviour to take action to reduce or mitigate the harmful effect of climate change in their farming situation (Mitter *et al.,* 2019). The diffusion of innovation theory (Rogers, 2010) explains how adaptation strategies spread through a social system. In this context, this theory can be used to understand the drivers that affect the adaptation for climate change.

Data: Primary data were collected through pre tested structured interview schedule by the sampled farmers who were practicing rice-wheat cropping system. Information was captured on socio-personal, agro-economical, communicational and psychological variables of the farmers and adaptation strategies for climate change.

Sampling frame: The study was conducted in purposely selected district Jabalpur of Madhya Pradesh as Rice-Wheat is the main cropping system. The study area comes under Kymore Plateau & Satpura Hills agro-climatic zones of Madhya Pradesh. The study was carried out in the purposely selected blocks i.e. Shahpura and Kundam of the district. Five villages from each block were selected for study where rice-wheat was dominant cropping system. From each selected village respondents were selected by proportionate random sampling method. So in total, a random sample of 240 farmers were selected as the respondents from ten villages of Jabalpur district.

Data analysis: Appropriate statistical procedures descriptive statistics were employed to draw references from the samples. Multiple regression analysis was used to assess the drivers of the adaptation for climate change.

RESULTS AND DISCUSSION

The data presented in the Table 1 shows socio-personal profile of the farmers. Results revealed that majority of the farmers (75.83%) were belonging to middle age group followed by old age group (24.17%). The previous studies suggested that middle age groups are more enthusiastic and have higher perception ability and can adopt new adaptation strategies towards climate change than old age group. This finding is supported by Singh (2015). In case of gender, almost 95.42 per cent farmers were male while only 4.58 per cent were female that shows that agriculture is male dominant occupation in the study area. This finding is in consonance with the study of Joshi (2016) and Niles and Mueller (2016). Near to one third farmers (32.92%) had higher secondary education and moreover 95 per cent farmers were formally educated. About 38.33 per cent of farmers had medium family size and more

Table 1: Socio-personal profile of the farmers

Categories	Frequency	Percentage
Age		
Young (Up to 35 years)	-	-
Middle (36 - 55 years)	182	75.83
Old (Above 55 years)	58	24.17
Gender		
Male	229	95.42
Female	11	4.58
Level of education		
No formal education	12	5.00
Primary school education	30	12.50
Middle school education	28	11.67
High school education	70	29.16
Higher secondary education	79	32.92
College level education	21	8.75
Size of family		
Small (< 5 members)	78	32.50
Medium (6 – 8 members)	92	38.33
Large (> 8 members)	70	29.17
Family type		
Nuclear	133	55.42
Joint	107	44.58
House type		
Kutcha	92	38.33
Mixed	66	27.50
Pucca	82	34.17
Social participation		
Low	99	41.25
Medium	123	51.25
High	18	7.50
Farming experience		
Up to 20 years	21	8.75
21 - 40 years	195	81.25
Above 40 years	24	10.00

than half of the farmers (55.42%) belonged to nuclear family. Further, more than one third farmers (38.33%) had *kutcha* house. In case of social participation, more than half of the farmers (51.25%) had medium social participation. The participation in any social organization not only indicates one's social orientation but also provides an opportunity for the individual to have wider contact. It might be due to that, some social organizations are active in the villages and are in reach of the farmers. It implies that social participation is important for getting information of daily weather parameters and information related to climate change. The study has the conformity with the findings of Gabhane (2014). About 81.25 per cent were having 21-40 years of experience of farming. This might be due that, the farmers were engaged in the farming from their early age. The finding is in line with the result of Panda and Singh (2016).

Agro-economic attributes of the farmers consists of occupation, annual income, credit assess, land holding size, cropping pattern, irrigation status and farm power and implements. Table 2 elicits that, majority of the farmers (85.83%) were engaged in agriculture as their main occupation and 14.17 per cent farmers main occupation was farming and other activities. Around two third of the farmers (69.58) were belonging to low-income category. It might be due to that the farmers were solely dependent on farming and they don't have diversified source of income. The finding is consonance with Sanodiya (2015).

The majority of the farmers (76.67%) had taken credit, while 23.33 per cent not had accessed credit. The probable reason might be that, cost of agricultural inputs is increasing day by day and easy access to credit helps the farmers to purchase the required inputs that increase their ability and flexibility to change production strategies in response to the forecasted climate conditions. This finding is in line with the study of Parganiha (2016) and Uddin *et al.* (2017). In case of land holding, 38.33 per cent were having large size land holding, followed by medium land holding (29.59%), small land holding (22.08%) and marginal land holding (10.00%). About 80.00 percent of the farmers had average cropping pattern. Higher percentage of the farmers (60.42%) had medium farm power followed by low farm power (20.83%) and only 18.75 per cent of farmers were having high farm power.

Communication has important role in adaptation strategies towards climate change as timely information of weather variation and suitable technologies to reduces the negative effect of climate change is beneficial to the farming community. This section provides inferences on extension contact, mass media exposure and information seeking behaviour of the

Table 2: Agro-economic attributes of the farmers

Categories	Frequency	Percentage
Occupation		
Solely farming	206	85.83
Farming + Labour	11	4.58
Farming + Caste Occupation	6	2.50
Farming + Dairy	7	2.91
Farming + Insecticide/Pesticide shop	5	2.08
Farming + Business	3	1.25
Farming + service	2	0.83
Annual income		
Low	167	69.58
Medium	145	21.67
High	45	8.75
Credit access		
Beneficiaries	184	76.67
Non beneficiaries	56	23.33
Size of land holding		
Marginal farmer (up to 1 ha)	24	10.00
Small farmer (1.01 – 2 ha)	53	22.08
Medium farmer (2.01 – 4 ha)	71	29.59
Large farmer (above 4 ha)	92	38.33
Cropping pattern		
Poor	0	00.00
Average	192	80.00
Good	48	20.00
Irrigation status		
Poor	7	2.92
Average	195	81.25
Good	38	15.83
Farm power and implements		
Low	50	20.83
Medium	145	60.42
High	45	18.75

Table 3: Communicational attributes of the farmers

Categories	Frequency	Percentage
Extension contact		
Low	19	7.92
Medium	192	80.00
High	29	12.08
Mass media exposure		
Low	37	15.42
Medium	169	70.42
High	34	14.16
Information seeking behaviour		
Low	37	15.42
Medium	162	67.50
High	41	17.08

farmers. It is evident form Table 3 that out of the total farmers, 80.00 per cent farmers had medium extension contact, followed by 12.08 per cent with high extension contact and only 7.92 per cent of the farmers had low extension contact. It might be due to those farmers were aware about the extension functionaries. If the farmers are in contact with extension personnel can gather more information regarding adaptation strategies towards climate change. Further, majority of the farmers (70.42%) were having medium mass media exposure followed by 15.42 percent and 14.16 percent had low and high mass media exposure, respectively. In case of information seeking behaviour, 67.50 per cent of farmers had medium information seeking behaviour, while17.08 per cent had high and 15.42 per cent had low information seeking behaviour. The findings are in consonance with Raghuvanshi *et al.* (2017).

The psychological characteristics also has significant contribution in adaptation of climate resilient practices. Table 4 depicted information of the psychological attributes of the farmers. Innovative proneness plays a greater role in the individual's personality. The person with higher innovativeness can do things rapidly and more precisely than others. About 67.92 per cent farmers had medium innovative proneness and 66.25 per cent had medium scientific orientation. While 68.75 per cent farmers were having medium decision making ability. Decision making ability is the nature of making decisions (individual, joint or collective) that the farmers have taken, while performing activities. It might be due to that, the farmers had medium scientific orientation and innovative proneness. It implies that farmers with good decision making ability can cope up with the impact of the vulnerability. This finding is supported by Brar (2016). Further, maximum number of farmers (65.00%) had medium risk preferring ability. It might be due to the reason that, the farmers had medium innovative proneness. The farmers possessing these

Table 4: Psychological attributes of the farmers

Categories	Frequency	Percentage
Innovative proneness		
Low	29	12.08
Medium	163	67.92
High	48	20.00
Scientific orientation		
Low	45	18.75
Medium	159	66.25
High	36	15.00
Decision making ability		
Low	37	15.42
Medium	165	68.75
High	38	15.83
Risk preference		
Low	44	18.33
Medium	156	65.00
High	40	16.67

characteristics were very critical and cautious in understanding different aspects of a technology which directly or indirectly helped them to acquire different aspects of essential for better management and adaptation to climate change. This finding is in consonance with results of Beg (2016).

Adaptation for climate change are the strategies adopted by the farmers to moderate, cope with and take advantages of the situation raised due to change in climatic parameters. These strategies are adjustment or alterations in farming situation in response to climate change. The data depicts (Table 5) that majority of the farmers (79.17%) had medium level of adaptation, while 14.58 per cent of the farmers had high level of adaptation and 6.25 per cent of the farmers had low level of adaptation for climate change. The findings are supported by the study conducted by Muttanna (2013).

Table 6 examines the drivers that influence farmers adaptation for climate change. For assessing the drivers

Table 5: Adaptation for climate change

Categories	Frequency	Percentage
Low	15	6.25
Medium	190	79.17
High	35	14.58

Table 6: Divers of the adaptation for climate change

Independent variables	'b' value	't' value
Age	0.106**	4.112
Gender	0.696	0.895
Education	-0.009	-0.056
Occupation	0.283*	2.089
Annual income	0.000	-0.301
Credit access	1.275**	3.109
Cropping pattern	0.086	0.948
Irrigation status	0.040	0.911
Farm Power and implements	0.035	1.160
Extension contact	0.024	0.548
Mass media exposure	0.173**	3.451
Information seeking behaviour	0.220**	4.990
Innovative proneness	0.230**	3.313
Scientific orientation	0.070	1.156
Decision making ability	0.070*	1.945
Risk preference	0.159**	3.081
Multiple R^2	0.773	
Adjusted R^2	0.756	
Intercept constant	43.726	
F	47.405**	

** Significant at 0.01 probability level
*Significant at 0.05 probability level

of the adaptation for climate change farming experience and land size were dropped as these variables had multicollinearity with the age and annual income respectively. Out of the sixteen variables, two variables namely occupation, and decision making ability showed positive and significant contribution on predicting adaptation strategies towards climate change at five per cent level of probability and six variables i.e. age, credit access, information seeking behaviour, mass media exposure, innovative proneness and risk preference showed positive and significant contribution on predicting adaptation strategies towards climate change at 1 per cent level of probability. Diversification of the farming activity will enhance adaptation for climate change and change in one unit of decision making enhances the adaptation by 0.07 units. The change in one unit of the credit access shall bring about change 1.275 units in the adaptation while other remaining constant. A change in one unit of mass media exposure shall bring about change of 0.173 units. Similarly, change in one unit of information seeking

behaviour, innovative proneness, decision making ability and risk preference shall bring about unit change 0.22, 0.23, 0.07 and 0.16 respectively, in the adaptation for climate change in the positive way when other things keep constant. The results revealed R^2 was significant as F was significant at that 1 per cent level of probability. All the sixteen variables jointly explained 77.30 per cent of the variation in adaptation for climate change.

CONCLUSION

It is concluded that majority of the farmers (79%) had medium level of adaptation for climate change. Further, farmers attributes viz., age, occupation, credit access, mass media exposure, information seeking behaviour, innovative proneness, decision making ability and risk preference were the main drivers of the adaptation for climate change in the study area. Thus, any efforts aimed to enhance farmers income and their livelihoods need to give maximum focus on these attributes as agriculture being the lifeline of the farmers in rainfed agriculture needs special attention apropos climatic variability and vulnerability being occurred on regular basis. In such situation, there is need to frame sound adaptation strategies and promote it among the farmers so that farming community could adopt and protect their assets from climatic vulnerable events. Hence, this study is initial steps in this direction and would be helpful for making it on wider scale.

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Screening of Rice Varieties Against *Ustilaginoidea virens* Causing Rice False Smut in Assam Condition

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ABSTRACT

Among the twenty two varieties tested with artificial inoculation, three varieties *viz*., Manohar Sali, Pareshash Biroin and Keteki Joha showed highly resistant reaction (*i.e.* completely free from the disease), while Ranjit and Bahadur were found to be resistant to rice false smut. Besides, eleven varieties were found moderately resistant, four varieties were moderately susceptible and two varieties *viz*., Mahsuri and Bhogali Bora showed susceptible reaction.

Keywords: False smut, Rice, Resistant, Susceptible, Varieties

INTRODUCTION

Rice false smut (RFS) disease caused by *Ustilaginoidea virens* (Cooke) Takahashi (teleomorph : *Villosiclava virens*) has become the most devastating grain disease in almost all the rice growing areas throughout the world. Historically, the disease has been categorized as a minor disease due to its sporadic occurrence in certain regions and causing insignificant yield loss regularly. However, the disease has emerged in severe form due to high input cultivation, heavy application of nitrogenous fertilizer, large scale planting of hybrid varieties and climate change (Lu *et al.*, 2009; Ladhalakshmi *et al.*, 2012; Guo *et al.*, 2012; Zhang *et al.*, 2014). The disease affects the grains and the symptoms produced are visible only after flowering. Usually only few grains are affected in a panicle but the number may rise up to 100 in case of severe disease incidence (Ladhalakshmi *et al.,* 2012). The disease results in both reductions in quality and quantity of rice. It is an important devastating disease and causes yield losses of 1.01 to 10.91 per cent (Atia, 2004). In India, depending on the disease intensity and varieties grown the yield losses caused by false smut in different states have been estimated to vary between 0.2 to 49 per cent (Doden and Singh, 1996). Besides, the disease results in generating mycotoxins that impose significant health hazards (Nakamura *et al.*, 1994; Koiso *et al.,* 1994), thereby raising great concerns for food and feed safety. In recent years, occurrence of false smut in a large number of varieties during wet season has become a cause of serious concern to the rice growers of Assam. Baruah *et al.* (1992) reported that false smut disease is an unattended rice disease and may become economically important under favourable environment causing considerable yield loss. Now a days, the utilization of resistance lines/ cultivars is the most effective, economical and environmentally safe practices for the management of disease. Like any crop diseases, resistance could be an important tool in managing RFS (TeBeest and Jecmen, 2012). In Assam, a large number of variety/ germplasm of rice are available and farmers are cultivating a number of good varieties including aromatic (*Joha*) and glutinous rice (*Bora*). In this context, the present study was undertaken to evaluate rice varieties for resistance and susceptibility against RFS.

MATERIALS AND METHODS

The experiment was conducted at Regional Agricultural Research Station (RARS), Assam Agricultural University, Titabar (26°34'36"N latitude and 94°10'48"E longitude and an elevation of 99 meter above mean sea level), Assam, India during *kharif* 2017. Twenty two (22) rice varieties including four hybrids were screened for their

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susceptibility and resistance under artificial conditions against RFS in wet land field condition.

Thirty days old seedlings of 22 varieties were uprooted from the seedbed and transplanted in a fixed plot with two rows, 2 m long at a distance of 15cm plant to plant and 20 cm row to row. In between the varieties, a space of 0.4 m was maintained. Two seedlings in each hill were planted. Fertilizers and other agronomical practices were followed as per standard Package of Practices (*Kharif*) (Anonymous, 2009). The experiment was replicated for twice.

The pathogen *U. virens* was isolated from false smut infected spikelets on potato dextrose agar (PDA) medium. For artificial inoculation conidial suspension was prepared as described by Ladhalakshmi *et al.* (2012). Four hills of each row were inoculated at booting stage by spraying conidial suspension (2×10^5 conidia/ml) as described by Haiyong *et al.* (2015) on the leaf surface using an atomizer until suspension dropped down. The inoculated plants were then covered with perforated polythene bags for 3-4 days to maintain the temperature and humidity, and tagged for observation. The infected rice plants and grains/ panicle were counted at maturity stage.

The per cent disease incidence (PDI) and average smutted ball per panicle were calculated on each variety infected by false smut and evaluated as follows.

$$\text{Disease incidence (\%)} = \frac{\text{Total infected rice panicles}}{\text{Total inoculated rice panicles}} \text{ X } 100$$

The rice false smut incidence and smut ball density (smutted ball/panicle) were classified into six scoring scales (Haiyong *et al.*, 2015) (Table 1). The comprehensive evaluation index (CEI) was calculated as follows.

$$\text{CEI} = \frac{[(\text{score of disease incidence x } 60) + (\text{score of smut ball density x } 40)]}{100}$$

Subsequently, the CEI was used for the resistance evaluation of the rice varieties using the criteria in Table 2 (Haiyong *et al.*, 2015).

RESULTS AND DISCUSSION

The results indicated that the per cent disease incidence and average smutted balls per panicle ranged from 0.0 to 25.64 per cent and 0.0 to 6.08, respectively (Table 3). The varieties screened were grouped based on their resistance reaction in to six groups *i.e.* highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible (Table 4).

Table 1: Scoring criteria for categorizing virulence level of *U. virens*

Scoring	Disease incidence (%)	Smut ball density (no./panicle)
0	≤1%	0
1	>1 but ≤5%	1
3	>5 but ≤10%	>1 but ≤5
5	>10 but ≤25%	>5 but ≤10
7	>25 but ≤50%	>10 but ≤15
9	>50 %	>15

Table 2: Scoring of the comprehensive evaluation index (CEI) of reaction of rice varieties to false smut disease

Scoring	CEI	Resistant level
0	0	Highly resistant (HR)
1	≤1	Resistant (R)
3	>1 but ≤3	Moderately resistant (MR)
5	>3 but ≤5	Moderately susceptible (MS)
7	>5 but ≤7	Susceptible (S)
9	>7	Highly susceptible (HS)

The evaluation of twenty two rice varieties against RFS (*U. virens*) revealed that three varieties *viz.,* Manohar Sali, Pareshash Biroin and Keteki Joha were completely free from the disease incidence. The highest disease incidence (%) was recorded in Mahsuri (25.64%) followed by Bhogali Bora (25.14%) and Bokul Joha (16.37%), whereas the lowest per cent disease incidence (1.14%) was recorded in the variety, Ranjit (Table 3).

Among the varieties tested, three varieties *viz.,* Manohar Sali, Pareshash Biroin and Keteki Joha were found completely false smut free. The highest number of smutted balls per panicle was recorded in Mahsuri (6.08) followed by Gandhi Biroin (5.91) and Bhogali Bora (5.86). Two varieties *viz.,* Ranjit and Bahadur recorded the lowest average smutted balls per panicle (1.0) (Table 3).

The varieties grouped based on their resistance reaction against false smut is presented in Table 4. Disease reaction data inferred that varieties *viz..,* Manohar Sali, Pareshash Biroin and Keteki Joha were

Table 3: Per cent disease incidence (DI), disease incidence score (DIS), smut ball density (SD), smut ball density score (SDS), comprehensive evaluation index (CEI) and CEI scores (CEIS) of rice varieties

S.No.	Variety Name	DI* (%)	DIS	SD* (Av. no /panicle)	SDS	CEI	CEIS	Reaction**
1	Ranjit	1.14	1	1.0	1	1	1	R
2	Bahadur	2.70	1	1.0	1	1	1	R
3	Satyaranjan	2.79	1	1.71	3	1.8	3	MR
4	Manohar Sali	0.0	0	0.0	0	0	0	HR
5	Dhanshree	10.19	5	2.29	3	4.2	5	MS
6	Diphalu	7.76	3	3.86	3	3	3	MR
7	Mahsuri	25.64	7	6.08	5	6.2	7	S
8	Kmj 3-1-3	2.36	1	1.43	3	1.8	3	MR
9	Kmj 1-2-17	2.29	1	1.57	3	1.8	3	MR
10	Manipuri Rice	9.91	3	1.71	3	3	3	MR
11	Aghoni Bora	3.31	1	1.57	3	1.8	3	MR
12	Bhogali Bora	25.13	7	5.86	5	6.2	7	S
13	Rongilee Bora	2.18	1	2.14	3	1.8	3	MR
14	Gandhi Biroin	11.58	5	5.91	5	5	5	MS
15	Pareshash Biroin	0.0	0	0.0	0	0	0	HR
16	Keteki Joha	0.0	0	0.0	0	0	0	HR
17	Bokul Joha	16.37	5	2.00	3	4.2	5	MS
18	Kalijerra	9.44	3	5.71	5	3.8	5	MS
19	Arise 6444 Gold	5.60	3	2.43	3	3	3	MR
20	NPH 924-1	2.02	1	2.57	3	1.8	3	MR
21	PAN 828	2.53	1	3.75	3	1.8	3	MR
22	PAC 8744	5.18	3	3.57	3	3	3	MR

* Data are mean of two replications
(Data of each replication are average of four observations)
** Where, HR = Highly resistant; R = Resistant; MR = Moderately resistant; MS = Moderately susceptible; S = Susceptible; HS = Highly susceptible

highly resistant (score 0) *i.e.* completely free from the disease. The varieties, Ranjit and Bahadur were found to be resistant (score 1). Eleven varieties *viz.*, Satyaranjan, Diphalu, Kmj 3-1-3, Kmj 1-2-17, Manipuri Rice, Aghoni Bora, Rongilee Bora, Arize 6444 Gold, NPH 924-1, PAN 828 and PAC 8744 were moderately resistant (score 3) against false smut disease. Four varieties *viz.*, Dhanshree, Gandhi Biroin, Bokul Joha and Kalijerra were found to be moderately susceptible (score 5) and two varieties *viz.*, Mahsuri and Bhogali Bora were susceptible (score 7). However, out of twenty two varieties, none of these was found susceptible (score 9) during experimentation. The differences between tested rice varieties to RFS might be attributed to differences in genetic makeup of tested varieties in addition to the environmental factors that might affect host-pathogen interactions.

Comparative transcriptome analysis revealed that many defense-related genes particularly, phytoalexin biosynthetic pathway genes such as OsCPS2, OsMAS, and OsKSL11 were only up-regulated in the resistant cultivar (IR28) but not in susceptible cultivar (LYP9), indicating that phytoalexins may contribute to rice resistance against RFS (Han *et al.,* 2015). They further reported that the PR family genes, such as β-1,3-glucanase and chitinase genes, were specifically up-regulated in IR28, while generally down-regulated in LYP9. Moreover, a chitinase gene cluster region was

Table 4: Reaction of rice varieties to *U. virens*

S.No.	Score	Varietal reaction	Frequency distribution	Rice varieties
1.	0	Highly Resistant (HR)	3	Manohar Sali, Pareshash Biroin and Keteki Joha
2.	1	Resistant (R)	2	Ranjit and Bahadur
3.	3	Moderately Resistant (MR)	11	Satyaranjan, Diphalu, Kmj 3-1-3, Kmj 1-2-17, Manipuri Rice, Aghoni Bora, Rongilee Bora, Arize 6444 Gold, NPH 924-1, PAC 8744 and PAN 828
4.	5	Moderately Susceptible (MS)	4	Dhanshree, Gandhi Biroin, Bokul Joha and Kalijerra
5.	7	Susceptible (S)	2	Mahsuri and Bhogali Bora
6.	9	Highly Susceptible (HS)	0	Nil

found closer to QTL conferring resistance to false smut and nine genes in this cluster were activated by *U. virens* infection. Another comparative transcriptome study demonstrated that peroxidase and flavin-containing monooxygenase genes, and genes involved in hormone metabolism were regulated differently in resistant and susceptible cultivars in response to *U. virens* infection (Yang *et al.*, 2014). A preliminary study conducted by Dai *et al.* (2005) described that higher contents of lignin and polyphenolic compounds were detected in spikelets of resistant rice variety Shuijing 3 than in those of susceptible variety 9522, suggesting the role of these secondary metabolites in RFS resistance. As has been observed in the present studies, variation in response of rice genotypes against RFS has also been reported earlier by several researchers (Singh *et al.*, 1987; Sugha *et al.*, 1992; Kurauchi *et al.*, 2006).

Mandhare *et al.* (2008) tested 19 genotypes and found that the incidence of RFS ranged from 0.00 to 72.92 per cent out of which, Kundlika genotype showed the highest false smut incidence (72.92%) and 6 genotypes were resistant to the disease. Sanghera *et al.* (2012) tested 10 rice genotypes among which, two genotypes *viz.,* Jhelum and Shalimar rice -1 exhibited resistance reaction while other 8 were infected to false smut of rice. They recorded the maximum disease incidence (34.11%) and severity index (14.47%) in Pusa Sungandha-3 followed by Pusa Sungandha-5 (26.94% and 13.18%, respectively). Lore *et al.* (2013) found two cultivars namely PR113 and PR114 with lowest disease intensity and two hybrids namely NPH 369 and NPH 909, consistently with highest level of disease intensity. Rashmi and Gokulapalan (2014) evaluated 20 rice varieties and found Harsha and Vaishak as highly resistant. On the other hand, Makom, Thekkancheera, Pavizham and Karthika were resistant, and Kanakom, Revathi and Prathyasha were moderately resistant to RFS. Kaur *et al.* (2015) artificially inoculated 125 rice genotypes comprising hybrids and inbred lines with false smut pathogen in field condition and identified 9 hybrids *viz.*, Hybrids VNR-211, GK5025, HRI-140, IRH-74, PRSH-9018, KPH467, RH-10428, 27P64 and KRH-4 resistant to RFS. El-Naggar *et al.* (2015) tested 11 genotypes for severity of RFS in Egypt and maximum severity (20.30%) was recorded in Giza-181, while least in Sakha 102 (0.2%), and Sakha 101 was found resistance against false smut disease.

Rani *et al.* (2016) found that among 31 germplasm lines evaluated against *U. virens*, three germplasm lines were highly resistant, two varieties were resistant, eleven lines were moderately resistant, thirteen lines were moderately susceptible, and two lines *viz.,* BS-1589 (hybrid) and PR116 were susceptible. Raji *et al.* (2016) evaluated 20 rice varieties to assess their resistance to false smut under natural disease pressure in field condition. Among them, seven varieties (Ptb 7, Ptb 23, Ptb 24, Ptb 32, Ptb 36, Ptb 42 and Ptb 46) showed no incidence of disease and the rest of varieties were infected to false smut. Baite *et al.* (2017) tested 15 cultivars to evaluate the incidence of RFS and found seven cultivars susceptible to false smut. The cultivar Pooja recorded the highest disease incidence (55.61%), whereas Geetanjali was found to be completely free from infection. Chaudhari *et al.* (2019) evaluated 18 cultivars against RFS under natural conditions in wetland field at Navsari (Gujarat) during 2017 and 2018 and grouped their resistance reaction against false smut. They reported that GNR-2, GNR-3, GNR-5, GNRH-1, Mahisagar, NAUR-1 and Dandi showed highly resistance; GNR-4, Tapeswari, Mahsuri, Jaya, Gurjari,

Sambha-Mahsuri, GR-4 and GR-7 showed moderately resistance; and TN-1, GR-11 and US-312 showed moderately susceptible.

In many studies it has been reported that the hybrids are much more prone to RFS than that of conventional rice varieties (Lv *et al.*, 2007; Kumari and Kumar, 2015; Chaudhari *et al.*, 2019). But in the present investigation all the hybrids screened *viz.,* Arize 6444 Gold, NPH 924-1, PAN 828 and PAC 8744 were found to be moderately resistant to RFS. The resistance of rice varieties has close relationship to types of varieties, plant types and growth characteristics. Reports claim that resistance level significantly varies among different varieties; therefore, rice cultivars play an important role in the degree of RFS infection (Biswas, 2001; Lu *et al.*, 2008).

CONCLUSION

The three highly resistant varieties *viz.,* Manohar Sali, Pareshash Biroin and Keteki Joha found against false smut disease may further be utilized for the development of new rice varieties with high false smut disease resistance considering the yield performance.

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A Study on Area, Production and Productivity of Groundnut Crop in India

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ABSTRACT

This survey has been carried out to discuss the groundnut area, production and productivity in India, Uttar Pradesh State and Jhansi district. It analyzed the area, production and productivity of groundnut crop at National level, state level and Jhansi district level during 2004-05 to 2016-17. The present comparatively analysis of groundnut production in Jhansi district of U.P during 2004-05 to 2016-17. The groundnut crop area, production and productivity at national level, state level and Jhansi district level of during 2004-05 to 2016-2017 were collected and presented graphically. Based on the results collected some conclusions are made about the improving the production of groundnut crop.

Keywords: Area, Groundnut, Production, Productivity

INTRODUCTION

India is one of the largest producers of oilseeds in the world and occupies an important position in the Indian agricultural economy. It is estimated that nine oilseeds namely groundnut, rapeseed-mustard, soybean, sunflower, safflower, sesame, Niger, castor and linseed. Groundnut is called as the 'King' of oilseeds. It is one of the most important food and cash crops of our country. While being a valuable source of all the nutrients, it is a low-priced commodity. Groundnut is also called as wonder nut and poor men's cashew nut. Groundnut is one of the most important cash crops of our country. It is a low-priced commodity but a valuable source of all the nutrients. Groundnut is not only an important oilseed crop of India but also an important agricultural export commodity.

The major groundnut producing countries in the world are China is the largest producer as well as consumer of groundnut in the world with 171.50 lakh tons in 2017-18 followed by India (91.79 lakh tons), United States (32.81 lakh tons), Nigeria (24.20 lakh tons) and Sudan (16.41 lakh tons). In India, during *kharif* 2019 lower sowing area was reported in few states compared to the previous year due to less rainfall at initial stage of crop, which may support the groundnut prices.

In *kharif* 2019 all India groundnut acreage was 39,31,700 hectares. Six states, Gujarat (15,52,200 ha; 39%), Andhra Pradesh (5,53,383 ha; 14%), Rajasthan (5,73,889 ha;15%), Karnataka (3,70,564 ha; 9%), Maharashtra (1,87,500 ha; 5%), Madhya Pradesh (2,21,700 ha; 6%) jointly accounted for about 88 per cent of the national acreage. At the national level, there was an increase in acreage by 1.1 per cent with respect to *kharif* 2018. The maximum increase was observed for Gujarat (5.8%) while maximum decrease was observed for Andhra Pradesh (16.2%). Increase was also observed for Rajasthan (4.5%).

In *kharif* 2019, the rainfall was rather irregular and large excess in major groundnut growing regions. Due to acreage increase by 1.1 per cent and yield increase in most of the states, *kharif* 2019 production (68.62 lakh MT) was estimated to be higher than that of *kharif* 2018 season (51.95 lakh MT).

MATERIALS AND METHODS

Agricultural development is a complex problem. Therefore, reliable collection and sources of data are

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necessary for decision making and future planning. The study relies on secondary data compiled from various published sources. Data on the area, production and yield were collected from the Agricultural Statistics at a Glance from 2004-05 to 2016-17, Directorate of Economics and Statistics (DES), Ministry of Agriculture, GOI.

RESULTS AND DISCUSSION

Groundnut is one of the most important cash crops of our country. It is a low-priced commodity but a valuable source of all the nutrients. Groundnut is the sixth most important oilseed crop in the world. It contains 48-50 per cent of oil and 26-28 per cent of protein, and is a rich source of dietary fiber, minerals, and vitamins. Groundnut oil has several uses but it is mainly used as cooking oil. It is used in many preparations, like soap making, fuel, cosmetics, shaving cream, leather dressings, furniture cream, lubricants, etc. Groundnut oil is also used in making vanaspati ghee and in fatty acids manufacturing. It is also used as a medium of preservation for preparation of pickles, chutney, etc. The groundnut oil is used in making different types of medicated ointments, plasters, syrups and medicated emulsion. It is also used to make various food preparations like butter, milk, candy and chocolate, chutney, groundnut pack, laddu, barfi (chukii), etc.

Groundnut is an important protein supplement for cattle and poultry rations. It is also consumed as a confectionery product. The cake can be used for manufacturing artificial fiber. The haulms are fed to livestock. Groundnut shell is used as fuel for manufacturing coarse boards, cork substitutes. Groundnut is also valued as a rotation crop. Being a legume with root nodules, it can synthesize with atmospheric nitrogen and thereby improve soil fertility.

During 2005-2006, 6.64 million hectares of area is under groundnut cultivation and produces 6.77 million tons with productivity 1020 kg/ha of the groundnut In India, However, the crop area under groundnut was continuously declined from 6.64 million hectare in 2004-05 to 5.34 million hectares in 2016-17. The reason for the declining trend of groundnut area is mainly change of cropping pattern and low rainfall in the southern states during the last few years. There were fluctuations in the production of groundnut in India during the decade 2004-05 to 2016-17 (Table 1). During 2006-07 the area, production and productivity of groundnut was low due to low rainfall. The annual average area, production and productivity of groundnut during 2004-05 to 2016-17 was 5.61 million hectares, 7.12 million tons of production and 1276.46 kg/ha respectively.

Table 1: Area, production and productivity of groundnut crop in India during 2004-05 to 2016-17

Year	Area (million hectares)	Production (million tons)	Productivity (kg/ha)
2004-05	6.64	6.77	1020
2005-06	6.74	7.99	1187
2006-07	5.62	4.86	866
2007-08	6.29	9.18	1459
2008-09	6.16	7.17	1163
2009-10	5.48	5.43	991
2010-11	5.86	8.26	1411
2011-12	5.26	6.96	1323
2012-13	4.72	4.70	995
2013-14	5.51	9.71	1764
2014-15	4.71	7.40	1552
2015-16	4.60	6.73	1465
2016-17	5.34	7.46	1398
Annual Average	5.61	7.12	1276.46

Source: Directorate of Economic and statistics New Delhi

The state-wise break up of area production and productivity of groundnut is presented in Table 2. It may be noted that Gujarat, Andhra Pradesh, Rajasthan and Karnataka occupied the top four positions in area cultivated. Gujarat tops with 1.68 million hectares, followed by Andhra Pradesh 0.74 million hectares, Rajasthan 0.64 million hectares, and Karnataka 0.62 million hectares. But there is a slight change in the order as far as production is concerned. Gujarat tops with 42.48 per cent of total production followed by Andhra Pradesh 11.33 per cent, Rajasthan 13.73 Per cent and Karnataka 6.10 per cent. Though other states like, Tamil Nadu, Maharashtra, Madhya Pradesh, Telangana and West Bengal are the important groundnut producing states etc.

The production of groundnut per hectare is high in Tamil Nadu with 2914 kg/ha, but it was in fourth place in total groundnut production during 2017-18.

Table 2: Area, production and productivity of groundnut crop in major groundnut growing states in India during 2017–2018

State	Area (million hectares)	Production (million tons)	Productivity (kg/ha)
Gujrat	1.68	3.94	2343
Andhra Pradesh	0.74	1.04	1416
Rajasthan	0.64	1.26	1966
Karnataka	0.62	0.56	908
Tamil Nadu	0.33	0.97	2914
Maharashtra	0.26	0.33	1255
Madhya Pradesh	0.22	0.35	1558
Telangana	0.17	0.35	2114
West Bengal	0.07	0.17	2343
Other state	0.19	0.21	@
India	4.91	9.18	1868

Source: Directorate of Economic and statistics New Delhi

The yield per hectare is low in major groundnut growing states of Andhra Pradesh. The yield per hectare is very low in Karnataka (908 kg/ha) comparatively with other states.

The area, production and productivity of groundnut crop in Uttar Pradesh during 2004-05 to 2016-17 are presented in Table 3. The area under groundnut crop in Uttar Pradesh was fluctuated between 0.08 million hectares in 2004-2005 and 0.09 million hectares in 2016-17. It is observed that the area under groundnut was increased in Uttar Pradesh.

Table 3: Area, production and yield of groundnut crop in Uttar Pradesh during 2004-05 to 2016-17

Year	Area (million hectares)	Production (million tons)	Productivity (kg/ha)
2004-05	0.08	0.07	816
2005-06	0.11	0.09	851
2006-07	0.10	0.07	730
2007-08	0.10	0.06	598
2008-09	0.10	0.07	705
2009-10	0.09	0.06	670
2010-11	0.09	0.08	988
2011-12	0.09	0.09	1000
2012-13	0.09	0.09	1000
2013-14	0.10	0.09	896
2014-15	0.10	0.08	857
2015-16	0.10	0.07	670
2016-17	0.09	0.09	904

Source: Directorate of Economic and statistics New Delhi

The production of groundnut crop was also fluctuated from year to year during the decade under this study. The production was 0.07 million tons in 2004-05 and in 2016-17 was 0.09 million tons. It is observed that the Production of groundnut also increased in Uttar Pradesh. Productivity of groundnut was also fluctuated from 2004-05 to 2016-17. Per hectare production of groundnut was 816 Q in 2004-05 and highest per hectare production observed in 2011-12 and 2012-13. It is observed that the per hectare production increased in Uttar Pradesh but per hectare production of groundnut decline in the year 2009-10 and 2015-16. The reason for this may be due to not suitable monsoons during these two years.

It can be observed from the Table 4 that the area and production of groundnut in Jhansi district are showing a steady growth with increasing trend. However, the average yield per hectare has almost remained different variations during the period under study. The total area under groundnut increased from 26480 hectares in 2004-05 to 30549 hectares in 2016-17 recording an increase of 15.37 per cent.

Table 4: Area, production and productivity of groundnut crop in Jhansi District during 2004-05 to 2016-17

Year	Area (hectares)	Production (tons)	Productivity (kg/ha)
2004-05	26480	24573	928
2005-06	26757	14462	540
2006-07	25080	13017	519
2007-08	23010	8698	378
2008-09	18634	13920	747
2009-10	20811	8220	350
2010-11	18620	22020	1183
2011-12	21303	22922	1076
2012-13	20662	20104	975
2013-14	29491	24153	819
2014-15	30549	27158	889
2015-16	30549	12521	410
2016-17	30549	18352	601

Source: Directorate of Economic and statistics New Delhi

Table 5: Area, production and yield at national, state and at the District level during 2004-05 to 2016-17

Year		India	Growth rate	Uttar Pradesh	Growth rate	Jhansi District	Growth rate
2004-05	Area	6.64	10.85	0.08	0.00	26480	28.38
	Production	6.77	-16.72	0.07	-16.67	24573	85.66
	Productivity	1020	-24.83	816	-50.57	928	51.63
2005-06	Area	6.74	1.50	0.11	37.5	26757	1.04
	Production	7.99	18.20	0.09	28.57	14462	-41.14
	Productivity	1187	16.37	851	4.28	540	-41.81
2006-07	Area	5.62	-16.61	0.10	9.09	25080	-6.26
	Production	4.86	-39.17	0.07	-36.36	13017	-9.99
	Productivity	866	-37.06	730	-14.21	519	-3.88
2007-08	Area	6.29	11.92	0.10	0.00	23010	-8.25
	Production	9.18	88.88	0.06	-14.28	8698	-33.17
	Productivity	1459	68.47	598	-18.08	378	-27.16
2008-09	Area	6.16	-2.06	0.10	0.00	18634	-19.01
	Production	7.17	-21.89	0.07	16.67	13920	60.03
	Productivity	1163	-20.28	705	17.89	747	97.61
2009-10	Area	5.48	-12.40	0.09	-10.00	20811	11.68
	Production	5.43	-24.26	0.06	-14.28	8220	-40.94
	Productivity	991	-14.78	670	-4.96	350	-53.14
2010-11	Area	5.86	6.93	0.09	0.00	18620	-10.52
	Production	8.26	52.11	0.08	33.33	22020	167.88
	Productivity	1411	42.38	988	47.46	1183	238.00
2011-12	Area	5.26	-10.23	0.09	0.00	21303	14.40
	Production	6.96	-15.73	0.09	12.5	22922	4.09
	Productivity	1323	-6.23	1000	1.21	1076	-9.04
2012-13	Area	4.72	-10.26	0.09	0.00	20662	-3.00
	Production	4.70	-32.47	0.09	0.00	20104	-12.29
	Productivity	995	-24.79	1000	0.00	975	-9.38
2013-14	Area	5.51	16.73	0.10	11.11	29491	42.73
	Production	9.71	106.59	0.09	0.00	24153	20.14
	Productivity	1764	77.28	896	-10.4	819	-16.00
2014-15	Area	4.71	-14.51	0.10	0.00	30549	3.58
	Production	7.40	-23.78	0.08	-11.11	27158	12.44
	Productivity	1552	-12.01	857	-4.35	889	8.54
2015-16	Area	4.60	-2.33	0.10	0.00	30549	0.00
	Production	6.73	-9.05	0.07	-12.5	12521	-53.89
	Productivity	1465	-6.01	670	-21.82	410	-53.88
2016-17	Area	5.34	16.08	0.09	-10.00	30549	0.00
	Production	7.46	10.84	0.09	28.57	18352	46.56
	Productivity	1398	-4.57	904	34.92	601	46.58

Correspondingly, the production has decreased form 24573 tons in 2004-05 to 18352 tons in 2016-17 registering a decrease of 25.31 per cent. The production was increased from 13920 tons in 2008-09 recording an increase of 60.04 percent and also production increased to 22020 tons in 2010-11 recording an increase of 167.88 percent and again it increased to 18352 tons in 2016-17. Highest productivity 1183 kg/ha was recorded in 2010-11 and lowest productivity 350 kg/ha was recorded in 2009-10. The productivity was decreased from 928 kg/ha in 2004-05 to 601 kg/ha in 2016-17 recorded a decrease of 35.23 per cent.

Table 5 presents the comparative analysis of area, production and productivity of groundnut crop at National level, state level and at district level during 2016-17. The area under groundnut production was 6.64 million hectares in India during 2004-05. During the same year, the area under groundnut in Uttar Pradesh was 0.08 million hectares and 26480 hectares in Jhansi district of Uttar Pradesh. The production of groundnut during the same period in was 6.77 million tons in India, 0.07 Million tons in Uttar Pradesh and 24573 tons in Jhansi district. The area under groundnut in

India was declined to 5.34 million hectares in 2016-17 but the production was increased to 7.46 million tons during the same year in India. The yield of groundnut per hectare was 1020 kgs in India, 816 kgs in Uttar Pradesh and 928 kgs in Jhansi district. The area under groundnut in India fluctuated between 6.64 million hectares in 2004-05 and 5.34 million hectares in 2016-17.

In Uttar Pradesh, the area under groundnut was also fluctuated from year to year. Whereas in Jhansi district the growth rate of area under groundnut during 2004-05 to 2016-17 was negative in six year out of thirteen years under study. Regarding to the growth rate of production trends is same in India and Uttar Pradesh but Jhansi district was also negative in some years under this study. The reason for this may be due to low rainfall under reference at national level to the district level.

The productivity of groundnut in India varied between 1764 kgs in 2013-14 and 866 kgs in 2006-07. Regarding to the state of Uttar Pradesh the yield per hectare was fluctuated between 1000 kgs in 2012-13 and 598 kgs per hectare in 2007-08. In Jhansi district the yield per hectare was high 1183 kgs per hectare in 2010-11 and low 378 kgs per hectare in 2007-08.

Table 6: Productivity of groundnut in Uttar Pradesh and Jhansi District

Year	Uttar Pradesh	Jhansi
2004-05	816	928
2005-06	851	540
2006-07	730	519
2007-08	598	378
2008-09	705	747
2009-10	670	350
2010-11	988	1183
2011-12	1000	1076
2012-13	1000	975
2013-14	896	819
2014-15	857	889
2015-16	670	410
2016-17	904	601

The Table 6 shows the comparative analysis of groundnut productivity in Uttar Pradesh and in Jhansi district during 2004-05 to 2016-17. The productivity of groundnut in Uttar Pradesh was highest 1000 kg/ha in 2011-12 and 2012-13 and low 598 kg/ha in 2007-08. Whereas in Jhansi district the productivity of groundnut was high 1183 kg/ha during 2010-11 and low 378 kg/ha during 2007-08.

CONCLUSION

Groundnut is the most important oilseed crop in India. Especially in drought prone district of Jhansi, the farmers are mainly depending on groundnut cultivation. Due to lack of irrigation facilities and poor alternative cropping pattern in rain fed areas like Jhansi districts the farmers have been cultivating groundnut crop from the last several decades. But of nine oil seed crops grown in India. Uttar Pradesh must become self-sufficient in groundnut to strengthen in overall economic position and also contribute to the national economy. Several policy and technological issues must be address in order to arrest the declined in the area by giving due weight to oil seeds crop like sugarcane and wheat and steps must be taken to evaluate the low yield levels which shall go a long way in establishing the production in the State.

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Short Communication

Dairy Enterprises: A Boon to Augment Farmer Income in Jammu and Kashmir

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ABSTRACT

This paper highlighted the contribution of dairy sector in Indian Agriculture and also examines opportunities for sustainable viability of small scale dairy in small land holding farming in India. The government initiative to support dairy industry for enhancing doubling farmers income by various means is discussed through this paper. The paper mainly focused the trends in dairy industry in union territory of Jammu and Kashmir, participation of small landless farmers in dairy, opportunities of value addition in milk, linking small holders with markets including value chains, in enhancing income generation. Dairy Industry as a future option of small farmers and institutional support to make it a boon to augment income is focused through this article.

Keywords: Augment, Boon, Dairy enterprises, Farmer, Income

Agriculture is the primary source economy and livelihood for our country and a total of fifty eight percent India's population dependent on agriculture sector. The India's economic security is directly proportional to the agricultural growth thus this sector stands as back bone. Of Indian economy, in financial Year 2020, it was estimated that Rs. Nineteen point four eight lakh crore from Gross Value Added (GVA) by agriculture, forestry and fishing. The agriculture alone contributes about seventeen percent to the total GDP of Indian economy and also provides sixty percent employment (Kekane, 2013). The investment in agriculture infrastructure is well visible in terms of irrigation facilities, warehousing and cold storage thus it is expected to generate better growth in this sector. However, nearly eighty five percent of the farming community of India are marginal, small and landless labour and with maximum of poverty line (Singh, 2012). In India, agriculture land area was recorded sixty and three percent (Data from World Bank). Jammu & Kashmir is usually mountainous area, here only thirty percent area is a cultivable land area. Due to staggeringly increasing in population, which causes imbalance in population as well as crop production leading to shrinkage of agricultural land area. Food security is not self sufficient now and import of food grains to fulfil the requirement of populations depends on other regions. Livestock sector is fast growing and has contributed four and one percent GDP and twenty five and six percent of total Agriculture GDP in nation. Dairying plays a vital role in the country's agricultural economy, which being the second largest contributor to gross agricultural produce and leading milk producer with eighteen and five percent of world production (Chand, 2017). Hon'ble prime Minister is also in the opinion of that dairy sector is emerging as a medium for growth in farmers income compared to traditional food grains, especially where landholdings are small and conditions are tough. Dairy sector gained popularities from time of Operation Flood (1970-1996). Rural milk outlet areas were linked with urban market through development of village cooperative network, also achieved through farmers' education, veterinary services availability, adequate feed and fodder

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availability and through artificial insemination. Dairy sector become one of the top-ranking asset in India. Earlier Agriculture and Animal husbandry, Dairy, Fishery these all were in one ministry. Present Government created separate ministry for Animal husbandry, Dairying and Fisheries with a vision doubling farmers' incomes by year 2022. India is the largest milk producer country in the world and deserved to have separate ministry. The value of output in dairy is almost equal to the combined output value of wheat and rice. The government of India has launched several schemes to achieve the goal of doubling farmer income by 2022. The National Dairy Development Board (NDDB) estimated that the demand of milk is likely to reach one eighty million tonnes by the 2022. The Central focus for animal husbandry is evident from the Union Finance Minister budget speech 2019-20 in July, where she said, "We will invest widely in agricultural infrastructure. We will support private entrepreneurship in driving value-addition to farmers' produce from the field and for those from allied activities. Dairying through cooperatives shall also be encouraged by creating infrastructure for cattle feed manufacturing, milk procurement, processing & marketing." This implies government intension to support the sector widely for the enhancement of farmer's income particularly in dairy sector as well.

The Indian Union Territory, Jammu and Kashmir is an agrarian State and a major proportion of people are engaged in subsistence agriculture of diverse kinds adapted to local conditions. The diversified climatic condition varying from subtropical to temperate condition make it varied cultivation pattern from other parts of the Indian state. A major group of people in J&K lives on hilly terrain and are landless. Earlier people live in joint family and now it becomes a nuclear family. In coming days, land will decline due to nuclear family. Small and marginal farmers own thirty three percent of land and sixty percent of female cattle and buffaloes.

In most of the rural areas the farmers are constantly facing lack of modern irrigation facilities, shortage of electricity supply and interrupted supply of high yielding varieties crop. They lack knowledge to enhance crop intensity and diversification towards high value crops, unable to establish integrated farming system for sustainability and lack of knowledge to rear high genetic potential dairy cattle by using scientific feeding management practices. There is also shrinking of agricultural land as population increases, converting cultivable land to residential one. In the diversified conditions livestock has been built a inherent component of the farming system throughout this state. It has been seen that with reducing the land holding, dairy farming is found as lucrative avenue for building entrepreneurs and diversifying farmers. The other agriculture enterprises in combination with dairy enterprise always offer great opportunities for increasing farmer's income particularly to weaker section of rural community (Vinodkumar *et al.,* 2017). Small scale dairy farming with two-three cows are very much promising and popular amongst landless and marginal weaker farmer for income generation. For years, J&K's dairy sector has been beset by challenges of low remuneration, costly milk production, competition from private dairy players, and farmers losing interest in animal husbandry.

India has the largest livestock population of around five hundred thirty five and seven eight million, which translates to around thirty one percent of the world population. Milk production in the country is expected to increase to two hundred eight MT in Financial Year 2021 from one hundred ninety eight MT in Financial Year 2020, registering a growth of ten percent year-over-year. India is having a bovine population of two hundred ninety nine and six million, with an average milk production of three and one kg and four and nine kg per milking cow and buffalo respectively. Low yielding dairy animals consumes maximum feed and fodder and farmers are not getting enough cash in hand rather negative profitability. Most of the livestock farmers are unaware about balanced feeding and scientific managemental practices for maintaining the high yielding dairy cattle and buffalo. They are unaware to combat animal from heat stress in tropical and sub-tropical areas and from cold stress in temperate/hilly areas to maintain persistency in production. Further they are not following the standard vaccination and deworming schedule judiciously to minimize disease outbreak. As a result the productivity of these animals is not expressed phenotypically as per their genetic potential and the animals are suffering from various metabolic diseases and infertility problems. Farmers are taking livestock sector as a burden due to non-

profitability and gradually the future of these sectors are reaching towards dark corner. To return the smiling face of farmers, these sectors need to be shifted towards profitable business. The elite indigenous breeds of Sahiwal, Red Sindhi and Tharparkar produces average milk yield of twelve to eighteen lt per day and the elite Murrah buffalo produces average milk yield of eighteen-twenty lt per day. The elite exotic Jersey breed produces average milk yield of twenty five-thirty lt per day and *Holstein Friesian* average milk yield is thirty-forty lt per day. The frozen semen of high yielding germplasm is very much effective in up gradation of local breeds of cattle and buffalo. In tropical and sub-tropical areas upto seventy five percent exotic cross breeding programme and 100% indigenous cross breeding with Sahiwal, Red Sindhi and Tharparkar frozen semen is most suitable. The Murrah buffalo cross breeding programme throughout the country can enhance the buffalo milk production. In temperate hilly areas the Jersey and *Holstein Friesian* cross breeding programme up to 100% is also encouraging result. These cattle and buffalo breeding programmes are well documented but these need to be implemented in a fast track way to enhance milk production. The artificial insemination (AI) needs to be accessible by opening sub-station AI centres at Gram panchayet level or through public private partnership delivery to farmer's door steps in far flung area.

The supply chain for agricultural items are informal or traditional that deliver products to local middlemen and then to small local stores. Bulk of the products are sold by the farmers in raw form and as such taken from field to Mandi after harvesting. This causes super fluidity in the market and suppresses the price to a low level. Farmers do not keep the produce for sale in lean seasons. There is need of warehouse for keeping raw materials or manufactured goods in village level for persistent supply and reduce super fluidity in market to realize better market price. Creation of small scale cooperative societies at Panchayet/block level may be helpful to get a better price, mitigating the involvement of middlemen. There is a need to integrate small producers as more modern value chains, both in domestic and export-oriented markets.

We have good production of milk in the UT of Jammu and Kashmir but due to low market linkage, unawareness about value addition, farmers are not getting remuneration. The newer technology for value addition of milk to get better price for their produce is substantially achieved in cooperative sector not at the farmer's level. The need is better marketing of milk and milk products. The centre has already taken initiative for strengthening the milk cooperatives of Jammu and Kashmir (JKMPLC). The central Govt of India is keeping eye to develop the Dairy and Animal Husbandry sector to create employment opportunities. The Centre can look to bring more youth under animal husbandry with increased fund allocation and bring the transformation.

Unfortunately, J&K couldn't ride on the dairy development bandwagon after 1970, for want of adequate support from the local governments. For decades, the processing capacities remained idle. It was in 2004, JKMPCL established and formal cooperative dairying began under the guidance from Amul. However, till now, only two operational processing facilities exist in the State one each in Jammu and Kashmir regions. The Federation's plant at Chashmeshahi has milk processing capacity of 50,000 litres per day (LPD). JKMPCL procures this milk from about 20,000-25,000 milk producers - mostly women who operate through Self-Help Groups (SHG). The milk is sold in retail under brand 'Snow Cap'. Even as the packaged liquid milk market is concentrated around Srinagar, there is a room for further expansion with value-added products such as cheese, butter, ice cream and paneer.

Empowerments of youth and women by providing skill development for value addition of dairy product can build a very strong entrepreneurship institution thereby employment generation. For the milk production, J&K boasts of unique agro-climatic region - similar to that of the European region. Due to this, some good varieties of cow are able to sustain and deliver the milk yield comparable to that in the European region.

The flush season in J&K differs from that in the other North Indian States. The flush season, when the milk production is at peak, begins after June and peaks till August, while the lean season begins from November to December. As most of the milk production happens through cow only, by communities

such as Gujjars of plains and Bakarwals of Valley, there is a greater focus required on breed improvement and development for higher yield, which will effectively bring increased earnings for breeders.

The remote hills in J&K which are the production centres of Kalari are not attractive for the private sector unless sufficient infrastructure and incentives are developed and this is where the state needs to step in. There is a need for small farmer groups, cooperatives or farmer-owned professionally managed companies in this area, depending on the level of production, infrastructure and investment available at each location. Local governments like the Panchayat are weak and the state government has not enabled the entry and operation of private sector stakeholders in the dairy sector particularly in dairy-based food processing. In order to have sufficient bargaining ability in the product market, marginal and small producers also need to scale up their operations. Enabling value chains for small farm dairy products and providing facilities for the emergence of appropriate markets can be a major trigger for changes in the operation of all these sectors. Many new value addition activities have already been introduced by several schemes and projects in the hill tracts in India as the hills of Jammu offer indigenous and sustainable value added products with assured market without disturbing the ecological balance of the hills.

In September 2020, the government launched the e-Gopala App and several initiatives in dairy and animal husbandry. Government initiative platform such as e-NAM, KisanRath app to facilitate interstate movement of perishable items, however these initiatives are not reached to the farmers of rural area. Thus effective implementations at true senses of this government programme are the duty of extension functionaries enabling rural farmer in right path. Thus the collaborative approaches to make the actual awareness and application in terms of cooperative and in line of self help group hold greater promises for effective execution of the schemes. The most popularize phrase in the present the "Self reliant India" of government of India is evolving with many activities in relation to the economic vision and economic development of the country named as Atmanirbhar Bharat. The ministry of Fisheries, AH & dairying of govt of India launched Animal Husbandry infrastructure development fund in 2020 with an out lay of Rs. 15000 Cr and dairy processing infrastructure development in 2017 with an out lay of Rs. 11,184Cr as a part of Atmanirbhar Bharat package stimulus. Thus considerable importance is given for creating and strengthening of milk processing, value addition & chilling facilities implementation. The beneficiaries of dairy cooperative, NGO, milk producer can avail this benefit under Atmanirbhar Bharat to make the dairy enterprises more profitable and sustainable.

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