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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 1740 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

The imperative for a profound metamorphosis in agriculture is emphasized by the need to align with and actualize the Sustainable Development Goals (SDGs), thereby elevating its pivotal role in advancing human well-being. Transformative agriculture, characterized by a comprehensive and innovative approach that surpasses conventional methodologies, strives to overhaul the entire agricultural system to yield resilient and sustainable outcomes. This paradigm shift involves the integration of avant-garde technologies, regenerative practices, and an intricate comprehension of ecological principles. Significantly, it underscores the paramount importance of soil health, biodiversity conservation, and water management. Encouraging the adoption of agroecological practices, data-driven decision-making, and precision farming techniques, transformative agriculture aims to optimize productivity while mitigating environmental impacts, fostering a symbiotic relationship between agriculture and the natural ecosystem. This approach is not only to mitigate the challenges arising from climate change and resource constraints but also to cultivate a more inclusive and equitable agricultural framework that simultaneously accrues benefits for both agricultural producers and consumers. Focused on mobilizing communities towards sustainable development, the Society for Community Mobilization for Sustainable Development (MOBILIZATION Society) takes a proactive approach to fostering positive change, particularly in the agricultural sector. Society consistently takes the lead in pioneering efforts to showcase technological and cognitive advancements in sustaining productive and profitable agriculture. In this regard, the organization has announced its 11th National Seminar on "Transformative Agriculture and Sustainable Development: Rethinking Agriculture for a Changing World," in collaboration with Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur which will be held during 15th -17th, February 2024 at MPUAT, Udaipur (for more details, please visit: http://mobilization.org.in/).

I am delighted to announce the release of the latest issue of the MOBILIZATION Journal to our readers. This issue encapsulates a diverse range of radical research, insightful analyses, and thought-provoking contributions from esteemed scholars and experts in various fields. Several noteworthy features in this edition encompass impact evaluation of the Diploma in Agricultural Extension Services for Input Dealers (DAESI), accessibility and usability of agro-met advisory services, communication research and information-seeking behaviour, environmental interaction and growth-yield study, adoption research in the field of agriculture, dairy and animal husbandry, organic farming and its structural breaks, plant genetics and development of an effective protocol for *in-vitro* propagation, development and validation of knowledge test, behavioural analysis and Farmer Producer Organizations (FPOs), farmers' knowledge and practices for the safe use of pesticides, engendering entrepreneurship, climate change adaptation strategies, irrigation engineering, one health approach, cluster front line demonstration and its impacts, millet based action research, constraint analysis, etc. I sincerely hope that this issue proves to be a valuable resource for our readers, fostering intellectual curiosity and serving as a catalyst for further exploration and discussion within the scholarly community.

I would like to express my sincere gratitude to the exceptional editorial team for their unwavering commitment, expertise, and dedication throughout the publication process of this issue. I am truly appreciative of the hard work and professionalism demonstrated by each member of the editorial team in the timely editing and finalisation of the journal content. I would like to extend my heartfelt appreciation to our esteemed readers and contributors for their invaluable support and participation in the latest issue. Your insightful contributions have enriched the diversity of perspectives within our scholarly community and have played a pivotal role in maintaining the high standards of intellectual discourse that our journal upholds. I am grateful for your continued support and look forward to fostering a collaborative environment for the exchange of knowledge and ideas in the future. Thank you for being an integral part of the success of this journal issue.

J.P. Sharma
Chief Editor

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Review Article

Boosting the Citrus Export of India through Institutional Support to Farmers: Assessing the Policy Initiatives

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ABSTRACT

India is a tropical country with a variety of perennial fruits that grow throughout the length and breadth of the country. Citrus fruits are the third most important fruit crop of India after mango and banana. In India citrus is cultivated in 10.86 lakh hectares with an annual production of 142.62 lakh tonnes and contribute about Rs. 26000 to 28000 crore in GDP every year from raw fruit and processed products. Maharashtra, Madhya Pradesh, Andhra Pradesh, Telangana, Punjab and North East India are the important centers of cultivation. India is the third highest producer of citrus in the world and successfully exports the fruit to different countries of the world. Bangladesh is the biggest market for Nagpur mandarins. Nagpur and Amravati districts of Maharashtra together produce 7 lakh MT of Nagpur mandarins on 1.26 lakh hectares. Of this, Bangladesh alone imports 25 per cent of the produce. Many institutions have been established which regulate and promote export activities. But to boost citrus export, research institutes of ICAR and other government research centres have also a major role to play. The authors explore the possibilities and propose a 6-pronged promising model of institutional support solely for citrus exporters which has the potential to benefit the citrus industry in long run. In this model research institutes and other State and Central Government regulatory bodies need to work in coordination.

Keywords: Citrus, Export, Institutional support, Role of research institutes, ICAR

INTRODUCTION

Citrus fruits are the third most important fruit crop of India after mango and banana. In India citrus is cultivated in 10.86 lakh hectares with an annual production of 142.62 lakh tonnes [1]. As a major fruit crop which is a store house of Vitamin C and other immunity building nutrients, citrus remains in demand all throughout the year not only in domestic but also international markets. The commercially cultivated cultivars of citrus in India are mandarin, sweet orange, acid lime, grapefruit and pummelo. In global markets a huge varietal base exists for all kinds of citrus cultivars which are not available in India. But nonetheless India exports citrus fruits to many countries of the world. Mandarins are the most widely cultivated cultivar in India and in 2021-22 mandarins worth 54.17 million USD was exported by India to 13 countries [2]. Nagpur mandarins which are a speciality of the Vidharbha region of Maharashtra are one of the finest mandarins of the world and have a huge export potential. Nagpur and Amravati districts of Maharashtra together produce 7 lakh MT of Nagpur mandarins on 1.26 lakh hectares. Of this, Bangladesh alone imports 25 per cent of the produce. Citrus fruits as a whole, especially mandarins have a huge potential for export and citrus growers need to be sensitized, supported and provided training and hand-holding support to etch a mark in the world of export business. With time, Government of India has realized this and a lot of policy initiatives have been undertaken to provide institutional support to citrus growers of Maharashtra and also the entire country. The authors have highlighted the primary institutions dealing with export of fruits and have proposed a 6-pronged promising model of institutional support solely for citrus exporters which has the potential to benefit the citrus industry in long run.

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Existing Institutional Support: APEDA

The Agricultural and Processed Food Products Export Development Authority (APEDA) is an apex government authority for export and trade promotion. Functions of APEDA include regulation of export, inspection certification, infrastructure development of processing plants, storage and transportation points, market development and conducting training and awareness programs for promotion of industrial development. They also have a guideline for exporters. Exporters need to register through APEDA website to initiate their export. The primary requirements for registration are:

i. Self certified copy of Import-Export code issued by D.G.F.T. (for merchant exporter category)

ii. Manufacture-Exporter: A Self-attested copy of the registration of the company with the relevant certification agencies.

iii. Online payment of Rs. 5900 towards registration, by debit/credit card/internet banking.

iv. The validity of APEDA Certificate is of 5 year. After every 5 year exporter shall renew their registration Certificate.

Existing Institutional Support: MSAMB to Citrus Exporters

Maharashtra State Agricultural Marketing Board (MSAMB) was launched by the State Government to promote agricultural marketing in the state. MSAMB plays an important role in developing and coordinating agricultural marketing system in the State of Maharashtra. Also, MSAMB has been developed to strengthen the interface with farmers and other beneficiaries and to provide international price trends of various agricultural commodities.

MSAMB has taken several initiatives for mandarin export. Mandarin was exported from Karanja Ghadge (Wardha district, Maharashtra) after a stakeholders meeting. MSAMB has handed over mandarin export facility to MAHAORANGE by providing them a revolving fund of Rs. 50 lakhs. About 40 containers of mandarin have been exported to Sri Lanka, Bahrain and Singapore. MSAMB also has schemes for promotion of GI products like organizing training programs, providing financial assistance, organizing exhibitions etc. The following are benefits of MSAMB infrastructure which exporters and also the agricultural economy of the state, as a whole, can reap:

- Export Promotion
- Employment generation
- Use of the Infrastructure on a pilot basis
- Export of Quality goods
- Facilities used for Market Access
- Increasing Participation of Private players
- Adoption of Traceability system
- Adoption of modern packaging practices
- Residual control of Chemicals
- Social Impact of Common Infrastructure
- Farmers became quality cautious
- Dependency on the local market reduced

Existing Institutional Support: ICAR-CCRI and SAUs

The Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India. The Council is the apex body for coordinating, guiding and managing research and education in agriculture and allied sciences in the entire country. In ICAR, each agricultural commodity has a research institute allocated for conducting research and extension on that commodity. The institute which works in the domain of citrus fruits is ICAR-Central Citrus Research Institute located in Nagpur district of Maharashtra state of India. Established in July, 1985, the journey of more than three decades has enabled ICAR- CCRI become a symbol of trust for farmers, industry, academia and other stakeholders in terms of research and development (R& D), extension and farm advisory services. The institute functions with the mandate of developing technologies for overall improvement of productivity and profitability of citrus farmers across India [3]. State Agricultural Universities like Dr. P.D.K.V Akola University, Maharashtra has also dedicated research facilities on citrus and trained manpower to disseminate technologies to field level. Other SAUs like Punjab Agricultural University,

Ludhiana and even Central Agricultural University and its sub-campuses and even Assam Agricultural University and several other horticultural research institutes are conducting research and extension activities in citrus domain.

Six Pronged Model for Institutional Support to Citrus Exporters: Policy Initiatives Required: Along with the role of technology development and infrastructural support, knowledge dissemination is one way in which institutions can help potential citrus exporters. Research institutes can act as knowledge hub (Figure 1) in the following six ways for potential citrus exporters and other stakeholders. Appropriate policy reforms or new policies need to be created to empower research organizations to impart designated services to citrus exporters.

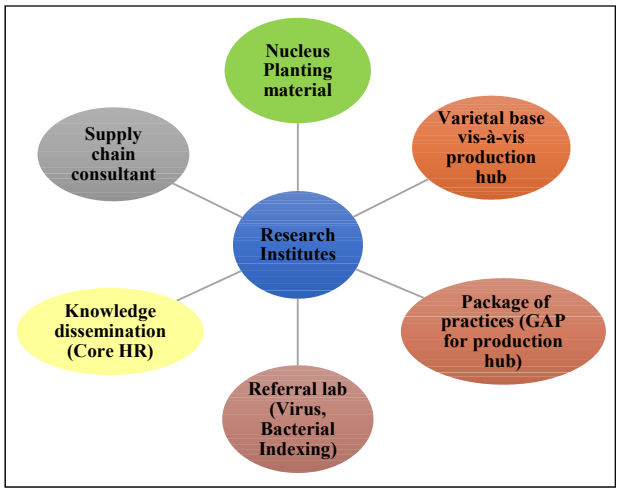

Figure 1: Six Pronged Model: Research Institutes as Knowledge Hub for Potential Citrus Exporters

Research Institutes as Knowledge Hub for Nucleus Planting Material: Research institutes like ICAR-CCRI have developed the technology of producing disease-free planting materials of citrus. The institute has state-of-the-art nurseries to maintain the nucleus mother blocks of citrus plants and multiply them for distribution to citrus growers of the region. This technology was first of its kind in the entire country. During last 5 years a total of 15.5 lakhs disease free planting material were produced and distributed by ICAR-CCRI to citrus growers from all over India generating revenue worth Rs. 7.2 crores. But the institute does not have the necessary infrastructure, fund and manpower to meet the growing demands of farmers for supply of disease free planting material. Hence ICAR-CCRI has adopted a PPP mode of technology licensing to private nurseries who learn the technology and produce and sell diseases-free planting material at their end thus ensuring availability of more number of healthy plants to farming community. Disease-free plants are the prime base of a good production and hence a good export. Hence this aspect of ICAR-CCRI can be leveraged by citrus exporters. Other research organizations can work in similar line and distribute nucleus plants to State and Central Government nurseries which in turn can multiply the plants at their own level and distribute amongst farmers and private agencies (Figure 2). Good quality planting material will ensure a good production and in turn boost chances of export.

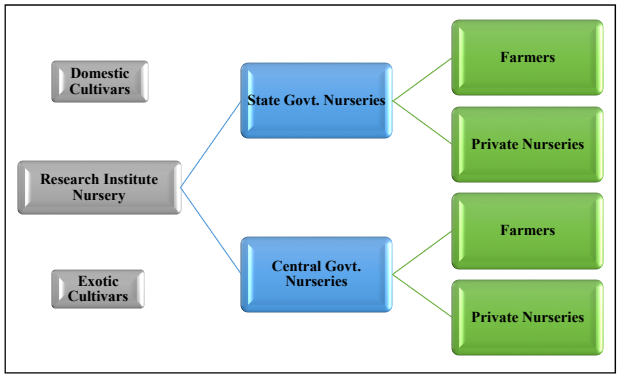

Figure 2: Research institutes as Knowledge Hub for Nucleus Planting Material

Research institutes as Knowledge Hub for Varietal Base: Research Institutes can play the role as a knowledge hub for enhancing the varietal base of citrus in India (Figure 3). The institute specializes in import and identification of new varieties, their evaluation, release and propagation. These new varieties can be distributed to various central and state department nurseries who can multiply and distribute amongst farmers and private agencies. A wide varietal base will improve India's prospects of exporting citrus fruits to many more countries with varied consumer preferences.

Research institutes as Knowledge Hub for Identifying Package of Practices: Research institutes are dedicatedly conducting research on identifying and standardizing package of practices for citrus cultivation in terms of production to post harvest. The institutes have released several technologies and publications in this regard. Till date they are continuing their research activities along with circulation of monthly farm

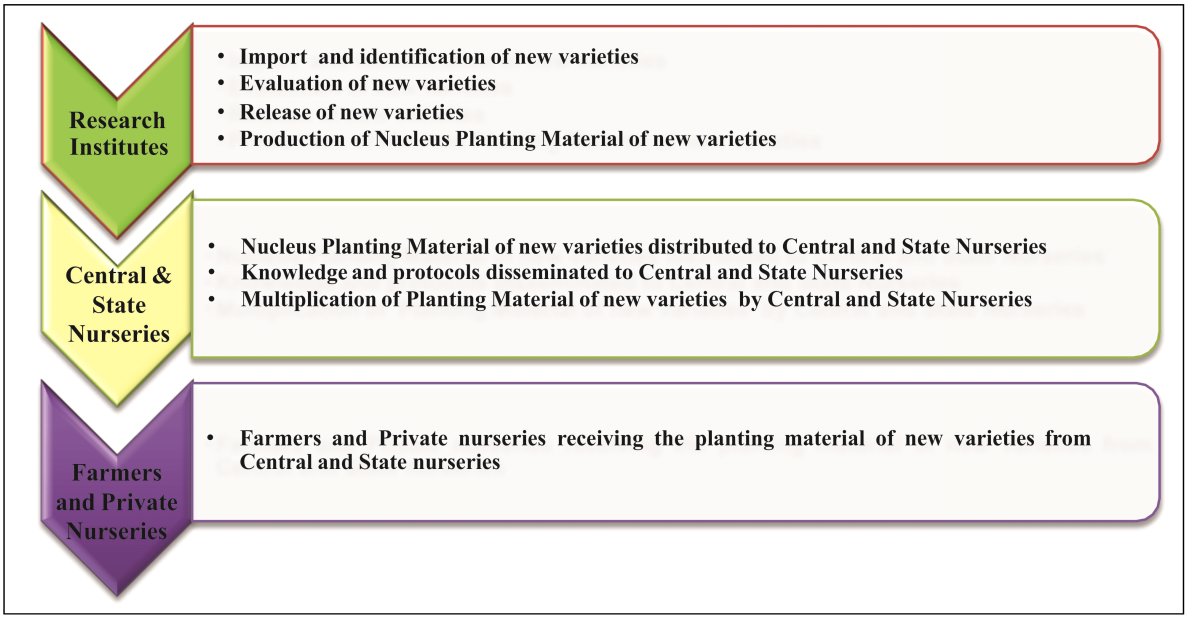

Figure 3: Research institutes as Knowledge Hub for Varietal Base

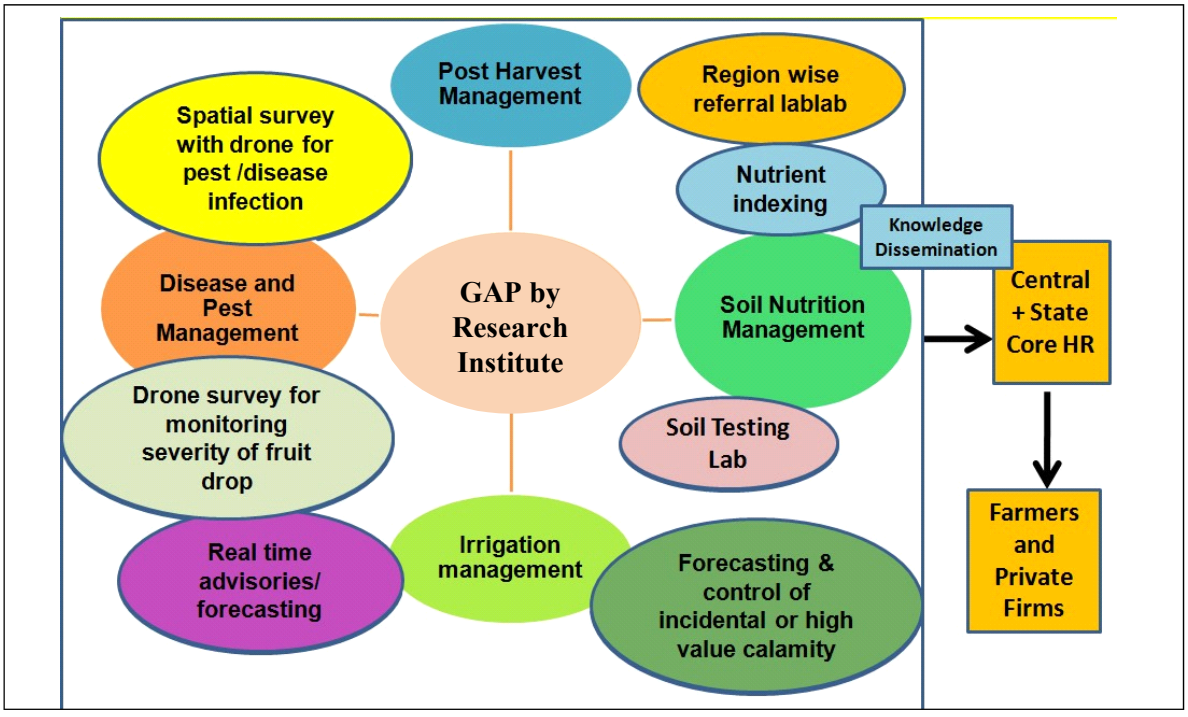

Figure 4: Research institutes as Knowledge Hub for Identifying Package of Practices

advisories especially catering to unpredictable natural calamities.

The core human resource of state and central departments can be trained by such research institutes in practising the Good Agricultural Practices of citrus cultivation (Figure 4). The knowledge thus disseminated can be further shared amongst farmers, private agencies and potential exporters. GAP is essential for having a stable production and good quality harvest.

Research institutes as Knowledge Hub for Referral Lab (Viral and Bacterial Indexing): Research institutes have state-of-the-art lab facilities for viral and bacterial indexing in citrus. ICAR-CCRI has already extended its diagnostic services to farmers and

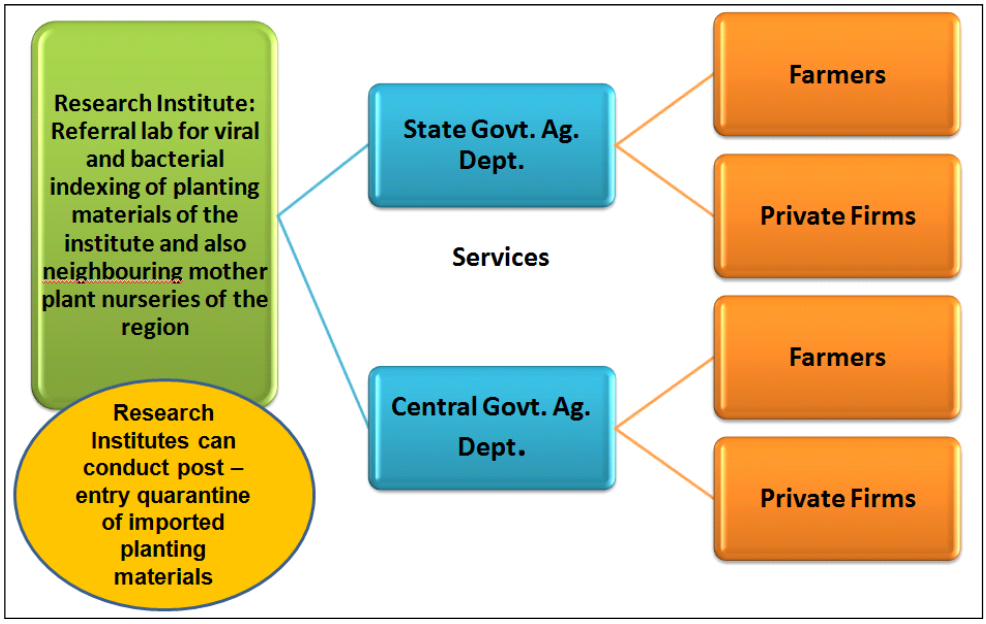

Figure 5: Research institutes as Knowledge Hub for Referral Lab

other stakeholders. The services include identification of citrus root stocks and diagnosis of greening bacterium from a small amount of citrus tissue.

The method is quick and can benefit several farmers and exporters if the facility of the institute is expanded and converted into a referral lab for citrus in the country. The referral labs of research organizations can then facilitate diagnosis of viral and bacterial diseases through State and Central Agriculture Departments (Figure 5). These departments can then guide farmers and private agencies in detection and control of these citrus diseases.

Research institutes as Knowledge Hub for Disseminating Knowledge to Core HR: Not only GAP of citrus, but research organizations can also disseminate knowledge of organisational and managerial skills in agriculture departments of centre and state (Figure 6). The core HR can then train farmers and private firms accordingly.

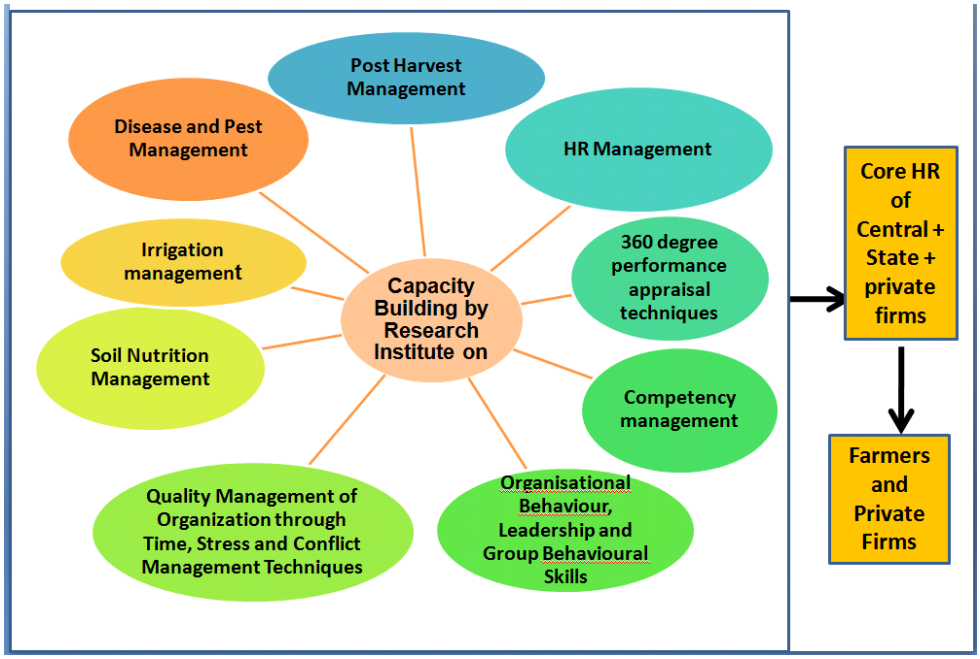

Figure 6: Research institutes as Knowledge Hub for Disseminating Knowledge to Core HR

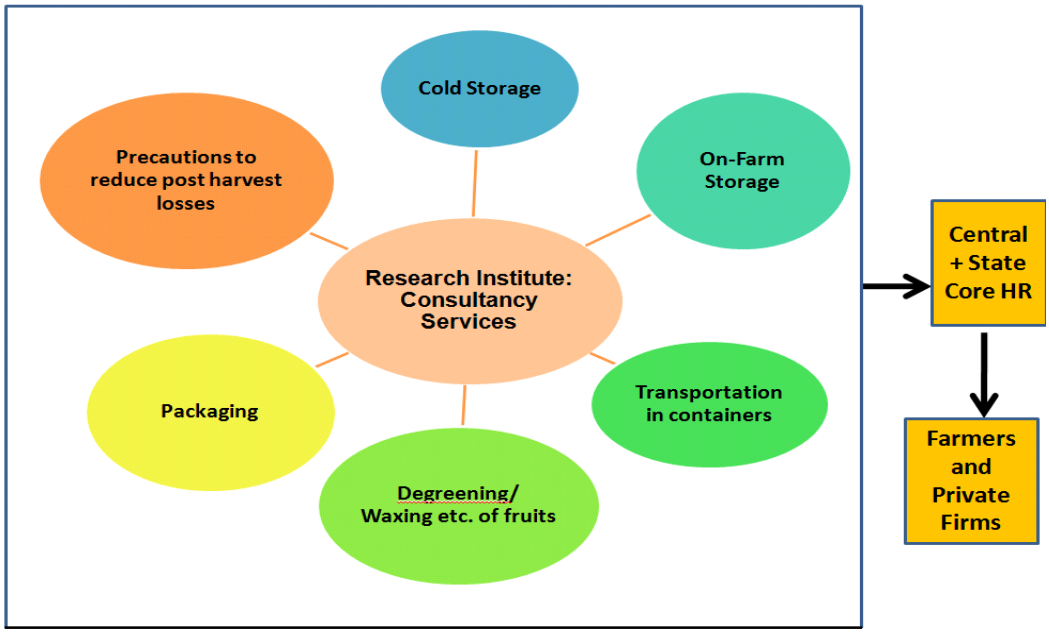

Figure 7: Research institutes as Supply Chain Consultant

Research institutes as Supply Chain Consultant: Research organizations of citrus have standardized the scientific post harvest handling procedures for reducing post harvest losses of citrus fruits (Figure 7). This knowledge is disseminated to stakeholders through HRD programs. This knowledge dissemination model can largely benefit citrus exporters. Such institutes can act as consultants to citrus exporters in various capacities.

CONCLUSION

Institutions related to agri-export, research and development have a major role to play in enhancing the agricultural export of the country. Farmers, exporters and other related stakeholders if can utilize the services of the institutes efficiently then they can reap the benefit. As Nagpur mandarin has the potential of good export, production, GI, favourable climate of the region and above all institutional support from Central and State institutions, it is high time for citrus growers to improve their production, profitability, export by leveraging the favourable factors. Necessary polices to empower research organizations with more funds and delegation of multi-faceted export oriented services can prove as a new impetus to citrus export industry of India.

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Review Article

The Challenges and Opportunities for One Health Approach

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ABSTRACT

Due to population expansion at tremendous rate, it is expected that demand for animal products would increase by about 70 per cent in developing nations during the next 30 years. The increasing demand for animal food items offers immense opportunities for the underprivileged to escape poverty by diversifying and stepping up livestock production and also livestock wealth is more evenly distributed in comparison to land. The livestock industry aids in finding solutions to these problems by promoting long-term economic expansion, social inclusion, and effective resource management. By reducing the cost of animal diseases, ensuring the safety of food, and preventing the development of antibiotic resistance, one can increase animal health and wellbeing. As a result, livestock producers must expend on veterinary care and animal disease monitoring. Zoonotic diseases can be controlled by preventing animal diseases thus emphasizing on "One Health" concept, which aims to enhance human, animal, and world health, includes better livestock management.

Keywords: Antibiotic resistance, Environment, One health approach, Zoonotic diseases

INTRODUCTION

The term "One Health" may be fairly new but the concept has long been recognized both nationally and globally. The term 'One Health' was first used in 2003–2004, and was associated with the emergence of severe acute respiratory disease (SARS) in early 2003 and subsequently by the spread of highly pathogenic avian influenza H5N1, and by the series of strategic goals known as the 'Manhattan Principles' derived at a meeting of the Wildlife Conservation Society in 2004, which clearly recognised the link between human and animal health and the threats that diseases pose to food supplies and economies. These principles were a vital step in recognising the critical importance of collaborative, cross-disciplinary approaches for responding to emerging and resurging diseases, and in particular, for the inclusion of wildlife health as an essential component of global disease prevention, surveillance, control, and mitigation (Parkes *et al.*, 2020).

The World Health Organization defines One Health as "an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes". 'One Health' is an integrated, unifying approach to balance and optimize the health of people, animals and the environment. It is particularly important to prevent, predict, detect and respond to global health threats such as the COVID-19 pandemic.

As per Mackenzie *et al.* (2014) the outbreak of SARS, the first severe and readily transmissible novel disease to emerge in the 21st century, led to the realisation that (a) a previously unknown pathogen could emerge from a wildlife source at any time and in any place and, without warning, threaten the health, well-being, and economies of all societies; (b) there was a clear need for countries to have the capability and capacity to maintain an effective alert and response

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system to detect and quickly react to outbreaks of international concern, and to share information about such outbreaks rapidly and transparently; and (c) responding to large multi-country outbreaks or pandemics requires global cooperation and global participation using the basic principles enshrined in One Health. According to Singer (2011) the emergence and spread of influenza H5N1 has been another excellent example of the importance of global cooperation and a One Health approach driven by the widespread concern that it might become the next influenza pandemic strain. It also served as a catalyst for the United Nations Secretary General to appoint a UN Systems Coordinator for Avian and Animal Influenza (UNSIC), and to form a major collaboration with a number of international and national organizations, including the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Organization for Animal Health (OIE), United Nations Children's Fund (UNICEF), and World Bank and various national heath ministries, to develop the International Ministerial Conferences on Avian and Pandemic Influenza (IMCAPI). IMCAPI was a major driver in the surveillance and responses to influenza H5N1 and subsequently in the development of a strategic framework built around a One Health approach that focussed on diminishing the risk and minimizing the global impact of epidemics and pandemics due to emerging infectious diseases (Singer, 1995).

In accordance with Khan *et al.* (2018) One Health is also prominent in several global commitments and political declarations such as the Sustainable Development Goals, the International Health Regulations, the Global Health Security Agenda, the UN Paris Agreement on climate change, and the UN Political Declaration on Antimicrobial Resistance. One Health consists of the triad of human health, animal health, and the environment, but the latter is often neglected, as evident from its absence or cursory mention in most of the initiatives mentioned. This neglect of the environment was also a key finding of the systematic analysis of One Health Networks (OHNs) reported by Mishal Khan and colleagues in The Lancet Planetary Health.

Cleaveland *et al.* (2016) reported that government officials, researchers and workers across sectors at the local, national, regional and global levels should implement joint responses to health threats. This includes developing shared databases and surveillance across different sectors and identifying new solutions that address the root causes and links between risks and impacts. Community engagement is also critical to promote risk-reducing habits and attitudes, and to support early detection and containment of disease threats. The social sciences help in understanding the disease and preventing its spread. Again taking COVID-19 as an example, it can be seen how people can reduce the effects of pandemics through social awareness, support of others, and self-isolation. One recent development that might help in generating increased global awareness of the One Health concept, particularly among students, but also more generally, has been the designation of November 3rd as One Health Day. One Health Day is celebrated through One Health educational and awareness events held around the world. Students are especially encouraged to envision and implement One Health projects, and to enter them into an annual competition for the best student-led initiatives in each of four global regions.

The One Health High-level Expert Panel (OHHLEP)

The Quadripartite One Health Joint Plan of Action (OH-JPA) of WHO outlines the changes needed to avoid and lessen the effects of current and upcoming health concerns at the global, regional, and national levels. The One Health High-Level Expert Panel (OHHLEP) was formed in May 2021 to advise FAO, UNEP, WHO and WOAH on One Health issues. This includes recommendations for research on emerging disease threats, and the development of a long-term global plan of action to avert outbreaks of diseases like H5N1 avian influenza, MERS, COVID-19, Ebola, and Zika.

The panel will also look into how human activity affects the ecosystem and wildlife habitats, and how it affects disease threats. One Health issues cover zoonotic illnesses, antibiotic resistance, food safety and security, environmental contamination, vector-borne illnesses and other health problems that affect people, animals, and the environment at the same time. According to Boqvist *et al.* (2018), critical areas include food production and distribution, trade and travel across the borders,

urbanisation and infrastructure development, activities that increase pressure on the natural resource base and activities that contribute to biodiversity loss and climate change, all of which can result in the emergence of zoonotic diseases.

Microbiological strains of microorganisms that influence human and animal health allow scientists to monitor their behavior and mutations, as well as develop new methods of disease prevention. It has become increasingly clear over the past three decades that the majority of novel, emergent zoonotic infectious diseases originate in animals, especially wildlife, and that the principal drivers of their emergence are associated with human activities, including changes in ecosystems and land use, intensification of agriculture, urbanisation, and international travel and trade (Khan *et al*., 2018; Mackenzie *et al*., 2014) Studies of interactions between humans and animals, especially wild ones, allow scientists to predict future virus emergences or biodiversity threats. A collaborative and multi-disciplinary approach, cutting across boundaries of animal, human, and environmental health, is needed to understand the ecology of each emerging zoonotic disease in order to undertake a risk assessment, and to develop plans for response and control (Jones *et al*., 2013).

Potential Danger to Human and Animal Health

Ecosystem health observations offer early warnings of potential threats to human and animal health. Additionally, it offers the potential to protect ecosystem biodiversity, which is necessary for both human and animal existence (Osterhaus *et al.,* 2020). As evidenced by the instances of antibiotic resistance and climate change, the environment is the most dynamic and thus the most perplexing sector of the One Health triangle, in accordance with results of Parkes *et al.* (2020). Antibiotic resistance has been called the "quintessential One Health issue" due to the fact that it affects all the areas. According to Hoelzer *et al.* (2017), antibiotic resistance is a direct result of the selection pressure due to indiscriminate use of antibiotics for human and animal health as well as exposure to antibiotics in the environment. However, there is a lack of knowledge regarding the relative contributions made by the three sectors to the emergence, spread, and durability of antibiotic resistance. Use of antibiotics in animal production systems at sub-therapeutic doses for prolonged periods creates optimal conditions for bacteria to entrench antibiotic resistance genes. These genes are subsequently transferred to human pathogens or commensals via humans, contaminated food, or the environment. Antibiotics used in humans and animals are frequently analogues of each other, which potentially drives the transmission of resistance between humans and animals, and there is growing evidence linking antibiotic consumption in livestock to antibiotic resistance in the clinic. Ceric *et al.* (2019) stated that the burden of antibiotic resistance is least well understood in the environment. Environmental bacteria, which are quantitatively the most prevalent bacteria, serve as reservoirs of resistance genes that can become incorporated into human and animal pathogens over time. These resistance gene reservoirs are augmented by the influx of resistance genes from livestock and human waste into the environment. They are further augmented by the entry of antibiotic residues from pharmaceutical industries, intensive livestock farming, and hospitals, which disrupt the soil and water microflora in addition to exerting selection pressure for the development of resistance. The environment is subject to variable weather patterns, particularly fluctuations in temperature, humidity, and precipitation (not the least of which is as a result of climate change) that affect bacterial ecosystems, making the environment a vacillating sector in the One Health antibiotic resistance triad.

The American Veterinary Association (2008) found that environmental issues have attracted the most attention in relation to climate change and its detrimental consequences on the health of people, animals and the environment. Climate change endangers the ecological and environmental integrity of living systems by causing changes in the lifecycles of pathogens, vectors, and reservoirs as well as new and emerging diseases of food-producing plants as well as domestic and wild animals, trophic cascades, interfering with the synchrony between interacting species in a given habitat, and modifying or destroying habitats.

Singer *et al.* (2011) termed it as the "threat multiplier" in that it adversely affects infectious diseases, zoonosis, food security, food safety, and local, regional,

and global responses to them. According to Callicott (1989), integrating one health with climate change could solidify the position of the environmental sector within the one health triangle. One Health requires a system approach due to the interconnectedness of human, animal, and environmental health. This strategy emphasises that complex molecular, biological, ecological, economic, social policy, and political systems play a role in the occurrence of both health and disease. The strategy focuses on analysing the operation of systems, both individually and collectively, in terms of their dynamic linkages, feedback loops, interactions, and dependencies.

Countries may contribute vital information about the state of the environment and the issues that need to be prioritised for people to protect the health of all species by taking part in the One Health Initiative. Diseases are more likely to spread due to the closer ties between humans and animals, and international collaboration is essential to keep populations healthy (Osterhaus *et al.,* 2020). A prime example of this would be COVID-19 and its research, which would aid in preventing the emergence of new coronaviruses. In order to increase pandemic preparedness, the One Health Institute in California is now working on developing open source FAQ containing comprehensive information on the subject contributed by numerous nations and organisations.

Role of Environment in One Health Approach

Although plant health is currently part of the definition of One Health, plants have typically not been well integrated into discussions of One Health approaches (Destoumieux, 2018; Fletcher *et al.,* 2009). However, plant health is vital to sustain human and animal health and a critical component of the complex interactions among the environment, humans, and animals. Recognizing the key role of plants in public health, the United Nations declared the year 2020 to be the International Year of Plant Health (IYPH). The overarching purpose of the IYPH was to raise awareness of plant health and its effects on society. Maintaining plant health has important consequences for human and animal health as an important driver of food security and safety, as a source of livelihoods in plant-based agriculture, as a source of pharmaceuticals, and as part of healthy environments (Boa *et al.,* 2015; Scholthof, 2003; Strange and Scott, 2005). Plants provide over 80 per cent of the food consumed by humans and are the primary source of nutrition for livestock. Food security-the state of having reliable access to sufficient, safe, affordable, and nutritious food at all times-is necessary to have healthy and productive societies (Savary *et al.,* 2019). Food security is also a crucial aspect of One Health and is a pillar of the United Nations Sustainable Development Goals (SDGs) (Choffness *et al.,* 2012). As per the reports of World summit on Food Security, FAO (2009) the UN definition of food security identified four key pillars: 1) availability, 2) access (both economic and socio-cultural), 3) utilization, including food preparation and safety, and 4) lastly the stability of these three pillars. Food security thus reflects a complex value chain of production, food processing and distribution, and food access, beginning with plant health in the field. Employing a One Health approach to ensure the safety and continuity of this value chain will result in the protection and advancement of public health. Plant diseases and pests influence the availability and safety of plants for human and animal consumption, reduce crop yield and detrimentally affect quality (Savary *et al.,* 2017; Strange and Scott, 2005). Measures to prevent or treat diseases, including application of pesticides, may adversely impact the health of agricultural workers and consumers, as well as drive the development of antimicrobial and antifungal resistance in pathogens (Fisher *et al.,* 2018; Ramakrishnan *et al.,* 2019). As per estimates of the Global Burden of Foodborne Diseases, WHO (2015) food plants may serve as carriers of human pathogens and harmful microbial-based toxins. For example, foodborne illnesses pose a serious global burden on human health, reportedly affecting 600 million people or 33 million Disability Adjusted Life Years (DALYs) in a single year. Although international food standards, such as the Codex Alimentarius, are implemented to protect consumers' health and fair trade, foodborne illnesses continue to affect high-, middle-, and low-income countries around the world. In accordance with Painter *et al.* (2013) plants are important origins of foodborne outbreaks, including fresh vegetables and fruits irrigated with, washed with, or exposed to water and soil contaminated with pathogens of animal or human origin. More than half (51%) of outbreak-associated illnesses in the US were traced to plant-foods over a

10-year period, higher than any other food commodity, such as meat, fish, and dairy products. Additionally, antibiotic resistant bacteria and resistance genes originating from animal faces can also contaminate fresh produce and pose health risks for humans. Therefore, a key aspect of food security is timely and effective management of plant pathogens and pests and other microbes associated with plants that can cause foodborne illnesses, often disproportionately impacting the most vulnerable and health disparate populations locally and globally. According to Jones *et al.* (2008), threats to plant health pose challenges to population health, productivity, and prosperity across the globe. Efforts to protect plants from emerging and endemic pathogens and pests help to not only increase food security and safety to ensure healthy lives, but also to alleviate poverty, promote equity, confront the impact of climate change, protect the environment, boost economic development, and strengthen global partnerships. Establishing a much closer partnership among advocates for One Health, including experts in sustainable agriculture, and public health practitioners will lead to promoting a safe, sustainable, and nutritious diet for families worldwide.

Rabinowitz *et al.* (2017) stated that the scope of One Health as envisaged by the international organizations (WHO, FAO, OIE, UNICEF), the World Bank, and many national organisations also clearly embraces other disciplines and domains, including environmental and ecosystem health, social sciences, ecology, wildlife, land use, and biodiversity. Interdisciplinary collaboration is at the heart of the One Health concept, but while the veterinarian community has embraced the One Health concept, the medical community has been much slower to fully engage, despite support for One Health from bodies such as the American Medical Association, Public Health England, and WHO. Engaging the medical community more fully in the future may require the incorporation of the One Health concept into the medical school curricula so that medical students see it as an essential component in the context of public health and infectious diseases.

Preventive Measures

According to Osterhaus *et al.* (2020), if today's health issues are treated just from a medical, veterinary, or ecological perspective then it is unlikely that effective mitigation strategies will be developed as these are usually complicated, worldwide, multidimensional and across species. A revolutionary approach to enhancing health is called One Health. As the "best solution" for reducing human health issues, particularly pandemic zoonotic infections, it boldly challenges centuries-old presumptions about wellness. The success of One Health is essential because severe distress and bad health will result from maintaining the existing quo. One Health is not radical enough, especially in its more ambitious guises. For instance, it does not agree with the newly popular philosophical theory that historical anthropocentrism is an unjustified ethical bias towards other animals.

CONCLUSION

Professionals in the fields of human health (doctors, nurses, epidemiologists, public health practitioners), animal health (veterinarians, paraprofessionals, agricultural workers), environment (ecologists, wildlife experts), and other areas of expertise need to coordinate their efforts for effective public health initiatives. Law enforcement, policymakers, the agricultural sector, local communities, and even pet owners might be additional important participants in a One Health strategy. A single person, group, or industry cannot solve problems at the animal-human-environment interaction by themselves. A One Health approach can produce the highest health results for people, animals, and plants in a shared environment by encouraging collaboration across all sectors.

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Efficient Callogenesis and Regeneration of *Japonica* Rice Varieties from Mature Seeds

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ABSTRACT

The present study was conducted to optimize a protocol for high efficiency embryogenic callus induction and regeneration in *japonica* rice. The dehusked seeds of two varieties namely Duggu and K 332 were subjected to treatment with mercuric chloride (0.1%) and sodium hypochloride (4%) for different durations and it was found that seed explants treated with 0.1% $HgCl_2$ for 8 minutes resulted in least contamination with maximum survival percent of cultures of K 332 and Duggu. The sterilized seeds were inoculated on MS medium with 2,4-D (2.0-4.0 mg/l) and BAP (0.5-1.0 mg/l) for callus induction and regeneration was attempted on MS medium supplemented with NAA (0.2-0.5 mg/l) and BAP (2.0-4.5 mg/l) in presence or absence of proline (50mg/l). Maximum callus induction (96.07%) of K 332 was obtained in MS medium supplemented with 2,4-D (2.5 mg/l) and BAP (1.0 mg/l) while in Duggu maximum callus induction (83.37%) was achieved in presence of 2,4-D (3.5 mg/l) and BAP (1.0 mg/l). Maximum callus regeneration frequency (67.7%) was obtained in K 332 in MS medium having BAP (2.5 mg/l) and NAA (0.4 mg/l) while maximum callus regeneration frequency (47.7%) was obtained in variety Duggu in presence of BAP (2.5 mg/l) and NAA (0.4 mg/l). Further, it was observed that presence of proline (50 mg/l) was beneficial for regeneration.

Keywords: Rice, *Japonica*, Callus, Induction, Regeneration, 2,4-D

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's most important cereal crop which provides half of total dietary carbohydrate, especially in Asian countries. It is placed next to wheat and maize supplying 50-80 per cent of daily calorie intake (Khush, 2005). Rice grain makes upto 20 per cent of the world's dietary energy supply for more than three billion people across the globe (Birla *et al.,* 2017). In order to meet the food demands of ever increasing population, 40 per cent more rice is needed to be produced globally by 2050 (Milovanovic and Smutka, 2017). India produced 124.37 million tonnes of milled rice from about 43.7 million ha of land area in the year 2020-21 (Anonymous, 2022a). In Jammu and Kashmir, rice was cultivated over an area of 267.58 thousand ha with production of 5861 thousand quintals during 2019-20 (Anonymous, 2022b). Against the total requirement of about 11 lakh tonnes, only 5.86 lakh tones is produced in Jammu and Kashmir, remaining deficit of about 47 percent is met through import from neighbouring states of the country.

Rice is grown in different climatic conditions, depending on quality of water, soil and genetic make-up of the cultivars (Thakur *et al.,* 2022). Due to increasing importance of rice in food and nutritional security, it is now felt that new varieties of rice with good agronomic characters, should be evolved. Many

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biotic and abiotic stresses severely restrain rice growth and development with an eventual reduction in crop yield. There is an urgent need to have more advanced and improved technologies that can develop new rice varieties with superior yield potential, enhanced abiotic stress tolerance, and improved resistance to major pests and pathogens (Feng *et al.,* 2018; Mishra *et al.,* 2018). Recent scientific developments in field of plant breeding have opened new opportunities for its improvement (Anders *et al.,* 2021). However, the prerequisites of sexual breeding and compatibility of species during crossing are key limitations of plant breeding. Selective breeding for high-yielding and stress-tolerant rice cultivars has restricted the genetic diversity of cultivated rice, rendering it more susceptible to plant pathogens and less resilient to effects of climate change (Callaway, 2014).

The crop improvement strategies have become less laborious and time saving with biotechnological interventions of tissue culture and genetic transformation (Azhakanandam *et al*., 2015; Thakur *et al.,* 2022). Plant tissue culture technology is an appropriate system for plant propagation by culturing of various explants. It is basic to most of the plant transformation techniques aimed at gene transfer and regeneration of transformants (Hellwig *et al.,* 2004) and acceleration of genetic improvement (Mohammed *et al.,* 2019). Particularly, great achievements in genetic improvement of monocot crops such as rice have become possible with refinements in tissue culture protocols for callus induction and regeneration (Cheng *et al*., 2004; Ullah *et al*., 2007). The anatomical features of such explants have major role their response to infection by *Agrobacetrium* (Sood *et al*., 2011). The responses of explant cells primarily depend on genotype which serves as a major factor for determining successful rice transformation (Sahoo *et al*., 2011).

MATERIALS AND METHODS

The research material comprised of two popular *Japonica* rice cultivars namely, Duggu and K 332. The disease free and healthy seeds of these were obtained from School of Biotechnology, SKUAST of Jammu, Jammu and Kashmir, India. They were dehusked and washed with liquid detergent (Tween 20) and a combination of fungicides: Bavistin (0.1%) and Dithane M-45 (0.1%) for 20 minutes followed by washing under running tap water. Final surface sterilization was performed under Laminar Air Flow Chamber with mercuric chloride (0.1%) for 2-8 minutes or NaOCl (4%) for 5-20 minutes. The seeds were then washed 3-4 times with sterile distilled water and dried on autoclaved filter paper.

These sterilized seed explants were inoculated in MS medium augmented with different concentrations of growth regulators (2,4-D and BAP) for *in vitro* callus induction. The cultures were incubated in culture room where temperature was maintained at 25±2°C under dark conditions. The selection of best callus induction medium was based on periodical visual observations like days to callus induction and proliferation of callus. After approximately 20-21 days, the induced callus of K332 and Duggu was carefully taken out of culture tubes and undesirable/brownish mass was removed from the callus before transferring to fresh medium with similar media combinations as was used for culture initiation. The culture tubes were then placed in the culture room under standard conditions of temperature (25 ± 2ºC) for dark incubation.

After two weeks growth in proliferation medium, small pieces of callus (4-6 mm in diameter) were placed on regeneration medium supplemented with different concentrations of BAP and NAA with or without proline. The culture tubes were then incubated in the culture room under standard conditions of temperature (25±2ºC) with photoperiod of 16 & 8 h.

Statistical analyses of data generated during *in vitro* studies was done using two factor completely randomized design (2x 2 factorial CRD) with three replicates following Panse and Sukhatme (1985). Genotypes in each experiment were considered as one factor or Factor (A). The media combinations attempted during different phases of *in vitro* studies, to induce response of genotypes, were considered as second factor or factor (B). The interactions of two factors were critically examined. The data in percent was transformed using arc sign transformation and interpretation was done based on actual data values.

RESULTS AND DISCUSSION

The most crucial and initial step in plant tissue culture is to obtain cultures free from microbial contaminants

(Daud *et al.,* 2012). Therefore, effective sterilization of explants with high percent survival is a prerequisite during initiation of aseptic cultures. In the present study, two-step sterilization treatment proved beneficial for both rice cultivars (Duggu and K 332) where the dehusked seeds were first treated with Tween-20 and a combination of Bavistin (0.1%) and Dithane M-45 (0.1%) followed by final treatment with 0.1% $HgCl_2$ or 4 per cent sodium hypochlorite (NaOCl). It was found that 0.1 per cent $HgCl_2$ was better sterilizing agent than 4 per cent NaOCl for treating the seeds to establish axenic cultures. It was observed that the seeds sterilized with 0.1% $HgCl_2$ for 8 minutes resulted in maximum per cent survival with least contamination percentage in both cultivars. The survival percentage of Duggu was 98.86 while that of K 332 showed 97.16 of survival percent which was comparable (Table 1). The effectiveness of 0.1 per cent mercuric chloride for sterilization of dehusked rice seeds was reported by Sah *et al.* (2014). However, Panjaitan *et al.* (2009); Azizi *et al.* (2015); Poeaim *et al.* (2016) and Meesook *et al.* (2020) observed that dehusked seeds of rice when sterilized with 20-100 per cent sodium hypochlorite for different durations after treating with 70 per cent ethanol resulted in least contamination. The selection of mature seeds as source of explant is a better option of explants because they are available throughout the year and amenable to transformation via callus culture. Moreover, the calli derived from scutellum of mature seeds are suitable starting materials for *in vitro* regeneration. In comparison to mercuric chloride, sodium hypochlorite was less effective for sterilizing seeds of rice varieties with 4 per cent sodium hypochlorite for 20 minutes showed contamination of 25.80 per cent in Duggu and 27.16 per cent in K 332.

The rice improvement through genetic modification is restricted due to low callus induction frequency and differentiation from mature embryos (Yan *et al.,* 2010). The callus induction and somatic embryogenesis are regulated by hormones in plant tissue culture (Jimenez, 2005; Zhi-Lei *et al.,* 2006). According to Wu *et al.* (2009), expression of genes in plant cells and tissues, metabolic processes, induction, maintenance and expression of the embryonic potential of plant cells are controlled by the endogenous hormones. In the present study, small callus mass started emerging from the basal regions (mesocotyl or coleoptile) of the germinated seeds (Figure 1) in MS medium fortified with 2,4-D and BAP. The callus was creamish, compact, globular and embryogenic as shown in Figure 2. All media combinations as depicted in Table 2 showed callus induction ranging from 59.97 to 83.37 per cent in case of Duggu while K 332 showed better response ranging from 73.87 to 96.07 per cent with typical embryogenic characteristics. Maximum callus induction frequency

Table 1: Effect of different sterilizing agents on seed explant for culture establishment

Sterilant		**Duggu**		**K 332**	
	Treatment	**% Contamination**	**% Survival**	**% Contamination**	**% Survival**
$HgCl_2$(0.1%)	2 min	57.12(60.34)	24.4(29.59)	78.86(62.63)	21.06(27.31)
	4 min	36.37(43.37)	52.73(46.56)	45.50(42.41)	54.50(47.58)
	6 min	04.82(12.10)	95.53(77.84)	03.86(11.28)	96.06(78.60)
	8 min	**02.83(04.93)**	**98.86(85.05)**	**02.77(9.47)**	**97.16(80.41)**
NaOCl (4%)	5 min	71.65(75.69)	06.06(14.23)	95.50(77.91)	04.40(11.94)
	10 min	55.37(57.11)	29.40(32.82)	73.86(59.25)	26.06(30.69)
	15 min	35.37(40.49)	57.73(49.49)	45.53(42.43)	54.43(47.54)
	20 min	25.80(31.77)	72.16(58.16)	27.16(31.41)	72.63(58.46)
	Factors	**Contamination % CD (0.01)**		**Survival% SE(m)**	
	Variety (A)	0.936	0.935	0.323	0.323
	Treatment (B)	1.872	1.870	0.647	0.646
	AXB	NA	NA	0.915	0.914
	CV	3.825	4.147		

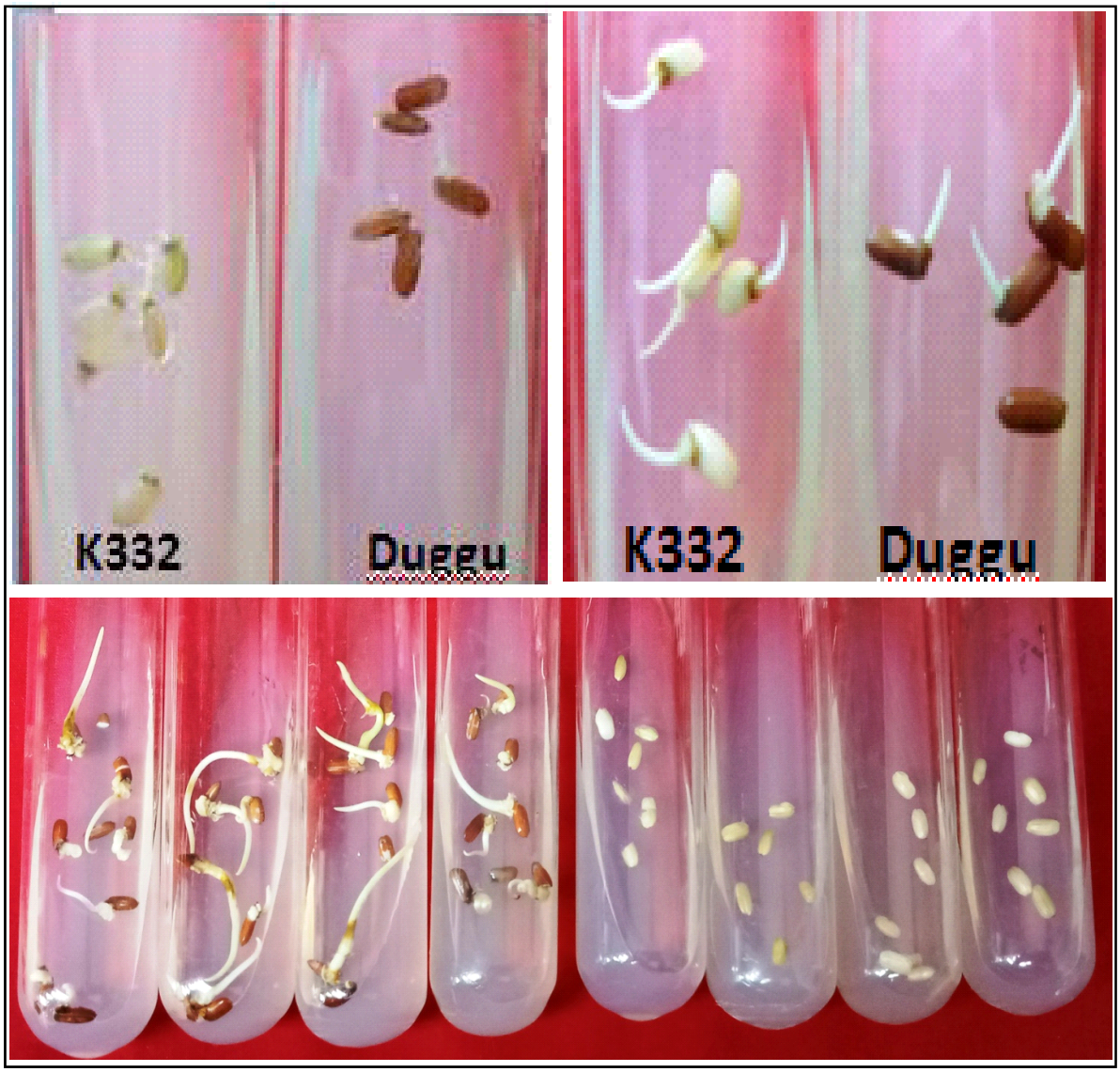

Figure 1: Inoculation of mature seeds of Duggu and K 332 after sterilization

(83.37%) in case of Duggu was observed in MS medium supplemented with 2,4-D (3.5 mg/l) and BAP (1.0 mg/l). Callus induction frequency of 96.07 per cent was observed in K 332 in presence of 2,4-D (2.5 mg/l) and BAP (1.0 mg/l). It was also observed that fortification of BAP at 1.0 mg/l was more beneficial for callus induction in comparison to BAP at 0.5 mg/l. There was significant difference between varieties as well as between each treatment. Similar observations were reported by Azizi *et al.* (2015) who reported that different cultivars had diverse sensitivity to the callus induction media. Ge *et al.* (2006) and Houqe *et al.* (2007) observed that response to *in vitro* culture conditions towards callus induction by a variety of rice cultivars was genotype-specific. The use of 2,4-D has been observed as an unavoidable growth regulator for callus induction in tissue culture. Nevertheless, our findings are in agreement with those of Ali *et al.,* (2004) who observed that 2,4-D combined with BAP or NAA exhibited better response to callus induction in wetland rice. Similarly, Trejo-Tapia *et al.* (2002) and Meesook *et al.* (2020) observed that combination of auxin (NAA and 2,4-D) was a better alternative rather than using the single auxin (Din *et al.,* 2016). There are reports on the effects of diverse concentrations of 2,4-D in several rice subspecies (Lin and Zhang, 2005; Karthikeyan *et al.,* 2009; Joyia and Khan, 2013; Khan *et al.,* 2019) while others used 2,4-D combined with BAP (Sahoo *et al.,* 2011) or NAA (Bano *et al.,* 2005). Azizi *et al.* (2015) observed that induction of calli on media containing

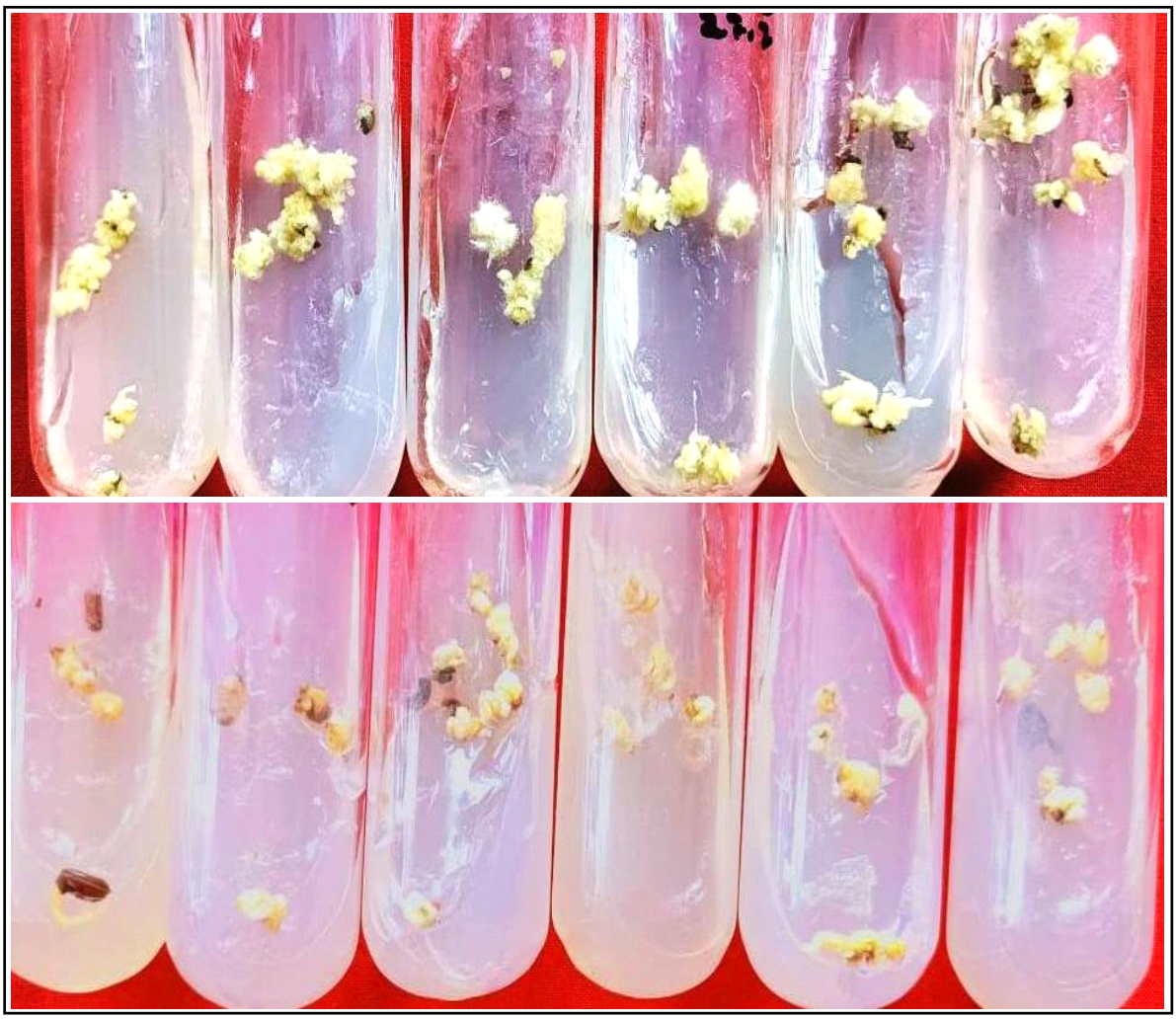

Figure 2: Callus initiation on MS media with varying concentrations of growth regulators

2,4-D only without any cytokinin led to production of non-embryogenic calli thereby resulting in low frequency of plant regeneration.

The embryogenic calli were carefully cut into small sections and subcultured on MS medium augmented with 2,4-D (2.0 to 3.5 mg/l) and BAP (0.5 to1.0 mg/l). The calli of cultivars Duggu and K 332 showed multiplication in the same medium in which initiation was done (Figure 3). Multiplication of Duggu was observed in MS media with 3.0 and 3.5 mg/l of 2,4-D in combination with BAP at 1.0 mg/l as depicted in Table 3. 2.4-D at lower concentration of 2.0-2.5 mg/l was found to be beneficial for attaining multiplication of callus of K 332. It is suggested that 2,4-D preserve highly mitotic mode of the cell by promoting DNA hypermethylation in a pre-embryonic phase (Endress, 1994). In the present study, it was observed that high concentration of 2,4-D (4 mg/l) caused the browning of callus at a later stage which was unfavorable for regeneration under *in vitro* conditions as high concentration of 2,4-D induces a suppressive effect on callusing as well as on *in vitro* regeneration (Rueb *et al.,* 1994). Similar observations pertaining to reduction in amount of callus induction with increase in 2,4-D concentration were also reported in rice (Ramesh *et al.,* 2009; Wani *et al.,* 2011; Meesook *et al.,* 2020). The calli of both cultivars, in the present study, were embryogenic, granular with creamish white in color. Similar morphological outlook was also observed by Sahoo *et al.* (2011). According to Lee *et al.* (2002), the induction of embryogenic callus was genotype specific and varied in terms of number, color, size and morphology depending on media composition, type of explants and interaction between these factors.

Table 2: Effect of growth regulators on callus induction

MS with growth regulators (mg/l)		Callus induction (%)		Mean
2,4-D	**BAP**	**Duggu**	**K 332**	
2.0	0.5	59.97(50.75)	76.63(61.10)	55.92
2.0	1.0	61.07(51.39)	91.07(72.62)	62.00
2.5	0.5	63.30(52.71)	81.63(64.63)	55.67
2.5	**1.0**	63.97(53.11)	**96.07(78.60)**	65.86
3.0	0.5	64.07(53.18)	82.77(65.50)	59.34
3.0	1.0	82.73(65.45)	83.87(66.32)	65.85
3.5	0.5	80.53(63.85)	83.33(65.95)	64.90
3.5	**1.0**	**83.37(66.32)**	83.83(66.33)	66.33
4.0	0.5	72.73(58.55)	75.53(60.35)	59.45
4.0	1.0	75.53(60.35)	73.87(59.25)	59.80
Mean		57.56	66.07	
Factors		CD (0.01)	SE(d)	SE(m)
Variety (A)		0.694	0.342	0.242
Treatment (B)		1.552	0.765	0.541
AXB		2.195	1.082	0.765
CV		2.143		

Table 3: Effect of different growth regulators on callus multiplication

MS with growth regulators (mg/l)		Callus induction (%)	
2,4-D	**BAP**	**Duggu**	**K 332**
2.0	0.5	++	+++
2.0	1.0	++	**+++++**
2.5	0.5	++	+++
2.5	**1.0**	++	**+++++**
3.0	0.5	++	+++
3.0	1.0	**++++**	+++
3.5	0.5	+++	+++
3.5	**1.0**	**++++**	+++

Response of callus to growth regulators
++ least; +++ mild; ++++ moderately responsive
+++++ highly responsive

Fortification of regeneration media with auxins and cytokinins promote regeneration frequency in the recalcitrant rice genotype (Rueb *et al.,* 1994). In the present study, fortification of BAP, NAA and proline in MS medium promoted regeneration of both cultivars. The calli of K 332 developed into somatic embryos which either developed hairy root like structures (rhizogenic calli) or turned green (embryogenic calli) as shown in Figure 4 while the calli of Duggu developed into somatic embryos that failed to turn green (Figure 5) and eventually died. Plantlet regeneration of K 332 was observed as early as 3 weeks after calli were placed on regeneration medium. As depicted in Table 4, maximum regeneration frequency of 67.7 percent was obtained in case of K 332 in MS medium fortified with BAP (2.5 mg/l), NAA (0.4 mg/l) and proline (50 mg/l) resulting in formation of somatic embryos and green segments on callus surface which ultimately led to formation of complete plantlets as shown in Figure 6. In comparison to K 332, Duggu was less responsive and showed regeneration response of 47.7 per cent in MS medium with BAP (3.5 mg/l), NAA (0.4 mg/l) and proline (50 mg/l). It was observed that presence of amino acid had a promotive influence on regeneration. Lee *et al.* (2002) obtained highest regeneration frequency on MS medium containing NAA (2.0 mg/l) and Kinetin at a range of 1.0–4.0 mg/l. Din *et al.* (2016) suggested that auxins and cytokinins may have synergistic, antagonistic and additive mechanisms that promote developmental decision toward callogenesis and shoot formation.

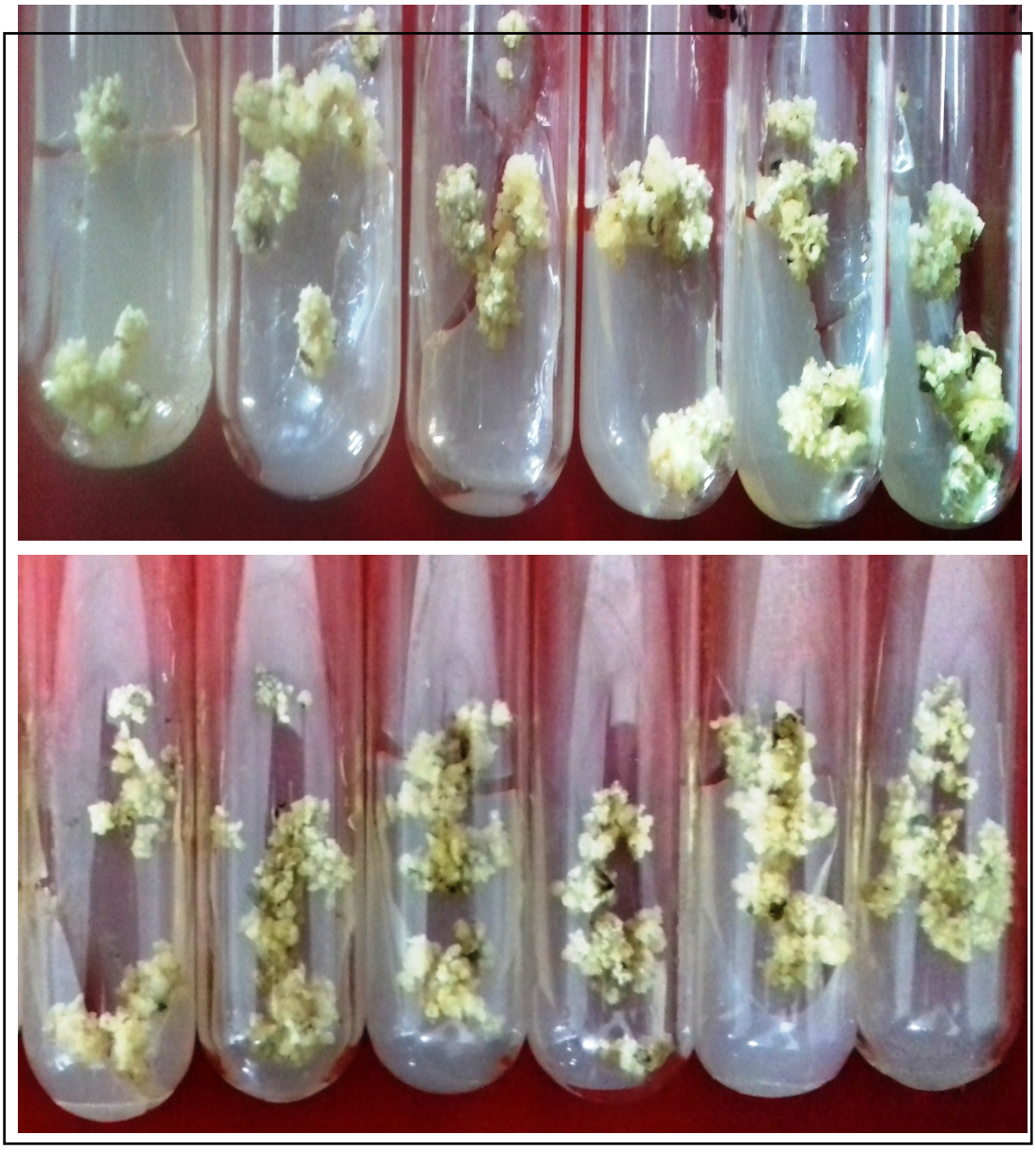

Figure 3: Callus multiplication on MS media with varying concentrations of growth regulators

Zhao *et al.* (2011) obtained highest regeneration frequency (81.2%) of upland rice callus in medium having a combination of BAP (0.5 mg/l), Kin (0.5 mg/l), Zeatin (1.0 mg/l), TDZ (0.5 mg/l), NAA (0.5 mg/l), IAA (0.15 mg/l) and IBA (0.15 mg/l). Din *et al.* (2016) formulated Zhao *et al.* (2011) medium except for Zeatin, IBA and IAA and observed a reduction of 66.6 per cent in regeneration percentage. Lee and Huang (2014) suggested that balance between auxin and cytokinin played a major role in the regeneration from induced calli. Both cytokinins and auxins are known to influence the cell cycle and morphogenic competence in plant growth (Jones *et al.,* 2010). The quality of callus in rice is one of the key factors that define rate of regeneration (Amarasinghe, 2009; Linh, 2017). In the present study, it was observed that colour of the callus turned to brown and started decaying when left without subculturing for more than 3 weeks. Amalraj (2012) suggested that browning of callus may be due to various reasons under *in vitro* conditions. One possible reason is the accumulation of gases like CO_2, ethylene and acetaldehyde in the culture vessels which can be prevented by ventilation. Cytokinins lead to ethylene production in culture vessel. Therefore, use of ethylene inhibitors like silver nitrate and silver thiosulphate can be used to prevent this. In addition,

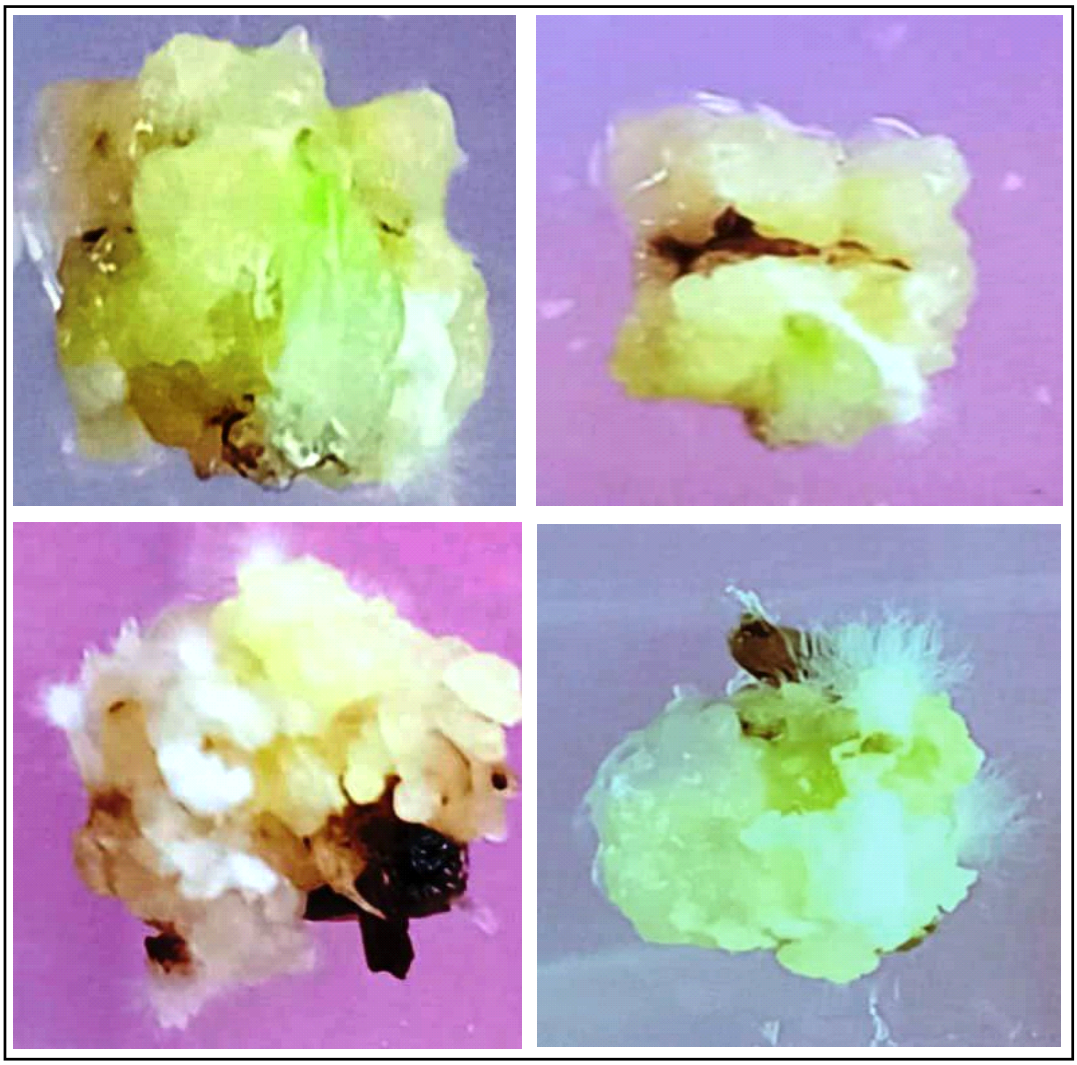

Figure 4: Somatic embryogenesis of K332 after 10 days on regeneration medium supplemented with BAP (2.5 mg/l) and NAA (0.4 mg/l)

Figure 5: Somatic embryos of Duggu showing regeneration on MS medium augmented with BAP (3.0 mg/l) and NAA (0.2 mg/l)

Table 4: Effect of different concentrations of growth regulators on callus regeneration

MS with growth regulators (mg/l)			Duggu	K 332	Mean
BAP	**NAA**	**Proline**			
2.0	0.2	-	5.5(13.41)	9.7(23.15)	18.28
2.0	0.2	50	12.2(20.40)	17.3(29.52)	24.96
2.0	0.4	-	11.1(19.42)	16.8(29.59)	24.50
2.0	0.4	50	14.4(22.27)	20.6(32.49)	27.38
2.5	0.2	-	12.2(28.09)	26.4(34.56)	31.33
2.5	0.2	50	17.7(24.88)	33.9(48.15)	36.52
2.5	0.4	-	24.4(29.59)	34.4(43.70)	36.64
2.5	0.4	50	32.3(34.56)	67.7(55.49)	45.03
3.0	0.2	-	32.2(34.56)	29.3(30.31)	32.44
3.0	0.2	50	47.7(43.70)	41.0(34.56)	39.13
3.0	0.4	-	21.2(27.39)	24.0(31.76)	29.58
3.0	0.4	50	27.7(31.76)	30.5(35.90)	33.83
			27.50	35.77	
Factors			CD (0.01)	SE(d)	SE(m)
Variety (A)			0.798	0.396	0.280
Treatment (B)			1.954	0.969	0.685
AXB			2.764	1.370	0.969
CV				2.645	

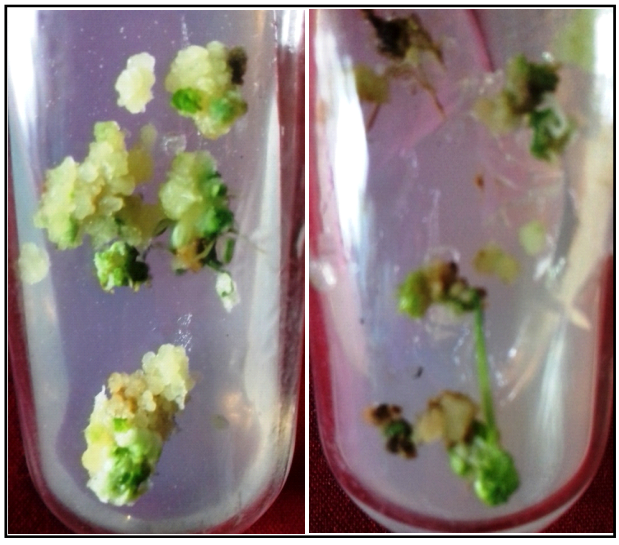

Figure 6: Regeneration of plantlets from somatic embryos of K332

oxidation of phenolic compounds can also lead to browning of callus tissues. The cultures were maintained for 6 weeks to allow time for potential regenerative calli to respond. Observations made at end of culture period revealed that percentage of callus regeneration was cultivar dependent.

CONCLUSION

The present study describes a complete regeneration protocol from callus obtained from mature seeds of *japonica* rice varieties Duggu and K 332. The treatment of seeds with (0.1%) mercuric chloride was more effective than 4% NaOCl resulting in minimum contamination. MS medium fortified with 2,4-D (2.5-3.5 mg/l) in combination with BAP (1.0 mg/l) resulted in maximum callus induction frequency. Maximum regeneration was obtained in K 332 when MS medium was supplemented with BAP (2.5 mg/l) and NAA (0.4 mg/l). Augmentation of proline (50 mg/l) was observed to be necessary for regeneration. Optimized protocol can be further used for incorporating improved agronomic traits through genetic transformation.

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Reading Behaviour of the Farmers in Nimar Agro Climatic Region of Madhya Pradesh Towards Mass Media of Newspapers

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ABSTRACT

The present study was conducted in Nimar Agro Climatic Region of Madhya Pradesh on Reading Behaviour of the Farmers towards Mass Media. The aim of this study is to know the reading behaviour of the farmers of newspapers. The study was carried out on a sample of 240 mass media user farmers. The data were collected through personal interviews of farmers with the help of a structured interview schedule. Data were analyzed with assist of suitable statistical tools. Vast majority of the farmers had purchased their own newspapers. Maximum of the farmers had motivation for purchasing own newspapers. Vast majority of the farmers had purchased newspapers for news and other information. Majority of the farmers read newspapers alone. Vast majority of the farmers had read newspapers in the morning time. Maximum of the farmers read the newspapers for 30 minutes. Maximum of the farmers' reader to newspapers preserves the information simply by memorizing in their mind. Vast majority of the farmers had discussed newspapers contents for getting news and current affairs. As far as level of mass media reading behaviour of the newspapers reading farmers were having high level of mass media reading behaviour, respectively.

Keywords: Reading behaviour, Mass media, Newspaper

INTRODUCTION

Print media, among the various mass media, play a very significant role in communication of farm information. Annual farm publications are the very important tools used in communicating farm information regularly to the readers. The main function of print media is to inform, educate and motivate the farmers. It helps the farmers to accept new ideas and agricultural practices in order to increase production per unit of land. The print media have lasting power over spoken words. The written word has power when written well it convinces, motivate people. Its power can be used in leading them to action. These also contain specific information in simple language. These are comparatively low cost communication media. Newspapers, books, bulletins, leaflets, folders, farm diaries, farm magazines etc. are increasingly being purchased by the farming community. The print media have several advantages over other media like audio, audio visual aids and even spoken words. The printed words can be used for reading number of times and also can be referred any time to refresh one's memory. Those given more time to the communicator to think, to organize ideas, understand easily the ideas and finally adopt them even in computer era, the printed word have proved its unique features. The computer aids could not replace printed word but it entered in printed technology and enhanced the power of printed word. Farmers attribute special significance to the written information. They perceive it as reliable and trustworthy and feel that the written words are more authentic. Print media are thus, the permanent and trusted source of information which can effectively and efficiently be used for disseminating farm technology.

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MATERIALS AND METHODS

The study was conducted in district Barwani (Tribal dominated district) and Khargone of Nimar Agro Climatic Region of Madhya Pradesh. The sample of the present study was selected by multistage sampling method. The Nimar Agro Climatic Region consist four districts viz., Barwani, Khargone, Khandwa and Bhurhanpur. Out of the four districts, two districts (Barwani and Khargone) were selected randomly by using simple random sampling method. Out of two selected districts, Three Blocks from each district; giving a total of six Blocks (Barwani, Pati, Sendhwa, Khargone, Segaon and Jhirnaiya) were selected using simple random sampling method. From the selected six blocks, two villages from each block (All 12 villages) were selected using simple random sampling method. A total of 20 farmers from each village were randomly selected as respondents for the study. Thus, a total of 240 respondents served as sample for the study. Data were collected through personal interviews of respondents with the assist of a structured interview schedule.

The mass media reading behaviour was assessed as per the responses of the selected farmers on different parameters related to agricultural technology; communication effectiveness and social development through mass media reading behaviour were assessed. A set of parameters/ aspects were developed with the help of scientists working at various levels and mass media experts to quantify the mass media reading behaviour of farmers about messages delivered through their mass media. The broad parameters decided to assess the mass media reading behaviour are:

- Availability of mass media
- Motivation for purchasing
- Purpose to purchase
- With whom accompany people
- Time slot
- Duration of programme
- Method of content retention
- Discussion about contents by the farmers

The responses of the farmers were collected on three point continuum as per questions framed above parameters. The parameters/ aspects wise and cumulative scores were obtained to determine the mass media reading behaviour. To ascertain the mass media reading behaviour, the farmers were categorized into three categories viz., low, medium and high on the basis of arbitrary method of total score (cumulative) given in all parameters of reading.

RESULTS AND DISCUSSION

The most available mass medium in the study area (Table 1) indicated that Vast majority (90%) of the farmers had purchased their own newspapers, followed by 79.16 per cent and 70.41 per cent of the farmers those who got as neighbours and community centre to them. Whereas, 67.08 per cent and 62.08 per cent of the farmers those who got the newspaper set which were tea shop and online to them. There were only 1.66 per cent of the farmers who got the newspapers set which were gifted by someone.

Maximum (39.16%) of the farmers had motivation for purchasing own newspapers, followed by 17.08 per cent and 13.33 per cent of them who motivated for purchasing as due to friends/ neighbours/ relatives and family, respectively. Vast majority (91.25%) of the farmers had purchased newspapers for news and other information. Whereas, 81.25 per cent of newspapers owners had purchased newspapers for weather forecast purpose, about 60 per cent of the farmers purchased newspapers for farm technology purpose. Majority (64.16%) of the farmers read newspapers alone, followed by 54.16 per cent and 40 per cent of them who accompanied family and friends/ neighbours/ relatives for reading the newspapers, respectively. Vast majority (94.16%) of the farmers had read newspapers in the morning, followed by 47.91 per cent of the farmers read newspapers at noon and 36.25 per cent of the farmers read newspapers with no specific time.

Maximum (48.75%) of the farmers read the newspapers for 30 minutes, followed by 43.33 per cent of the farmers read it for no specific time and 12.08 per cent of the farmers read it for 30-60 minutes in a day. Maximum (46.25%) of the farmers' reader to newspapers preserves the information simply by memorizing in their mind. Whereas, 8.33 per cent and 6.25 per cent of newspapers readers for noting down some key points on a paper and screen shot for the

Table 1: Distribution of the respondents according to their reading behaviour of mass media (n=240)

Availability of mass media	Regular	Occasional	Never	TS
Self purchased	216 (90.00)	15 (06.25)	09 (03.75)	687
Gifted by someone	04 (01.66)	41 (17.08)	195 (81.26)	289
Community centre	169 (70.41)	63 (26.25)	08 (03.33)	641
Neighbours	190 (79.16)	36 (15.00)	14 (05.84)	656
Barber's shop	161 (67.08)	63 (26.26)	16 (06.66)	625
Tea shop	149 (62.08)	63 (26.25)	28 (11.66)	601
Total	2667	562	270	3499
Motivation for purchasing				
Self	94 (39.16)	116 (48.33)	30 (12.50)	544
Family	32 (13.33)	96 (40.00)	112 (46.66)	400
Friends/ Neighbours/ Relatives	41 (17.08)	75 (31.25)	124 (51.66)	397
Extension workers	12 (05.00)	94 (39.16)	134 (55.83)	358
Total	537	762	400	1699
Purpose to purchase				
News and other information	219 (91.25)	17 (07.08)	04 (01.66)	695
Weather forecast	195 (81.25)	39 (16.25)	06 (02.50)	669
Entertainment	48 (20.00)	149 (62.08)	43 (17.91)	485
Farm technology	144 (60.00)	75 (31.25)	21 (08.75)	603
Total	1818	560	74	2452
With whom accompany people				
Alone	154 (64.16)	77 (32.08)	09 (03.75)	625
With family	130 (54.16)	92 (38.33)	18 (07.50)	592
Friends/ Neighbours/ Relatives	96 (40.00)	123 (51.25)	21 (08.75)	555
Extension workers	36 (15.00)	72 (30.00)	132 (55.00)	384
Total	1248	728	180	2156
Time slot (When)				
In the Morning (6-10 a.m.)	226 (94.16)	10 (04.16)	04 (01.66)	702
In the Noon (10 a.m. - 3 p.m.)	115 (47.91)	66 (27.50)	59 (24.58)	536
In the Evening (3-8 p.m.)	46 (19.16)	108 (45.00)	86 (35.83)	440
At Night (8 p.m. onwards)	00 (00.00)	12 (05.00)	228 (95.00)	252
No, specific time	87 (36.25)	51 (21.25)	102 (42.50)	465
Total	1422	494	479	2395
Duration of programme				
Up to 30 minutes	117 (48.75)	84 (35.00)	39 (16.25)	558
30-60 minutes	29 (12.08)	60 (25.00)	151 (62.91)	358
1-3 hours	00 (00.00)	09 (03.75)	231 (96.25)	249
More than 3 hours	00 (00.00)	00 (00.00)	240 (100)	240
No, specific duration	104 (43.33)	71 (29.58)	65 (27.08)	519
Total	750	448	726	1924

Table 1 contd....

Availability of mass media	Regular	Occasional	Never	TS
Method of content retention				
Noting down some key points	20 (08.33)	116 (48.33)	104 (43.33)	396
Maintaining a regular dairy	08 (03.33)	20 (08.33)	212 (88.33)	276
Audio/Video recording and written article	05 (02.08)	20 (08.33)	215 (89.58)	270
Taking screenshot	15 (06.25)	36 (15.00)	189 (78.75)	306
Simply memorizing	111 (46.25)	108 (45.00)	21 (08.75)	570
Total	477	600	741	1818
Discussion/ Sharing about contents				
General				
News & Current Affairs	209 (87.08)	22 (09.16)	09 (03.75)	680
Entertainment	118 (49.16)	72 (30.00)	50 (20.83)	548
Sports	197 (82.08)	36 (15.00)	07 (02.91)	670
Agriculture				
Weather forecasting in agriculture	192 (80.00)	32 (13.33)	16 (06.66)	656
Agriculture marketing	188 (78.33)	34 (14.16)	18 (07.50)	650
Technical package of practices	173 (72.08)	48 (20.00)	19 (07.91)	634
Achievement story	154 (64.16)	63 (26.25)	23 (09.58)	611
Total	3693	614	142	4449

The figures in the parentheses indicate percentages

purpose of preservation of farm information for future reference. Vast majority (87.08%) of the farmers had discussed newspapers contents for getting news and current affairs. Whereas, 82.08 per cent of newspapers owning farmers had discussed newspapers for getting sports related news, about 80 per cent of the farmers discussed newspapers for weather forecast information.

The data presented in Table 2 and Figure 1 indicated that maximum (43.75%) of the newspapers users were having high level of mass media reading behaviour. Whereas, 31.25 per cent of the newspapers users were having low and 25 per cent of the newspapers users were having medium level of mass media reading behaviour, respectively.

Table 2: Distribution of the respondents according to their level of mass media reading behaviour (n=240)

Level of reading behaviour	Frequency	Percentage
Low (40-67 Score)	75	31.25
Medium (68-93 Score)	60	25.00
High (94-120 Score)	105	43.75

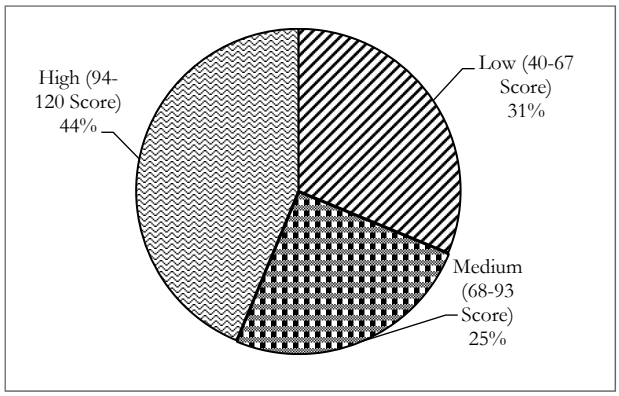

Figure 1: Percentage distribution of the respondents according to their level of mass media reading behaviour

CONCLUSION

Among the parameters chosen for reading behaviour of mass media, majority of the farmers had purchased their own newspapers. Maximum of the farmers had motivation for purchasing own newspapers. Vast majority of the farmers had purchased newspapers for news and other information. Majority of the farmers read newspapers alone. Vast majority of the

farmers had read newspapers in the morning time. Maximum of the farmers read the newspapers for 30 minutes. Maximum of the farmers' reader to newspapers preserves the information simply by memorizing in their mind. Vast majority of the farmers had discussed newspapers contents for getting news and current affairs. As far as level of mass media reading behaviour of the newspapers reading farmers were having high level of mass media reading behaviour. The findings of the study indicate that discussion about contents, availability of mass media and time slot received through mass media reading.

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An Insight of Value Chain Analysis of Paddy in Eastern Uttar Pradesh

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ABSTRACT

India is the largest producer of food grains in India. Paddy is an important cereal crop grown in India. The study was conducted in Basti district of Uttar Pradesh for value chain analysis of paddy. Paddy production status revealed negative growth in area and production in the study area. The study revealed the existence of five marketing channels for marketing of paddy in the region. The most efficient marketing channel was found as channel III as there is non-existence of any intermediary in the channel. In contrast, channel I was found least efficient as there were the existence of large number of value chain actors.

Keywords: Paddy, Production, Marketing Channel, Value chain analysis

INTRODUCTION

Cereals production is the important component of global food security which serves as a cornerstone of agricultural economies worldwide. Paddy is the primary staple for more than half of the world's population that have important role in insuring nutritional sustenance and economic stability. It is dominated by production of major food grains which is consumes as important source of carbohydrate. Paddy, wheat, barley maize, sorghum and pearl millets are grown as major cereal crops. The eastern part of Uttar Pradesh is dominated by paddy and wheat. Pushpa *et al.* (2017) also revealed that paddy is important crop grown in eastern region of Uttar Pradesh. Paddy contains is a good source of the B vitamins, thiamine, riboflavin and niacin (FAO, 1993).

The concept of "value chain" was introduced by Porter (1985) to describe the full range of activities, which are required to bring a product or service from conception, through the different phases of production, distribution to consumers, and final disposal after use. As the product moves from one player in the chain to another, it is assumed to gain value (Hellin and Meijer, 2006). As such, the value chain can be used as a tool to disaggregate a business into major activities, thereby allowing the identification of sources of competitive advantage (Brown, 1997). Value chain is activities that take place within a company in order to deliver a valuable product or service the market through different stages that adds value in that successive stages (Dubey *et al.,* 2020). In the similar context, Value chain analysis has been employed to examine and evaluate entire process that employed to add the value at each successive stage. The available literature fails to give the brief concept of paddy value chains in Basti district of Uttar Pradesh. So the study was conducted to cater the purpose in the district.

India is the second largest food grain producing country in the world. Paddy is an important crop in which grown in India. The total food grain production was reported in 2021-22 was 315.20 MT covering 130.53 MH area. Uttar Pradesh was the leading state

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which shared 64.03 per cent in area and 17.81 per cent in total food grain production in the country in the year 2021-22. In similar lines, the total paddy production was reported in 2021-22 in country was 130.29 MT covering 46.38 MH. Uttar Pradesh was the leading state shared 34.79 per cent in area and 11.72 per cent in production in year 2021-22.

The time series data of area and production under paddy was observed to be changed over the time. The Combined Annual Growth Rate (CAGR) for area (-0.58 per cent) as well as production (-2.36%) was observed to be decline from 2012-13 to 2021-22. Ansari and Ansari (2023) also reported that sharp decline in area and production of paddy during the same time period in Uttar Pradesh. Sah *et al.* (2022) conducted a research in Bundelkhand region of UP revealed that area and production of paddy in the region declined over the time.

MATERIALS AND METHODS

Time series data on paddy of India for the past ten years was procured from 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 paddy from year to year, Triennium data (TE) on area, production and productivity of cereals crops was computed for analysis. Ten year time series data from 2012-13 to 2021-22 on area, production and productivity of paddy was worked out. The data was subjected to descriptive statistics to ascertain the paddy production scenario. Compound Annual Growth Rate (CAGR) was computed to inspect the trend in area, production and productivity of the cultivated cereals crops taken in the study. The compound growth rate has been determined by using the following exponential function (Maurya, 2016).

Descriptive research methodology was used to carry out the present investigation during 2021-22. Basti district of Uttar Pradesh state were chosen purposively for the study. Further, farmers, traders, processers, whole salers, retailers, and village traders were selected using multistage stratified random sampling. To gather information from the sampled value chain actors, semi-structured interviews, group meetings, and focus group discussions were conducted. Research variables included marketing cost (Rs/t), marketing margins (Rs/t), value added (Rs/t), producer share in consumer rupees (%), and marketing efficiency were assessed as per the market price at the time of data collection. Marketing cost was taken as the value invested by value chain actors in performing functions for furthering the paddy to next actor in the value chain. Magnitude of value added was operationalised as the sum of cost incurred in marketing of the produce and the margin drawn by a value chain actor.

Methodology given by Acharya and Agarwal (2016) was used to calculate the Marketing Efficiency Index (MEI) and producer share in consumer rupees.

Producer's share in consumer's Rs.: $Ps = (P_f/P_c) \times 100$

Where, Ps = Producer's share in consumer's rupee, Pf =Producer's price (Rs/q), Pc= Price paid by the consumer (Rs/q)

Marketing efficiency: ME = FP / (MC + MM)

Where, ME = MEI, FP = Price received by the farmer, MC = Total MC and MM = Net MM

It was worked out by computing the difference between the sale prices of retailers to consumer and net price received by the producer, as follows (Vengoto and Sharma, 2018):

Price spread: Pr-Pg

Whereas, Pr= Price paid by consumer
Pg= Price received by the growers

Table 1: Status of paddy production in the country (2021-22)

Food grain				Paddy			
India (2021-22)		Uttar Pradesh (2021-22)		India (2021-22)		Uttar Pradesh (2021-22)	
Area (MH)	Production (MT)	Area (MH)	Production (MT)	Area (MH)	Production (MT)	Area (MH)	Production (MT)
130.53(100)	315.20(100)	19.55(64.03)	56.11(17.81)	46.38(100)	130.29(100)	5.70(34.79)	15.27(11.72)

Source: Authors calculation from secondary data

Table 2: Analysis of marketing charges of channels in study area

Particulars	Marketing charges				
	Channel-I	Channel-II	Channel-III	Channel-IV	Channel-V
Charges paid by producers					
Transportation	-	8.50	5.25	6.25	-
Loading and unloading	-	2.50	2.50	2.50	-
Cleaning	1.60	2.25	1.75	2.00	2.75
Others	1.25	1.25	21.50	1.25	1.25
Sub total	2.85	14.50	31.00	12.00	4.00
Charges paid by the village traders					
Transportation	7.25	-	-	-	-
Loading and unloading	2.50	-	-	-	-
Weighing	2.25	-	-	-	-
Market fee (Rs. 2.5%)	10.50	-	-	-	-
Sub total	22.50	-	-	-	-
Charges paid by wholesaler					
Transportation	7.75	7.75	-	7.75	-
Loading and unloading	2.75	2.75	-	2.75	-
Market fee (Rs. 2.5%)	12.25	12.25	-	12.25	-
Commission (Rs. 2%)	9.50	9.50	-	9.50	-
Storage	12.75	12.75	-	12.75	-
Gunny bags	18.50	18.50	-	18.50	-
Sub total	63.50	63.50	-	63.50	-
Charges paid by commission agents					
Commission (Rs. 2%)	-	9.50	-	-	-
Sub total	-	9.50	-	-	-
Charges paid by retailer					
Transportation	7.50	7.25	-	7.25	-
Loading and unloading	3.25	3.25	-	3.25	-
Weighing	2.50	2.25	-	2.25	-
Others	2.75	2.75	-	2.75	-
Sub total	16.00	16.00	-	16.00	-
Charges paid by millers/traders					
Transportation	-	-	-	-	9.50
Loading and unloading	-	-	-	-	4.25
Weighing	-	-	-	-	2.50
Gunny bags	-	-	-	-	18.50
Storage	-	-	-	-	15.00
Others	-	-	-	-	5.50
Sub total	-	-	-	-	55.25
Total marketing charges (A+B+C+D+E+F)	104.85	103.50	31	91	59.25

Table 2: Price-spread analysis in marketing of wheat under different channels

Particulars	Marketing charges				
	Channel-I	Channel-II	Channel-III	Channel-IV	Channel-V
Producer's					
Sale price	2000	2100	2600	2100	2200
Marketing charges	2.85	14.50	31.00	12.00	4.00
Net price received	1997.15	2058.50	2569	2088	2196
Village trader's					
Purchase price	2000	-	-	-	-
Marketing price	22.50	-	-	-	-
Margin	77.50	-	-	-	-
Sale price	2100	-	-	-	-
Wholesaler's					
Purchase price	2100	2100	-	2100	-
Marketing price	63.50	63.50	-	63.50	-
Margin	86.50	61.25	-	61.25	-
Sale price	2250	2225	-	2225	-
Commission agent's					
Purchase price	-	2225	-	-	-
Marketing price	-	9.50	-	-	-
Margin	-	15.50	-	-	-
Sale price	-	2250	-	-	-
Online Millers/Trader's					
Purchase price	-	-	-	-	2196
Marketing price	-	-	-	-	55.25
Margin	-	-	-	-	248.75
Sale price	-	-	-	-	2500
Retailer's					
Purchase price	2250	2250	-	2250	-
Marketing price	16.00	16.00	-	16.00	-
Margin	84.00	84.00	-	84.00	-
Sale price	2350	2350	-	2350	-
Price Spread	352.85	291.50	-	262	304
Producer's share in consumer's price (%)	85.10	89.36	80.76	89.36	88.00
Marketing efficiency	22.41	22.70	83.87	25.82	42.19

RESULTS AND DISCUSSION

Value Chain Map of paddy in the region indicated presence of input dealers, producers, village level aggregator, second node aggregators, traders, processors, wholesalers, retailers and consumers as the major actors in moving forward from producer to consumers. The producers after harvest sold the product either directly in market yards or to the village level aggregator. The village aggregator, the first node of aggregation, in turn transported the produce to the to the nearby market yards and sold them to the aggregators at marketing yards, who finally disposed the purchased produce to traders present in the same marketing yards. The traders, after cleaning the produce transported it to the processors or wholesalers located in the region or outside. Commission agents played a significant role in this transaction on mutually agreed term and conditions. The processor after required cleaning and grading

forwarded paddy to wholesaler or retailers present in the region or outside, depending upon the demand and margins. The wholesaler transported the produce after storage and packaging to retailers, who finally sold the produce to consumers.

The value chains of paddy in the region were found supported by an array of actors and institutions including infrastructural support for marketing of crop, financial support by bank, technological support by exiting research institution and agricultural universities, Krishi Vigyan Kendras, support for inputs through existing sale counters of seed, fertilizer and plant protection chemicals and information support system from extension machinery of UP state, along with the existence of agriculture service centers and cooperative societies for purchase and sale of the produce (Sah *et al.,* 2022).

The data of the table revealed that prices paid by the producers including transportation, loading and unloading, cleaning charges was found highest in channel III which incurred the highest others charges in the same channel. In contrast to the above lines, total charges paid by the producers was found lowest in channel I. The existence of village traders was found in channel I only. In the similar lines, the existence of wholesaler was found in channel I, II and IV. The charges paid by wholesalers was found Rs. 63.50 in all the said channels. It was very interesting to note that the existence of commission agent was found in channel II only. The existence of retailers was found in channels in in channel I, II and IV and charges paid by the retailers was found same (Rs. 16.00) in said channels. In similar lines, existence of millers/traders was found in channel V only. The total marketing charges was found highest for channel I (Rs. 104.85) followed by channel II (Rs. 103.50) and channel IV (Rs. 91).

Price spread analysis defined as the difference between the sale prices of retailers to consumer and net price received by the producer. The existence of producer, village trader, wholesaler, commission agent, miller and retailers. The net price received by the producer was highest in channel III (Rs. 2569) followed by channel V (Rs. 2196) and channel IV (Rs. 2088). The existence of village trader was reported in the channel I only. In the similar lines, the highest marketing margin was reported in case of wholesaler in channel V (Rs. 248.75) while the lowest marketing margin was reported for commission agent in channel II (Rs. 15.50). The price spread was highest in channel I (Rs. 352.85) and producers share in consumer rupee was highest in channel II and channel III (Rs. 89.36). The data of marketing efficiency revealed that channel III is most efficient channel as there is nonexistence of middle man in the channel. In contrast, the lowest marketing efficiency was revealed in channel I as there is large number of middleman in the channel.

CONCLUSION

Paddy is important cereal crop of the study area which growth in area and production was found registered negative during 2012-13 to 2020-21. There was five major marketing channels existing in the region in which channel III was found most efficient. In contrast, the lowest marketing efficiency was revealed in channel I as there is large number of middleman in the channel.

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Study on Adaptation Strategies Adopted by Farmer and Factors Influencing Regarding Adaptation Strategies to Climate Change in Satpura Range Agro Climatic Zone of Madhya Pradesh

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ABSTRACT

The climate change has greater impact on agriculture production in turn on food security which appears to be more complicated in the developing countries like India. In India Madhya Pradesh state, which depends on rain-fed for production with low socioeconomic development, is also affected by climate change. Farmers face numerous challenges in implementing adaptation strategies, including socioeconomic, credit, irrigation access, and a lack of timely reliable information. Thus, this study was conducted in Chhindwara district. which is part of agro climatic zone of Satpura range of M.P. Face-to-face interview with the help of semi-structured questionnaire was used to collect primary data from the total population. The number of respondents from all the 6 blocks was 240. The data gathered through a semi-structured interview schedule was analysed using frequency, percentage, and mean statistics. The results indicate that most common adaptation strategies adopted by farmers in the study area are "selection of appropriate crop/varieties" and "alteration of sowing dates" as about 92.50 per cent and 92.08 per cent of the respondents adopted them with mean score of 1.92 and was ranked 1st and the remaining 7.50 per cent and 7.92 per cent did not adopt these. The findings show that "unavailability of appropriate crop/variety" and "delay in timely availability of inputs like crop variety, insecticides, and pesticides" are the major factors influencing the farmers with a mean score of 2.27 and were ranked I. Training courses, land management and control of water inputs have been suggested to improve adaptation activities to enhance the adaptive capacity of farmers to mitigate these conditions.

Keywords: Climate change, Farmers' perception, Frequency, Mitigation, Percentage, Variables

INTRODUCTION

The climate change has greater impact on agriculture production in turn on food security which appears to be more complicated in the developing countries like India. The projections shows that due to increase in temperature by 2.5 to 4.9°C, rice yields are reduced by 32–40 per cent and wheat yields by 41–52 per cent resulting into GDP to fall by 1.8–3.4 per cent (Ravi Shankar *et al.,* 2013).

There is no denying that agriculture and climate change are linked. Depending on geography and other factors, the effects of climate change on the agricultural sector can be either beneficial or detrimental. Agriculture in developing nations, the majority of which are at lower latitudes, is extremely vulnerable to climate change (Babel *et al.*, 2011). Due to this, crop varieties, sowing dates, and cultivation methods will continue to change (Jiang *et al.*, 2017). This has had a negative impact on agricultural production in turn on food security which appears to be more complicated in the developing countries like India. The projections shows that due to increase in temperature by 2.5 to 4.9°C, rice yields are reduced by 32–40 per cent and wheat

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yields by 41–52 per cent resulting into GDP to fall by 1.8–3.4 per cent (IPCC, 2014).

The adaptation to the climate change has drawn greater attention at global level due to increase in climatic or natural disasters and climate change projections. (IPCC, 2014). Specifically, Indian sub-continent and other continents are highly vulnerable to all kinds of existing climate change issues. For instance, in case of rice crop the productivity declined to the tune of 3 to 15 per cent due to increase in the temperature (1.50) and decrease in the rainfall by 2 mm (Morton, 2007). Similarly, vegetable crops are severely affected by the floods and accumulations of endogenous ethylene. Suppose an ozone concentration reaches more than 50 ppb/day, the productivity of the crops reduced by 5 to 15 per cent (Rajni, 2016). However, IFPRI predicts that 15 per cent decrease in the irrigated rice yields in the developing countries as results of this 12 per cent increase in the rice yield by 2050 and which translate into the food security. This in turn, climate change will affect domestic market as well as international trade. Apart from this, alters pathogens invasion that gradually affect the growth and yields of crops severely and also lead to increase in the pest and disease of the crops which limits the future food production. Thereby enhancing the crop productivity is most significant for safe guarding the food and nutritional security especially small and marginal framers who are most vulnerable to the climate change.

Moreover, in India most of the farmers lack awareness about recent technologies and also depends on the cognitive skills of the farmers varies across the households and mainly influenced by demographic features (age, head of the family, family size, education and caste) and other socio-economic parameters varies at regions and local levels. Further depending on other factors such as source of irrigation, access to knowledge, infrastructure, agricultural extension services, rural financial markets, economic parameters and suitable farm technology the impact of climate change has severe vulnerability on livelihoods of farmers. The farmers' exposure to climatic extremes and frequent changes in the climatic conditions is major responsible for their vulnerability. (Paavola, 2008 and Morton, 2007).

Furthermore, the present study focuses on the factors influencing decisions regarding adaptation strategies to climate change in Madhya Pradesh which influence the intensity of adoption of adaptation options governed by different characteristics of farmers of Madhya Pradesh.

The study area was located at chhindwara district. which is part of agro climatic zone of Satpura range of M.P. The Satpura slope is more pronounced to the south and less pronounced to the north. Tawa, Johila, Denwa, Wainganga, and Vardhan rivers all provide irrigation for the area. Included in this area are the districts of Chhindwara, Betul, and Seoni. The main crops are maize, paddy, arhar, sugarcane, wheat, vegetable, gramme, and soyabean, and there is an average annual rainfall of 1084 millimetres. The soil type is shallow black.

The selected district Chhindwara consists of 11 blocks. Out of 11 blocks, 6 blocks i.e. Mohkhed, Bichhua, Chhindwara, Parasia, Amarwada and Chourai were selected randomly. Out of selected blocks 2 villages from each block were selected randomly. In total 12 villages were selected & from each of these villages, 20 farmers were randomly selected. Thus, total 40 farmers were selected from each block, making total no. of respondents as 240 from all the 6 blocks.

Face-to-face interview with the help of semi-structured questionnaire was used to collect primary data from the total population. The number of respondents from all the 6 blocks was 240. The number of respondents selected from each block was determined using a random sampling technique. Therefore, the number of respondents is determined by their number relative to the entire population. Further, farming communities and blocks were selected because they are part of Chhindwara district. The data gathered through a semi-structured interview schedule was analysed using frequency, percentage, and mean statistics.

RESULTS AND DISCUSSION

The distribution of the respondents based on adaptation strategies is presented in the Table 1. The findings show that more than half (55.42 %) of respondents were under the category of high, which shows that majority were adopting the adaptation strategies to cope up with climate change. Further, it was found that 36.25 per cent of the respondents were

Table 1: Distribution of farmers based on adaptation strategies

Categorization	Frequency	Percentage
Low (20-26)	20	8.33
Medium (27-33)	87	36.25
High (34-40)	133	55.42

categorized under medium category and only 8.33 per cent were under the low category. The findings infer that most of respondents (55.42%) had high category adaptation strategies in the study area.

The farmers were questioned about 20 different adaptation strategies for their selection of adaptation strategies to climate change. The results are presented in the Table 2 The results indicate that most common adaptation strategies adopted by farmers in the study area are "selection of appropriate crop/varieties" and "alteration of sowing dates" as about 92.50 per cent and 92.08 per cent of the respondents adopted them with mean score of 1.92 and was ranked 1st and the remaining 7.50 per cent and 7.92 per cent did not adopt these. About 83.75 per cent and 82.92 per cent of the respondent adopted "use of farm yard manure "and "Insurance of crops under PMFBY" having ranked II in selection of adaptation strategies with mean score of 1.83. Likewise, 79.58, 79.17 and 78.75 per cent of the respondents go for "use for labour saving equipment for farming"; "inter cropping system' and "use of water saving technology like sprinkler" with a mean score of 1.79 and ranked III. About 69.58 and 68.75 per cent of them employed "Intensified the *Rabi* crop cultivation during *Kharif* crop failure' and "increasing area under cash crops under assured

Table 2: Adaptation strategies adopted by employed the farmers in the study area.

S. No.	Parameters	Adopted strategies (f)	%	Not adopted strategies (f)	%	Mean score	Rank
1.	Selection of appropriate crop/ varieties	222	92.50	18	7.50	1.92	I
2.	Alteration in sowing dates	221	92.08	19	7.92	1.92	I
3.	Applying balanced chemical fertilizer to rain-fed crops	126	52.50	114	47.50	1.52	VI
4.	Increasing area under cash crops under assured irrigation/ water supply	165	68.75	75	31.25	1.69	IV
5.	Intensified the Rabi crop cultivation during Kharif crop failure	167	69.58	73	30.42	1.69	IV
6.	Adopting IPM methods for pest management	164	68.33	76	31.67	1.69	IV
7.	Use of various climate resilient technology. Like conservation agriculture, zero - tillage etc.	127	52.92	113	47.08	1.52	VI
8.	Use of water saving technology like sprinkler/drip irrigation	189	78.75	51	21.25	1.79	III
9.	Reducing plant population during stress season	151	62.92	89	37.08	1.63	V
10.	Recommended spacing between the rows/plants	153	63.75	87	36.25	1.63	V
11.	Recommended seed rate use	124	51.67	116	48.33	1.52	VI
12.	Seed treatment before planting	166	69.16	74	30.84	1.69	IV
13.	Inter-cultivation Practices	152	63.33	88	36.67	1.63	V
14.	Inter-cropping System	190	79.17	50	20.83	1.79	III
15.	Use of farm manure	201	83.75	39	16.25	1.83	II
16.	Adopting water saving farming method	108	45.00	132	55.00	1.45	VII
17.	Natural farming to reduce the cost of cultivation and improve soil fertility	109	45.42	131	54.84	1.45	VII
18.	Use for labour saving equipment for farming	191	79.58	49	20.42	1.79	III
19.	Insurance of crops under PMFBY	199	82.92	41	17.08	1.83	II
20.	Keeping trace of expenses and returns	69	28.75	171	71.25	1.29	VIII

irrigation/water supply" with a mean score of 1.69 and ranked IV.

Besides, 63.75, 63.33 and 62.92 per cent of the respondents were employing these strategies "recommended spacing between the rows and plants"; "Intercultural activities" and "reducing plant population during stress season" with a mean score of 1.63 and ranked V. About 52.92, 52.50 and 51.67 per cent of them employed "Use of various climate resilient technology like conservation agriculture, zero–tillage"; "Applying balanced chemical fertilizer to rain-fed crops" and "recommended seed rate use" with a mean score of 1.52 and ranked VI. Likewise, 45.42 and 45.00 per cent of the respondents go for "adopting water saving farming methods" and "natural farming to reduce the cost of cultivation" with a mean score 1.45 and ranked VII. Finally, "keeping trace of expenses and returns" adapts this strategy of about 61.25 per cent with a mean score of 1.29 and ranks VIII position in the study area. The factors influencing the decision to employ adaptation strategies to cope with climate change in the study area depicted in Table 3. The findings show that "unavailability of appropriate crop/ variety" and "delay in timely availability of inputs like crop variety, insecticides, and pesticides" are the major factors influencing the farmers with a mean score of 2.27 and were ranked I. At score level, about 50.42 per cent respondents strongly agree; 30 per cent of them agree whilst 19.58 per cent of them disagree with respect to the unavailiabity of appropriate crop. About 47.92 per cent of the respondents strongly agree, 35 per cent of them agree and only 17.08 per cent of disagree with respect to "delay in timely availability of inputs like crop variety, insecticides, pesticides" etc.

Table 3: Distribution of Factor influencing changes in climate variable

S.No.	Factors	Response						Mean score	Rank
		SA	%	A	%	DA	%		
1.	Unavailability of appropriate crop/variety	121	50.42	72	30.00	47	19.58	2.27	I
2.	Delay in timely availability of inputs like crop variety, insecticides, pesticides etc.	115	47.92	84	35.00	41	17.08	2.27	I
3.	Lack of knowledge about climate resilient technology like conservation agriculture, zero tillage etc.	112	46.67	62	25.83	66	27.50	2.19	II
4.	High cost in adoption of climate resilient strategies.	109	45.42	68	28.33	63	26.25	2.19	II
5.	Lack of knowledge about proper package and practices of improved technology related to climate change.	84	35.00	58	21.16	98	40.84	1.94	III
6.	Less subsidies in planting material.	64	26.67	79	32.92	97	40.41	1.86	VI
7.	Lack of contact with extension officers KVK scientists etc.	75	31.25	63	26.25	102	42.50	1.88	V
8.	Long procedure of bank to avail crop insurance under PMFBY (PM Fasal Bima Yojna)	60	25.00	87	36.25	93	38.75	1.86	VI
9.	Use of water saving technologies is very costly.	78	32.50	70	29.17	92	38.33	1.94	III
10.	Decreasing in yield in practicing natural/organic farming.	91	37.92	38	15.83	111	46.25	1.91	IV
11.	Unavailability of equipments like happy seeder, zero till seed drill etc. for adopting climate resilient technology.	90	37.50	40	16.67	110	45.83	1.91	IV
12.	High cost of equipments.	58	24.17	99	41.25	83	34.58	1.89	IV
13.	Market price of produce is less thus no need of investing high amount in adaptation strategies.	54	22.50	94	39.17	97	40.43	1.86	VI
14.	Lack of information related to weather function.	42	17.50	56	23.33	142	59.17	1.58	VII
15.	Climate is changing vigorously, thus adaptation strategies also fails.	62	25.83	96	40.00	82	34.17	1.91	IV
16.	Lack of timely availability of water influences in alteration of sowing dates.	34	14.17	72	30.00	134	55.83	1.58	VII
17.	Lack of knowledge about balance use of fertilizer	25	10.42	40	16.67	175	72.91	1.37	VIII

About 46.67 per cent of the respondents strongly agree and 25.83 per cent of them agree and only 27.50 per cent of disagree with respect to "lack of knowledge about climate resilient technology like conservation agriculture, zero tillage" whilst "high cost in adoption of climate resilient strategies" where 45.42 per cent of the respondents strongly agree and 28.33 per cent of them agree and only 26.25 per cent disagree, with mean score of 2.19 and ranks II. With respect to "lack of knowledge about proper packages and practices of improved technology related to climate change" about 35 per cent of the respondents strongly agree, 21.16 per cent of them agree and only 40.84 per cent disagree. "Use of water savings technologies is very costly" about 32.50 percentage strongly agree, 29.17 per cent of them agree and 38.33 per cent of them disagree, with a mean score of 1.94 and a rank of III. "Decreasing in yield in practicing natural/organic farming" about 37.92 per cent strongly agree, 15.83 per cent of them agree and 46.25 per cent of them disagree and 25.83 percent of them strongly agree, 40.00 per cent of them agree and 34.17 per cent of the disagree with "climate is changing vigorously, thus adaptation strategies also fails" and "unavailability of equipment like happy seeder, zero till seed drill etc. for adopting climate resilient technology" 37.50 per cent of them strongly agree, 16.67 per cent of them agree and 45.83 per cent of the disagree with mean score of 1.91 and ranks IV. Furthermore, "Lack of contact with extension officers and KVK scientists" and mean score of 1.88 and ranks V. Similarly, "Long procedure of bank to avail crop insurance under PMFBY (PM Fasal Bima Yojna)" and "Market price of produce is less thus no need of investing high amount in adaptation strategies" with mean score of 1.86 and ranks VI. "Lack of knowledge about balance use of fertilizer" with mean score of 1.37 and ranks VIII.

This study also identifies some of the factors affecting decisions in employing adaptation strategies. It was found that majority of the respondents expressed the unavailability of appropriate crop/variety and delay in timely availability of inputs like crop variety, insecticides and pesticides as the major factors influencing their decision and thus, these two statements secured rank I among all the factors influencing. The second most important factor influencing their decision to adopt climate resilient strategies was lack of knowledge about climate resilient technology such as conservation agriculture, zero tillage and the high cost of adopting climate resilient strategies. These were followed by some other factors like lack of knowledge about proper packages and practices of improved technology, cost effective water savings technologies, decreasing yield due to practising natural/organic farming, unavailability of equipment like happy seeder, zero till seed drill etc. for adopting climate resilient technology, high cost equipment and climate is changing vigorously, thus adaptation strategies also fail. These findings are in line with shrivastava (2018).

CONCLUSION

The major goals of the present study were to examine adaptive actions, and factors influencing each adaptation strategy to severe climatic events in Satpura range agro climatic zone of Madhya Pradesh. In addition, the final part was devoted to distinguishing the variables that influence the adoption of adaptation strategies and the variables that influence the adaptation level. The results indicate that most common adaptation strategies adopted by farmers in the study area are "selection of appropriate crop/varieties" and "alteration of sowing dates" as about 92.50 per cent and 92.08 per cent of the respondents adopted them with mean score of 1.92 and was ranked 1st and the remaining 7.50 per cent and 7.92 per cent did not adopt these. The findings show that "unavailability of appropriate crop/variety" and "delay in timely availability of inputs like crop variety, insecticides, and pesticides" are the major factors influencing the farmers with a mean score of 2.27 and were ranked I. Training courses, land management and control of water inputs have been suggested to improve adaptation activities to enhance the adaptive capacity of farmers to mitigate these conditions.

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Fly Ash Emission from Kolaghat Thermal Power Plant and its Effect on Surrounding Agriculture: Application of Multivariate Analytical Techniques for Impact Analysis

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ABSTRACT

Fly ash emissions from thermal power stations are inflicting detrimental impacts on the crop, livestock, icthyofaunal population, livelihood, and ecosystem services across the world. Kolaghat Thermal Power Plant (KTPP) has been no exception to it. The study has been conducted on 100 respondents pursuing agriculture as their primary occupation to elicit the detrimental impact of adjoining agriculture and livelihoods operating therein. The respondents were selected from five villages of Kolaghat block of Purba Medinipur, West Bengal following simple random sampling method. The statistical tools used for data analysis are; correlation coefficient, multiple regression analysis, stepwise regression analysis, and path analysis. The empirical evidence delineates that the dominant variables, age, distance from the power plant, annual income, productivity, viz., are negatively impacting agriculture in adjoining areas. Through path analysis, it has been evinced that the following variables, age, cropping intensity, and average input cost have been exerting strong indirect impacts on the overall dynamics of agriculture in the surrounding ecosystem. This empirical study has got tremendous policy implications for managing the negative impact of thermal emissions and also catering to the needs of clean energy for its adequate consumption.

Keywords: Agricultural waste, Ecology, Human health, Thermal pollution, Crop production

INTRODUCTION

The management of energy producing installations in developing nations like India will determine the degree of global warming in this century (Mishra, 2004). The vegetation systems surrounding thermal power plants are constantly subjected to gaseous and particle contaminants of various types and nature. Evidently, the responses of the plants reflect these emissions. The leaf area was greater in the least polluted area and decreased in more polluted areas. Lower dust deposition on leaves was seen upstream and higher in areas that were impacted (Soni and Sengar, 1993). The ambient air in the area around the power plant had SO2 and NOx values below the permissible levels, but more total suspended particulate matter was present. Chlorophyll loss and metal accumulation were indicators of plant damage, which were generally more severe at sites closer to the power plant than at those farther away (Beg *et al.*, 1990).

The pH, organic matter, cation exchange capacity, electrical conductivity, nitrogen phosphorus, and water-holding capacity of soils irrigated with effluent increased whereas potassium and calcium decreased. The study revealed that crop plants in the soil ingested water-soluble salts, phosphorus, and nitrogen. If waste water is treated adequately, it can be used by farmers for irrigation (Dhankhar and Sushma, 2003). Around the Kolaghat Thermal Power Plant (KTPP), there is

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often a mixed sort of vegetation. Many distinct types of plants have been seen in various land conditions. Broad leaf, sedge, and grass-like plants flourish on fallow land. Trees and bushes can be found in upland and medium terrain. With time, the area around KTPP's agricultural crop coverage is dwindling (Adak *et al.*, 2017). In terms of the use of land, health issues, and the quality of the air, soil, and water around the world, these thermal power plants are regarded as one of the major sources of pollution harming the environment (Vasistha, 2014). Despite the facility's numerous facilities, the quality and productivity of the principal marketable crops in the area have suffered due to the lack of treatment for the fly ash that exits the plant. This lack of treatment is also to blame for some changes in the land use pattern (Mondal, 2017).

Studies were conducted to determine how Kolaghat's thermal power plant will affect the nearby water and vegetation. On the basis of plant reactions, the area's native flora can be repeatedly categorised as insensitive, intermediate, and sensitive depending on where it was found. It appears that the local pollutant gradient influences how power plant emissions affect water, soil, and eco-physiological traits like chlorophyll content, relative water content, and ascorbic acid (Maity *et al.*, 2016). It is possible to assert that the enrichment of these metals is entirely due to the input of the ash contamination from thermal power plants. Due to this, these soils experienced a significant level of hazardous metal enrichment (Sengupta *et al.*, 2010). Also, site-specific evaluation and recommendation as well as organic farming and precision agriculture should be adopted to abate the impact of coal-burned thermal power plant for agricultural sustainability in rural India (Adak *et al.*, 2016).

Studies implies that land under cultivation have got a propensity for impact on cultivated crops. As size of land holding has increased the adverse effect on cultivated crops, it also increased as because of more amounts of contaminants connected with the cultivars. If more numbers of live stocks are there, more no of contaminated products transfer from livestock to human. So, the result would be vice-versa (Acharya *et al.*, 2019; Biswas *et al.*, 2019). Similar researches revealed that the toxic substances and fly ash released from the Kolaghat thermal power station had an effect on the immediate environment, people, crops, and livestock, as well as negatively impacting the local social ecology (Acharya *et al.*, 2020; Quader *et al.*, 2020). The objective of this paper is the general status of agriculture due to thermal emissions. to estimate the inter and intra-levels of interaction between consequent variable, impact on cultivated crops due to emission and 16 exogenous variables (x_1-x_{16}).

MATERIALS AND METHODS

To assess the impact of air pollution on the cultivation of crops situated in the vicinity of the Kolaghat thermal power plant, the study was conducted in 5 villages of Kolaghat block of Purba Medinipur, West Bengal. Simple random sampling and purposive sampling were both utilized to get the necessary data from respondents and diverse sources. The State, District, Block, and Villages were selected using purposive sampling approaches; however, the 100 respondents were selected using a simple random sampling method. With the assistance of block officials, a comprehensive list of responses is created. The data were collected through a pilot survey and structured interview schedule. Proper operationalization and assessment of the variables aided the researcher in reaching reliable 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), family size (x_3), annual income (x_4), homestead land (x_5), cultivated land (x_6), land fragments (x_7), irrigated land (x_8), rainfed land (x_9), distance from powerplant (x_{10}), cropping intensity (x_{11}), average input cost (x_{12}), productivity (x_{13}), market value of land (x_{14}), number of associated crops (x_{15}) and number of livestock (x_{16}). Dependent variable selected for the study was, impact on cultivated crops (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

Explicit numerical approach is employed in the measurement of the subjective data. The information was then evaluated using analytic techniques, such as path analysis, multiple regression analysis, step down regression analysis and co-efficient of correlation. Table

Table 1: Coefficient of correlation (r): Impact on cultivated crops (y) vs 16 independent variables (x_1-x_{16})

Independent variables	'r' value
Age (x_1)	-0.506**
Education (x_2)	0.450**
Family size (x_3)	0.403**
Annual income (x_4)	-0.377**
Homestead land (x_5)	-0.056
Cultivated land (x_6)	0.065
Land fragments (x_7)	0.368**
Irrigated land (x_8)	0.163
Rainfed land (x_9)	-0.079
Distance from power plant (x_{10})	-0.430**
Cropping intensity (x_{11})	0.524**
Average input cost (x_{12})	0.298**
Productivity (x_{13})	-0.331**
Market value of land (x_{14})	-0.024
Number of associated crops (x_{15})	-0.064
Number of livestock (x_{16})	0.538**

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level

1 presents the coefficient of co-relation between impact on cultivated crops (y) and 16 independent variables.

It has been elicited that the following variables viz. age (x_1), education (x_2), family size (x_3), annual income (x_4), land fragments (x_7), distance from the power plant (x_{10}), cropping intensity (x_{11}), average input cost (x_{12}), productivity (x_{13}) and number of livestock (x_{16}) have recorded significant correlation with impact on cultivated crops.

The correlation coefficients revealed that the younger respondents have recorded a higher perception of the impact of the cultivated crop. On the contrary, those who are having higher education, have recorded a higher perception of the impact on the cultivated crop. The variable education has gone positively correlated with the impact on cultivated crops. Young and educated respondents are more sensitive about the impact of thermal power emission on the cultivated crop.

The variable annual income has recorded a significant but negative correlation. The respondents having lower income, are more vulnerable to the brunt of environmental pollution due to thermal power emission. As usual, the respondents from poor economy have been the worst sufferer. Fragmentation of holdings by its very nature have not only turned the tiny holdings energy prodigal, it has also been vulnerable to the pollution due to thermal emissions. When small size of holdings are fragmented into tiny land pieces, the management of both resource and pollution have gone difficult and complicated. It has been revealed that with the increasing cropping intensity, the impact on cultivated crops has gone robust and the reason is quite obvious. It has also been found that the higher the impact on the crop, the higher has been the cost of mitigation to cope with the impact of population. It has adverse effects on the input cost of farming. It is obvious that with the highest and worst impact of pollution, the productivity of crops has gone down. Similar studies have found that distance from thermal power plant has significant effect on perceived impact of KTPP on betel vine cultivation (Quader *et al.*, 2020).

Table 2 presents the full model of regression analysis between the consequent variable, impact on cultivated crops (y) vs. 16 causal variables. It is found that 16 causal variables together have contributed 76 per cent of the variance in the consequent variable impact on cultivated crops (y). It has been found that the cultivated land (x_6) has exerted the highest direct effect on the consequent variable, the impact on cultivated crops. It is discernible that the area of cultivated land has got a significant functional relationship with the impact on cultivated crops. This implies that more areas of cultivated land are subjected to have more impact on the cultivated crop.

Table 3 presents a step-down regression analysis. In stepwise regression analysis, it is discernible that the variables are the number of livestock (x_{16}), cropping intensity (x_{11}), land fragments (x_7), education (x_2), distance from the power plant (x_{10}), average input cost (x_{12}), productivity (x_{13}), annual income (x_4) have exerted the substantive functional impact on cultivated crops (y). It implies that these 8 variables have a significant functional relationship with the impact on cultivated crops generated by the farmers. The variable education has been screened out as an important indicator to perceive and respond to the impact of thermal power emission on the cultivation of crops. The impact created

Table 2: Multiple regression analysis: Impact on cultivated crops (y) vs 16 independent variables (x_1-x_{16})

Variables	Reg. Coef. B	S.E. B	Beta	t value
Age (x_1)	-0.045	0.074	-0.045	-0.612
Education (x_2)	0.231	0.069	0.231	3.325
Family size (x_3)	0.078	0.084	0.078	0.934
Annual income (x_4)	-0.147	0.061	-0.147	-2.414
Homestead land (x_5)	-0.040	0.061	-0.040	-0.647
Cultivated land (x_6)	0.410	0.320	0.410	1.282
Land fragments (x_7)	0.186	0.070	0.186	2.668
Irrigated land (x_8)	-0.179	0.233	-0.179	-0.768
Rainfed land (x_9)	-0.197	0.157	-0.197	-1.249
Distance from power plant (x_{10})	-0.201	0.073	-0.201	-2.763
Cropping intensity (x_{11})	0.260	0.076	0.260	3.403
Average input cost (x_{12})	0.262	0.077	0.262	3.419
Productivity (x_{13})	-0.196	0.063	-0.196	-3.094
Market value of land (x_{14})	-0.142	0.078	-0.142	-1.828
Number of associated crops (x_{15})	-0.026	0.061	-0.026	-0.436
Number of livestock (x_{16})	0.171	0.071	0.171	2.411

R square: 76.00%; The standard error of the estimate: 0.535

Table 3: Stepwise regression analysis: Impact on cultivated crops (y) vs 16 independent variables (x_1-x_{16})

Variables	Reg. Coef. B	S.E. B	Beta	t value
Number of livestocks (x_{16})	0.208	0.067	0.208	3.104
Cropping intensity (x_{11})	0.302	0.061	0.302	4.962
Land fragments (x_7)	0.198	0.060	0.198	3.319
Education (x_2)	0.231	0.064	0.231	3.614
Distance from power plant (x_{10})	-0.231	0.063	-0.231	-3.690
Average input cost (x_{12})	0.225	0.057	0.225	3.929
Productivity (x_{13})	-0.187	0.062	-0.187	-3.029
Annual income (x_4)	-0.150	0.059	-0.150	-2.550

R square: 73.20%; The standard error of the estimate: 0.540

by the emission from a thermal power plant has got a unique distance dimension. This is not exactly linear rather it is a nonlinear correlation. However, the longer the distance from the thermal power plant the lesser would impact on cultivated crops. Nevertheless, distance from the thermal power station of the habitat is an important determinant to decide the impact on cultivated crops. The variable cropping intensity is also related to the density of foliage distribution alongside its phyllotaxy which affects the growth of crops. It has been revealed that fragmentation of holding seriously jeopardizes the variation and restoration of ecological dynamics. Our farm is becoming more resource and energy prodigal as a result of the holding's unabated fragmentation. On the other hand, it increases the vulnerability of our crops and land to harmful pollution because of thermal emissions. The visibility of the impact of thermal power emission has been more conspicuous for a large consolidated holding and the same has been mantle of invisibility for the tiny and fragmented holding. Also, the variables average input cost (x_{12}), productivity (x_{13}), and annual income (x_4) for their obvious reasons have been intrigued with the consequent variable The r^2 value being 73.20 per cent,

these 8 variables have together contributed to 96.31 of 76 per cent total variance of explicated variables to vindicate their distinctive contribution in characterizing impact on cultivated crops. Studies conducted in the same research locale have found distance from thermal power plant has significant effect on perceived impact of KTPP on betel vine cultivation (Quader *et al.*, 2020). Table 4 revealed that the cultivated land is one of the strongest determinants to estimate the impact of emission from a thermal power station on the cultivation of crops. It implies that the higher the area under cultivation, the higher the impact of all the

Table 4: Path analysis: Decomposition of residual effect: impact on cultivated crops (y) vs 16 independent variables (x_1-x_{16})

Variables	Total effect	Direct effect	Indirect effect	Highest indirect effect
Age (x_1)	-0.506	-0.044	**-0.462**	-0.09 (x_{12})
Education (x_2)	0.450	0.232	0.218	0.075 (x_{16})
Family size (x_3)	0.403	0.081	0.322	0.137 (x_{11})
Annual income (x_4)	-0.377	-0.147	-0.230	-0.076 (x_2)
Homestead land (x_5)	-0.056	-0.040	-0.016	0.133 (x_6)
Cultivated land (x_6)	0.065	**0.426**	-0.361	-0.168 (x_8)
Land fragments (x_7)	0.368	0.186	0.182	0.052 (x_{12})
Irrigated land (x_8)	0.163	-0.190	0.353	0.376 (x_6)
Rainfed land (x_9)	-0.079	-0.205	0.126	0.309 (x_6)
Distance from power plant (x_{10})	-0.430	-0.200	-0.230	-0.066 (x_{16})
Cropping intensity (x_{11})	0.524	0.258	0.266	0.065 (x_{13})
Average input cost (x_{12})	0.298	0.261	0.037	-0.074 (x_{14})
Productivity (x_{13})	-0.331	-0.196	-0.135	-0.085 (x_{11})
Market value of land (x_{14})	-0.024	-0.142	0.118	0.136 (x_{12})
Number of associated crops (x_{15})	-0.064	-0.027	-0.037	-0.058 (x_{11})
Number of livestock (x_{16})	**0.538**	0.171	0.367	0.102 (x_2)

Residual effect: 0.240; Highest Indirect Individual effect: x_6, x_{11}, x_{12} (3)

Table 5: Model summary of the artificial neural network

Model summary			
Training	Sum of squares error		26.634
	Average overall relative error		0.172
	Relativeerror forscaledependents	Impact on human health (y_1)	0.176
		Impact on cultivated crops (y_2)	0.119
		Impact on livestock (y_3)	0.226
		Impact on crop and biodiversity (y_4)	0.192
		Perception score (y_5)	0.146
Testing	Sum of squares error		34.027
	Average overall relative error		0.323
	Relativeerror forscaledependents	Impact on human health (y_1)	0.316
		Impact on cultivated crops (y_2)	0.293
		Impact on livestock (y_3)	0.341
		Impact on crop and biodiversity (y_4)	0.284
		Perception score (y_5)	0.405

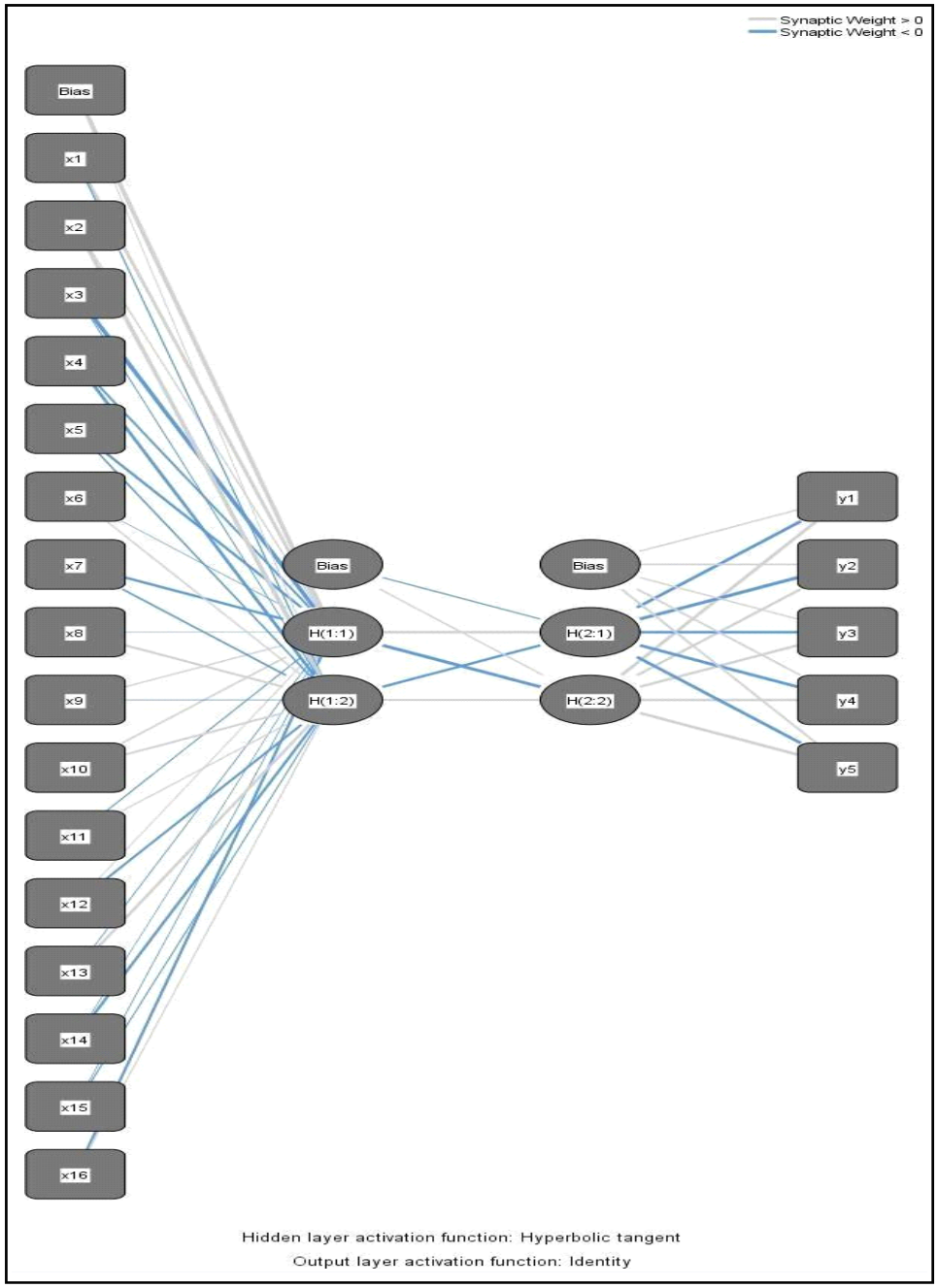

Figure 1: Diagrammatic representation of artificial neural networking obtained in the study

pollutants emitted by the thermal power plant. It has also been found that the highest indirect effect has been contributed to age in a negative direction, which means respondents of the younger age category have been the most vulnerable and sensitive to the problem of environmental pollution. The variables average input cost and cropping intensity have routed the highest indirect effect on the consequent variable, impact on the cultivated crop. The residual effect being 0.240, it is to conclude that even with the combination of 16 exogenous variables, 24 per cent variance in the dependent variable could not be explained. This shows that more consistent and pertinent factors should be included in this study's framework. Similar studies have revealed age of the respondents having substantive effect on perceived impact of KTPP on betel vine cultivation (Quader *et al.*, 2020).

Artificial Neural Network is an advanced and statistical tool for screening out for dominant variables out of total pool of input variables for any kind of ANN there would be input variables, hidden layer and output variables. The following input variables number

of enterprises (x_3), family size (x_5), crop yield (x_{11}), annual income (x_{13}), marketable surplus (x_{16}), number of male worker (x_{18}) and number of female worker (x_{19}) being displayed through blue or bold lines are extracting strong and dominant impact on the output variables, whenever the input variables are pursuing through the hidden layers, their respective error will be minimized by the application of the bias value.

CONCLUSION

The entire study extracts altogether technical policy and management implications for the entire pollution episodes inflicting into the surrounding agriculture. Here it also comes out that fragmentation has got a negative effect in not only managing energy and resource, but also keeping the farms deterrent of deleterious impact of air pollution. In a response to air pollution due to fly ash emissions, the farmers from poorer economy have fallen vulnerable in comparison with farmers from higher economic echelon. The government should take a classified and catalogues analysis, approach and action to protect the crop as well as livestock health of the affected areas by making positive affordable and adaptable interventions considering the social ecology of the farming system. It has also been important to take a note on the role of distances from the epicenters of the pollution. So, a distance based, resource based, holding size based, social status- based management systems and interventions should be made immediately so that a comprehensive improvement in the surrounding crop ecosystem can be visible as a tangible outcome.

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Evaluation of Drudgery and Mitigation with Improved Technological Backstopping in Vegetable Production System of Hill Region of NWHR

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ABSTRACT

Agricultural work in the crop production system is one of the laborious jobs that require physical stamina and good posture, but it is also very exhausting, time-consuming, and stressful. Farm women are forced to work in extremely hazardous conditions because they lack access to improved agricultural technologies. The research envisaged assessing and quantifying the drudgery in crop production system by rural hill women in which physiological and postural evaluation of agricultural activities was done for different activities by women farm workers with three replications of ten minutes work cycle without rest pause. Observations were recorded on farm women worker with normal health, without any major illness, regularly involved in farm operations. In the attempt to obtain and analyze the prioritized drudgery experiences in crop production activities through drudgery assessment and reduction, various ergonomically sound farm tools and implements were provided for crop cultivation and intercultural operations. The study was conducted in North Western Himalayan Region and physiological ergonomics evaluation was done for traditional method and with improved technological support. Various postural ergonomics techniques were used for quantification of musculoskeletal issues with traditional method and postural evaluation of farm women while performing various agricultural activities. Data for indicating musculoskeletal disorders were analysed by android based mobile applications available for ergonomics assessment of postural and biomechanical assessments viz. Rapid Entire Body assessment (REBA), Rapid Upper Limb Assessment (RULA) and Human Physical Drudgery Index (HPDI). After quantification, gender friendly agricultural tools were demonstrated for weeding activities done by women in nutri-gardens. Weeding efficiency was evaluated using traditional and improved agricultural tools developed for women. Different types of weeding tools were evaluated in vegetables crops (Brinjal, Tomato, Capsicum, cauliflower and Okra). The weeding operation with improved technology was observed advantageous in terms of time, quality and weeding efficiency for all the crops.

Keywords: Intercultural operations, Vegetable production system, Ergonomics, Drudgery, Postural and biomechanical assessment

INTRODUCTION

In our nation's rural areas, women carry out a variety of tasks, including managing the farm caring for domestic animals, administering the household, and managing the family. As a result, farm women might be thought of as "farmers" in a certain sense since almost all of them are involved in some form of farming or related activity, either directly or indirectly. Farming practises vary from area to region within India. Because they perform a wide range of tasks related to agriculture, housework, and other activities from dawn to dusk, they shoulder a lot of responsibility and adopt many unnatural postures that increase cardiovascular stress and musculoskeletal disorders (Klasen and Lamanna, 2009; Kumar *et al.,* 2011). These physically demanding agricultural jobs are sources of

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drudgery for rural women that have not yet been clearly characterized and measured. They not only take up a lot of time and energy in performing agricultural task but also taking toll to their health (Joshi *et al.*, 2018). Women are the keepers of tradition and cultural history, managers of resources, and parents of the next generation, making their health a vital indication of national growth. Due to a lack of access to improved agricultural technologies, farm women are subjected to very strenuous working conditions that cause both physical and psychological stress (Sadhna Pandey *et al.,* 2020). Agricultural activities are one of the drudgery-prone jobs that demand physical and psychological energy, are difficult, tiring, and stressful. Poor working circumstances and a lack of necessary amenities lead employees to adopt static, repetitive, often, neo-neutral postures that are unsupported. The mechanical benefits of tools and appliances have not been used to support the majority of agricultural activities in the production system, which are laborious. Degenerative disc disease and musculoskeletal problems are caused by work-related biomechanical risks (Kuiper *et al.,* 1999; Vuuren *et al.,* 2005). Women are expected to perform heavy work in crop production, which includes bending over for extended periods of time, jerking movements while threshing, cuts and bruises while harvesting, and carrying loads on the head, back, and shoulders. These unfavorable working conditions are taxing on women's health. Boocock *et al.* (1994) reported that tasks involving lumber flexion or extended postures for prolong (manual weeding, harvesting and threshing) are relatively common, may incur moderately high compressive loads on the lumbar spine, and are a potential source of occupationally related back injuries and hazards.

MATERIALS AND METHODS

The study was conducted on the basic data collection of physical fitness index and human physical drudgery index accompanying 50 farm women with random sampling technique. The maximum drudgery prone activities of agriculture operation can be identified as per procedure for Human Physical Drudgery Index. For the study, farm women in the age group of 25-45 years, non pregnant, non lactating with no history of acute or chronic illness or cardio vascular diseases with random sampling technique were taken.

The classification of physical workload based on physiological variables has been taken from Nag and Chatterjee (1981). The Table 1 details the range of physical work load and corresponding physiological parameters.

Quantifying drudgery with Human Physical Drudgery Index: Human Physical Drudgery index can be calculated based on linear combination method using the scores obtained from Time spend on the activity, task performance score, difficulty score of the activity, body posture adopted, frequency of postural change, load/force and postural discomfort.

- **Step I-** ***Time spent (hrs/year):*** time in hr/day x total no of days performed in a year
- **Step II-** ***Task performance score:*** Daily- 5, Alternate days-4, Weekly-3, Fortnightly-2 and seasonally- 1.
- **Step III-** ***Difficulty score of activity:*** Most difficult -5, difficult- 4, neutral- 3, easy- 2 and very
- **Step IV-** ***Body posture adopted:*** Upright-1, trunk flexion/extension 0-20°-2, trunk flexion 20-

Table 1: Classification of workload

Physical work load	Physiological variables			
	Energy expenditure (KJ/Min)	Heart beats (beats/min)	VO_2 max (%)	O_2 consumption (l/min)
Very Light	Up to 5.0	Up to 90	-	-
Light	5.0-7.5	91-105	< 25%	0-0.435
Moderate	7.6-10.0	106-120	Up to 50%	0.436-0.870
Heavy	10.0-12.5	121-135	Up to 75%	0.871-1.305
Very Heavy	12.6-15.0	136-150	Above 75%	> 1.306
Extremely Heavy	<15.0	Above 151	-	-

Source: Nag and Chatterjee (1981)

60°/extension >20°-3, trunk flexion >60°-4 (Additional scores if back twisted +1, squatting/ stooping +1, one or more body parts are static for longer than 1 min +1, repetition of activity +1)

- **Step V-** ***Frequency of Postural change (no of times posture changes):*** 1-3 times- 1, 4-6 times-2, 7-9 times-3 and >9 times
- **Step VI-** ***Postural discomfort (pain/ numbness/tingling in body parts):*** Very severe-5, Severe- 4, Moderate-3, Light-2 and Very Light-1
- **Step VII-** ***Load/force:*** 0-5 kg-score 1, 5-10 kg-score 2, 10-15 kg-score 3, 15-20 kg score-4, >20 kg-5
- **Co-efficient of Time spent (A_i):** = Time spent per day for the i^{th} activity/total time
- **Co-efficient for task performance score (B_i)** = Frequency score for the i^{th} activity/ Total weight of frequency scores
- **Co-efficient of Difficulty score (C_i)** = Difficulty score obtained for the i^{th} activity/ Total weight of difficulty
- **Co-efficient for Body posture (D_i)** = Body Posture score for the i^{th} activity/ Total weighing score of body posture
- **Co-efficient for Frequency of Postural change (E_i)** = Frequency of postural change score for the i^{th} activity/ Total weighing score of Frequency of postural change
- **Co-efficient of Postural discomfort (F_i)** = Postural discomfort score for the i^{th} activity/ Total weighing score of postural discomfort
- **Co-efficient of Load/force carried (G_i)** = load/force carried for the i^{th} activity/ Total weighing score of load/force
- **Formula for Calculating HPDI:** *HPDI (Human Physical Drudgery Index)* = $(Ai+Bi……+Gi)$ /7 *100

Weeding activity with various agricultural implements: Traditionally, weeding is a manual operation performed with hand tools which require high energy, resulting in fatigue and low productivity. The manual weeder is operated in a standing posture in a pull, push or a pull- push mode. Manual weeding is a labour intensive farm activity, which accounts for 25% of the total labour requirement of crop cultivation

Weeding efficiency (%) is a ratio of the number of weeds removed by a weeder and the number present in unit area and is expressed as:

$$\text{Weeding efficiency, (e)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where, W_1 = Number of weeds before weeding, and W_2 = Number of weeds after weeding.

RESULTS AND DISCUSSION

The most laborious and backbreaking jobs in agriculture, animal care, and household chores are performed by women. The physical demands of many farming and related occupations carried out by women have a negative impact on their productivity and can present a variety of occupational health risks. Due to a lack of access to improved agricultural technologies, women who work in agriculture are subjected to extremely strenuous working conditions that cause stress on both a physical and mental level. This makes agricultural work one of the most drudgery-prone jobs that demands both physical and mental energy. Several ergonomically sound farm tools and implements were provided for crop cultivation and intercultural operations as part of the project for drudgery assessment and reduction. Following are the details of various equipment and activities:

Line sowing: To test the performance of line maker in various crop viz. finger millet, wheat and lentil the improved tool is used over broadcasting method. With the introduction of line maker for the crops, farmers benefitted with good germination percentage of crop, ease of operation, ease of weeding and more no of tillers in case of wheat etc.

Table 2: Categorization of HPDI

Categorization of HPDI	Action level	Interpretation
<20	I	Low Risk, no need to change
20-30	II	Medium Risk, Change Required
30-40	III	High Risk
>40	IV	Very High Risk, need necessary action Immediately

Table 3: Activities undertaken by women in different crops using improved farm tools

Crop	Activity	Posture adopted while activity with traditional method	Traditional tool used	Posture adopted while activity with improved tool used	Improved Tool Used	Farmers Perception and benefits with improved tools
Finger Millet, Wheat and Lentil	Sowing/ Line sowing	Broadcasting method	-	Standing	Line maker	This hand tool is used for making the lines for sowing of cereals and vegetable crop. In the improved tool, the wooden handle of tradition line maker has been replaced with an iron handle with rubber grip. The depth of coverage and spacing of the line maker can be adjusted as per need of the crop. Farmers perceive line maker as light in weight and easy to operate; avoids bending/squatting postures, which is generally adopted in traditional method etc. For finger millet and lentil, farmers are generally using broadcasting method. With the introduction of line maker for the crops farmers benefitted with good germination percentage of crop, ease of operation, ease of weeding and more no of tillers in case of wheat etc.
For land preparation in nutri-gardens and other collection activity	Collection of grasses, leaves, stones and also used for breaking earth crust	-	-	Standing	Garden Rake	Eight to ten spikes has been used in this rake. The tool is used in a standing position. Therefore, a long handle is used for easy operation. In the improved garden rake the handle has been made with MS pipe with two rubber grips. It avoids bending/squatting postures, which is generally adopted in traditional method.
Finger Millet, Wheat and Lentil or Kitchen Garden preparation	Weeding	Sitting	Traditional *kutla*	Sitting	VL *Kutla*/ VL *Khurpi* / VL hand fork	Traditional kutla handle is made of wood. So bruises and cuts after long duration uses are observed. In the VL *kutla,* for better grip and safety of operator a rubber grip has been provided on the iron handle of the *kutla.* This rubber grip provides comfort in operation in winter season. The rake angle of the kutla share is kept between 30 to 60º for easy operation and less draft requirement. Improved *Khurpi* hand tool is used for intercultural operation and for transplanting the vegetable seeds. In traditional *Khurpi*the grip has been made of wood.Improved Hand Fork tool is used for weeding and interculture operation and can also be used for collecting the grasses of the pulverized fields.
Vegetables	Weeding	Sitting	Traditional *Kutla*	Standing	VL hand hoe	Timely weeding is very much essential for a good yield. Productivity of worker increased with the improved tool equipment than traditional method because forward bending and squatting/sitting posture is avoided with VL hand hoe, which is generally adopted with short handled Kutla/ Khurpi or fork in traditional method.
Wheat, Finger millet	Harvesting	Sitting and forward bending posture	Traditional *Daranti*	Sitting	VL *Daranti*	Serrated sickle developed by VPKAS i.e. VL *Daranti* does not require the sharpening of cutting edge frequently. Farmers preferred the improved tool for its light weight, material used and shape. It also provides safety to the workers due to its better construction.

Intercultural operations: Weeding activity was done in finger millet, wheat, lentil and improved tool developed by VPKAS i.e. VL *Kutla*/ VL *Khurpi* / VL hand fork tested over traditional tools used by women farmers.

Collection of grasses leaves etc.: For collection of grasses, leaves, stones and also used for breaking earth crust multi spike garden rake were provided which found helpful for posture correction and avoids bending/squatting postures, which is generally adopted in traditional method.

Harvesting: For harvesting of crops i.e. Wheat, and Finger millet, serrated sickle developed by VPKAS i.e. VL *Daranti* does not require the sharpening of cutting edge frequently. Farmers preferred the improved tool for its light weight, material used and shape. It also provides safety to the workers due to its better construction.

Physiological Characteristics of Respondents: The physiological characteristics of farm women selected on the basis of physical fitness index for ergonomics assessment of cultivation practices are given in Table 4. As per the physiological characteristics of the subject the mean age of the subjects was 28.56 years with ±8.26 standard deviation. The corresponding blood pressure was with a mean value of 121.78 systolic and 71.51 mmHg diastolic. The pulse rate of the subjects was 69.86 /min with ±5.36 SD which is normal in Indian women.

Postural Assessment of farmers while agricultural operations: Various postural ergonomics techniques were used for quantification of musculoskeletal issues with traditional method and postural evaluation of farm women while performing various agricultural activities.

With the introduction of line maker for the crops farmers benefitted with good germination percentage

Table 4: Physiological characteristics of the subject

Physiological characteristics	Mean± SD
Age, Years	28.56 ± 8.26
Weight, Kg	48.68 ± 7.56
Height, cm	153.63 ± 7.42
Blood Pressure (Sys/Dia), mmHg	121.78/71.51
Pulse Rate (per min)	69.86 ± 5.36

Table 5: Human Physical Drudgery Index for Agricultural Activities before and after improved agricultural tool intervention

	Work Responsibilities	Time spent Coefficient	Coefficient of Task perfor-mance score	Difficulty score of activity	Coefficient Coefficient of Body posture adopted	Coefficient of Frequ-ency of Postural change	Coefficient of Postural discomfort	Coefficient of Load/ force	HPDI	Test Signifi cance
Traditional Method	For land preparation in	0.031	0.71	0.83	0.61	0.42	0.29	0.45	38.97	2.6* (**'t' value**)
Improved Tool (Garden Rake)	kitchen garden and other collection activity	0.008	0.32	0.54	0.35	0.31	0.27	0.32	18.62	0.008 (**p-value**)
Traditional Method	Sowing	0.015	0.11	0.31	0.46	0.14	0.21	0.03	19.63	3.38** (**'t' value**)
Improved Tool (Line maker)		0.61	0.09	0.22	0.05	0.08	0.19	0.33	18.53	0.012 (**p-value**)
Traditional Method	Weeding/Interculture	0.89	0.64	0.56	0.52	0.39	0.65	0.41	59.52	2.46* (**'t' value**)
Improved Tool (VL hand hoe)		0.002	0.05	0.64	0.41	0.05	0.24	0.31	19.51	0.004 (**p-value**)

Note: * Table value for significance at 0.05 level, ** Table value for significance at 0.01 level

Table 6: Postural Assessment Technique for identification of MSD

Activity	Postural Assessment Technique for identification of MSD	
	For Traditional method	**With improved tool**
Sowing/ Line sowing	Activity Done standing posture: < 20 (HPDI Score, Low Risk, no need to change), REBA interpretation (High risk)	Activity Done standing posture: < 20 (HPDI Score, Low Risk, no need to change), REBA interpretation (Low risk)
collection of grasses, leaves, stones and also used for breaking earth crust	Activity Done sitting posture: 30-40 (HPDI Score, High Risk), RULA interpretation (Medium risk change soon)	Activity Done standing posture: < 20 (HPDI Score, Low Risk, no need to change), REBA interpretation (Low risk)
Vegetables Weeding	Activity Done sitting posture: > 40 (HPDI Score, Very High Risk, need necessary action Immediately), RULA interpretation (Medium risk change soon)	Activity Done standing posture: < 20 (HPDI Score, Low Risk, no need to change), REBA interpretation (Low risk)

Table 7: Evaluation of weeding activity with traditional mode and with hand hoe in vegetables crops

Parameters	Crops									
	Brinjal		**Tomato**		**Capsicum**		**Cauliflower**		**Okra**	
	TRD	**Hand hoe**	**TRD**	**Hand hoe**	**TRD**	**Hand hoe**	**TRD**	**Hand hoe**	**TRD**	**Hand hoe**
Plant to plant spacing (cm)	40	40	50	50	50	50	45	45	45	45
Row Spacing (cm)	40	40	50	50	50	50	60	60	45	45
Height of plants (cm)	16	16	20	20	20	20	15	15	20	20
For 500 m^2 area coverage time required (min.)	>60	30	>60	30	>60	28	>60	25	>60	30
Depth of cut (cm)	3.0	4.5	3.0	5.0	3.0	5.0	3.0	5.0	3.0	6.0
Width of cut (cm)	15	15	17	15	15	15	15	15	15	15
No. of labour engaged (m)	1	1	1	1	1	1	1	1	1	1
No. of weeds before weeding (weeds/m^2)	302	310	386	400	232	235	350	350	250	250
No. of weeds after weeding (weeds/m^2)	132	85	108	96	102	87	132	81	105	91
Weeding efficiency (%)	56.29	72.58	72.02	76	56.03	62.97	62.28	76.85	58	63.6
Test Significance	3.78* ('t' value) .001 (p-value)		3.27** ('t' value) .092 (p-value)		1.68** ('t' value) .008 (p-value)		2.54** ('t' value) .003 (p-value)		3.12** ('t' value)) .003 (p-value	

Note: * Table value for significance at 0.05 level, ** Table value for significance at 0.01 level

of crop, ease of operation, ease of weeding and more no of tillers in case of wheat etc. Use of improved garden rake for land preparation in nutri-garden and other collection activity avoids bending/squatting postures, which is generally adopted in traditional method. Various postural ergonomics techniques were used for quantification of musculoskeletal issues with traditional method and postural evaluation of farm women while performing various agricultural activities. Collection of grasses, leaves, stones and breaking earth crust for field preparation were usually done by women in sitting position. RULA techniques interpret it as medium risk activity. Whereas if it is done using improved gender friendly agriculture tool like garden rake, it will become low risk activity for women as the activity can be done in standing posture. Gender friendly agricultural tools were demonstrated for weeding activities done by women in nutri-gardens.

Different types of weeding tools were evaluated in vegetables crops (Brinjal, Tomato, Capsicum, cauliflower and Okra). Two plots with different crops having two different weed populations i.e. high and low weed intensity were taken for assessment. Weeds

count of 1 x 1 m area for three different plots before and after weeding was recorded. This procedure was done for all the vegetable fields under the project where line sowing with average plant spacing was done. Traditionally, weeding is a manual operation performed with hand tools which require high energy, resulting in fatigue and low productivity. The manual weeder is operated in a standing posture in a pull, push or a pull-push mode. Manual weeding is a labour intensive farm activity, which accounts for 25% of the total labour requirement of crop cultivation.

The plant to plant spacing was 40-45 cm, row spacing was 40-60 cm and height of plant was 16-23 cms. Test parameters were width of cut, depth of cut, and weeding efficiency. Actual operating time for vegetables crop ranges from > 60 min in traditional method vs. 25-30 min with hand hoe for the area coverage of 500 m^2 depth of cut was 3-6 cm having approximately 15-17 cm. effective width of cut of the unit in one run. The weeding operation with improved technology was observed advantageous in terms of time, quality and weeding efficiency for all the crops. Suitable statistical technique was used to check the significance of weeding efficiency with traditional method vs. improved agricultural mechanized tool.

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Estimation of Ecological Resilience in Agriculture as reflected in yield Behaviour: Perception and Interpretation

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ABSTRACT

The agricultural challenges in Eastern India's alluvial region stem from geographical variations, climate differences, excessive mechanization, and energy inefficiency. To restore ecological balance, reclaiming ecosystems' ability to function and recover from disturbances is crucial. Stronger farming methods, including soil preservation, diverse crops, agroforestry, water management, and pest control, enhance farming efficiency, sustainability, and adaptability. The assessment of ecological resilience was carried out employing a set of symbolic variables and evaluating changes with respect to crop yield. With this perspective in mind, the study was carried out in four purposively chosen villages of Kastodanga gram panchayat-I, Haringhata block, Nadia district, West Bengal. The study involved 80 respondents, chosen randomly, using a structured interview schedule. The study was conducted through the subsequent statistical methods viz. Coefficient of correlation, Multiple regression analysis, Stepwise regression analysis, and Path analysis. From the study, it can be perceived that crop yield plays a very crucial role in indicating different exogenous variables and their impacts on the livelihood of the farmers. In summary, the research produces a substantial micro-level sociological and ecological strategy aimed at achieving the targeted level of sustainability and productivity. This involves promoting and putting into action resilient methods among farmers to improve their quality of life.

Keywords: Agro-ecosystems, Climate change, Ecological resilience, Livelihood, people's participation in planning, Resilient farming practices

INTRODUCTION

In the era of the Anthropocene, human impacts take centerstage on Earth, and our extensive reshaping of the natural world is giving rise to numerous new interactions between society and ecology (Ellis, 2011). While the Earth's ecosystems experience swift transformations, the primary basis for human welfare still relies on the essential life-support mechanisms provided by these ecological systems (Vitousek *et al.*, 1986). Furthermore, even as there is a growing body of proof showcasing our reliance on natural resources, the unappreciated provision of vital ecosystem services, which constitute the foundation of this life support, persists (Daily, 1997; Folke, 1991).

Global shifts in society and the economy, coupled with the effects of climate change, are influencing the conditions under which agriculture operates. This has prompted endeavours to enhance agricultural output and crop yields, commonly achieved through the application of agrochemicals like pesticides and fertilizers, the expansion of irrigation, and alterations in seed types. This intensified approach, accompanied by the expansion of agricultural activities into previously untouched regions, has indeed bolstered harvests, but it has also brought about widely recognized adverse consequences for the environment. As a result, the resilience and sustainability of agro-ecosystems have been compromised. When compounded with characteristics inherent to agricultural systems, such as the uneven distribution of ecosystem services and the interplay among these services, which is in part influenced by managerial decisions, this intensification has disturbed crucial feedback loops within agricultural

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systems. Enhancing the resilience of Ecology and Livelihood is crucial for the long-term sustainability of agriculture in this rapidly changing world (Bennett *et al.*, 2021).

With the advent of climate change, economic globalization, and the swift escalation of land values, along with changes in food demand and motivations to embrace technological advancements, agricultural practitioners and their systems are compelled to navigate a multitude of transformations. These changes introduce new and unexpected challenges as well as potential opportunities. The food production networks confront a crucial task: catering to the requirements of a potential population of up to nine billion people, all the while undergoing a metamorphosis towards systems that prioritize sustainability and resilience (Helfenstein *et al.*, 2020). To meet the essential need for resilience in agricultural systems, they must be capable of accommodating changes when possible and undergoing substantial transformations as required. This flexibility and capacity for change are vital to ensure the ongoing delivery of a wide range of ecosystem services to global populations (Bennett *et al.*, 2014; Meuwissen *et al.*, 2019).

Agriculture contributes to approximately 30 per cent of India's gross domestic product (GDP) and supports the livelihoods of around two-thirds of the country's population. Indian agriculture heavily relies on rain-fed irrigation, making it susceptible to irregular rainfall, pest infestations, and extreme weather events. Due to their strong ties to the environment and resources, indigenous communities are particularly vulnerable to the effects of a changing climate (Aich *et al.*, 2022). Farmers consistently face unfavorable factors and activities, both on the farm and within their households, rendering their well-being and dietary conditions more delicate and susceptible. An array of pressures, encompassing risks, dangers, and challenges, are infiltrating agricultural systems, thereby affecting the farmers, as well as the farmwomen, who are now experiencing and enduring the adverse impacts of these harmful influences (Acharya and Ghoshal, 2020).

Recognizing the significance of the farmers in the Indian economy is crucial in the current situation. The paper aims to understand and address the climate shocks, which involves not only adapting to foreseeable alterations but also building resilience against fluctuations and unpredictability in the climate. This holds critical relevance for Indian agricultural systems to increase farm yield, as well as the farmers' income following their livelihood.

MATERIALS AND METHODS

The present study was conducted in four villages viz. Jalkar Bhomra, Subuddipur, Sekandarpur, and Kasthdanga villages under Kasthadanga-I gram panchayat of Haringhata block, Nadia district, West Bengal. A score of 80 farmer respondents was selected through random sampling using a structured interview schedule. The study employed the subsequent statistical methods:

Coefficient of correlation, Multiple regression analysis, Stepwise regression analysis, and Path analysis. Appropriate definition and measurement of variables were pivotal in ensuring accurate outcomes. Therefore, the selected variables for this research were defined and measured in the following manner:

1) Independent variables: Age (x_1), Education (x_2), Family size (x_3), Family income per capita (x_4), Expenditure per capita (x_5), Landholding per capita (x_6), Homestead land per capita (x_7), Electricity consumption per capita (x_8), Fuel consumption per capita (x_9), Market interaction (x_{10}), Group interaction (x_{11}), Distant matrix (x_{12}), Innovation proneness (x_{13}), Market orientation (x_{14}), Biodiversity index (x_{15}), Soil conservation (x_{16}).

2) Dependent variable: Crop yield (y_1). In this study, Rice was taken as the crop to be studied because of the high productivity of the crop in the study area.

RESULTS AND DISCUSSION

The information based on personal opinions is assessed using a specific numerical approach. Then the data was analyzed through Coefficient of correlation, Multiple and Stepwise regression analysis, and Path analysis.

Table 1 exhibits the correlation coefficients between yield (y_1) and 16 independent variables. The analysis reveals that certain variables, namely age (x_1), family size (x_3), family income per capita (x_4),

expenditure per capita (x_5), land holding per capita (x_6), homestead land per capita (x_7), electricity consumption per capita (x_8) and innovation proneness (x_{13}) show a significant and positive correlation with the dependent variable. On the other hand, market interaction (x_{10}) and group interaction (x_{11}) exhibit a significant but negative correlation with yield.

Table 1: Coefficient of correlation (r): yield (y_1) vs. 16 independent variables

S.No.	Independent variables	'r' Value
1	Age (x_1)	0.279*
2	Education (x_2)	0.008
3	Family size (x_3)	0.448**
4	Family income per capita (x_4)	0.721**
5	Expenditure per capita (x_5)	0.652**
6	Landholding per capita (x_6)	0.566**
7	Homestead land per capita (x_7)	0.516**
8	Electricity consumption per capita (x_8)	0.286*
9	Fuel consumption per capita (x_9)	-0.201
10	Market interaction (x_{10})	-0.237*
11	Group interaction (x_{11})	-0.274*
12	Distant matrix (x_{12})	-0.075
13	Innovation proneness (x_{13})	0.270*
14	Market orientation (x_{14})	-0.098
15	Biodiversity index (x_{15})	0.045
16	Soil conservation (x_{16})	-0.034

*Correlation is significant at the 0.05 level
**Correlation is significant at the 0.01 level

Table 2 showcases the complete model of multiple regression analysis examining the relationship between 16 causal variables and the dependent variable yield (y_1). The table highlights the three most significant influences (Beta values) on the yield, listed in their respective order of importance-

The causal variable family size (x_3) has shown a positive and statistically significant Beta coefficient. It indicates that, in agricultural studies, a larger family size may bring more labour resources for farming activities, which can positively impact the outcome variable, such as crop yield. The presence of more family members could contribute to increased workforce capacity, enabling more efficient farming practices or greater utilization of available land and resources.

The causal variable family income per capita (x_4) has displayed a positive and statistically significant Beta coefficient. It implies that an increase in family income leads to an increase in yield, potentially due to factors such as improved access to resources, better farming practices, investment in agricultural inputs, or enhanced capacity to manage agricultural operations.

The causal variable land holding per capita (x_6) shows a positive and statistically significant Beta coefficient which means, the association between land holding per capita and yield is reliable and can be observed even after controlling for other factors in the analysis. Having a larger land holding per capita can provide more space for agricultural activities,

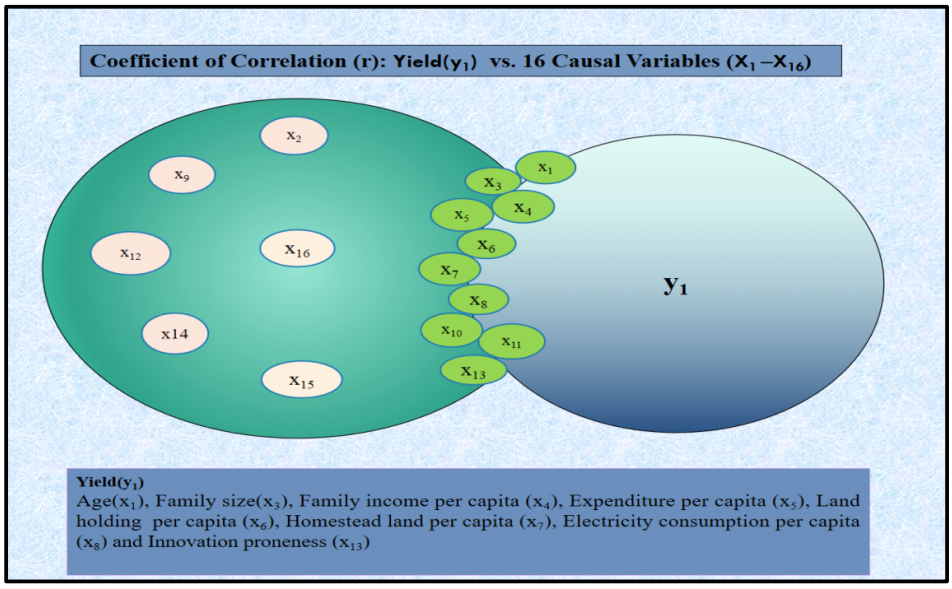

Figure 1: Coefficient of correlation (r): yield (y_1) vs. 16 independent variables

Table 2: Multiple regression analysis: yield (y_1) vs. 16 causal variables

S. No.	Variables	Reg. Coef. B	S.E. B	Beta	t Value
1	Age (x_1)	0.014	0.057	0.021	0.250
2	Education (x_2)	-0.273	0.176	-0.094	-1.549
3	Family size (x_3)	2.919	0.665	**0.505**	4.391
4	Family income per capita (x_4)	0.000	0.000	**0.623**	3.166
5	Expenditure per capita (x_5)	0.000	0.000	-0.192	-1.153
6	Landholding per capita (x_6)	0.203	0.075	**0.300**	2.712
7	Homestead land per capita (x_7)	0.258	0.311	0.071	0.831
8	Electricity consumption per capita (x_8)	0.005	0.004	0.101	1.483
9	Fuel consumption per capita (x_9)	0.001	0.002	0.051	0.561
10	Market interaction (x_{10})	-0.146	0.262	-0.041	-0.556
11	Group interaction (x_{11})	-0.799	0.577	-0.106	-1.385
12	Distant matrix (x_{12})	-0.201	0.861	-0.015	-0.234
13	Innovation proneness (x_{13})	0.536	0.698	0.045	0.768
14	Market orientation (x_{14})	0.378	0.638	0.033	0.593
15	Biodiversity index (x_{15})	1.722	2.807	0.036	0.613
16	Soil conservation (x_{16})	-0.305	0.428	-0.039	-0.711

R square: 83.30%; The standard error of the estimate: 0.696

Table 3: Stepwise regression analysis: yield (y_1) vs. 16 causal variables

S.No.	Variables	Reg. coef. B	S.E. B	Beta	t value
1	Family income (x_4)	0.000	0.000	0.476	5.613
2	Family size (x_3)	3.114	0.312	0.539	9.986
3	Landholding (x_6)	0.218	0.059	0.322	3.715
4	Group interaction (x_{11})	-1.142	0.389	-0.151	-2.941

R square: 80.8%; The standard error of the estimate: 0.626

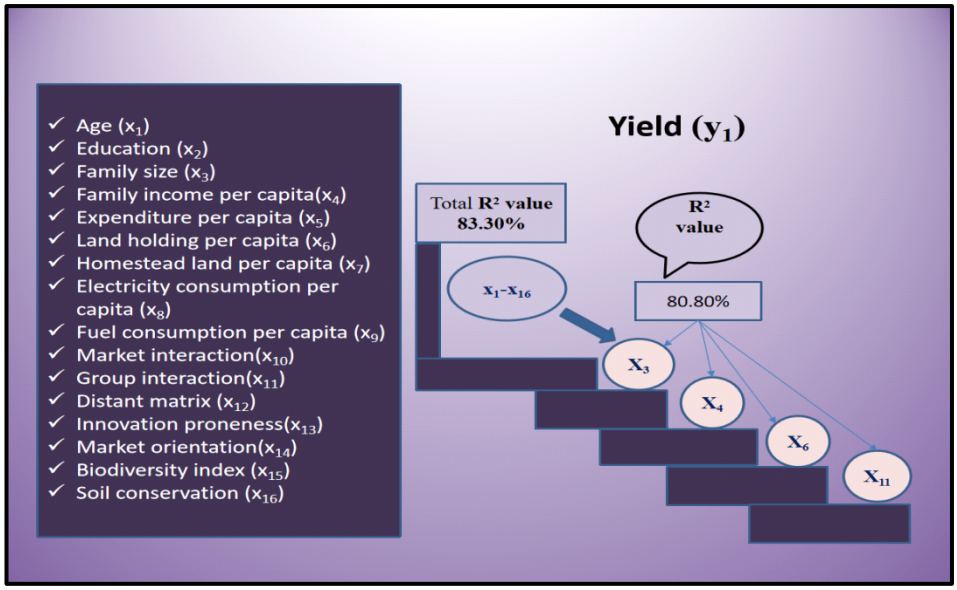

Figure 2: Stepwise regression analysis: yield (y_1) vs. 16 causal variables

enabling greater cultivation of crops and potentially leading to higher yields. It may also indicate access to more resources, such as irrigation or better-quality of soil, which can contribute to improved agricultural productivity.

Table 3 depicts the stepwise regression analysis which elicits that four causal variables, family income (x_4), family size (x_3), land holding (x_6), and group interaction (x_{11}) have come out with stronger determining character on yield (y_1).

The stepwise regression analysis has resulted in the retention of four causal variables at the final step. These variables are; family income (x_4), family size (x_3), land holding (x_6), and group interaction (x_{11}). Together, these four causal variables account for 80.8 per cent of the variance. This suggests that their collective contribution is significant compared to the remaining 12 causal variables, which only contribute 2.5 per cent of the total variance (based on the difference between 80.8% and 83.3%). This means, that to increase yield, farm income should be increased. In addition to this, the combination of family size, land holding, and group interaction (x_{11}) are jointly contributing to yield. These four variables require careful attention and effective management skills because of their strong and disciple impact on yield.

Table 4 depicts the path analysis, which breaks down the overall impact of an independent variable on the dependent variable into direct, indirect, and residual effects. The variable expenditure per capita (x_5) has been identified as having the strongest direct effect. This suggests that to achieve a higher yield, it is crucial to allocate a higher expenditure per capita. This variable significantly influences the yield substantially. It can be seen that the variable family income per capita (x_4) has exerted the highest direct effect as well as the highest total effect. This implies that to get more yield; more family income per capita (x_4) is necessary.

The residual value 0.166 indicates that slightly more than 16.5 per cent of the data cannot be explained by the combination of these 16 variables. This finding is supported by the high R-squared value of 83.3 per cent, which indicates that the 16 variables account for a significant portion of the variance in the data.

CONCLUSION

Global agriculture is facing a rapid decline in ecological resilience, primarily caused by the reckless exploitation

Table 4: Path analysis: decomposition of total effect into direct, indirect, and residual effect: yield (y_1)

S. No.	Variables	Total effect	Direct effect	Indirect effect	Highest indirect effect
1	Age (x_1)	0.279	0.020	0.259	0.339 (x3)
2	Education (x_2)	0.008	-0.094	0.102	0.15 (x4)
3	Family size (x_3)	0.448	0.509	-0.061	-0.076 (x6)
4	Family income per capita (x_4)	**0.721**	**0.624**	0.097	0.238 (x6)
5	Expenditure per capita (x_5)	0.652	-0.194	**0.846**	0.586 (x4)
6	Landholding per capita (x_6)	0.566	0.303	0.263	0.489 (x4)
7	Homestead land per capita (x_7)	0.516	0.070	0.446	0.304 (x4)
8	Electricity consumption per capita (x_8)	0.286	0.100	0.186	0.135 (x4)
9	Fuel consumption per capita (x_9)	-0.201	0.053	-0.254	-0.381 (x3)
10	Market interaction (x_{10})	-0.237	-0.041	-0.196	-0.077 (x3)
11	Group interaction (x_{11})	-0.274	-0.106	-0.168	-0.082 (x4)
12	Distant matrix (x_{12})	-0.075	-0.015	-0.060	-0.074 (x3)
13	Innovation proneness (x_{13})	0.270	0.046	0.224	0.188 (x4)
14	Market orientation (x_{14})	-0.098	0.033	-0.131	-0.069 (x4)
15	Biodiversity index (x_{15})	0.045	0.036	0.009	0.031 (x6)
16	Soil conservation (x_{16})	-0.034	-0.039	0.005	0.012 (x3)

Residual effect: 0.166; Highest Indirect Individual effect: Family Income per capita (x_4) (Frequency: 8)

of ecological resources. This exploitation has disrupted the natural balance, leading to diminished ecological resilience within the agricultural domain. This disruption is evident through a decline in both crop yield and biodiversity. The unpredictable fluctuations in yield patterns have further exacerbated challenges for farmers, distorting their livelihoods and income. An alarming 67.3 per cent of India's agricultural land is grappling with a deficiency in organic carbon content. This could potentially be attributed to factors such as diminishing livestock populations, improper utilization of agricultural inputs, aggressive tillage practices eroding the soil structure, and farmers' growing disillusionment with agriculture due to its unpredictable and sharp declines in yield, affecting income. It can be concluded that crop yield plays a very crucial role in estimating Ecological resilience in Agriculture and Livelihood with respect to age, family size, family income per capita, expenditure per capita, land holding per capita, homestead land per capita, electricity consumption per capita and innovation proneness of the respondents.

Implementation of resilient farming practices, better soil health management, livestock integration, and adaptive management can work as strategies to achieve the goal. Simultaneously, it also demands continuous monitoring and attention to market trends, livelihood creation, social adaptability, and ecological shifts. As a result, this study carries significant policy implications, offering insights for policy research and the development of tailored strategies at both local and state levels. These strategies aim to foster the restoration of both ecological and social resilience in tandem.

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Impact of Climate Change as Perceived by Respondents of Haryana and Himachal Pradesh

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ABSTRACT

Climate change is one of the biggest challenges of our times, as it has the potential to disrupt and even threaten the existence of human civilization. Changes in weather patterns, rise in sea levels, changes in agricultural zones, spread of tropical diseases, change in availability of fresh water, floods, droughts, heat waves, storms, hurricanes etc. are other serious impacts of climate change. According to the World Economic Forum's Global Risks Report, 2016, the failure to mitigate and adapt to climate change will be "the most impactful risk" facing communities worldwide in the coming decade–ahead even of weapons of mass destruction and water crises (Cooper, 2016). The present comparative study was conducted in the purposively selected Haryana state and Himachal Pradesh state to know the impact of climate change. One district from each state i.e., Hisar from Haryana and Shimla from Himachal Pradesh were selected at random. A total sample of 240 farm families, 40 from each village (total six village, 1 village from each block) was selected purposively comprising of 120 farm families of Hisar district and 120 of Shimla district. Regarding impact of climate change on crop production as perceived by respondents, data showed that in Haryana maximum impact was perceived in case of more type and number of insect/pest/diseases followed by decrease in soil fertility whereas, in Himachal Pradesh, maximum impact was perceived in case of more type and number of insect/pest/diseases followed by poor quality and taste of production. In case of impact of climate change on animal husbandry as perceived by respondents, in Haryana high impact was perceived in case of high temperature affects health of livestock followed by increased water consumption in animals whereas, in Himachal Pradesh, majority of the respondents perceived maximum impact on low milk production followed by reduced reproduction efficiency. In respect of impact of climate change on human health as perceived by respondent's data explained that in Haryana, majority of the respondents of Haryana perceived maximum impact on new viruses, insects etc. followed by increased incidence of diseases whereas, in Himachal Pradesh, maximum respondents perceived impact on increased incidence of diseases followed by psychological stress. Regarding impact of climate change on food and nutrition security as perceived by respondents, result showed that majority of the respondents of Haryana perceived maximum impact on high price of food followed by food stored for consumption get damaged, whereas, in Himachal Pradesh, maximum respondents perceived high impact on less availability of food followed by high price of food. Overall the farmers perceived moderate impact of climate change on agriculture and animal husbandry and high on human health.

Keywords: Crop production, Animal husbandry, Human health, Food and nutrition

INTRODUCTION

Climate change is among the biggest challenges in our times, as it has the potential to disrupt and even threaten the existence of human civilization. The term *climate* stands for general weather conditions prevailing over a period of many years, while climate *change* refers to significant variation in average weather conditions during a long time period that may be several decades or more. Hence the long-term trend relates to climate change which differentiates it from the short-term i.e. natural weather variability. The concepts related to

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Climate change include high temperatures, precipitation changes, and high atmospheric CO_2 concentrations.

Agriculture is the major source of livelihood for almost 60% of the India's total population. Its different regions are highly vulnerable to various natural disasters like avalanches, earthquakes, floods, drought etc. It is a known fact that producing and transporting food results in greenhouse gas emissions. Various studies show the overall loss in the crop production in various parts of the country in the last few years due to the anticipated rise in the temperature (Zhao *et al.*, 2017).

Frequent extreme temperature and precipitation events can disrupt crop production. Extreme events like floods and droughts can harm crops and reduce yields. Climate change lowers the "Farmer income between 15 to 18 per cent on average, rising to anywhere between 20 to 25 per cent in irrigated areas (Economic Survey, 2018-19).

A study claims that climate change is reducing the major crop yields in the state of Haryana, it is also reducing the agricultural productivity due to unpredictable moisture deficits during crop growth which are major constraints to productivity (Haryana State Action Plan on Climate Change, 2011) which posing a threat to long term food security**.** Similarly, in Himachal Pradesh, among the most reported incidents of climate change is increasing water scarcity. There is a strong evidence in favour of anthropogenic climate change as one of many stressors of water resource.

The present study attempt to ascertain impact of climate change among farmers. Study generates important data on impact of climate change on crop production, animal husbandry, human health and food and nutrition.

MATERIALS AND METHODS

Present comparative study was conducted in the purposively selected Haryana state and Himachal Pradesh state. One district from each state i.e., Hisar from Haryana and Shimla from Himachal Pradesh were selected at random. Further three block each from Hisar and Shimla were considered to draw the sample. From each block, one village were approached to draw the required sample. List of farm families engaged in farming and other allied activities of different age group were prepared. A total sample of 240 farm families, 40 from each village (total six village, 1 village from each block) was selected purposively comprising of 120 farm families of Hisar district and 120 of Shimla district. The sample represented both males and females. Two types of variables independent (family profile, land characteristics, household assets, household amenities and communication variables) and dependent (perception about climate change, impact of climate change and adaptation to climate change) were studied. For this work a well-reasoned scheme for interview was developed and the information was collected personally by the researcher. This data was quantified and interpreted using suitable statistical tools such as frequency, percentage, mean, standard deviation, weighted mean score, t value, z value, spearman's correlation and pearson's correlation coefficient.

RESULTS AND DISCUSSION

Table 1 elucidates the impact of climate change on crop production as perceived by respondents. Data shows that in Haryana, very high impact was perceived in case of 'more type and number of insect/pest/diseases' (54.17%) followed by 'decrease in soil fertility' (50.00%). Majority of the respondents perceived somewhat changes in 'poor growth of crop' (75.00%) followed by 'severe weed infestation' (69.16%), 'poor quality and taste of production' (60.83%) and 'low yield' (59.17%). However, no changes were perceived in respect of 'poor germination of seed' (80.00%) followed by 'change in time of land preparation and sowing time' (68.33%).

In Himachal Pradesh, very high impact was perceived in case of 'poor growth of crop' (75.00%) followed by 'poor quality and taste of production' (63.33%) whereas somewhat changes were seen in respect of 'decrease in soil fertility' (64.17%) followed by 'severe weed infestation' (63.33%) and 'low yield' (62.50%). There was no impact of climate change perceived on crop production such as 'change in time of land preparation and sowing time' (54.17%) followed by 'poor germination of seed' (45.00%).

It can be concluded from the data that in Haryana very high impact was perceived in case of 'more type and number of insect/pest/diseases' and 'decrease in soil fertility' whereas, in Himachal Pradesh, very high impact was perceived in case of 'poor growth of crop' and 'poor quality and taste of production'.

Table 1: Impact of climate change on crop production as perceived by respondents (n=240)

Impact	Haryana (n1-120) F (%)				Himachal Pradesh (n2-120) F (%)			
	Very high	Some what	No change	Mean weighted score (Rank)	Very high	Some what	No change	Mean weighted score (Rank)
Change in time of land preparation and sowing time	16(13.33)	22(18.33)	82(68.33)	1.45(VII)	21(17.50)	34(28.33)	65(54.17)	1.63(VIII)
Poor germination of seed	0(0.00)	24(20.00)	96(80.00)	1.20(VIII)	27(22.50)	39(32.50)	54(45.00)	1.77(VII)
Poor growth of crop	28(23.33)	90((75.00)	02(1.67)	2.22(V)	60(75.00)	45(20.83)	15(4.17)	2.37(III)
Decrease in soil fertility	60(50.00)	56(46.67)	04(3.33)	2.47(II)	40(33.33)	77((64.17)	03(2.50)	2.31(V)
Poor quality & taste of production	41(34.17)	73(60.83)	06(5.00)	2.29(IV)	76(63.33)	40(33.33)	04(3.33)	2.60(II)
More type and number of insect/ pest/diseases	65(54.17)	50(41.67)	05(4.17)	2.50(I)	89(74.17)	27(22.50)	04(3.33)	2.71(I)
Severe weed infestation	23(19.16)	83(69.16)	14(11.67)	2.07 (VI)	40(33.33)	76(63.33)	04(3.33)	2.30(VI)
Low yield	47(39.17)	71(59.17)	02(1.67)	2.38(III)	43(35.83)	75(62.50)	02(1.67)	2.34(IV)

Data regarding distribution of respondents according to overall impact of climate change on crop production has been shown in Table 2. Table clearly reported that in both Haryana and Himachal Pradesh majority of the respondents i.e., 73.33 per cent and 65.00 per cent had perceived medium impact of climate change on crop production respectively followed by high impact i.e., 26.67 per cent in Haryana and Himachal Pradesh (35.00%). None of the respondents perceived low impact of climate change on agriculture. It can be concluded from Table 2 that respondents of Himachal Pradesh perceived more impact of climate change on agriculture as compared to Haryana.

Data of Table 2 explains the impact of climate change on animal husbandry as perceived by respondents. Table reveals that in Haryana, very high impact was perceived in case of 'increased water consumption in animals' (78.33%) followed by 'high temperature affects health of livestock' (76.67%). Majority of the respondents perceived somewhat changes in 'reduced reproduction efficiency' (83.33%) followed by equal percentage i.e., 79.17 per cent perceived somewhat changes in 'decreased feed intake' and 'high mortality in grazing cattle'. Nearly sixty i.e., 59.16 per cent perceived somewhat 'changes in new disease affects livestock immunity' whereas little higher than fifty per cent i.e., 50.83 per cent reported 'low milk production' and more than forty (46.67%) respondents were perceived changes in 'shortage of adequate nutrients'.

Table 2: Distribution of respondents according to impact of climate change on crop production (n-240)

Category	Haryana (n1-120) F (%)	Himachal Pradesh (n2-120) F (%)
Low impact (8-13)	0(0.00)	0(0.00)
Medium impact (14-18)	88(73.33)	78(65.00)
High impact (19-24)	32(26.67)	42(35.00)

In Himachal Pradesh, majority of the respondents perceived somewhat high impact on animal husbandry in case of 'high temperature affects health of livestock' (83.33%) followed by 'increased water consumption in animals' (81.67%), 'decreased feed intake' (79.17%), 'shortage of adequate nutrients' (75.00%), 'high mortality in grazing cattle' (72.50%). More than sixty i.e., 66.67 per cent and 61.67 per cent respondents perceived changes in 'new disease affects livestock immunity' and 'low milk production' respectively. Sixty per cent of the respondents perceived no changes in 'reduced reproduction efficiency'.

It can be explained from the Table 3 that in Haryana maximum impact was perceived in terms of high temperature affects health of livestock and increased water consumption in animals whereas, in Himachal Pradesh, maximum impact was perceived with respect to low milk production and reduced reproduction efficiency.

Table 3: Impact of climate change on animal husbandry as perceived by respondents (n=240)

Impact	Haryana (n1-120) F (%)				Himachal Pradesh (n2-120) F (%)			
	Very high	Some what	No change	Mean weighted score (Rank)	Very high	Some what	No change	Mean weighted score (Rank)
Increased water consumption in animals	94(78.33)	20(16.67)	06(5.00)	2.73(II)	07(5.83)	98(81.67)	15(12.50)	1.93(VIII)
Shortage of adequate nutrients	16(13.33)	56(46.67)	48(40.00)	1.73(VIII)	24(20.00)	90(75.00)	06(5.00)	2.15(V)
Low milk production	38(31.66)	61(50.83)	21(17.50)	2.14(IV)	40(33.33)	74(61.67)	06(5.00)	2.28(I)
Reduced reproduction efficiency	08(6.67)	100(83.33)	12(10.00)	1.97(V)	40(33.33)	72(60.00)	08(66.67)	2.27(II)
Decreased feed intake	06(5.00)	95(79.17)	19(15.83)	1.89(VI)	13(10.83)	95(79.17)	12(10.00)	2.01(VII)
High mortality in grazing cattle	05(4.17)	95(79.17)	20(16.67)	1.88(VII)	28(23.33)	87(72.50)	05(4.17)	2.19(IV)
New disease affects livestock immunity	37(30.83)	71(59.16)	12(10.00)	2.20(III)	40(33.33)	71(66.67)	09(7.50)	2.26(III)
High temperature affects health of livestock	92(76.67)	26(21.67)	02(1.67)	2.75(I)	16(13.33)	100(83.33)	04(3.33)	2.10(VI)

Table 4:Distribution of respondents according to overall impact of climate change on animal husbandry (n-240)

Category	Haryana (n1-120) F (%)	Himachal Pradesh (n2-120) F (%)
Low impact (8-13)	0(0.00)	0(0.00)
Medium impact (14-18)	87(72.50)	88(73.33)
High impact (19-24)	33(27.50)	32(26.67)

Table 4 explains the distribution of respondents according to impact of climate change on animal husbandry which clearly shows that in both Haryana and Himachal Pradesh majority of the respondents i.e., 72.50 per cent and 73.33 per cent had medium impact of climate change on animal husbandry respectively followed by high impact i.e., 27.50 per cent in Haryana and 26.67 per cent in Himachal Pradesh. None of the respondents perceived low impact of climate change on animal husbandry.

Impact of climate change on human health as perceived by respondents has been presented in Table 5. Table clearly shows that majority of the respondents of Haryana perceived very high impact with respect to 'new viruses, insects etc.' (94.17%) followed by 'increased incidence of diseases like asthma, skin disease and cancer etc.' (93.33%), 'pollution causes irritation in eyes/dizziness/nausea' (91.67%), 'psychological stress' (90.00%) and 'decreased work efficiency' (62.50%). In Himachal Pradesh, maximum respondents perceived somewhat high impact in terms of 'pollution causes irritation in eyes/dizziness/nausea' (87.50%) followed by 'decreased work efficiency' (85.00%), 'new viruses, insects etc.' (83.33%), 'psychological stress' (79.17%) and 'increased incidence of diseases like asthma, skin disease and cancer etc.' (75.83%).

It can be seen from the data of Table 5 that in Haryana, maximum impact was perceived in terms of 'new viruses, insects etc.' (rank I) and 'increased incidence of diseases like asthma, skin disease and cancer etc.' (rank II) whereas, in Himachal Pradesh, maximum impact was perceived in terms of 'incidence of diseases like asthma, skin disease and cancer etc.' (rank I) and 'psychological stress' (rank II).

Table 6 shows impact of climate change on food and nutrition security as perceived by respondents. Data elucidates that majority of the respondents of Haryana perceived very high impact with respect to 'less availability of food' (87.50%) followed by 'high price of food' (59.17%). Somewhat high impact was perceived in case of 'wastage of food' (59.17%) followed by 'lower nutritional quality of food' (57.50%) and 'food stored for consumption get damaged' (50.83%).

In Himachal Pradesh, maximum respondents perceived high impact on 'less availability of food' (91.67%) followed by 'high price of food' (88.33%), 'lower nutritional quality of food' (83.33%), 'food

Table 5: Impact of climate change on human health as perceived by respondents (n=240)

Impact	Haryana (n1-120) F (%)				Himachal Pradesh (n2-120) F (%)			
	Very high	Some what	No change	Mean weighted score (Rank)	Very high	Some what	No change	Mean weighted score (Rank)
New viruses, insects etc.	113(94.17)	05(4.17)	02(1.67)	2.93(I)	17(14.17)	100(83.33)	03(2.50)	2.12(IV)
Psychological stress	108(90.00)	09(7.50)	03(2.50)	2.88(IV)	23(19.17)	95(79.17)	02(1.67)	2.18(II)
Increased incidence of diseases like asthma, skin disease and cancer etc.	112(93.33)	05(4.17)	03(2.50)	2.91(II)	27(22.50)	91(75.83)	02(1.67)	2.21(I)
Pollution causes irritation in eyes/ dizziness/nausea	110(91.67)	07(5.83)	03(2.50)	2.89(III)	13(10.83)	105(87.50)	02(1.67)	2.09(V)
Decreased work efficiency	75(62.50)	41(34.17)	04(3.33)	2.59(V)	15(12.50)	102(85.00)	03(2.50)	2.10(III)

Table 6: Distribution of respondents according to overall impact of climate change on human health (n-240)

Category	Haryana (n1-120) F (%)	Himachal Pradesh (n2-120) F (%)
Low impact (5-8)	0(0.00)	0(0.00)
Medium impact (9-11)	23(19.17)	59(49.17)
High impact (12-15)	97(80.83)	61(50.83)

stored for consumption get damaged' (78.33%) and 'wastage of food' (62.50%).

It can be explained from the Table 7 that Haryana respondents perceived maximum impact in terms of 'high price of food' and 'food stored for consumption get damaged' whereas in Himachal Pradesh maximum impact was perceived in respect to 'less availability of food' and 'high price of food'.

Data of Table 8 shows the distribution of respondents according to overall impact of climate change on food and nutrition security as perceived by respondents and found that majority of the respondents had perceived medium impact in Haryana as well as in Himachal Pradesh i.e., 70.83 per cent and 48.33 per cent respectively followed by high impact of climate change on food and nutrition security i.e., 29.17 per cent in Haryana and 51.17 per cent in Himachal Pradesh. None of the respondents perceived low impact of climate change on food and nutrition security.

Table 8: Distribution of respondents according to overall impact of climate change on food and nutrition security as perceived by respondents (n-240)

Category	Haryana (n1-120) F (%)	Himachal Pradesh (n2-120) F (%)
Low impact (5-8)	0(0.00)	0(0.00)
Medium impact (9-11)	85(70.83)	58(48.33)
High impact (12-15)	35(29.17)	62(51.17)

Table 7: Impact of climate change on food and nutrition security as perceived by respondents (n=240)

Impact	Haryana (n1-120) F (%)				Himachal Pradesh (n2-120) F (%)			
	Very high	Some what	No change	Mean weighted score (Rank)	Very high	Some what	No change	Mean weighted score (Rank)
Less availability of food	65(87.50)	31(9.17)	24(3.33)	2.34(V)	110(91.67)	07(5.83)	03(2.50)	2.89(I)
High price of food	71(59.17)	45(37.50)	04(3.33)	2.56(I)	106(88.33)	11(9.17)	03(2.50)	2.86(II)
Food stored for consumption get damaged	57(47.50)	61(50.83)	02(1.67)	2.46(II)	94(78.33)	23(19.17)	03(2.50)	2.76(IV)
Lower nutritional quality of food	48(40.00)	69(57.50)	03(2.50)	2.38 (III)	100(83.33)	18(15.00)	02(1.67)	2.82(III)
Wastage of food	46(38.33)	71(59.17)	03(2.50)	2.36(IV)	75(62.50)	43(35.83)	02(1.67)	2.61(V)

CONCLUSION

Maximum impact of climate change on agriculture in Haryana was perceived in case of 'more type and number of insect/pest/diseases' and 'decrease in soil fertility' whereas, in Himachal Pradesh, maximum impact was perceived in case of 'poor growth of crop' and 'poor quality and taste of production'. Regarding impact of animal husbandry, in Haryana maximum impact was perceived in terms of high temperature affects health of livestock and increased water consumption in animals whereas, in Himachal Pradesh, maximum impact was perceived with respect to low milk production and reduced reproduction efficiency. 'New viruses, insects etc.' and 'increased incidence of diseases like asthma, skin disease and cancer etc.' in Haryana and 'incidence of diseases like asthma, skin disease and cancer etc.' and 'psychological stress' were most important impacts perceived of climate change on human health. As regards food and nutrition security, Haryana respondents perceived maximum impact in terms of 'high price of food' and 'food stored for consumption get whereas in Himachal Pradesh maximum impact was perceived in respect to 'less availability of food' and 'high price of food'.

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Effect of Foliar Application of Potassium Nitrate on Yield Attributes, Productivity and Economics of Chickpea (*Cicer arietinum* L.) Cultivation in South-Western Punjab

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ABSTRACT

Green chickpea is a popular proteinaceous vegetable in Punjab. Abiotic stress due to high temperature under saline irrigation is a potential cause of low productivity. To assess the effect of nutrient management strategies on the productivity of chick pea mitigating abiotic stress, an on farm study was conducted in selected villages in Faridkot district of Punjab during 2019-20. Foliar application of 2% urea (T_2), 1% KNO_3 (T_3) and urea followed by 1% KNO_3 (T_4) along with recommended fertilizer dose increased the productivity of green chickpea (8.9 to 12.1%), peeled off chickpea (5.5 to 11.1%) and chickpea seed (20.7 to 30.2%) over recommended fertilizer dose (T_1), contributing to increase in total biomass due to more uptake of nutrients. The marketing of green chickpea generated farm income of 77.1 to 141.1 q ha^{-1} of Wheat Equivalent Yield (WEY).

Keywords: Green chickpea, Seed yield, Productivity, Wheat equivalent yield (WEY), Soil health

INTRODUCTION

Pulses, popularly known as 'poor man's meet' are considered an important source of protein, vitamins & minerals (Singh *et al.*, 2015) which contribute 11 per cent of the total intake of proteins in India (Reddy, 2010). Therefore, it is imperative to increase pulses production to increase balanced diet among the economically backward classes. Chickpea have been cultivated in India on about 10.17 million hectares, producing 11.35 million tons of seeds (Anonymous, 2020). India, being the largest consumer and importer of pulses, is producing about, 65 per cent of global chickpea. Its cultivation is known to have several advantages viz. it can be grown under limited moisture conditions with limited inputs, secondly its ability to fix atmospheric nitrogen improve the soil health.

Punjab state is producing 2.6 thousand ton of chickpea with the productivity of 1.32 t ha^{-1}. Traditionally, *Holan*, i.e. roasted green chick pea used to be a popular proteinaceous recipe for children in rural Punjab. However, with the popularization of commercial farming, cultivation of chickpea has been marginalized. Moreover, inadequate nutrition restrict the growth and development of plant whereas, unpredicted rise in temperature, consequent soil moisture stress at the time of flowering and pod formation is likely to lower productivity (Ali *et al.*, 2009) and the effect is more sever under saline irrigation conditions.

Therefore, nutrition management strategies may play a major role to achieve target yield of pulses by invigorating vigour to withstand abiotic stress. Among different plant nutrients nitrogen is the most important nutrient (Pate *et al.,* 1977) to play role in synthesis of chlorophyll and amino acid (Masclaux Daubresse *et al.*, 2006). The potassium is the third most important essential nutrient after nitrogen and phosphorus. The potassium activates more than 60 enzymes involved in photosynthesis, and translocation of carbohydrates and proteins, membrane permeability, stomatal regulation and water utilization. Other benefits ascribed to K include resistance of plants against stresses caused by

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drought, salinity and sodicity (Kherawat *et al*., 2013), inducing salt stress tolerance in crops by enhancing Na/K ratio. In order to assess worth of technology enhancing productivity of chick pea under saline conditions, an on farm trial was conducted aiming to generate site specific technologies. Further, empowerment of farmers through market led extension is necessary to respond to the changes in the food market for production system diversification, product quality, consumer's preference, and realization of value addition opportunities (Gummagolmath *et al*., 2013). Hence, approach will also serve capacity building in marketing as a critical intervention.

Generally, chick pea is considered as a non-significant crop of *rabi* season, being grown on a marginal land with minimum inputs resulting in poor productivity. Not only need based nutrition management strategies may enhance the productivity but, the skillful marketing of raw chick pea (*Chholiya*) can earn monetary benefits. Hence, a study was planned to analyse potential production technologies and the promises of direct marketing of raw chick pea, in the Faridkot district of Punjab.

MATERIALS AND METHODS

The study was conducted during 2019-20 in Dal Singh wala, Pindi Blochan, Bhagthala Kalan and Romana Albel Singh villages situated between 30° 40' 41.4696″ N & 74° 44' 22.3980″ E. The fields were prepared by deep ploughing and planking. Recommended dose of fertilizer (RDF) - 33 kg per ha of urea before planking and 125 kg per ha of single super phosphate was drilled along with seed to all plots. Chick pea cultivar PBG-7 was sown manually at 30 cm row spacing using 40 kg seed per ha. Along with RDF, foliar nutritional treatments viz. Spray of 2% urea was given at 90 DAS (T_2) and 1% KNO_3 was given at 120 DAS (T_3). Similarly, T_4 was applied as 2% urea at 90 DAS followed by spray of 1% KNO_3 at 120 DAS, keeping T_1 as control (RDF only). All the triplicated treatments were applied in randomized block manner. Hoeing, irrigation and plant protection measures were followed as per recommendation of PAU Ludhiana.

The green chick was harvested from area of 0.1 ha, starting from 25th February to 25th March, while an area of 20m x 10m was harvested to peel off green chick pea. The fresh produce was harvested in staggered mode and sold @ Rs. 10/- per bundle of one kg as whole plant where as peeled off green chick pea was sold @ Rs. 120/- per kg of grain. During this period one labourer was engaged for one month @ Rs. 300 per day for harvesting, packaging and sale of produce while additional labour was involved for peeling off @ Rs. 20 per kg of grain. The quantity of green chick pea 148.5-166.5 q per ha was produced, whereas, 30.6 to 34.0 q per ha peeled off chickpea obtained at various locations was sold in local market. A plot of 10m x 5m was kept aside for harvesting ripened grain. Cost of all inputs were included for calculation of B:C ratio.

The phenological observations were recorded. The mature plants were harvested to draw samples for chemical analysis of seed and stover. The plant samples were oven dried, thrashed manually to separate seed and stover, machine grinded and digested in acid mix solution for analysis of nutrient concentration. The soil samples were analysed for pH, EC (dSm^{-1}), OC (%), available P & K and presented information of fertility status of area in Table 1.

RESULTS AND DISCUSSION

The data Table 2 purported that foliar application of urea followed by 1% KNO_3 (T_4) produced maximum biomass at Dal Singh Wala which was 36.7 per cent higher than RDF only while the highest increase of 37 per cent in biomass production was recorded at Bhagthala Kalan village under the same treatment. Irrespective of villages, overall increase in biomass production varied from 11.8 to 30.1 per cent and 15.9 to 31.4 per cent under T_2 and T_3, respectively. The productivity of chick pea under improved production technologies ranged between 15.4 to 21.3 q ha^{-1}. The statistical analysis revealed that T_4 produced the highest seed yield at village Dal Singh Wala which was 28.3 per cent higher than sole RDF, however, the highest incremental grain yield was obtained at village Bhagthala Kalan to the tune of 35.1 per cent higher than T_1. Similarly, significant increase of 28.6 and 27.5 per cent in seed yield was recorded at Romana Albel Singh and Pindi Blochan village, respectively. The data advocated that foliar application of urea (T_2) proved superior at Bhagthala Kalan where it helped produce 24.7 per cent more seed yield than RDF only as compared to Romana Albel Singh, Pindi Blochan and

Table 1: Analysis of soil properties of study area

Location	Village	pH	EC (dsm^{-1})	TOC (%)	Olsen P ($kg\ ha^{-1}$)	NH_3OAC extractable K ($kg\ ha^{-1}$)
Kotkapura	Dal Singh wala	7.96	0.21	0.38	16.3	164.3
	Romana Albel Singh	8.09	0.36	0.37	17.6	253.1
Faridkot	Pindi Blochan	8.03	0.23	0.41	16.5	151.5
	Bhagthala Kalan	8.14	0.27	0.42	15.9	162.3

Table 2: Effect of nutrient management strategies on chick pea yield and yield attributing characteristics

Treatment	Biomas ($q\ ha^{-1}$)				Seed yield ($q\ ha^{-1}$)			
	Dal Singh Wala	Pindi Blochan	Bhagthala Kalan	Romana Albel Singh	Dal Singh Wala	Pindi Blochan	Bhagthala Kalan	Romana Albel Singh
RDF	35.7	36.2	34.3	36.4	16.6	16.0	15.4	15.7
RDF + 2% Urea	42.3	44.4	44.6	40.7	19.1	19.1	19.2	19.3
RDF + 1% KNO_3	44.6	44.5	45.1	42.2	19.3	19.7	19.4	19.6
RDF + 2% Urea + 1% KNO_3	48.8	44.7	47.0	44.3	21.3	20.4	20.8	20.2
CD (p-5%)	1.15	1.6	1.83	2.09	0.59	0.22	0.36	0.35
SE	0.34	0.48	0.57	0.63	0.18	0.06	0.10	0.11

Dal Singh Wala villages where it produced 22.9, 19.3 and 15.1 per cent higher seed yield, respectively, over T_1. Spray of 1% KNO_3 (T_3) performed better at Bhagthala Kalan where it gave the highest increase in biomass as well as seed yield among the villages which was 31.4 per cent and 25.9 per cent more than T_1. It may be attributed to the fact that due to timely sowing, improved soil health and adoption of site specific nutrition management practices resulted in better establishment of plant. The results corroborate with the findings of Singh *et al.* (2015) who reported the superiority of application of balanced fertilizers contributed towards the improvement in yield over the practice, where only urea fertilizer was applied. Studies have reported that the combined application of potassium with nitrogen have synergistic impact on the biomass accumulation, seed yield, and protein content in chick pea (Ali *et al.*, 2010; Memon *et al.*, 2016).

The statistical analysis purported that application of additional nutrients help to accumulate more above and below ground biomass (Figure 1), therefore facilitate carbon sequestration in soil. It was noticed that spary of 2% urea (T_2) performed better to enhance plant height at a higher rate than that of T_3 at Dal Singh Wala, however, T_3 help to acquire more plant height at Pindi blochan, Bhagthala Kalan and Romana Albel Singh as compared to T_2 (Figure 1A). The data advocated that T_4 produced the highest plant height at all locations which was 33.1, 24.9, 24.4 and 24.1 per cent more that T_1 at Dal Singh Wala, Bhagthala Kalan, Pindi Blochan and Romana Albel Singh, respectively. Similarly, a significant increase in number of branches per plant (Figure 1B) was observed under T_4 over T_1. The highest increase (64.1%) in number of branches per plant was observed at Dal Singh Wala followed by Bhagthala Kalan (61.4%), Romana Albel Singh (55.8%) and the least at Pindi blochan (32.5%). However, no significant change in number of branches per plant was observed with the spray of 2% urea (T_2) or 1% KNO_3 (T_3) at either of locations. As there is an increase in above ground biomass in case of T_4, thereafter increased accumulation of biomolecules in leaves forced the expansion of roots below ground, thereby, increase in the number of root nodules per plant (Figure 1D) as well as root mass biomass (Figure 1E) was noticed leading to exploration of more rhizospheric zone in search of nutrients, facilitating enhanced rate of uptake of nutrition, accounting for increase in number of pods per plant (Figure 1C), also more vigorous seeds, depicting higher 100-seed weight under foliar nutrition management strategies as compared to RDF only (Figure 1F).The study reported

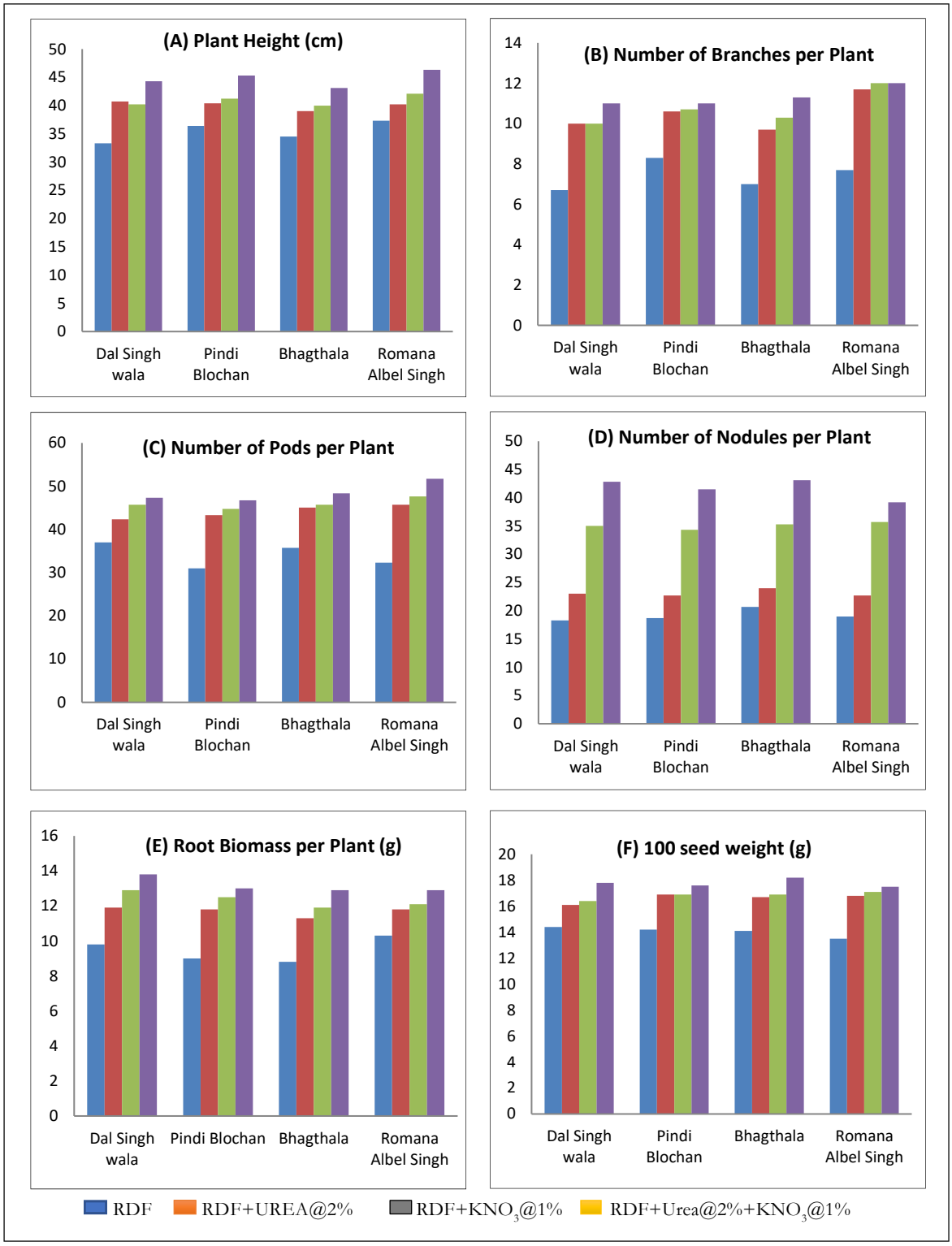

Figure 1: Effect of nutrient management strategies on chick pea yield attributing characteristics

that spray of 2% urea (T_2) resulted in increase of 14.5 to 31.4 per cent in root mass over RDF (T_1) while spry of 1% KNO_3 (T_3) produced 17.4 to 38.9 per cent higher root mass than that of T_1 at different locations. The maximum increase in root mass (46.5%) was reported under T_4 at Bhagthala Kalan followed by 44.4, 40.8 and 25.2 per cent increase in root mass at Pindi Blochan and Romana Albel Singh, respectively under T_4 over T_1. An increase in number of nodules as well as number of pods per plant were observed in

various treatments at different villages. The data reported that due to application of nutrients overall significant increase in plant height could be attributed to the fact that potassium enhances plant vigour and strengthens the stalk, further it has synergistic effect with nitrogen and phosphorous resulted in better plant growth and more number of branches/plant (Goud, 2014). Further, Hamida *et al.* (2019) reported that synergistic interaction of nutritional status and microbial inoculation improved plant vigour, enhancing root nodulation and nitrogen fixation under saline conditions.

In order to tap the potential of demand of green chick pea during February to March in local market, the farmers were motivated for direct marketing of green chick pea. In this way, they obtained average yield of 159.9 q ha^{-1} and earned income equivalent to 83 q ha^{-1} grain yield of wheat. However, after peeling off the skin, there is a collection of 32.5 q ha^{-1} green chick pea (grains). The grains so obtained were sold and it gave an average income equivalent to 135 q ha^{-1} yield of wheat. The WEY of sale of chick pea seed, green chick pea (whole plant) and peeled off green chick pea (grains) is presented in Table 3. The intervention of marketing of green chick pea helped to achieve average gross returns to the tune 48.7 per cent higher than traditional mode of production whereas, marketing of peeled off chick pea obtained 181.5 per cent more returns than that of sale of ripened grains. Further, foliar application of nutrition treatments i.e. T_3, T_2 and T_4 facilitated 9.6, 8.9 and 12.1 per cent increase in green chick pea yield, following similar trend of increase in WEY. It was observed that spray of nutrients gave 5.5 to 11.1 per cent higher yield of peeled off green chickpea as compared to control (T_1). About 11.4 per cent increase in WEY of peeled off green chick pea was noticed under T_4 over T_1 while 5.5 and 8.3 per cent higher WEY was recorded in T_2 and T_3 respectively, as compared to T_1. It is worth to mention that foliar application of nutrition variants increased the seed yield by 25.6 to 30.3 per cent. The sale of green chickpea produced under treatment T_3, T_2 and T_4 help to enhance net returns on investment by 9.8, 11.4 and 13.2 per cent while peeled off chick pea under these treatments increased net returns by 9.4, 6.4 and 12.9 per cent over T_1. The data revealed that direct marketing of raw chick pea (bundle of plants) as well as peeled off chick pea are more economically efficient than sale of ripened chick pea grain. Moreover, the practice generates additional employment opportunities for landless farmers. Further, it accounted for addition of 4.5 q ha^{-1} of organic matter improving soil health.

The concentration of N in ripened chickpea seed ranged between 2.8–3.2%, 2.9–3.3%, 2.9-3.2% and 2.9–3.3% at Dal Singh Wala, Pindi Blochan, Bhagthala Kalan and Romana Albel Singh, respectively. Similarly, chickpea Stover N concentration varied 0.78-1.24%, 0.84-1.23%, 0.86-1.25% and 0.88-1.29 at respective locations under study. Though all treatments resulted in increased concentration of N in seed as well as stover, however, the highest increase of 14.2% in seed and 5.9% in stover was recorded under T_4 at Dal Singh Wala village. The chickpea seed P concentration ranged 0.33–0.65%, 0.22–0.60%, 0.17-0.48% and 0.23–0.55% at respective locations (Table 4). Similarly, the phosphorous concentration in chick pea stover across the treatments was found 0.15-0.35%, 0.14-0.34%, 0.16-0.34% and 0.11-0.31% at locations under study. The data reported that the P concentration in seed was the highest under T_4 at village Bhagthala Kalan which was 182.3 higher than T_1 whereas in case of stover P

Table 3: Effect of nutrient management strategies on wheat equivalent yield (WEY) of chickpea

Treatment	Yield (q ha^{-1})			Wheat equivalent yield (q ha^{-1})			NROI (Rs ha^{-1})*		
	Green chickpea	Peeled off chickpea	Ripened chickpea	Green chickpea	Peeled off chickpea	Ripened chickpea	Green chickpea	Peeled off chickpea	Ripened chickpea
RDF	148.5	30.6	15.3	77.1	127.1	38.3	110038	211113	65343
RDF + 2% Urea	162.8	32.3	19.3	84.5	134.2	48.1	122638	224713	84743
RDF + 1% KNO_3	161.8	33.1	19.6	84.0	137.7	49.1	120838	231113	86198
RDF + 2% Urea + 1% KNO_3	166.5	34.0	20.0	86.5	141.1	49.9	124638	238313	88138
Average	159.9	32.5	18.4	83.0	135.0	46.3	119538	226313	80378

*Net Returns over investment

Table 4: Effect of nutrient management strategies on nutrient concentration in chickpea

Treatment	Seed				Straw			
	Dal Singh Wala	Pindi Blochan	Bhagthala Kalan	Romana Albel Singh	Dal Singh Wala	Pindi Blochan	Bhagthala Kalan	Romana Albel Singh
Concentration of nitrogen (%)								
RDF	2.8	2.9	2.9	2.9	0.78	0.84	0.86	0.88
RDF + 2% Urea	3.1	3.1	3.1	3.1	1.12	1.17	1.16	1.17
RDF + 1% KNO_3	3.1	3.2	3.2	3.2	1.22	1.24	1.19	1.22
RDF + 2% Urea + 1% KNO_3	3.2	3.3	3.2	3.3	1.24	1.23	1.25	1.29
CD (p-0.05)	0.15	0.09	0.12	0.07	0.16	0.10	0.14	0.05
SE(M)	0.14	0.2	0.03	0.22	0.14	0.02	0.042	0.01
Concentration of phosphorous (%)								
RDF	0.33	0.22	0.17	0.23	0.15	0.14	0.16	0.11
RDF + 2% Urea	0.49	0.42	0.35	0.39	0.26	0.23	0.18	0.21
RDF + 1% KNO_3	0.62	0.53	0.43	0.48	0.32	0.31	0.21	0.29
RDF + 2% Urea + 1% KNO_3	0.65	0.60	0.48	0.55	0.35	0.34	0.34	0.31
CD (p-0.05)	0.06	0.10	0.05	0.08	0.07	0.06	0.05	0.03
SE(M)	0.19	0.03	0.016	0.02	0.02	0.01	0.014	0.01
Concentration of potassium (%)								
RDF	1.04	1.10	0.99	1.06	1.22	1.21	1.16	1.27
RDF + 2% Urea	1.12	1.17	1.15	1.18	1.31	1.33	1.36	1.39
RDF + 1% KNO_3	1.18	1.20	1.25	1.24	1.37	1.40	1.48	1.45
RDF + 2% Urea + 1% KNO_3	1.26	1.16	1.30	1.19	1.40	1.41	1.51	1.40
CD (p-0.05)	0.91	NA	0.03	0.06	0.09	0.11	0.05	0.06
SE(M)	1.04	0.03	0.010	0.19	0.02	0.03	0.016	0.19

concentration was the highest at Romana Albel Singh under T_4 giving an increase of 181.8% over T_1. The potassium concentration in chickpea seed ranged 1.04-1.26%, 1.10-1.20%, 0.99-1.30% and 1.06-1.19% at Dal Singh Wala, Pindi blochan, Bhagthala Kalan and Romana Albel Singh, respectively. Similarly, K concentration in chickpea stover ranged between 1.22–1.40%, 1.21-1.41%, 1.16-1.51% and 1.27-1.45% at respective locations under study. The highest concentration of potassium in seed was found under T_4 at Dal Singh Wala which was 21.5% higher than T_1. Similarly, the highest concentration of K in stover was recorded in T_4 treatment at Bhagthala Kalan which was 30.1% higher than T_1. In general, the uptake of N, P and K in chickpea was found higher under the treatments receiving the foliar nutrient management modules. The improvement in crop performance with adequate and balanced nutrition application has already been documented (Singh and Khushwaha, 2018).

CONCLUSION

Foliar application of 2% urea followed by spray of 1% potassium nitrate at the time of flowering along with recommended fertilizer application stimulates the productivity of chick pea. The fusion of site specific technological intervention for productivity enhancement & direct marketing of green chickpea proved miraculous for rural livelihood upliftment. Moreover, leftover root biomass incorporation enriched the soil health.

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Elucidating the Binary of Entrepreneurial Communication in Farmer Producer Organizations (FPOs): The Localite vs. Cosmopolite Information System

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ABSTRACT

The current study conducts an in-depth investigation into communication strategies employed by FPOs, explicitly focusing on the interaction between two distinct paradigms: the Localite and Cosmopolite Information Systems. This research was carried out in the 5 villages of Uttar Dinajpur and Nadia districts of West Bengal. For the state, districts and Villages were selected through purposive selection method. A sample of 75 FPO members were selected using a combination of both random and non-random snowball sampling techniques. The collected data underwent meticulous analysis through stepwise regression to identify key variables that significantly impact communication dynamics within FPOs. Further, a path analysis has been conducted to evaluate the direct and indirect effects of a set of variables acting on the localite and cosmopolite channels. The localite strategy places a strong emphasis on community-centred engagement and knowledge sharing, nurturing localized identity and self-reliance. In contrast, the cosmopolite approach underscores global perspectives, promoting innovation and adaptability to shifting market trends. The study uncovers challenges and opportunities associated with each paradigm, offering insight into how FPOs navigate the delicate equilibrium between upholding local authenticity and achieving global competitiveness. The outcomes contribute to an enriched understanding of effective communication strategies within FPOs. By dissecting the dynamics of both localite and cosmopolite information systems, this research offers valuable insights for FPO leaders, policymakers, and stakeholders dedicated to nurturing the prosperity of smallholder farmers in an interconnected world. As FPOs continue to serve as drivers of agricultural progress, this study equips them with refined communication insights to steer sustainable growth and empower communities.

Keywords: Communication strategies, Cosmopolite information system, Entrepreneurial communication, FPOs, Localite information system

INTRODUCTION

Effective communication plays a crucial role in promoting the integration of sustainable and climate-resilient agricultural methods. This facilitates the enduring sustainability of agriculture and the overall welfare of the farming community (Rao *et al.*, 2016). The demographic of younger respondents has shown a substantial impact on the reception of entrepreneurial information derived from cosmopolitan sources (Acharya *et al.*, 2022). In the realm of agriculture, the significance of information has escalated, thereby making access to information an essential prerequisite and a valuable asset for the advancement of agricultural endeavors (Rodman, 2006). ICTs play a crucial role in propelling rural entrepreneurship to facilitate India's economic growth, with an emphasis on coordinated strategies and innovative frameworks as vital components for nurturing rural economic development (Beriya, 2022). Policy strategies need to address

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information, regulatory, and financial needs while encouraging collaboration among public, private, and non-profit sectors. As underlined by Kathiravan *et al.* (2020), ICTs and digital technologies uniquely drive rural entrepreneurship, effectively catering to various demands. The interplay between communication, agricultural insights, and homestead actions reveals its role in rural development. Local leaders and government extensions serve as key informants, while weaving and gardening activities display diverse patterns of independent and joint participation (Nath *et al.*, 2022). The entrepreneurial drive within Farmer Producer Organizations (FPOs) has a substantial influence on the livelihood security of their members, highlighting the crucial function of this mindset in ensuring the welfare of FPO participants (Elizabeth, 2020). The collective perception among farmers was that the managerial and governance characteristics of the Farmer Producer Organization (FPO) demonstrated a level of group communication that can be reasonably categorized as impartial (Amitha *et al.*, 2021). Numerous scholarly investigations propose that the establishment of farmer collectives can serve as a catalyst for augmenting the information assimilation capacities among the agricultural community (Munoz *et al.*, 2015; Fleming *et al.*, 2021). The establishment of Farmer Producer Organizations (FPOs) results in heightened earnings for farmers by granting them privileges such as access to institutional credit, informed and astute decision-making, improved entry to higher quality inputs, increased efficacy in agricultural operations, and enhanced marketing prospects (Sharma *et al.*, 2019).

MATERIALS AND METHODS

This study had been carried out in five villages: Dalimgaon, Fatepur, Kunor, Gopalpur, and Badkulla, situated in the Uttar Dinajpur and Nadia districts of West Bengal. For the state, districts and Villages were selected through purposive selection method. A total of 75 farmers were selected as respondents through random sampling technique. All the selected farmers were interviewed personally by the researcher with a structured interview schedule. The study utilized statistical methods like coefficient of correlation, stepwise regression analysis, and path analysis. Achieving accurate results required precise definition and measurement of variables. Hence, the identified variables for this study were operationally defined and measured as follows:

Independent variables: Age (x_1), Education (x_2), Year of experience (x_3), Family size (x_4), Mean Family education (x_5), Material possessed (x_6) like TV, Fridge, Bike, cycle, Car, Power, Tiller, Tractor, etc, Size of holding (x_7), Size of homestead land (x_8), Size of cultivated land (x_9), Size of land under irrigation (x_{10}), No. of fragments (x_{11}), Crop yield (x_{12}), Cropping intensity (x_{13}), Per Capita Income (x_{14}), Per Capita expenditure (x_{15}), Marketable surplus (x_{16}), Marketed surplus (x_{17}), Dependency ratio (x_{18}).

Dependent variable: Entrepreneurial Information Received from Cosmopolite Sources (y_1), Entrepreneurial Information Received from Localite Sources (y_2).

Softwares used: MS Excel, SPSS, OPSTAT

RESULTS AND DISCUSSION

The correlation coefficients between entrepreneurial information derived from cosmopolite sources (y_1) and entrepreneurial information received from localite sources (y_2) in relation to 18 independent variables (x_1-x_{18}) are outlined in Table 1. the outcomes reveal that education (x_2), year of experience (x_3), family size (x_4), and mean family education (x_5) exhibit noteworthy correlations with both sources of entrepreneurial information. These variables have displayed correlations with the acquisition and utilization of both cosmopolitan and local sources for entrepreneurial communication (Panda *et al.*, 2019; Acharya and Roy, 2021).

These findings suggest that individuals with higher educational levels are more prone to accessing entrepreneurial information from cosmopolite and local sources, implying greater engagement and interaction with these information channels.

Furthermore, the analysis indicates a positive connection between the years of experience (x_3) and entrepreneurial information from cosmopolite and local sources, bolstered by family size and mean family education. Therefore, factors like family education, years of experience, and family size collectively influence the acquisition of entrepreneurial information from

Table 1: Coefficient of Correlation (r): Entrepreneurial information received from cosmopolite sources (y_1) and Entrepreneurial Information Received from Localite Sources (y_2) Vs. 18 Independent Variables (x_1-x_{18})

S.No.	Independent Variables	'r' Value	
		Entrepreneurial Information Received from Cosmopolite Sources (y_1)	Entrepreneurial Information Received from Localite Sources (y_2)
1	Age (x_1)	-0.032	-0.035
2	Education (x_2)	0.687**	0.760**
3	Year of experience (x_3)	0.438**	0.521**
4	Family size (x_4)	0.396**	0.341**
5	Mean family education (x_5)	0.530**	0.536**
6	Material possessed (x_6)	-0.245*	-0.250*
7	Size of land holding (acre) (x_7)	-0.008	0.012
8	Size of homestead land acre (x_8)	0.130	0.145
9	Size of cultivated land acre (x_9)	0.288*	0.317**
10	Size of land under irrigation acre (x_{10})	-0.001	0.018
11	No of fragment (x_{11})	0.026	0.061
12	Crop yield (q) (x_{12})	0.058	0.068
13	Cropping intensity (%) (x_{13})	0.162	0.179
14	Per Capita Income (x_{14})	0.012	0.023
15	Per Capita Expenditure (x_{15})	0.027	0.040
16	Marketable surplus (x_{16})	0.019	0.033
17	Marketed surplus (x_{17})	0.001	0.017
18	Dependency ratio (x_{18})	0.179	0.184

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level

cosmopolite and local sources. Individuals with better education, larger families, and more experience tend to access higher levels of entrepreneurial information from these sources.

These insights highlight that larger family sizes and improved education contribute positively to the utilization of diverse entrepreneurial information, ultimately leading to enhanced income and profitability.

However, a negative correlation is observed between material possessions and received entrepreneurial information. This implies that individuals with greater material possessions engage less frequently with cosmopolite and local sources of information.

Moreover, the size of cultivated land displays a positive correlation with the acquisition of entrepreneurial information from both cosmopolite and local sources. This indicates that farmers with larger land holdings have more regular interactions with sources like input dealers. Larger-scale farmers are more actively involved with cosmopolite and local sources.

In conclusion, these findings emphasize the pivotal roles of education, family size, years of experience, material possessions, and landholding size in influencing the extent of entrepreneurial information accessed from both cosmopolite and local sources.

The outcomes of the stepwise regression analysis are presented in Table 2, unveiling four noteworthy variables - education (x_2), year of experience (x_3), family size (x_4), and mean family education (x_5) - which collectively contribute significantly to explaining the variation in entrepreneurial information received from cosmopolite sources (y_1). these variables jointly account for 68.90% of the variance.

The results highlight that individuals with elevated educational levels, larger family sizes, improved family

Table 2: Stepwise Regression Analysis: Entrepreneurial information received from cosmopolite sources (y_1) vs. 18 Causal Variables

S.No.	Variables	Reg. Coef. B	S.E. B	Beta	t value
1	Education (x_2)	0.216	0.044	0.423	4.900
2	Family size (x_4)	0.400	0.070	0.389	5.689
3	Mean family education (x_5)	0.486	0.112	0.320	4.335
4	Year of experience (x_3)	0.026	0.012	0.172	2.130

R square: 68.90%; The standard error of the estimate: 0.86

Table 3: Stepwise Regression Analysis: Entrepreneurial Information Received from Localite Sources (y_2) Vs. 18 Causal Variables

S.No	Variables	Reg. Coef. B	S.E. B	Beta	t value
1	Education (x_2)	0.208	0.033	0.491	6.386
2	Family size (x_4)	0.283	0.052	0.333	5.463
3	Mean family education (x_5)	0.356	0.083	0.283	4.307
4	Year of experience (x_3)	0.027	0.009	0.221	3.077

R square: 75.40%; The standard error of the estimate: 0.63

education, and increased years of experience are pivotal factors influencing the interpretation of Entrepreneurial information obtained from cosmopolite sources.

This phase of the analysis revealed that the four variables – education (x_2), year of experience (x_3), family size (x_4), and mean family education (x_5) – maintained their significance as predictors. together, these variables explained a substantial portion of the variance, exhibiting an r^2 value of 75.40%. The findings suggest that elevated levels of education contribute to the enhancement of communication proficiency and active participation in interactions with stakeholders. Increased years of experience amplify communication capabilities and the adeptness to articulate a vision. While larger family sizes could foster interpersonal skills, they might also place constraints on communication growth. Furthermore, higher mean family education has a positive impact on the communication proficiencies of members within Farmer Producer Organizations (FPOs).

The findings presented in Table 4 offer a comprehensive overview of the outcomes of the path analysis, providing insights into the various components of the total effect of the correlation coefficient. Notably, the study reveals an unexpected yet substantial direct impact of landholding size on the acquisition of entrepreneurial information, albeit in a negative direction. This intriguing discovery suggests that smaller-scale farmers tend to engage more with global information sources, contrary to conventional assumptions. This apparent paradox prompts further exploration into underlying factors contributing to this counterintuitive behavior in seeking entrepreneurial information. It's also interesting to highlight that the Size of Land Holding (x_9) had the highest indirect impact, passing through thirteen different variables, to ultimately shape the dependent variable of entrepreneurial information from cosmopolitan sources (Acharya and Roy, 2021).

Of particular interest, the same variable demonstrates a significant indirect effect as well. This signifies that beyond landholding size, the practices and behaviors linked to entrepreneurship on the farm are influential determinants. While the correlation coefficient might indicate a positive direct effect, the path analysis reveals a contrasting negative direct impact. Consequently, it becomes essential for small farmers to partake in entrepreneurial training, establish connections to markets, prioritize value addition, and foster an appetite for entrepreneurial information to achieve positive outcomes. This insight underscores the pivotal role that supplementary factors play in shaping the acquisition of entrepreneurial information.

In the context of West Bengal, where small and fragmented landholdings predominate and constitute the majority, it becomes imperative to equip farmers

Table 4: Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Entrepreneurial Information Received from Cosmopolite Sources (y_1)-

S.No	Variables	Total effect	Direct effect	Indirect effect	Highest indirect effect
1	Age (x_1)	-0.032	0.008	-0.040	0.065 (x_{17})
2	Education (x_2)	**0.687**	0.347	0.340	0.117 (x_5)
3	Year of experience (x_3)	0.438	0.214	0.224	0.189 (x_2)
4	Family size (x_4)	0.396	0.429	-0.033	-0.063 (x_{17})
5	Mean family education (x_5)	0.530	0.274	0.256	0.148 (x_2)
6	Material possessed (x_6)	-0.245	-0.091	-0.154	-0.091 (x_7)
7	Size of land holding (acre) (x_7)	-0.008	**-0.469**	**0.461**	0.279 (x_{12})
8	Size of homestead land acre (x_8)	0.130	-0.019	0.149	0.064 (x_2)
9	Size of cultivated land acre (x_9)	0.288	0.140	0.148	-0.319 (x_7)
10	Size of land under irrigation acre (x_{10})	-0.001	0.087	-0.088	-0.462 (x_7)
11	No of fragment (x_{11})	0.026	-0.016	0.042	-0.39 (x_7)
12	Crop yield (q) (x_{12})	0.058	0.305	-0.247	-0.429 (x_7)
13	Cropping intensity (%) (x_{13})	0.162	0.151	0.011	0.073 (x_2)
14	Per Capita Income (x_{14})	0.012	0.149	-0.137	-0.095 (x_{15})
15	Per Capita Expenditure (x_{15})	0.027	-0.104	0.131	0.136 (x_{14})
16	Marketable surplus (x_{16})	0.019	0.314	-0.295	-0.406 (x_{17})
17	Marketed surplus (x_{17})	0.001	-0.412	0.413	0.31 (x_{16})
18	Dependency ratio (x_{18})	0.179	-0.071	0.250	0.07 (x_4)

Residual effect: 0.255; Highest individual indirect effect: Size of land holding (acre) (x_7) (5).

with business skills to encourage entrepreneurship, innovation, and brand development. The sheer size of the farm becomes less significant when compared to the increasing influence of climate and the ecosystem on farmers' undertakings.

In summary, these findings emphasize the need to transcend the sole consideration of land size and concentrate on factors like training, market connectivity, value enhancement, and the overarching business environment. This comprehensive approach is crucial for facilitating small-scale farmers' access to entrepreneurial information from cosmopolite sources, thereby contributing to their overall success and sustainability in the evolving agricultural landscape.

The findings presented in Table 5. provide an insightful breakdown of the results derived from the path analysis. This analytical approach dissects the overall influence of the exogenous variable on the subsequent variable, considering direct, indirect, and residual effects. The analysis underscores the pivotal role of education (x_2) in shaping the acquisition of Entrepreneurial information from localite sources (y_2). Particularly noteworthy is the Education variable's substantial sixfold indirect impact, which stands out among all variables. This underscores the multifaceted significance of education, not solely due to its pronounced direct influence but also its pervasive indirect contributions.

Additionally, it is noteworthy that a portion of about 20.10% of the variability in Entrepreneurial information received from localite sources (y_2) remains unaccounted for by the encompassed exogenous variables in the analysis. This observation suggests that elements beyond the parameters considered in this study could potentially contribute to the intricate process of acquiring entrepreneurial information.

It is noteworthy to observe that the correlation coefficients between entrepreneurial information received from cosmopolite sources (y_1) and entrepreneurial information received from localite sources (y_2), in relation to the 18 independent variables (x_1-x_{18}), have been delineated through the analysis. The findings reveal that education (x_2), years of experience

Table 5: Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Entrepreneurial Information Received from Localite Sources (y_2)-

S.No.	Variables	Total effect	Direct effect	Indirect effect	Highest indirect effect
1	Age (x_1)	-0.035	0.002	-0.037	0.054 (x_{17})
2	Education (x_2)	**0.760**	0.414	0.346	0.142 (x_3)
3	Year of experience (x_3)	0.521	0.260	0.261	0.225 (x_2)
4	Family size (x_4)	0.341	0.368	-0.027	-0.052 (x_{17})
5	Mean family education (x_5)	0.536	0.237	0.299	0.176 (x_2)
6	Material possessed (x_6)	-0.250	-0.082	-0.168	-0.103 (x_2)
7	Size of land holding (acre) (x_7)	0.012	**-0.433**	**0.445**	0.234 (x_{12})
8	Size of homestead land acre (x_8)	0.145	-0.016	0.161	0.076 (x_2)
9	Size of cultivated land acre (x_9)	0.317	0.152	0.165	-0.294 (x_7)
10	Size of land under irrigation acre (x_{10})	0.018	0.098	-0.080	-0.427 (x_7)
11	No of fragment (x_{11})	0.061	-0.018	0.079	-0.36 (x_7)
12	Crop yield (q) (x_{12})	0.068	0.256	-0.188	-0.397 (x_7)
13	Cropping intensity (%) (x_{13})	0.179	0.142	0.037	0.087 (x_2)
14	Per Capita Income (x_{14})	0.023	0.141	-0.118	-0.09 (x_{15})
15	Per Capita Expenditure (x_{15})	0.040	-0.098	0.138	0.129 (x_{14})
16	Marketable surplus (x_{16})	0.033	0.261	-0.228	-0.337 (x_{17})
17	Marketed surplus (x_{17})	0.017	-0.342	0.359	0.257 (x_{16})
18	Dependency ratio (x_{18})	0.184	-0.064	0.248	0.063 (x_2)

Residual effect: 0.201; Highest individual indirect effect: Education (x_2) (6)

(x_3), family size (x_4), and mean family education (x_5) exhibit significant correlations with both sources of entrepreneurial information. This signifies that members' educational attainment, cumulative years of experience, family size, and the educational level of their family members collectively impact their engagement with entrepreneurial insights from diverse sources.

Similarly, the stepwise regression analysis has revealed that the following four variables - education (x_2), years of experience (x_3), family size (x_4), and mean family education (x_5) - have maintained their significance as pivotal variables for both dependent variables.

The binary path analysis for both consequent variables highlights the fact that the size of land holding (x_7) has the highest individual direct and indirect effect on Entrepreneurial Information Received from Cosmopolite Sources (y_1), whereas Education (x_2) has the highest individual direct and indirect effect on Entrepreneurial Information Received from Localite Sources (y_2). These findings reveal how factors like education, years of experience, family-related aspects, and land ownership all come together to shape FPO members communicate about their businesses. This understanding allows us to create communication strategies that suit each member's unique situation, ultimately boosting the effectiveness of their entrepreneurial pursuits.

CONCLUSION

In the dynamic agricultural landscape of West Bengal, the emergence of Farmer Producer Organizations (FPOs) has ignited a transformative shift, addressing the challenges faced by small and marginalized landholders. These organizations play a pivotal role in countering fragmentation and limited resources by providing essential market support to local farmers. As FPOs transition into Farmer Producer Companies, the need for a robust entrepreneurial communication strategy becomes apparent, encompassing the dissemination of market information, strategic customer positioning, and the enhancement of product value. Delving into variables like age, education, years of experience, family size, mean family education, and

cultivated land acreage, the study reveals their intricate impacts on entrepreneurial communication within FPOs, particularly concerning the localite and cosmopolite information systems. Age and experience contribute to a nuanced understanding of the local agricultural context, allowing experienced members to adeptly navigate market dynamics and share invaluable insights. Education and mean family education emerge as pivotal influencers, enhancing members' ability to engage in sophisticated communication strategies, adapt to technological advancements, and grasp the complexities of modern markets. Family size influences communication patterns, potentially shaping the exchange of entrepreneurial insights. Meanwhile, the size of cultivated land acreage is intertwined with members' engagement in entrepreneurial activities, influencing their need for diverse information sources. These variables collectively underscore the multifaceted nature of entrepreneurial communication within FPOs, orchestrating the blend of traditional wisdom and contemporary market intelligence, both from cosmopolite and localite sources. By harnessing and understanding the influences of these variables, FPOs empower their members to effectively navigate both local and global information systems, catalyzing sustainable growth and bolstering resilience in the agricultural sector.

The integration of traditional knowledge with global insights through effective entrepreneurial communication propels FPOs toward sustainable growth, improved livelihoods, and enhanced rural development, making them catalysts for progress amid West Bengal's agricultural transformation. This study ultimately underscores that the communication strategies adopted by FPOs, considering both cosmopolite and localite dimensions, have profound implications for the future of agriculture in the region, steering economic growth, inclusivity, and resilience in the face of evolving challenges.

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Impact of Cluster Frontline Demonstration (CFLD) on Yield Improvement of Mustard Crop in Koderma District of Chhota Nagpur Plateau of Jharkhand

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ABSTRACT

The present study was conducted in Koderma district in Chhota Nagpur Plateau of Jharkhand situated at Central North-Eastern Plateau at 275-670 m above mean-sea level where average annual rainfall was 1198.35 mm during the years 2021 and 2022 in Koderma district Krishi Vigyan Kendra, Koderma, Jharkhand conducted 308 Cluster Front Line Demonstrations on Mustard crop in an area of 80 ha under rain fed condition in the farmer's fields of the selected villages viz. Chehal, Gopaldih and Sardarodih of Koderma Jharkhand. The objective of the CFLD was to transfer the technology to increase the productivity and quality of mustard crop. Various types of interventions viz., Varietal replacement, Seed treatment, time of sowing, Plant Protection measures, Irrigation management and INM. High yielding Mustard variety Pusa Mustard-30 (PM-30) was given to the farmers and for basal application 120 kg N, 60 kg P_2O_5, 30 kg K_2O and 20 kg S per hectare as per recommendation in demonstration plots were advised. The seed was treated with fungicide before sowing. It was observed that in cluster front line demonstrations, the improved Mustard variety Pusa Mustard-30 recorded an average yield of 985 and 1290 kg/ha which was much higher than the average yield of farmers practice 680 and 700 kg/ha, respectively during 2021-22 and 2022-2023 The average percentage increase in the yield over farmer's practices was 44.85 and 84.28 for the year 2021-2022 and 2022-2023, respectively. The technology gap was found 916 kg to 611 kg over the potential yield. The highest extension gap of 590 kg/ha was recorded in 2022-2023 and the lowest was observed 305 kg/ha in 2021-2022. From these results, it is evident that the performance of improved variety was found better than the local check under the same environmental conditions.

Keyword: Mustard, Yield improvement, Pusa Mustard-30, CFLD

INTRODUCTION

The Indian agriculture has been considered as backbone of Indian economy. Mustard (*Brassica juncea*) is one of the first oilseed crops in rabi season. India is the third largest producer of rapeseed after China and Canada (Directorate of Economics and Statistics, 2015). Mustard crop is one of the most important crops adopted by the farmers in the Koderma district in Chhota Nagpur Plateau of Jharkhand India. This is a potential crop in winter (*rabi*) season due to its wider adaptability and suitability to exploit residual moisture. The area under major oilseeds viz., groundnut, sesame, rapeseed, mustard, linseed, castor, soybean, cottonseed, sunflower, safflower and niger seed occupied 20 per cent net area sown across India (Ministry of Agriculture, 2014). It must, however, be noted that the production of oilseeds has always fallen short of national demand and overwhelm import of oilseeds has been ultimate option. The total oilseeds production in the country recorded during 2016-17 was about 35.40 million metric tons. It is widely cultivated in tropical and sub-tropical areas of the world. Globally, it is mainly cultivated in India. The oilseeds contribute second largest agricultural commodity in India. Among the edible oilseeds crops, Rapeseed & mustard occupies

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an important position in Indian oilseeds scenario. Indian mustard is the most important member of the group, accounting for more than 70 per cent of the area under rapeseed-mustard, followed by toria, yellow sarson and brown sarson. Rapeseed and mustard are the third most important edible oilseed crops of the world after soybean and oil. In India, it is grown in 26 states and union territories. The total production (9.34 m tones) of the country, Rajasthan, Uttar Pradesh and Haryana accounts for over 69.07 per cent during 2019-20. Nearly 30 per cent area under rapeseed mustard is under rain-fed farming. The highest productivity is in Jharkhand (6.76 q/ha), with overall national yield of 14.99 q/ha. In Koderma district of Jharkhand, the productivity of mustard was 7.92 q/ha during 2016-2020. Mustard is an important oilseed crop of the district and still a vast yield gap exists between potential yield and the yield obtained under real farming situation. This may be due to partial adoption of recommended package of practices by the mustard growers. Technology gap is a major problem in increasing mustard production in the region of the State. Due to its low water requirement (80-240 mm), rapeseed-mustard crops fit well in the rain-fed cropping system. Rapeseed-mustard is the major source of income especially even to the marginal and small farmers in rain-fed areas. Since these crops are cultivated mainly in the rain-fed and resource scarce regions of the country, their contribution to livelihood security of the small and marginal farmers in these regions is also very important So far, not much systematic effort was made to study the technological gap existing in various components of mustard cultivation. The government of India has introduced National Mission on Oilseeds and Pulses, with a vision to increase production of vegetable oils sourced from oilseeds. Keeping this in view, front line demonstrations were organized in participatory mode with the objective to analyze the yield gaps in mustard cultivation on the newly recommended package of practice.

MATERIALS AND METHODS

The present study was carried out by Krishi Vigyan Kendra (ICAR-NRRI) Koderma Jharkhand during *rabi* seasons from 2021-2022 to 2022-2023 in the farmers field of Koderma district. During these two years of study, an area of 80 ha was covered with plot size 0.4 ha under cluster front-line demonstration with active participation of 308 farmers. Before conducting CFLDs, a list of farmers was prepared from group meeting and specific crop cultivation training was given to the selected farmers regarding package of practices of mustard. The difference between demonstration package and existing farmers practices are given in Table 1. The improved technology included high yielding varieties, seed treatment, soil preparation, sowing time, line sowing, maintenance of optimum plant population, recommended fertilizer management, plant protection management etc. The sowing was done in the month of mid-October with spacing of 45 ×15 cm apart keeping the seed rate of 5-6 kg/ha. The fertilizers were given as per soil testing however, the average recommended dose of fertilizer applied in the demo plots was 120 kg N, 60 kg P_2O_5, 30 kg K_2O and 20 kg S per hectare. The NPK and S fertilizers were applied through urea, DAP, MOP and elemental S, respectively. Thinning and first-hand weeding within lines was done at 20-25 days after sowing and second-hand weeding was done at 45-50 days after sowing, if necessary. In demonstration plots, critical inputs in the form of quality seeds of improved varieties, timely weeding, need based of insecticide and pesticides as well as balanced fertilization, irrigation at critical stages were emphasized by the KVK and comparison has been made with the existing practices (Table 1). The traditional practices were maintained in case of local check. The data were collected from both CFLD plots as well as control plots and finally the extension gap, technology gap, technology index along with the benefit cost ratio (BC ratio) were worked out (Samui *et al.,* 2000) as given below

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmer's yield

Technology index = Technology gap / Potential yield X 100

RESULTS AND DISCUSSION

The data presented in Table 2 indicated that after Cluster front line demonstrations (CFLD) majority of the farmers got aware of the importance of variety to increase the yield. Out of total beneficiary farmers, 85.06 per cent farmers reported the importance of variety in the enhancement of yield. Likewise, significant awareness was reported by the beneficiary farmers in the field of seed rate (82.46%), insect pest management (78.24%), seed treatment (76.62%) nutrients

Table 1: Comparison of CFLD cultural practices V/S traditional practices on Mustard crop

Particulars	Cluster front line demonstration practices	Traditional practices
Farming situation	Rainfed	Rainfed
Variety	Pusa Mustard -30 (PM-30)	Local
Seed treatment	Seed treatment with Carbandazime 2 g/kg seed	Nil
Time of sowing	The first fortnight of October	Last week of October
Method of sowing	Line sowing	Broadcasting
Irrigation	1-2 light irrigation	Nil
Weeding	1-2 manually weeding	Nil
Seed rate	5-6 kg/ha	8-10 kg/ha
Fertilizer dose	120 kg N, 60 kg P_2O_5, 30 kg K_2O and 20 kg S per hectare	80 kg N, 40 kg P_2O_5
Plant protection measurement	Seed treatment with Carbandazime @ 2 g/kg seed + Trichoderma @ 5 g/kg seed and spraying of Imidacloprid 17.8 SL@ 0.2 ml g/liter of water to protect the crop against aphid	Nil

Table 2: Extent of adoption of recommended technology (N= 308)

Improved technology	Before CFLD		After CFLD		Rank
	Number	Percentage	Number	Percentage	
Selection of suitable variety	149	48.37	262	85.06	1
Seed rate (kg/ha)	141	45.77	254	82.46	2
Seed treatment	128	41.55	236	76.62	4
Sowing time	118	38.31	215	69.80	6
Use of culture	82	26.62	180	58.44	10
Nutrient management	120	38.96	224	72.72	5
Irrigation management	106	34.41	205	66.55	7
Insect Pest management	135	43.83	241	78.24	3
Weed management	97	31.49	202	65.58	8
Spray technology	88	28.57	198	64.28	9

management (72.72%), and sowing time (69.80%) The highest adoption was reported in the awareness of variety. Before the conduction of the demonstration less then 50 per cent of farmers were aware of the improved variety of mustard crop but after the demonstration majority of the farmers got aware of improved varieties. Before the introduction of demonstrations in the area vary few farmers were aware of the use of spray technology (28.57%) and culture (26.62%), weed management (31.49%). The majority of the farmers raised their crops without seed treatment either culture or pesticides and they sow their crop with the broadcasting method. After the introduction of cluster front-line demonstrations, farmers become aware in these areas also and reported an increase in awareness to the tune of 26.62 per cent in the use of culture, 28.57 per cent in spray technology, 31.49 per cent in weed management and 34.31 per cent in the irrigation management. An increase in awareness in agronomical practices due to demonstrations was also reported by Yadav *et al.* (2012) and Singh *et al.* (2016). Performance of CFLD In the study, a comparison of productivity levels between demonstrated variety and local checks is shown in Table 3. It was observed that in cluster front line demonstrations, the improved mustard variety Pusa mustard-30 recorded an average yields of 985 and 1290 kg/ha which was much higher than average yields of farmers practices 680 and 700 kg/ha, respectively during 2021-2022 & 2022-2023. The average percent increase in the yield over farmer's practices was 44.85 and 84.28 for the year 2021-2022 & 2022-2023,

respectively. From these results, it is evident that the performance of improved variety was found better than the local check under the same environmental conditions. Farmers were motivated by the results of agro-technologies applied in the CFLDs trials and it is expected that they would adopt these technologies in the coming years. This finding is in corroboration with the findings of Prajapati and Kumar (2012) and Singh *et al.* (2016) who have also highlighted that adoption of an improved package of practices can fetch higher yields the fill the gap between production potential and production obtained.

Data in Table 3 reveals that the technology gap shows the gap in the demonstration yield over potential yield and it was 916 and 611 kg/ha for the years 2021-2022 & 2022-2023, respectively while in 2021-2022 yield of the demonstration was 916 kg/ha more than potential yield. The cluster front-line demonstrations were laid down under the supervision of KVK scientists at the farmer's field. There exists a gap between the potential yield and demonstration yield first three years. This may be due to soil fertility and weather conditions. Hence, location-specific recommendations are necessary to bridge the gap. These findings are similar to the findings of Prajapati and Kumar (2012) who have also reported that frontline demonstration plays a vital role in minimizing the technological gap through the supply of critical input with updating of technological aspects The highest extension gap of 590 kg/ha was recorded in 2022-2023 and the lowest was observed 305 kg/ha in the year 2021-2022. This emphasized the need to educate the farmers through various means for adoption of improved agricultural production technologies to reverse this trend of the wide extension gap. More and more use of the latest production technologies with high yielding variety will subsequently change this alarming trend of galloping extension gap. The new technologies will eventually lead the farmers to discontinue the old technology and to adopt new technology (Table 3). This finding is in corroboration with the findings of Lepcha *et al.* (2015).

The technology index shows the feasibility of the evolved technology at the farmer's fields and the lower the value of the technology index more is the feasibility of the technology (Jeengar *et al.,* 2006). The technology index was 7.1, 13.18 and 16.11 per cents for the years 2019-2020, 2020-2 and 2021-2022, respectively (Table 3).

The economics of mustard production under cluster frontline demonstration was estimated and the result of the study has been given in Table 4. The inputs and outputs prices of commodities prevailed during the study of demonstrations were taken for calculating gross return, cost of cultivation, net return and benefit: cost ratio. The cultivation of mustard under improved technologies gave higher net returns of Rs. 32135 and 47350 /ha in 2021-22 & 2022-2023, respectively as compared to farmers practices of Rs. 17080 and 20300. The benefit-cost ratio of mustard crop cultivation under improved technologies was 2.77 and 3.00 as compared to 1.97 and 2.11 under farmer's

Table 3: Productivity, technology gap, extension gap and technology index of mustard crop under CFLDs

Year	Area (ha)	No. farmers	Yield (q/ha)			Percentage increase over FP	Tech. gap (q/ha)	Ext. gap (q/ha)	Tech. index
			Potential	FP	DP				
2021-2022	30	122	19.01	6.8	9.85	44.85	9.16	3.05	48.18
2022-2023	50	186	19.01	7.0	12.9	84.28	6.11	5.90	32.14

Table 4: Cost of cultivation, gross return, net return and B:C ratio as affected by Demonstrate and farmers practice of mustard crop under CFLDs

Year	Cost of cultivation (Rs./ha)		Gross return (Rs./ha)		Net return (Rs./ha)		B:C ratio	
	DP	FP	DP	FP	DP	FP	DP	FP
2021-2022	18100	17600	50235	34680	32135	17080	2.77	1.97
2022-2023	23600	18200	70950	38500	47350	20300	3.00	2.11

P = Farmers practice, DP = Demonstration practice

practices. This may be due to higher yields obtained under improved technologies compared to local checks (farmer's practice). This finding is in corroboration with the findings of Mishra *et al.* (2009) and Raj *et al.* (2013).

CONCLUSION

Thus, the findings of the study revealed that a wide gap existed in potential and demonstration yield in high yielding mustard varieties due to the technology and extension gap in Koderma District of Jharkhand. By conducting cluster front line demonstrations of proven technologies, the yield potential of mustard can be increased to a great extent. This will substantially increase the income as well as the livelihood of the farming community. The study emphasizes the need to educate the farmers in the adoption of improved technology to narrow the extension gaps through various technology transfer centers. Therefore, it is suggested that these factors may be taken for consideration to increase the scientific temperament of the farmer.

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Assessing Efficacy of Portable Public Address System during Off Campus Training Programmes in Harda District of Madhya Pradesh

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ABSTRACT

The transfer of new proven technology and innovation among farming community is the main mandate of Krishi Vigyan Kendras in India, for which the KVK regularly organizes different kinds of training programmes like trainings for rural youth, for extension personnel's, trainings for farmers and farm women, trainings for unemployed rural youths, skill development trainings, sangoshthies etc. through on campus and off campus both. Here the success of the trainings or efforts of KVKs depends upon the technological adoption rate and technology replacements rate that may be improve by the farmers if they learns the things seriously, understands the technology gap, and increases their interest in change the present practices. This may be done by quality extension trainings only, for this purpose the efforts were made by KVK Harda to provide off campus trainings programmes to the farmers by using portable public address system which yields very good results in better understanding, time saving in assembling at training spot, increase learning experiences, improves hearings of the message which results in better adoption of new technologies and better production in the district.

Keywords: Assessing, Efficacy, Off campus training programmes, Portable public address system

INTRODUCTION

In the present modern era of information communication numerous way of communication is being used by the public to communication their feelings among each other and in-group or at mass level. Here we are focusing on group speaking or addressing by the public sector institution called as Krishi Vigyan Kendra. This district level institutions is working with the mandate of providing different kind of training to different segment of the people of rural setting especially in agricultural sector for their self reliance, self-employment and for being self dependent by adopting agricultural based small enterprises and improved production technology and crop and animal management. The Krishi Vigyan Kendra identifies the technical and entrepreneurial thrust of farmers and unemployed rural youth. As per need of location specific farmers they provide training to them through on campus and off campus mode. In the present study we conducted research efforts on the participants which were participated in off campus training programmes organized by KVK Harda MP by using portable public address system. This system was found very useful to collect farmers at training spot simultaneously it improves the number of participants in the training including with their sound attention and maintain discipline during the programme more in comparison to earlier provided training as off campus to the farmers without using this device.

The public address system was used by department of agriculture to address few major agricultural problems of Konkan region for better cultivation of Rice with the sole aim of keeping the local farmers up to date with the latest rice crop cultivation techniques (Jamdade, 2011). PAS system can improve speech effectively (Sakae *et al.,* 2005 and Lundin, 1986), digital

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public address system found good for teaching in Tiawan (Lin *et al.,* 2013), it also meets the vocal requirement in the given environment (Knesebeck *et al.*, 2010).

The portable public address system is an electronic device equipped with the microphone, amplifier and loudspeaker etc. Knesebeck *et al.* (2010). This device is found much useful to maintain decorum and peace, attention during the training programme for addressing the farmers and rural youth.

Public address system may also define as this is an immediate way to address everyone at a given location. It is a very effective form of communication to communicate a large group of people even targeted or non targeted both. It has immense importance in the modern era of communication where numerous updated and innovative devices are available for communication among people.

Such devices may provide many advantages such as; 1. Reduced maintenance 2. Economical cabling 3. Flexibility for longer distance connectivity 4. Ability for expansion 5. Monitoring the system 6. No alternate current power source required. (https://www.google.com/search?q=need+of+public+address+system&rlz=1C1CHBF_enIN852IN852&oq=need+of+public+address+system&aqs=chrome..69i57.11685j0j15&sourceid=chrome&ie=UTF-8)

This is very unique and novice experiments were conducted by the extension scientist of KVK, Harda during 2016-2020. The main objective of this experiment was to increase participation, attention and time saving in collection of farmers at training spot in the village for successful conduction of training programme. (https://en.wikipedia.org › wiki › Public_address_system)

MATERIALS AND METHODS

Krishi Vigyan Kendra is a district level extension unit of Vishwa Vidyalaya working for transfer and testing different technologies at different location to verify its potential and appropriateness in local climatic and weather conditions for better production and profitability for farmers to boost their economic status and social life. The present study was conducted in the Harda district of Madhya Pradesh during 2016 to 2020 regularly. The off campus training were given to farmers by using portable public address system by KVK, Harda for easy understanding, listening, and attention of farmers during training programme. Earlier to this off campus training were conducted without using portable public addressing system by the same KVK. This innovative idea was implemented by the extension scientist of KVK, Harda for the better learning situation of the farmers to enhance adoption rate of technologies in Harda district of MP. The feedback of the beneficiaries' farmers was collected though well developed interviews schedule. The total 600 famers were interviewed during the whole study period. In this way responses of farmers for total five years' were recorded for the statistical analyses. The major statistical tools like percentage, mean, average, standard deviation etc. were exercised in this study.

RESULTS AND DISCUSSION

The average data shown in the Table 3 clearly represents the importance and efficacy of portable public address system used during off campus trainings programmes of farmers. The number of turning were

Table 1: Result found as per performance indicators /variables of the trial without use of public address system

Variables	Year					Mean
	2015-16	2016-17	2017-18	2018-19	2019-20	
Number of OFF campus training programmes conducted by KVK	27	25	28	20	8	21.6
Total No. of Participants	769	677	816	589	228	615.8
Average Participation	28.48	27.08	29.14	29.45	28.5	28.53
Time taking by farmers to assemble at training spot (Minute)	25-30	25-28	25-27	26-29	26-30	25.4-28.8

This Table 1 reflects data of off campus training programmes variable wise as noted during conduction of the programme without using the public address system.

Table 2: Result found as per performance indicators /variables of the trial with public address system

Variables	Year					Mean
	2015-16	2016-17	2017-18	2018-19	2019-20	
Number of OFF campus training programmes conducted by KVK	27	25	28	20	8	21.6
Total No. of Participants	1076	956	1082	795	325	846.8
Average Participation	39.85	38.24	38.64	39.75	40.62	39.42
Time taking by farmers to assemble at training spot (Minute)	18-20	12-18	12-15	12-15	10-14	12.8-16.4

This Table 2 reflects data of off campus training programmes variable wise as noted during conduction of the programme with use the portable public address system.

Table 3: Comparison between Results of different variables of the off campus trainings with public address system and without public address systems

Variables	Mean/average of different training variables with portable public address system	Mean/Average of different training variables without use of portable public address system
Number of OFF campus training programmes conducted by KVK	21.6	21.6
Total No. of Participants	846.8	615.8
Average Participation	39.42	28.53
Time taking by farmers to assemble at training spot (Minute)	12.8-16.4	25.4-28.8

assessed the same hence the variable number of off campus trainings programmes conducted by KVK shows the same in both the columns i.e. 21.6.

The variable number two denoted the total number of participants participated in the trainings programs. It is loud clear that the total participants under trainings programmes during use of public address system (846.8) are more then to non use of public address system (615.8) i.e. 231 more participant or 37.51 per cent more participants over the non use of public address system during the off campus training programmes in Harda district.

The variable number 3 reflects the average participation in the off campus training programme, where as the participation of farmers was found more when the public address system was used during off campus training programme i.e. 10.89 means 38.17 per cent more participation over the non use of public address system.

The variable number 4 reflects the average time taking by the farmers to get assembled at training spot in minutes. Here, the average time was taken by farmers/participants is less when there was use of public address system i.e. 12.8-16.4 minutes only. Whereas when public address system was not used during the programmes the time was taken by farmers /participants more i.e. average 25.4-28.8 minutes. It again clears that the use of portable public address system during off campus trainings programmes may save time assembling of famers at training spot.

It may be concluded that the use of portable public address system during off campus training programmes in Harda district of Madhya Pradesh was found efficient to organize training programme in less time with huge participants successfully.

The Table 4 explore that the mean average 87.6 per cent participants /farmers showed favorable attitude towards use of public addressing system during off campus trainings programmes of KVK Harda. It also reveals that the public addressing system was found very suitable information communication tool to boost no. of participants per programme and early assembling of farmers in less time at training spot in the village during organization of off campus training

Table 4: Change in attitude of farmers towards off campus KVK training programmes with use of public address system

Variables	Year					Mean
	2015-16	2016-17	2017-18	2018-19	2019-20	
Change in attitude of farmers towards KVK training programmes						
Favorable	89	90	86	87	86	87.6
Un Favorable	4	3	6	5	6	4.8
Undecided	7	7	8	5	8	7.0

programmes, so must be generalized in KVK system of India. Farmers also admitted as good practice for old and young farmers for better attention and hearing of the message during the programmes.

CONCLUSION

Public address system has wide range publicity and use. It may give new heights to communication process if being adopt in off campus training programees of Krishi Vigyan Kendras. The farming community of district realized very effective technology and get agreed to use it for better understanding of the message. An average 87.6 per cent participants /farmers showed favorable attitude towards use of public addressing system during off campus trainings programmes of KVK Harda. The use of portable public address system during off campus trainings programmes may save time assembling of famers at training spot. The 38.17 per cent more participation was observed over the non use of public address system. The use of portable public address system yields very good results in better understanding, time saving in assembling at training spot, increase learning experiences, improves hearings of the message, increases interest in learning which results in better adoption of new technologies and better production in the district.

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Impact of Mushroom Production Training on Knowledge, Attitude and Practice of Rural Women and Their Empowerment

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ABSTRACT

Impact of Mushroom production training on Knowledge, Attitude and Practice of Rural Women and their Empowerment of was conducted in Assam. For the study 100 rural women were randomly selected from the operational villages of five selected KVKs, where 50 respondents were participants of the vocational training on Mushroom Production and equal numbers were nonparticipants. Personal interview was conducted using a knowledge test, one attitude scale and interview schedule for collection of data. The findings reflect that highest percentage participant respondents had medium level of knowledge on Mushroom production and highest percentage had moderately favourable attitude. Regarding extent of adoption, highest percentage respondents fall in medium level of adoption. Participant respondents had more knowledge, better level of adoption than the nonparticipant respondents. Around 54.00 per cent respondents had started mushroom production for income generation and out of this, 55.56 per cent earned less than Rs. 500 whereas 29.63 per cent could earn Rs. 501 to 1000. Regarding level of empowerment, 50.00 per cent acquired high level of empowerment from earlier 24.00 per cent. Among the participant respondents, average economic empowerment was 65.03 which increased up to 76.73 and psychological empowerment had a very large improvement from 39.71 to 68.67 per cent whereas among the nonparticipants the highest gain was observed in economic empowerment which was from 66.22 to 71.03per cent. The findings reflect that vocational trainings organized by KVKs are instrumental in increasing the income of the trainees as well as their level of empowerment in different dimensions.

Keywords: Impact, Mushroom training, Knowledge, Attitude, Adoption, Empowerment, Rural women

INTRODUCTION

Krishi Vigyan Kendra (KVK) is an innovative science based institution at district level with the vision of science and technology-led growth for enhanced productivity, profitability and sustainability of agriculture. The objectives of KVK includes solving the problem of unemployment in the rural areas by providing training and advisory services, strengthening the allied enterprises other than crop production, increasing the production and productivity in the area of main crops and other enterprises, educating the farming community and making them economically and socially sound, disseminating new, proven and economically viable technologies in the area etc. In order to achieve these objectives, KVKs organize different extension activities such as On Farm Trial, Front Line Demonstrations as well as short and long-term vocational trainings in agriculture and allied vocations for the farmers, farm women and rural youths with emphasis on "learning by doing" for higher production and generating self-employment. The vocational trainings may generate diversified livelihood and can create a pool of human resources who are capable of ensuring livelihood security for themselves and for their family. The first KVK in Assam was established way back in 1981 in Sonitpur district under administrative control of Assam Agricultural University (AAU), Jorhat. Since then there has been considerable growth of KVKs in the state. At present 26 KVKs are functioning in the state out of which twenty three

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KVKs are under the administrative control of AAU. These KVKs have been conducting different mandated activities and other extension activities in their respective districts. A large number of highly qualified manpower is engaged and huge amount of budgets are allotted by Government of India to the KVKs for technology transfer. Despite the plethora of technologies developed by the scientists and efforts are being made for transferring such technologies to the ultimate users, the impact in terms of knowledge gain, change in attitude, level of adoption and change in level of income as well as other dimensions of impact is not known until and unless studies are conducted with such parameters.

Mushroom production is such a technology which needs less area than other agricultural crops and is primarily an indoor activity. It can be profitably started with small capital by landless farmers, unemployed youths, rural women and other entrepreneurs and may contribute in strengthening the allied enterprises other than crop production as source of income for diversification of agriculture. It has the ability to improve people's lives directly by delivering economic, dietary and therapeutic benefits. Mushroom growing can also aid in the conversion of agricultural and forest wastes into valuable stuff and can reduce pollution in the environment. Hence Mushroom cultivation may provide different important contributions such as the creation of healthy foods, manufacturing of nutraceuticals, providing gainful livelihood and the reduction of pollution. The climatic condition of Assam is suitable for several mushroom varieties including Oyster mushroom. Having seen the importance, many KVKs used to organize vocational trainings on Mushroom Production. However, the challenge lies with the KVKs is how effectively such technology is being transferred and what outcomes it can yield for the benefit of the target group. Further available literature reveals that in Assam such studies especially on impact of technology transfer by KVKs on rural women have not been undertaken. In this context, the present study was conducted to assess the impact of training programmes on the participants in terms of knowledge, attitude and practice of the trainees and adoption of mushroom production as an enterprise, the economic benefits it could fetch and empowerment of rural women.

MATERIALS AND METHODS

The study was carried out in the state of Assam where 23 numbers of KVKs are functioning under administrative control of AAU, Jorhat. For selection of respondents, five KVKs were identified based on the number of vocational trainings conducted on 'Mushroom production' in the preceding five years of the study. A list of rural women who participated in the vocational trainings on 'Mushroom production' conducted by the KVK was prepared considering certain criteria. From the prepared list, ten respondents under each KVK were selected using simple random sampling method. Thus total fifty participant respondents were selected from five KVKs. An equal number of rural women were selected as control group for comparing the level of knowledge, attitude and practice with the participant respondents. The non-participant respondents were randomly selected from participants' village. The socio-economic status was studied with nine different indicators. For assessing the knowledge of participants on mushroom production, one knowledge test on mushroom production was developed with dichotomous questions containing 32 statements under seven sub heads. For each correct answer, assigned score was "1", otherwise "0". Score of knowledge test for individual respondent was calculated and based on the mean and SD of the obtained scores, respondents were categorized as 'Low level of knowledge', 'Medium level of knowledge' and 'High level of knowledge'. Attitude of the respondents towards mushroom production was measured using a Likert type attitude scale with 25 attitude statements. Response for each item was recorded on a five point continuum scale *viz.,* 'Strongly agree', 'agree', 'undecided', 'disagree' and 'strongly disagree', with a scoring pattern of 5,4,3,2 and 1 respectively for positive items and 1,2,3,4 and 5 respectively for negative items. Total attitude score for each respondent was obtained by summing up the scores of all items. Based on the mean and SD of the obtained scores, respondents were categorized as below:

Category	**Score**
Less favourable attitude	Below (X-SD)
Moderately favourable attitude	'X-SD to'X+SD
Highly favourable attitude	Above (X+SD)

Ranking of attitude statements was done based on the responses of the participant respondents.

Adoption for the present study refers to the decision of the respondents to practice the technology which was learnt during the vocational training on Mushroom production. To study the extent of adoption the response categories were 'Complete adoption', 'partial adoption' and 'no adoption' and assigned scores were 2, 1 and 0 respectively. Based on the obtained scores, respondents were categorized as Low, medium and high. In addition, ranking of practice was done according to obtained score by each practice. Further, status of adoption was studied in terms of starting of mushroom production as income generating activities by the participants after receiving the vocational training. Response codes assigned for different categories of status of adoption were as below:

Categories	Code
Not yet started mushroom production	1
Started mushroom production for household-consumption	2
Started mushroom production for income generation	3
Started mushroom production, but discontinued	4

Socio-economic empowerment defines increased level of autonomy in different dimensions of life. As all the dimensions of empowerment is closely intertwined, for the present study, Socio economic empowerment of rural women is operationally defined in terms of change in economic, social, political, psychological and legal aspects. Based on the Empowerment Index, the respondents were categorized as 'Low level of empowerment', 'Medium level of empowerment' and 'High level of empowerment' by calculating the percentile where '1' is considered as highest level of empowerment and '0' for no empowerment.

Since the study focuses on impact of the vocational trainings on socio economic empowerment, therefore 'before' and 'after' exposure of the participant respondents were calculated in terms of change in level of empowerment. Nonparticipant respondents were asked about the earlier position and the transformation taken place in their status after the last five years. Responses for the nonparticipants were also recorded as 'before' and 'after'. Further, average empowerment for each dimension was calculated and compared the level of empowerment indicating the change.

RESULTS AND DISCUSSION

The socio-economic status of participants of the vocational training on Mushroom Production and non-participants were studied with nine indicators and data presented in Table 1. The data shows that the socio-economic status of both the category of respondents is comparable. Highest percentage of respondents from both participant and non-participant category belonged to medium socio economic status with 72.00 and 70.00 per cent respectively, 16.00 per cent of from both participant and non-participant belonged to high Socio-economic status followed by low socio-economic status. The mean value of both the categories also does not have huge gap. For the participant respondents mean was 42.57 whereas 40.47 was the mean for the non-participants.

Knowledge of respondents on mushroom production was assessed in terms of health and nutritional benefits of mushroom, suitable mushroom varieties for climatic condition of Assam, substrate preparation, spawning, incubation in dark cropping room, inter-culture management, harvesting, post-harvest processing etc. The data presented in the Table 2 reflects that a large majority (84.00%) of the participant respondents had medium level of knowledge, whereas equal percentage (i.e. 8.00%) had low and high level of knowledge. The finding is in line with Sonam (2018) where it was reported that 75.00 per cent respondents had medium level of knowledge.

Table 1: Distribution of participant respondents according to their Socio economic Status

Category	Participants (n_1=50)			Non-Participant (n_2=50)		
	Frequency	Percentage		Frequency	Percentage	
Low	6	12.00	Mean: 42.57	7	14.00	Mean: 40.47
Medium	36	72.00	SD: 10.79	35	70.00	SD: 11.24
High	8	16.00		8	16.00	

Table 2: Distribution of respondents according to knowledge on mushroom production

Level of knowledge	Participant (n_1=50)			Non-participant (n_2=50)		
	Frequency	Percentage		Frequency	Percentage	
Low	4	8.00	Mean: 20.83	3	6.00	Mean: 4.56
Medium	42	84.00	SD: 4.05	41	82.00	SD: 3.21
High	4	8.00		6	12.00	

It is observed that among the nonparticipant respondents majority belonged to medium category with 82.00 per cent, however the mean value was found to be very low i.e. only 4.56. It may be inferred that there was noticeable knowledge gap between the participant and nonparticipant respondents as the mean score of knowledge of the participant respondents was 20.83.

Ranking of knowledge on mushroom production is presented in Table 3 and it is observed that 'substrate preparation' ranked I with the highest mean score 0.90 and 'Importance of Mushroom production' ranked II with mean score 0.87. On the other hand cost of cultivation ranked lowest i.e. IX with mean score 0.26 followed by knowledge regarding 'suitable mushroom varieties for Assam' ranked VIII with mean score 0.34. Health and nutritional benefits ranked VII with mean score 0.39. It is observed that there is a wide variation among the mean scores of different areas of mushroom production with highest mean score 0.90 to lowest 0.26.The variation in different aspects of knowledge on mushroom production may be interpreted from content coverage during the training and individual variation in knowledge retention after the training and level of adoption.

Table 3: Ranking of knowledge on mushroom production

S. No.	Area	Mean score	Rank
1	Suitable mushroom varieties for climatic condition of Assam	0.34	VIII
2	Substrate preparation	0.90	I
3	Spawning	0.63	V
4	Incubation in dark cropping room	0.72	III
5	Importance of mushroom production	0.87	II
6	Harvesting	0.70	IV
7	Post-harvest processing	0.59	VI
8	Health and nutritional benefits of mushroom	0.39	VII
9	Cost of mushroom cultivation	0.26	IX

Attitude determines whether a person is inclined towards something or is repulsive towards it. Attitude of respondents towards mushroom production was measured and results are presented in the Table 4. The Table shows that 52.00 per cent respondents had moderately favourable attitude towards mushroom production as an enterprise, followed by 26.00 per cent with highly favourable attitude. Mushroom has been gaining popularity during the last couple of years due to its health and nutritional benefits. The high and moderately favourable attitude of the respondents may be interpreted from the perspective of its recent popularity. However 22.00 per cent respondents had less favourable attitude towards mushroom production. The attitude of nonparticipant respondents was found to be moderately favourable by all the respondents.

The finding is in line with Manju *et al.* (2012) where it was reported that women respondents after exposure to training acquired knowledge and changed their attitude.

Table 4: Distribution of respondents according to attitude towards mushroom production

Level of attitude	Participant (n_1=50)			Non-Participant (n_2=50)		
	Frequency	Percentage		Frequency	Percentage	
Less favourable	11	22.00	Mean: 80.36	0	0.00	Mean: 66.68
Moderately favourable	26	52.00	SD: 7.60	50	100.00	SD:4.65
Highly favourable	13	26.00		0	0.00	

Ranking of attitude statements according to their mean score is presented in the Table 5 which shows that 'Mushroom cultivation gives return within short time' ranks highest with mean score 4.62. Mushroom may give return approximately within two months and the producers can earn cash income frequently, such contented experience got reflected in positive attitude statements. 'Mushroom cultivation is a highly profitable venture' ranked second with mean score 4.60, which may be due to the reasonable benefit cost ratio per kilogram mushroom as the cost of mushroom production is low and it gets a ready market with attractive rate. 'Mushroom cultivation is a suitable enterprise for women' ranked third with mean score 4.46. Reviewing the mean scores of the statements, it may be interpreted that respondents were happy about its frequency of return, profit and simplicity in operation. However some statements obtained considerably low score. 'Disease attack and insect infestation is a major cause of concern in mushroom cultivation' scored lowest with mean score 1.78. Likewise, 'Mushroom cultivation is a labour intensive enterprise' ranked second lowest with mean score 1.88. 'Mushroom cultivation cannot be profitable as it is highly perishable' ranked third lowest with mean score 2.22. It may be due to the difficulty they were facing during mushroom cultivation, the time it demands and their worry about the short shelf life or high perishability of mushroom which may ultimately control the marketing as well as production.

Adoption of any technology depends on various factors such as respondents' knowledge, situational factors, extent of support, personal, social and

Table 5: Ranking of attitude statements on mushroom production according to mean score

S.No.	Statement	Mean score	Rank
1	Mushroom cultivation gives return within short time	4.62	I
2	Mushroom cultivation is a labour intensive enterprise	1.88	XXI
3	Mushroom cultivation is very rewarding and fascinating enterprise	4.20	IX
4	Mushroom cultivation is a suitable enterprise for women	4.46	III
5	Cost of production is low in mushroom cultivation	4.26	VII
6	Mushroom cultivation is not profitable as it is highly perishable	2.22	XX
7	Mushroom cultivation is a highly profitable venture	4.60	II
8	Mushroom cultivation requires minimum physical and financial resource	4.36	V
9	Mushroom cultivation is an ideal activity for continuous income	3.98	XI
10	Mushroom is a very good substitute for non-vegetarian diet	4.42	IV
11	Mushroom growers face difficulty in selling their products	3.70	XIV
12	Mushroom production is a complex process	3.66	XV
13	Marketing of mushroom is affected by some superstition related to mushroom consumption	2.86	XVIII
14	High cost of mushroom spawn is a cause of concern	2.88	XVII
15	Availability of good quality mushroom is a cause of concern	3.12	XVI
16	Mushroom cultivation cannot provide year round income	2.78	XIX
17	Customers purchase mushroom for its medicinal property	3.78	XII
18	Mushroom production has tremendous potential as an enterprise	4.28	VII
19	Organic waste can be gainfully utilized for income generation through mushroom cultivation	4.28	VII
20	Mushroom production is important for its nutritional and medicinal value	4.32	VI
21	Increased awareness about health and nutritional benefits helps in easy marketing of mushroom	4.22	VIII
22	Mushroom enterprise can address rural unemployment and poverty levels	3.84	XI
23	Mushroom is an important subsidiary occupation for the landless and small farmers	4.10	X
24	Disease attack and insect infestation is a major cause of concern in mushroom cultivation	1.78	XXII
25	Mushroom production requires lots of technical knowledge and skills	3.72	XIII

psychological characteristics of the respondents, the characteristics of innovation itself, complexity of practices, timely availability of inputs etc. Among the participants highest percentage belonged to low level of adoption with percentage 46.00 followed by medium level of adoption with 42.00 per cent. It is observed that cent per cent non-participant had low level of adoption (Table 6).

The data presented in the Table 7 shows the ranking of different mushroom production practices adopted by respondents. The data reflects that 'suitable mushroom varieties are used' ranked I with mean score 2.00. It was found in the Table. 3 that the respondents did not have knowledge on suitable mushroom varieties for Assam. Contrary to this, adoption of this practice was complete. This may be because of the fact that the spawn is supplied either by KVK or by some large scale producers who usually procure from a firm based in Siliguri, West Bengal. While contacted the respective KVK and the large scale producers it was informed that the spawn was of 'Oyster mushroom'. Both these sources are reliable and the mushroom producers were using these spawns. 'Ideal size of the bag for mushroom production '60 cm X 40 cm' and 'Paddy straw is used as substrate material for mushroom production' were two practices ranked II with mean score 1.92. On the contrary, 'Brown paper bag is used for storing harvested mushroom' ranked lowest i.e. XIV. It was not practised even by a single respondent. 'Value added products are prepared from mushroom' ranked XIII with mean score 0.32. Table. 3 reflects low knowledge of respondents on 'post-harvest processing of mushroom. So, it may be due to the lack of knowledge on value added products from mushroom. 'Hygiene is properly maintained in mushroom farms' ranked XII with mean score 1.32. It may due to lack of knowledge or lack of adequate facility for maintaining hygiene.

Table 6: Distribution of respondents according to level of adoption of mushroom production (n_1=50)

Level of adoption	Participant		Non participant	
	Freq-uency	Perce-ntage	Freq-uency	Perce-ntage
Low	23	46.00	50	100.00
Medium	21	42.00	0	0
High	6	12.00	0	0

Table 7: Ranking of mushroom production practices according to level of adoption

S.No.	Practices	Mean score	Rank
1	Suitable mushroom varieties are used	2.00	I
2	Paddy straw is used as substrate material for mushroom production	1.92	II
3	Paddy straw used for mushroom cultivation is chopped in to 3-5 cm pieces	1.84	III
4	Paddy straw is soaked overnight in water before pasteurization	1.70	VII
5	Paddy straw is boiled for 30-40 minutes	1.76	V
6	Spawn is collected from reliable source	1.72	VI
7	2-3 per cent spawn of wet substrate is used	1.40	X
8	Spawn is mixed thoroughly or in layers with the substrate	1.72	VI
9	Ideal size of the bag for mushroom production 60 cm X 40 cm	1.92	II
10	After spawning mushroom bags are kept in dark room 5 -17 days	1.80	IV
11	Perforated bags are used for mushroom production	1.60	VIII
12	Hessian cloth is hung along the walls and sprayed with water in mushroom house	1.38	XI
13	Mushroom is not kept more than 24 hours in room temperature after harvesting	1.38	XI
14	Mushroom bags are destroyed when green mould appears	1.38	XI
15	Oyster mushroom is harvested when the cap is 4-5 inches	1.56	IX
17	Brown paper bag is used for storing harvested mushroom	0	XIV
18	Value added products are prepared from mushroom	0.32	XIII
19	Hygiene is properly maintained in mushroom farms	1.32	XII

Table 8: Distribution of participant respondents according to status of adoption of mushroom production (n_1=50)

Status of adoption	Mushroom production	
	Frequency	Percentage
Not yet started mushroom production	16	32.00
Started mushroom production for household-consumption	7	14.00
Started mushroom production for income generation	27	54.00

Table 8 reflects that a considerable percentage i.e. 54.00 per cent respondents had started utilizing the technology for income generation whereas 32.00 per cent had never practised or utilized the skill they learnt in the vocational trainings on mushroom production and 14.00 per cent respondents produced for household consumption.

Income from Mushroom production was asked to those respondents who had started producing mushroom (n=27) and among them 55.56 per cent earned less than Rs. 500 whereas 29.63 per cent could earn Rs. 501 to 1000 followed by 14.81 per cent could earn Rs. 1001/- to Rs. 5000/- monthly. Variation in income may be argued from the amount of initial investment, support received from different agencies in terms of input, technical guidance, scope for marketing, time devoted in income generating activity and size and type of the enterprise.

Santhi *et al.* (2013) reported that eighty three per cent of the women trainees who adopted all the three employment generating technologies i.e. mushroom production, food processing and preservation and home-made products could earn income of Rs. 750 or above. Similarly, Singh *et al.* (2014) found that 25.00 per cent of trained women adopted mushroom cultivation and started earning a handsome amount of income. Kumar *et al.* (2019) studied the impact of Mushroom training conducted by Bihar Agriculture College and found that 26, 55, 81 and 114 mushroom units were established with adoption rate, 18.47, 21.73, 28.39 and 23.69 per cent during the year 2011–12, 2012–13, 2013–14 and 2014–15, respectively.

Table 9: Distribution of respondents according to income from mushroom production unit

Monthly income (Rs.)	Mushroom production (n_1=27)	
	Frequency	Percentage
<500	15	55.56
501-1000	8	29.63
1001-5000	4	14.81

Table 10: Distribution of participant respondents according to level of empowerment (n_1=50)

Level of empowerment	Participant		Non participant	
	Frequency	Percentage	Frequency	Percentage
Low	22	44.00	8	16.00
Medium	16	32.00	17	34.00
High	12	24.00	25	50.00

Table 10 reflects that among the respondents 50.00 per cent acquired high level of empowerment from earlier 24.00 per cent. It may be interpreted that among the participants, there had been a quantum lift in level of empowerment from a lower level to a higher level, clearly showing impact of the vocational trainings and adoption of the technology by the respondents. In addition to the trainings, several other subsequent factors such as involvement of the participants in different KVK activities, extension contact, discussion with different agencies, officials, shop keepers for managing raw materials and equipment and discussion with potential buyers help them to realize their inherent qualities resulting the higher level of empowerment.

Figure 1 shows that among the participant respondents average economic empowerment was 65.03 which increased up to 76.73, social empowerment was 40.48 per cent which had a observable gain up to 59.26, political empowerment was from 35.81 to 42.95 per cent, psychological empowerment had a very large improvement from 39.71 to 68.67 per cent and legal empowerment from 35.17 to 53.00 per cent. Among the nonparticipants the highest gain was observed in economic empowerment which was from 66.22 to 71.03 per cent, while social empowerment was increased up to average 42.15 from 38.67 per cent (Figure 2).

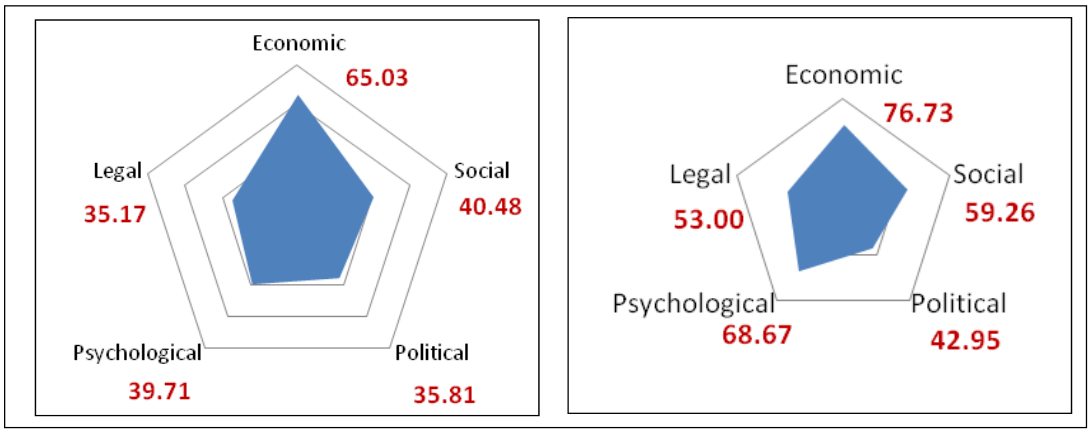

Figure 1: Before and after difference in empowerment level of participants in five dimensions of socio-economic empowerment

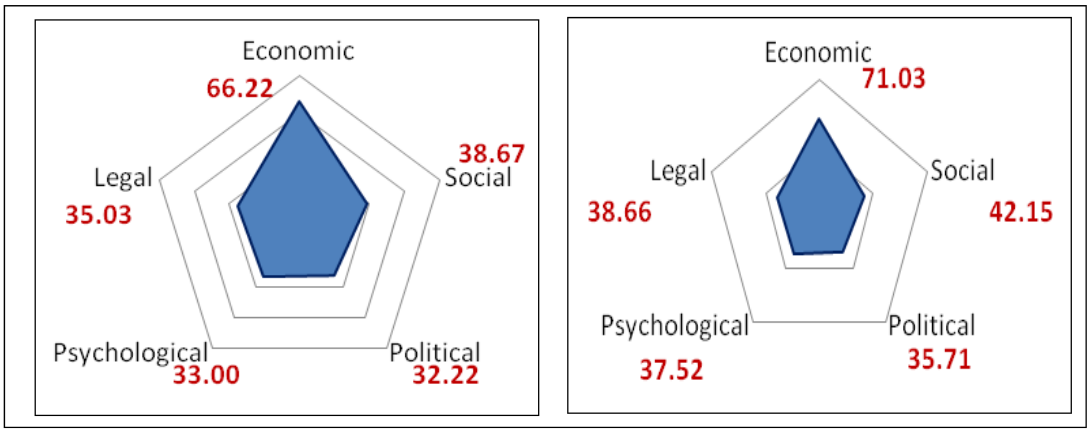

Figure 2: Before and after difference in empowerment level of nonparticipants in five dimensions of socio-economic empowerment

The data reflects that there has been considerable improvement among the participant respondents in all the five dimensions of empowerment, whereas among the nonparticipant respondents minor improvement was observed. Once, new ventures are started, concerned personnel such as trainers, experts from different departments or agencies try to boost the new comer for sustainability of the venture. Additionally, once the new activity starts fetching return, it gradually instils self-confidence and courage to face any situation in the person. They get more extension contact than before and get opportunity to interact with different types of visitors. This may be the reason why the findings reflect highest improvement in psychological domain among the participant respondents.

CONCLUSION

It may be summarized from the findings related to knowledge, attitude and level of adoption of the technology that highest percentage participant respondents had medium level of knowledge and highest percentage had moderately favourable attitude towards the mushroom production and highest percentage respondents had medium level of adoption. Participant respondents had more knowledge, better level of adoption than the nonparticipant respondents. Among the 50 participant respondents, a considerable percentage i.e. 54.00 per cent respondents had started utilizing the technology for income generation and out of them, 55.56 per cent earned less than Rs. 500 whereas 29.63 per cent could earn Rs. 501 to 1000. Around 15.00 per cent could earn Rs. 1001/- to Rs. 5000/- monthly. Regarding impact on empowerment, 50.00 per cent participant respondents acquired high level of empowerment from earlier 24.00 per cent. In all the dimensions of women empowerment, participant as well as non participant respondents had improved from their earlier level of empowerment, however

among the participant respondents the gain was found to be more. From the findings it may be concluded that the vocational trainings organized by the KVKs are instrumental in increasing the knowledge, attitude and extent of adoption of technology and in fetching income from such technologies. And eventually may lead to empowerment of rural women.

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Psychometric Validation of Knowledge Test Developed on Nutrition and Nutri-rich Foods

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ABSTRACT

A test was constructed to measure the rural women between 15 to 49 years old knowledge level on nutrition related aspects and nutri-rich foods during 2022-23 in the Nutri-SMART Village (NSV) of KVKs. The test was developed using scientific procedures including item collection through preliminary screening, item selection based on expert opinions, item analysis (difficulty index, discrimination index), testing reliability and validity of knowledge test and final administration to respondents. Total 75 items were collected and sent to 150 nutrition and home science experts for relevancy test on five-point continuum through google forms and 50 judges responded within the stipulated time. Out of 75 items, 48 items were selected for item analysis based on the mean score. Selected items were administrated to 60 women's between 15-49 years old age group of Narmadapuram and Jabalpur district, Madhya Pradesh for item analysis. Item difficulty index (Pi) and item discrimination index were used for item analysis. After estimating the item difficulty and discrimination index values, 37 items were tested for the validity by point biserial correlation (rpbis) and also experts' opinion were used. Split-half technique was used for testing the reliability of the scale in which correlation coefficient (r) was found to be 0.875.

Keywords: Balanced diet, Dietary behavior, Item analysis, Nutrition literacy, Reliability and validity

INTRODUCTION

Knowledge is a one of the components of the human behavior that play a vital role in changing of nutrition related behavior which drive person to change dietary pattern by choosing healthy diets. Improvement in diet assumed to depend on information necessary for selection of healthy diet (Parmenter and Wardle, 1999). According to this view, information about nutrition related aspects on undernutrition as it causes, micronutrients deficiency and other health related issues. Hence knowing nutritional source to remove these deficiencies, nutrients requirement at different stages of life specially for children and women of reproductive age will be highly beneficial to improve their health and will help in changing dietary habits.

As we know that nutrition security has emerged as challenging issues with the increasing population of India. The under-nutrition levels in rural areas vis-à-vis over-nutrition in urban areas causes double burden of malnutrition. Poor feeding of infants and children affect initial growth of the child as the starting 1000 days (opportunity window) are very important for overall brain development. Undernourished mothers give birth to malnourished children, with high probability of suffering from chronic diseases in adulthood. Anaemia is also a prevailing phenomenon in adolescent girls and women affecting their health as well as reproductive stages. Over-nutrition is also cause of overweight, obesity and severe non communicable diseases (Sharma, 2019). To solve these problems, there is need

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to make adequate awareness and necessary information on nutrition related aspects, nutri-dense food and balance diet among women and adolescent girls. Further, it is essential to have sound knowledge about healthy diet, its availability, accessibility and utilization.

Having knowledge about diet, foods, hygiene and health issues for optimal dietary and feeding practices will ensure nutritional improvements. Food and Agriculture Organization (FAO) also emphasized the need for educating the people about taking the right food to maintain good health. In this regard, knowledge adequacy can play a key role in enhancing outcomes of nutrition related interventions and programmes. It will be helpful to make right nutrition related decisions at household level with having information on nutrient rich foods, traditional foods, new food options, seasonality of foods, food preparation skills, care and feeding practices etc. And, it will lead in changing nutrition related behavior of the individual as well as households. Moreover, in long term, developing deep understanding on healthy diet may result into acquiring related cognitive skills on nutrition related aspects for nutritious food preparation by the women at household.

Krishi Vigyan Kendra are disseminating nutrition related information and knowledge by conducting awareness and training programmes, demonstration of traditional food rich *poshan thali*, *poshan mala*, *poshan rangoli* and *poshan* calendar in Nutri-SMART Village. Also, KVKs are conducting training programmes on nutritive recipes based on locally available food items and making of traditional food to farm women and Aganbadi workers. KVKs also demonstrated nutrition garden in households, residential schools and Aganbadi centers so that children and farm women may also aware about the seasonal fruits and vegetables and used it in their daily diets.

Hence, it is important to gain a clear insight in the nutrition related knowledge by the women particularly 15-49 years old age group in rural areas and also helpful in measuring nutrition literacy among the rural women due to the efforts of KVK home science experts. Knowledge on nutrition can be difficult to assess and good instruments for valid and reliable measurements are required (Feren *et al.,* 2011). This paper aims to describe the development and validation of the knowledge test on nutritional aspects among the women aged between 15-49 years old from the Nutri-SMART Villages where planned interventions on nutrition carried out by KVKs over the years since initiation of the NSVs. The test assessed the level of general nutrition knowledge among women about the undernutrition, balanced food, sources of nutrients and nutrient deficiency and its impact on different stages of life.

MATERIALS AND METHODS

A standard methodology was followed by the project team for the development of knowledge test on nutrition related aspects and nutri-rich foods adopted by Mukherjee *et al.* (2019) and Priyadarshani *et al.* (2021) with desired modification.

Items about nutrition related aspects and nutri-rich foods were collected from the various literature sources and discussion held with extension scientist and home science experts during pilot study. Finally, 75 items were collected covering topics balanced diet & undernutrition, pregnancy and infant feeding, adolescence, micro-nutrients and its deficiency. The items were edited and drafted in such a way that each item highlighted only one idea and represent particular topic and did not have any ambiguity and with a logical sequence.

Jury opinion is first phase of knowledge test development to judge the relevancy of the items for knowledge test. These 75 collected items were mailed to the 150 nutrition and home science experts for the judgement purpose for relevancy rating on a five-point continuum scale from most relevant (5) to not at all relevant (1). The experts were requested to check each item carefully whether the items were really capable to measure the knowledge of the womens about nutrition related aspects and nutri-rich dish considered or not and also add/ delete or modify those item/ items based on the suitability. Final selection of the items was based on relevancy value. Those items were retained for second phase analysis whose relevancy value was higher than the mean value of the items.

Item analysis is a statistical procedure to identify the best items on the basis of item difficulty, item discrimination index and item validity after the jury opinion. The 48 knowledge items consisted of all closed

end questions includes 24 "multiple choice" and 24 "yes/no" type questions. Those items were carried out with non-sampled 60 women farmers of Narmadapuram and Jabalpur district, Madhya Pradesh, who were not a part of final administration of the tool and having same socio-economic status where study to be conducted. There was only one correct answer to each question and responses were scored with 1 for each right answer and 0 to each wrong answer or blank response.

The item difficulty index indicated the extent to which an item was difficult to understand. It was worked out as the percentage of the womens answered items correctly. The measurement of item difficulty assumed to show the difficulty is linearly related with the level of womens knowledge about nutrition related aspects and nutri-rich foods. This index assesses the items neither too easy nor too difficult for the selected womens. The item difficulty index was calculated by following formula:

$$P = \frac{\text{No. of respondents answered correctly}}{\text{Total No. of respondents}} \text{ x } 100$$

Where, P = item difficulty index

Item discrimination index is second criteria for item analysis to know what extent an item discriminate well informed women from poorly informed ones. The scores obtained by 60 women respondents were arranged in descending order and divided into six group's i.e. 10 respondents in each group. The groups were named as G1, G2, G3, G4, G5 and G6. For the purpose of item analysis, the middle two groups G3 and G4 were eliminated keeping four extreme groups with high and low scores. The following formula was employed to calculate $E^{1/3}$:

$$(E^{1/3}) = \frac{(S1 + S2) - (S5 + S6)}{N/3}$$

Where, S1, S2, S5 and S6 are frequencies of correct answer in the group of G1, G2, G5 and G6, respectively.

N= Total number of respondents in the item Analysis

Validity refers to the appropriateness of the instrument/test. The validity of the test was measured by employing two methods jury opinion and point bi-serial correlation. Jury opinion ensures content validity of the test by administering every item to experts to evaluate items relevance and appropriateness for the representation of universe by the test. Point bi-serial correlation (r_{pbi}) is calculated to know the construct validity of the test that measures internal consistency of the items on the basis of formula given Guilford and Fruchter (1978):

$$r_{pbi} = \frac{\bar{X}p - \bar{X}q}{S_t} * \sqrt{p * q}$$

Where, r_{pbi} = Point-biserial correlation coefficient

$\bar{X}p$ = Mean score on continuous variable of successful group on dichotomous variable

$\bar{X}q$ = Mean score on continuous variable of unsuccessful group on dichotomous variable

S_t = Standard deviation on continuous variable for total groups

p = Proportion of respondents who answered correctly on dichotomous variable

q = Proportion of respondents who answered wrong on dichotomous variable

RESULTS AND DISCUSSION

In Jury opinion, item relevancy test was calculated by which those items were selected whose relevancy value were higher the mean value of the total score i.e. 4.50, thus total 48 items were retained for administration to 60 women respondents who are not the part of the final study. Item difficulty index analysis shows that items p value ranged between 0.07 to 0.93 (Table 1). Items whose value ranged between 0.30 to 0.95 were selected for final test (Althouse, 2000). The items fall on less than 0.30 value are supposed to be easy and items with value more than 0.95 are assumed to be very difficult to answer. Item numbers 34 (p value=0.20) and 43 (p value=0.07) were excluded from the final set of test due to low p value.

The second criteria for selection of items is based on item discrimination index ($E^{1/3}$) that indicated the difference between a well-informed women and an ill-informed woman on nutrition. A higher discrimination value indicates that the item has validity. The acceptable range for selection of items is between

Table 1: Difficulty index, discrimination index and point –biserial correlation coefficient of knowledge items related to nutrition related aspects and nutri-rich foods

S.No.	Knowledge Items	Difficulty Index (P)	Discrim-ination index (DI)	Point-biserial correlation coefficient (rpbi)
Balanced diet				
1	Balanced diet includes in .....proportion of cereals and nutricereals, pulses, eggs & fresh foods, fruit, vegetables, nuts & seeds, fats & oils and milk & milk products.	0.65	0.60	0.62
2	Balanced diet includes all the ..... and ..... nutrients needed for good health	0.77	0.55	0.48
3	Balanced diet is helpful in ..... malnutrition	0.77	0.50	0.48
4	Balanced diet is helpful in ..... immunity	0.82	0.45	0.41
5*	Does balanced diet improves resistance to infections	0.78	-0.05	0.46
6	Does balanced diet ensures adequate intake of fiber	0.77	0.50	0.48
Pregnancy and Infant feeding				
7*	During pregnancy and lactation period women required additional calorie with balanced diet equal to	0.68	0.10	0.59
8	Calcium and iron requirement is……in pregnant and lactating women	0.60	0.60	0.65
9	Does folic acid supplements helps in normal development of the nervous system	0.63	0.60	0.63
10	First available milk after delivery is known as	0.55	0.85	0.67
11	Does colostrum is helpful in fighting against diseases in new born babies	0.85	0.40	0.35
12*	Up to what age, a mother has to breast feed to babies	0.93	0.20	0.17
13	Mother's milk includes	0.83	0.40	0.38
14	At what age, complementary food has to be started to the baby	0.92	0.25	0.21
15*	Breast feeding helps in the……. of breast and anemia cancers	0.50	0.00	0.68
16	Can complementary foods be prepared by millets like Ragi, Jowar and Bajra	0.78	0.30	0.46
17	Amylase-Rich-Food (ARFs) is prepared from	0.63	0.80	0.63
18	Does Amylase- rich-food (ARFs) improves digestibility of complementary foods of babies	0.68	0.50	0.59
Adolescents				
19	Does rapid physical growth and development occur in adolescent stage	0.83	0.45	0.38
20	Does physiological & emotional changes are the characteristics of adolescence	0.83	0.50	0.38
21	Does social and psychological maturity occur in adolescent stage	0.88	0.35	0.28
22	Is mental growth development occurring in the adolescents' stages	0.85	0.40	0.35
23*	What are the body building foods required to meet body demands for adequate growth in adolescents	0.92	0.25	0.21
24	Does micro-nutrients are essential for proper growth and development in adolescents	0.85	0.40	0.35
Micronutrients and it's deficiency				
25	Anaemic condition in human body is due to	0.73	0.60	0.53
26*	Anaemia is caused due to low ……. intake from diets	0.33	-0.10	0.60
27	Does hookworm infestation also cause anaemic condition in humans.	0.75	0.50	0.51

Table 1: contd....

S.No.	Knowledge Items	Difficulty Index (P)	Discrim-ination index (DI)	Point-biserial correlation coefficient (rpbi)
28	Does blood loss for prolonged period is also a reason for anaemia	0.83	0.50	0.38
29*	What is the symptom of anaemia	0.90	0.25	0.24
30*	Does anaemia leads low birth weight of newly born babies and premature delivery	0.90	0.25	0.24
31	Does maternal morbidity and mortality is caused by anaemia	0.88	0.30	0.28
32	What are the rich source of iron…….	0.87	0.40	0.31
33*	Does consumption of green leafy vegetables increases haemoglobin level in blood of humans	0.90	0.25	0.24
34*	Which vitamin ensures better absorption of iron from green leafy vegetables	0.20	0.00	0.43
35	Does green leafy vegetables are also a good source of dietary fiber	0.72	0.40	0.55
36	What are the source of vitamin 'A'……..	0.78	0.45	0.46
37	Does vitamin 'A' found in animal origin foods like butter, whole milk, egg yolk and liver	0.78	0.45	0.46
38	Does Vitamin 'A' maintains reproductive health in adolescents	0.67	0.70	0.60
39	Which vitamin provides resistance to fight against infection in children	0.40	0.75	0.65
40	Which vitamin is important for the healthy vision of children	0.55	0.90	0.67
41	Does stored iron in the body being utilized for fetal growth and development during pregnancy	0.70	0.70	0.57
42	Which micro-nutrient required more in girls during mesuration	0.68	0.60	0.59
43*	Which micro-nutrient required for normal growth and development of the human brain and body	0.07	0.70	0.17
44	Does iodine deficiency leads to premature abortion	0.68	0.70	0.59
45	Does improper fetal growth and poor mental development is due to iodine deficiency	0.68	0.70	0.59
46	What can meet deficiency of iodine in the body	0.75	0.50	0.51
47	Are dairy products rich source of calcium	0.78	0.55	0.46
48	Does finger millet and drumstick leaves are good source of calcium	0.70	0.60	0.57

*Rejected items on the basis of calculated item difficulty, discrimination index and point bi-serial value

0.30 to 0.70. The analysis of discrimination index value of items ranged between (-0.05) to 0.90. On the basis of acceptable range, items with $E^{1/3}$ value lower than -0.05 (5^{th}), -0.10 (26^{th}), 0.00 (15^{th} & 34^{th}), 0.10 (7^{th}), 0.20 (12^{th}) and 0.25 (23^{rd}, 29^{th}, 30^{th} & 33^{rd}) were excluded from the test.

The biserial correlation (r_{pbi}) was considered as a measure of test items validity. It indicates the relationship between the overall score and dichotomous response for each particular items. The value of biserial correlation (r_{pbi}) at least 0.15 is recommended for selection of items in test. From the Table 1, it is cleared that the biserial correlation (r_{pbi}) of all items are ranged between 0.17 to 0.67. On the basis of item difficulty, item discrimination and point bi-serial correlation, total 37 items were included for final test.

Split-half method was used for measuring test reliability due to single administration. In this method, all the 37 items were first randomly arranged and in next step whole items were divided into two halves one containing the odd items and another one

Table 2: Correlation value in split-half method

		Odd knowledge items	Even knowledge items
Odd knowledge items	Pearson correlation	1	0.875**
	Sign. (2 tailed)		0.001
	N	19	18
Even knowledge items	Pearson correlation	0.875**	1
	Sign. (2 tailed)	0.001	
	N	19	18

**Correlation is significant at the 0.01 level (2 tailed)

containing even items. Then, correlation coefficient (r) between odd and even items scores was computed and the 'r' value of 0.875 was found to be significant at 1% level of significance which indicates reliability of the test.

CONCLUSION

Knowledge on the nutrition related aspects and nutri-rich foods significantly contribute towards change in the nutrition behaviour. In the present study, a reliable and valid knowledge test was developed by following standardized methodology. The developed knowledge test could be used for assessing the knowledge level across the country among the womens particularly 15-49 years old which could be a testimony for nutrition related interventions carried out by KVKs. Further, this knowledge test also can make a way to plan capacity building programmes for the womens residing in rural areas by addressing the knowledge gaps in these aspects which will be helpful in eradication of malnutrition from the country by making womens nutrition literate.

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Development of an Effective Protocol for *in vitro* Propagation of *Centella asiatica* L.

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ABSTRACT

Centella asiatica L. (Brahmi) is a widely recognized medicinal herb of Asian subcontinent especially in Ayurvedic medicines as a brain tonic. Increased demand of this herb has resulted in overexploitation and gradual reduction of its natural habitat. *Centella asiatica* is under threat of extinction due to unscientific management and conservation of the herb. Under such situation in vitro propagation can promote rapid multiplication as well as conservation. The shoot tips or apical buds of runners were used as explants and were sterilized with 0.1% $HgCl_2$ for 6 minutes and inoculation was done on Murashige and Skoog basal medium having varying concentrations of 6-Benzyl amino purine, Kinetin and Naphthalene acetic acid. Maximum sprouting percent of explants (97.2) was observed in presence of BAP (3.0 mg/l) and NAA (0.5 mg/l) within one week of culture. Increase in BAP concentration enhanced the average number of shoots/explant along with huge callus mass at the base which demanded repeated subculturing. Therefore, concentration of NAA was reduced to 0.1 mg/l in multiplication medium. Rooting of *in vitro* shoots occurred within 16 days on MS medium augmented with Indole butyric acid (1.5 mg/l) and activated charcoal. The survival percent of plantlets in field after acclimatization and hardening was 75%. The protocol developed can be useful for mass production of genetically uniform material.

Keywords: *Centella asiatica,* Brahmi, *in vitro,* Medicinal herb, Micropropagation

INTRODUCTION

Centella asiatica (L.) also referred as *Hydrocotyle asiatica* belongs to family *Apiaceae.* It is also known by the name "Brahmi" or Indian Pennywort as it is considered as native to India and is a perennial, faintly aromatic creeper which is predominantly used as a valuable medicinal herb since ages. *Centella* is found in tropical and sub-tropical regions and comprises of some 50 species as reported by James and Dubery (2009). *C. asiatica* is called "brain food" as it revitalizes the brain cells (Singh *et al.,* 2010) and acts as a memory enhancer. It is used for curing chronic mental and neuropharmacological problems (Rachetti and Biradar, 2016). It also helps in treating skin problems. Besides, the herb is reported to have antidiabetic, antiviral, antiulcer, antibacterial and antitumor activity (Seevaratnam *et al.,* 2012).

In India, *Centella asiatica* is categorized as an endangered plant. Due to modern agricultural practices including increased use of herbicides and chemical fertilizers; depleting water resources and disturbed natural habitats, the biodiversity in the species is under threat of extinction. It has been considered as a endangered species by International Union for Conservation of Nature and National Resources (Pandey *et al.,* 1993; Singh, 1989). In order to protect this endangered plant there is a need to develop an efficient micropropagation protocol for propagation

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of superior clones of *Centella asiatica*. The utilization of this biotechnical approach can play a significant part in the rapid clonal propagation and conservation of elite germplasm (Tiwari *et al.,* 2000). *C. asiatica* has been micro-propagated using callus from leaf explants (Banerjee *et al.,* 1999), somatic embryos (Martin, 2004) and nodal shoots (Hossain *et al.,* 2000). The present investigation was conducted to develop a viable protocol for true-to-type mass propagation and conservation of *C. asiatica* under *in vitro* conditions in order to meet the increasing demand in pharmaceuticals.

MATERIALS AND METHODS

Disease free and healthy plants of Brahmi (*Centella asiatica* L.) were collected from Herbal Garden, Division of Agroforestry and were maintained in pots in the polyhouse at School of Biotechnology SKUAST-J, Chatha, Jammu (J&K). These mother plants were the source of explants.

The apical buds of stolons or runners with actively dividing meristematic zone were used as explants after removing leaves and roots. These were not embedded in the soil and consequently resulted in better establishment under *in vitro* conditions. They were kept under continuously flowing tap water for 30 min. These were then kept in a solution of detergent Tween-20 for 20 minutes with continuous shaking. The washed explants were further treated with 0.1% Bavistin (w/v) and streptomycin sulphate (0.2%) for another 30 minutes. The final sterilization of explants was done under laminar flow chamber by treating with mercuric chloride (0.1%) for different durations followed by three times washing with autoclaved water.

Murashige and Skoog (1962) basal medium with various amounts and combinations of growth regulators was used in carrying out the study. The medium was enriched with sucrose (30g/l). Semi solid medium was prepared by adding 0.8 percent agar. Before autoclaving the pH of medium was adjusted to 5.8 using 0.1N HCl or 0.1N NaOH solutions. Sterilization of the medium was done at 1.1 kg/cm^2 pressure and 121°C temperature for 20 min and was allowed to cool at room temperature. The culture vessels containing the explants were incubated in culture room at 22±2°C temperature and photoperiod of 16:8 hrs. The light intensity of 2500 lux was provided using florescent tubes.

The cut ends of sterilized explants were trimmed from base and inoculated in MS fortified with different growth regulators like, BAP (Benzyl amino purine), Kinetin and NAA (Naphthalene acetic acid). The bud break was observed after approximately 7-10 days of inoculation. The selection of best shoot regeneration medium was based on periodical visual observations like number of buds sprouted and days taken for sprouting. A minimum of three replicates was used per treatment.

The multiplication of *in vitro* established cultures of *Centella* was performed by separating the shoots and subculturing on MS medium with variable concentration of BAP and NAA. The observations pertaining to average number of shoots from each explant and other visual changes were taken after 4 weeks of culture.

When sufficient number of shoots were obtained, the sturdy and healthy individual shoots (approximately 2-3 cm long) were separated and sub-cultured on activated charcoal containing media augmented with a varying concentrations of auxins (IBA, NAA, IAA). The culture tubes were carefully incubated in culture room for 2-3 weeks under the same conditions and data were recorded to study the effect of varying concentrations of auxins on number of days for root initiation and average number of roots/shoots.

The rooted plantlets were carefully taken out of culture tubes using forceps avoiding any root damage. These plantlets were washed under continuous water to remove any medium sticking to them as it results in infection of plantlets during hardening. These rooted shoots were kept in 0.1 percent Bavistin solution (w/v) for 10 minutes in order to protect the plant from fungal attack. They were carefully planted in pots containing sand: soil: FYM (1:1:1) mixture and moistened with 0.1 per cent Bavistin solution. These were then watered and kept in poly house under humidity range of 90-100 per cent for 1 week. After this these plantlets were kept in polyhouse under humidity ranging between 60-70 per cent.

A completely randomized design was used for laying out all experiments. Per cent contamination, mortality, explant regeneration and multiple shoot induction were calculated on the basis of number of explants used. OPSTAT software was used to

statistically analyze the data of all experiments. The experiments were performed in triplicates and shown in terms of mean ± standard error (M ± SE) and compared using one-way ANOVA (Analysis of variance) with P ≥0.05.

RESULTS AND DISCUSSION

In micropropagation, the sterilization of explants is the most crucial step for aseptic culture establishment. The *in vitro* establishment of explants of Brahmi (*Centella asiatica* L.) was challenging owing to heavy fungal and bacterial contamination. In present study soaking of explants in a solution of 0.1 per cent Bavistin and 0.2 percent streptomycin sulphate for 30 minutes proved beneficial for the successful establishment of cultures. Moghaddam *et al.* (2011) also proposed that treatment of explants with a combination of fungicide and antibiotics prior to mercuric chloride treatment resulted in least contamination.

Centella asiatica is a soft herbaceous plant therefore duration of exposure to mercuric chloride (0.1% w/v) is very critical. In order to find optimum duration of mercuric chloride treatment the explants were treated with $HgCl_2$ (0.1%) for variable time periods ranging from 0-8 minutes (Table 1). The apical buds of runners used as explants when treated with 0.1% $HgCl_2$ for 6 minutes resulted in least contamination and mortality (11.1% each) along with maximum of 77.8 per cent establishment of cultures. The explants failed to survive in absence of mercuric chloride treatment as these were highly contaminated. It was observed that with increase in exposure time of mercuric chloride percent contamination decreased while there was increase in percent mortality indicating the toxic effect of the sterilant. This is in agreement with the observations recorded by Patra *et al.* (1998) where treatment of explants with mercuric chloride for 20 minutes not only caused blackening of tissues but also led to death of the explants. Joshee *et al.* (2007) obtained control over fungal and bacterial contamination by giving a 60 min soak treatment in a 2 per cent PPM solution before culture establishment.

Table 1: Effect of duration of mercuric chloride treatment on *in vitro* establishment of explants of *C. asiatica*

Duration (minutes)	% Contamination	% Mortality	% Survival
0	100(90)	0(0)	0(0)
2	88.8(70.7)	0(0)	9.4(17.8)
4	77.8(61.9)	11.1(19.2)	11.1(19.2)
6	11.1(19.2)	11.1(19.2)	77.8(61.9)
8	2.8(5.6)	88.0(70.7)	8.3(13.6)
C.D.	9.76	6.006	11.19

Surface sterilized apical buds (1-1.5 cm) from the runners of *C. asiatica* used as explants were cultured on MS medium supplemented with various concentrations of cytokinins viz BAP and Kinetin in presence of auxin (NAA) for shoot induction (Figure 1). MS media composition has a strong impact on shoot proliferation of *Centella asiatica* (Roy *et al.,* 2016; Roy and Bhardvaja, 2018). Observations pertaining to sprouting (percentage shoot induction) and number of days required for shoot induction in presence of various growth regulators are shown in Table 2. These observations are comparable to those obtained by Tiwari *et al.* (2013) where bud break in explants of *Centella asiatica* was reported within 7-10 days of inoculation followed by multiple shoot induction in presence of BAP along with mild concentration of auxin. BAP has been widely accepted as the most widely used cytokinin (Roy *et al.,* 2016), particularly at commercial level where cost is one of the major consideration (Tiwari *et al.,* 2013). Fortification of BAP in the initiation medium was more effective in comparison to Kinetin as it initiated bud break within

Figure 1: Initiation of apical buds of *Centella asiatica* on MS medium

Table 2: Effect of growth hormones on initiation of apical buds of *Centella asiatica*

S.No.	Cytokinins (mg/l)		Auxin (mg/l)	% sprouting	No. of days
	BAP	Kinetin	NAA		
1.	0.5		0.5	27.8(31.7	13
2.	1.0	-	0.5	58.3(49.8)	11
3.	1.5	-	0.5	72.2(58.2)	11
4.	2.0	-	0.5	77.8(61.9)	10
5.	2.5	-	0.5	86.1(68.3)	10
6.	3.0	-	0.5	97.2(84.4)	7
7.		0.5	0.5	13.8(21.6)	15
8.	-	1.0	0.5	41.6(40.1)	15
9.	-	1.5	0.5	52.8(46.4)	14
10.	-	2.0	0.5	61.1(51.4)	13
11	-	2.5	0.5	77.8(61.9)	12
12	-	3.0	0.5	86.1(68.3)	12
	C.D.			7.77	

one week and resulted in 100 per cent sprouting (Figure 2). Karthikeyan *et al.* (2009) and Siddiqui *et al.* (2019) observed better shoot induction as well as multiplication of *Centella asiatica* in MS medium augmented with BAP rather in presence of Kinetin which is complementary to our observations.

After establishment of explants, the primary shoots were cut and separated into segments containing 2-3 shoots and sub-cultured on MS media having different concentrations of BAP with or without NAA to assess their impact on shoot proliferation of *Centella asiatica.* The shoot multiplication data was taken after 21 days of culture. Maximum number of shoots per explant (27.3±0.5 shoots) was obtained in medium having BAP (5-6 mg/l) and NAA (0.5 mg/l) after 21 days of subculturing (Figure 3). As evident from Table 3, similar rate of multiplication was also observed in medium fortified with BAP at concentration of 3-4 mg/l along with NAA (0.5 mg/l). In all the combinations supplemented with NAA (0.5 mg/l) callus mass formation at the base was observed which required repeated subculturing. If left unattended for some time in medium with high concentrations of BAP it resulted in decaying of shoots and ultimately death of the plantlets. The intensity of callus formation decreased with decrease in amount of NAA and no callus was seen in medium with 0.1 mg/l of NAA. These observations are in comparison to the results obtained

Table 3: Effect of growth hormones on shoot multiplication of *Centella asiatica*

S.No.	BAP (mg/l)	NAA (mg/l)	No. of shoots/ explant	Callus formation
1.	3.0	0.1	23±0.8	-
2.	3.0	0.3	22.7±0.9	++
3.	3.0	0.5	25.3±0.5	++++
4.	4.0	0.1	17.3±0.9	-
5.	4.0	0.3	21.7±0.5	+++
6.	4.0	0.5	26.0±0.8	++++
7.	5.0	0.1	21.7±0.5	+
8.	5.0	0.3	22.3±0.5	++
9.	5.0	0.5	27.0±0.8	+++
10.	6.0	0.1	23.7±0.5	+
11.	6.0	0.3	25.3±0.5	+++
12.	6.0	0.5	27.3±0.5	++++

Figure 2: Established apical buds of *Centella asiatica* on MS medium supplemented with BAP 3.0 mg/l and NAA (0.5 mg/l)

Figure 3: Proliferated shoots showing multiplication of *Centella asiatica*

by Das *et al.* (2008) who reported highest shoot multiplication (76.6%) in medium fortified with BAP (4.0 mg/l) and NAA (0.1 mg/l). Similar observations were recorded by Kumar (2017) where the frequency of shoot proliferation of *Centella asiatica* increased with the increase of BAP concentration upto 4.0 mg/l and NAA 0.4 mg/l and any further increase in amount of growth hormones resulted in callus formation. The study conducted by Siddiqui *et al.* (2019) showed rapid shoot proliferation of *C. asiatica* in the minimum concentration of cytokinin while formation of callus mass was observed by increasing concentration of BAP up to 2.0 mg/l.

The healthy shoots from proliferated cultures were separated individually and inoculated aseptically to charcoal containing medium having different auxins (NAA, IBA and IAA) at variable concentrations for root induction (Figure 4). The results shown in Table 4 reveal that maximum of 3 roots per shoot were obtained after 16 days when medium was supplemented with IBA (1.5 mg/l) followed by fortification of IBA and NAA at 2.0 mg/l, respectively. *In vitro* rooted shoot are shown in Figure 5. The observations recorded are in line with the findings of Kumar (2019) and Banerjee *et al.* (1999) who reported positive influence of IBA on root induction of *C. asiatica* under *in vitro* conditions. Mercy *et al.* (2014) reported *in*

Table 4: Effect of auxins on rooting of *in vitro* raised shoots of *Centella asiatica*

S.No.	IAA (mg/l)	IBA (mg/l)	NAA (mg/l)	No. of root per plantlet	No. of days to root initiation
1.	1.0	-	-	-	-
2.	1.5	-	-	-	-
3.	2.0	-	-	1	25
4.	2.5	-	-	1	22
5.	-	1.0	-	-	-
6.	-	1.5	-	**3**	**16**
7.	-	2.0	-	2	18
8.	-	2.5	-	2	21
9.	-	-	1.0	0	-
10.	-	-	1.5	2	22
11.	-	-	2.0	2	18
12.	-	-	2.5	1	18

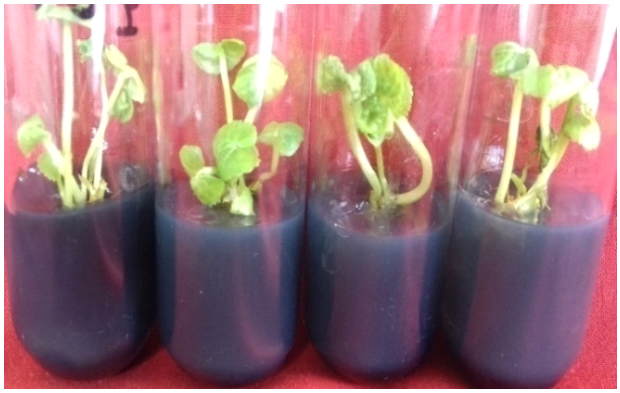

Figure 4: Root induction in MS medium containing charcoal

Figure 5: *In vitro* rooting of shoots of *Centella asiatica*

Figure 6: Hardening of *in vitro* raised rooted shoots of *Centella asiatica*

vitro rooting of shoots of *Centella asiatica* on full-strength MS medium augmented with IBA (0.5 mg/l). Biradar, (2017) also studied the influence of IBA, NAA and IAA on rooting of shoots and found that IAA (2.5 mg/l) was comparatively better as it produced maximum root number as well as root length.

The rooted shoots were planted in sterilized potting mixture of sand: soil: FYM (1:1:1) after 4 weeks (Figure 6). These were initially kept in culture room for 1 week under 90-100 per cent humidity followed by gradual decrease in humidity. Survival of 75 per cent plantlets was observed on final transfer to the field conditions. Biradar (2017) successfully micro-propagated plantlets and transferred to field after hardening and acclimatization. Das *et al.* (2008) reported 80 percent survival of these plantlets after transfer to field conditions.

CONCLUSION

A continuous demand of medicinal plants has resulted in overexploitation and gradual reduction of their natural habitat especially *Centella asiatica* which is commonly known as brain tonic. *In vitro* propagation plays a significant role in mass multiplication and conservation of elite genotypes. Shoot tips or apical buds of runners used as explants were successfully established on Murashige and Skoog medium fortified with BAP (3.0 mg/l) and NAA (0.5 mg/l) which resulted sprouting of apical buds within one week of culture. Rooting of *in vitro* raised shoots was achieved in 16 days on full strength medium augmented with IBA (1.5 mg/l) and activated charcoal. The survival percent of plantlets in field after acclimatization and hardening was 75 per cent. Thus, a reproducible protocol for mass propagation of *C. asiatica* has been developed which can be useful for mass production of genetically uniform material.

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Sikkim's Transition to Organic Farming: Assessing Structural Break Using Dummy Variable Model

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ABSTRACT

Sikkim was declared as the first organic state in the world in 2016 with adoption of cent percent organic farming practices while preserving the flora and fauna, lively ecology, and soil fertility. In 2010, the State launched 'Organic Mission' and removed the incentives for the purchase of all chemical farm inputs as well as the import of chemical fertilizers. This significant development might have induced changes in agriculture sector in the State which need to be investigated timely to remain safeguard from any unwanted change. Therefore, this paper assessed the structural changes in the crop sector, if any occurred and how the demand-supply gap will be affected. It was found that the state's organic policy has negative effect on the area planted for different food grain crops, with the exception of maize but positive impact was observed on the yields of all food grain crops in the State. No structural change was noticed for pulses in the State. Positive change was identified as a result of the programme in area under ginger, turmeric, vegetables and fruits whereas oilseeds area declined, but, yield of vegetables and rape seed and mustard increased after 2010.A massive deficit was forecasted for the food grains in the state by 2024-25 as per current trend. Hence, efforts should be made to enhance the organic production by bringing newer areas under cultivation and improving the yield as it provides safe and sustainable food. Establishing specific organic market with premium prices, organic supply chain, introduction of effective package of practices and development of effective bio-pesticides would aid in improving the yield of the crops and boost the local economy.

Keywords: Organic, Farming, Structural change, Forecast, Policy, Sikkim

INTRODUCTION

Organic agriculture is a production system that sustains the health of soils, ecosystems, and people (IFOAM, 2008). It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. It combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved (IFOAM, 2008). The Unites States Department of Agriculture (USDA) defined organic farming as a unique system which avoids or excludes the use of synthetic inputs (*viz.*, pesticides, fertilizers, feed additives, hormones *etc.*) and totally rely on crop residues, crop rotations, manures, off-farm organic waste and biological management of plant protection and nutrient mobilization. The Food and Agricultural Organization (FAO) in 2007 stated that the conventional food models are problematic for the future and along with macroeconomic and new environmental challenges; it will hurt the helpless population (FAO, 2008). In broader terms, the organic farm management helps in the mitigation of climate

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change. Even if it results in lower yield, the organic conversion would still have socio-economic and environmental benefits over conventional agriculture. It also has the capacity to improve the food security but its potential depends on the political will. Food security is not only the concern of developing countries as climate change and other weakness in food chain may also jeopardize the food secure places too. Sligh and Christman (2007) felt that the organic agriculture can contribute to food security as it improves the nutrient intake leading to healthy diets and increases the capacity to buy food by commercializing the farming of small holders. It increases ecosystem stability and it is self-reliant in nature. Land degradation, resource crunches, erratic rainfall, chronic and acute droughts are the major threats to food security in developing countries (Azadi *et al*., 2013). Organic agriculture has the potential to address this in long term (Hulsebusch *et al*., 2007). But it has its flaws too, in short run, the yields of crops decrease and cannot produce high yield in comparison to conventional farming system (Connor, 2008; Gianessi, 2009).

A number of studies reported decline in yield of various crops. Polat *et al*. (2008) compared the yield, quality, and nutrient content of lettuce grown in conventional and organic farming systems in Turkey for two successive years (2000-02). This was done by comparing the effects of various natural substances *viz*., manure, blood flour and liquid seaweed extract *etc*. on the yield, nutrient content and quality of organic versus conventionally grown lettuces. They found that in both years conventional farming produced higher yields than organic farming, by 20 per cent and 21 per cent, respectively in terms of total yield and marketable yield. However, there were no differences in terms of food quality or nutrition, making it possible to suggest growing organic lettuce because it has a far greater favorable impact on human health. Dresboll *et al*. (2008) found that conventionally grown cauliflower and onion produced yield that were 20 per cent and 45 per cent higher, respectively. Vegetables cultivated organically have lower yields, which can be mostly attributed to management techniques developed specifically for the organic system.

Kitchen *et al*. (2003) conducted a study in one moderate rainfall area and two marginal rainfall areas of South Australia to evaluate the biomass and grain output of wheat from certified organic farming systems with conventional farming systems. Two old wheat varieties from relatively low input environments, Baroota Wonder and Dirk-48, were compared, along with varieties that have been demonstrated to be inefficient (Yallaroi) and efficient in terms of micronutrient uptake *i.e*., Janz and Trident. In both the locations with moderate and marginal rainfall, the organic farming systems produced considerably less biomass at late tillering than the conventional farming systems. For 11 of the 14 comparisons, the grain yield was variable but significantly lower in the organic farming practice. None of the cultivars showed a better ability to adapt to one farming system than another. In ten locations from northern to southern Italy, Annicchiarico *et al*. (2010) assessed grain production and test weight of common wheat types under organic and conventional systems. They found that the average yield under organic system reduced and had the tendency to have slightly reduced test weight too. Likewise, Mader *et al*. (2002) reported from a 21 years study of organic and conventional farming system in Central Europe that the yield of cereal and potato under organic farming system decreased by 20 per cent. Dufault *et al*. (2008) found that yield, nutrient content and vigor of sweet corn treated by synthetic fertilizer was higher as compared to the organically grown one.

Lockeretz *et al*. (1978) compared 14 organic crop/livestock farms in the Midwest to 14 conventional farms' economic performance. According to physical attributes and different farm enterprise models, the study farms were linked. On the organic farms, there was an 11 per cent decrease in the market value of the commodities produced per unit area. However, because the cost of production was lower in organic farm, the net income per unit area was same for the two systems. In a 1979 research, Roberts *et al*. compared information from 15 organic farms in the western Corn Belt with USDA information on typical conventional farms in the same region. Most of the time, organic farms had higher net returns. Both analyses demonstrated that production costs were higher on organic farms. In the state of Washington, there have been two studies comparing cash grain farms. In the first study, Eberle and Holland (1979) examined three organic and three conventional farms, finding that the

conventional farms' net returns per unit area were 38 per cent greater. But the author of a subsequent analysis of six organic farms discovered that net profits on these farms were 22 per cent greater than on the typical conventional farms (Kraten, 1979). Only returns from the production of wheat were examined between 10 conventional and 10 organic farms in New York and Pennsylvania by Berardi (1978). On organic farms, the profits were higher when cash operating expenditures alone were taken into account. But when land prices and unpaid family work were taken into consideration, the conventional farming had greater average return. Therefore, a trade-off should be maintained between organic agriculture and conventional farming system. A critical evaluation is required to understand these aspects in relation with organic farming; hence, this study was carried out.

The North-Eastern Hill (NEH) region of India has relatively more potential for the practice of organic farming in comparison to the other parts of the country (Singh *et al*., 2021). Due to the innate nutrient deficiency, only an iota of chemicals and synthetic fertilizers (< 12.0 kg/ha) has been used in the NEH region's ecosystem to increase the crop productivity. But in 2016, Sikkim one the NEH states, was declared as the first organic state in the world with adoption of 100 per cent organic farming by conserving the plethora of flora and fauna, vibrant ecosystem and soil fertility with substantial organic matter content. Sikkim's agriculture was carried out in minimal input conditions, using less than 20 and less than 1 kg/ha of fertilizer and plant protection chemicals in 2002-03, respectively (Bhutia *et al*., 2016). In 2003, the Government of Sikkim (GoS), took a resolution to transform the state into a "Total organic state" by adopting specific policy interventions (GoS, 2015). Post-declaration, few organic farming programmes on subsidization of vermicompost pit construction, biofertiliser use and availability of organic manures and adoption of bio-village *etc.* were launched. Till 2009, about 10000 farmers from all the four districts of the state benefitted from the adoption of more than 100 villages as bio-village (GoS, 2015). To implement the policies and programmes of organic farming in a mission mode and to fully transform the state into an organic state, Sikkim Organic Mission was launched on 15th August 2010. The state withdrew the imports of chemical fertilizers and subsidies for procurement of all chemical farm inputs (Mohan, 2016). It was observed that the area under organic farming gradually expanded since 2010. In most of the years the State surpassed the target vis-à-vis area under organic farming. The state achieved 18234 ha and 19216 ha under organic farming in 2010-11 and 2011-12 against the target of 18000 ha (GoS, 2015). The achievement was higher by about 37 per cent (19188 ha) than the target of 14000 ha in 2012-13.

More than 64 per cent of people are dependent on agriculture directly or indirectly in Sikkim (Sikkim Action Plan on Climate Change, 2011). In Sikkim, terrace farming is mainly practiced on its' hilly terrain. Paddy, wheat, maize, millets *etc.* are the main crops grown in the state. Rice is the staple diet for the people of the state but maize is the primary crop in the state with a production of 68.70 thousand MT from 39.00 thousand ha, followed by rice with production of 19.70 thousand MT from 10.70 thousand ha. Rape seed and mustard was cultivated in 3.70 thousand ha with 3.20 thousand tones of production as in 2016-17 (Reserve Bank of India 2018). Sikkim is known for being bestowed as the first organic state of the country. This huge step in the agriculture sector of the State created the exigent need to study the structural change if any occurred in the crop productions through crop areas and yields which can affect the food security situation of the State, if not addressed at appropriate time.

MATERIALS AND METHODS

The state of Sikkim is located in the North-eastern Himalayan range of India at longitude of 88° 00' to 88° 55' E (East) and latitude of 27° 04' to 28° 07' N (North). It shares its international boundary in three sides with Tibet in north-east, Bhutan in east, Nepal in west and south by Darjeeling district of West Bengal. The geographical area of the state is 7096 thousand ha (GoS, 2018) which constitute 0.21 per cent of the country's total geographical area. The state comprises of four districts *viz*., North Sikkim, East Sikkim, West Sikkim and South Sikkim. Major part of the area is of hilly terrain with an elevation ranging from 280 m in south to about 8596 m in north. The total forest and tree cover area of Sikkim is 337900 ha which shares 47.62 per cent of the total geographical area. The climate ranges from sub-tropical in south to temperate in north of Sikkim.

Table 1: Data period and source

Crop (Area, Yield)	Period	Source
Total food grains, Rice, Wheat, Maize, Pulses, Barley, Rapeseed and mustard, Soybean, Oilseeds	1981-82 to 2016-17	Agriculture statistics at a glance (Government of India, 2015a), Handbook of statistics on Indian states RBI (2017-18), Basic statistics of North Eastern hill region (GoI, 2015b), ENVIS centre Sikkim (status of environment and related issues) (GoS, 2019)
Finger millet	2003-04 to 2015-16	ENVIS centre Sikkim (status of environment and related issues) (GoS, 2019)
Cardamom, Ginger	1996-97 to 2017-18	Horticulture Statistics at a Glance (GoI, 2015c, GoI, 2017a), Spices board (GoI, 2015d)
Total spices	2006-07 to 2016-17	Horticulture Statistics at a Glance (GoI, 2017a)
Vegetables, Fruits	2001-02 to 2016-17	Statistical year book of India (GoI, 2017b), Horticulture Statistics at a Glance (GoI, 2017a)

The total population of Sikkim is 6.11 lakhs (Census, 2011) out of which 74.85 per cent belongs to rural population and the rest 25.15 per cent is the urban population. The population density in the state is 86 persons per sq.km. The state is pre-dominantly inhabited by three major tribes namely *Lepchas*, *Bhutias* and *Nepalis* with variant cultures and languages of which the latter contributes the major share.

The secondary data on area and yield for various crops were collected from various published materials of the State Government and Government of India for different time periods based on the availability (Table 1).

Analytical measures like mean, standard error, growth trends *etc.* were calculated using the secondary data[1]. Linear trends for area and yield of selected crops *etc.* were estimated using linear regression model in equation (i).

$$Y = a + bt \quad \text{.... (i)}$$

Where, Y = dependent variable (*e.g.*, area, yield *etc.*), t = time, a = intercept and b = slope coefficient

The Compound Annual Growth Rate (CAGR) was calculated by using log-linear model given in equation (ii)

$$\text{Log } Y = a + bt \quad \text{...(ii)}$$

Where, Y = dependent variable (*e.g.*, area, yield *etc.*), t = time, a = intercept and b = slope coefficient

The formula for CAGR is as follows.

$$CAGR = \{EXP(b) - 1\} \times 100 \quad \text{... (iii)}$$

There have been many discussions of structural change or break in many macroeconomic and finance variables, however, there are only few studies that has been done on structural change in agricultural crops. Czech (2016) detected structural break in the wheat prices in the United States (US) using time series data of wheat prices from January 1995 to December 2015. One structural break was observed in the series and was associated with the global financial crisis which was started in 2007. Zainudin and Shaharudin (2011) investigated the structural break in the spot and future crude palm oil returns in Malaysia between 1996 and 2005. They found the presence of certain structural break in the series throughout 1999 to 2008. Ghosh (2010) estimated the critical turning points in agriculture of 15 different major states by estimating the growth performance between 1960-61 and 2006-07. The growth performance of the nation has been evaluated pre and post period of economic reforms in 1991. He concluded that the growth rate of Gross Domestic Product from Agriculture (GDPA) in India as a whole significantly decreased from the pre-reform period to the post-reform period. During the pre-reform period, improved growth performance in agriculture was primarily attained in the 1980s. Similar trends in agricultural growth performance were observed across the states.

[1]The changes in different variables were compared with different reference periods due to non-availability of secondary data for a common period.

A structural change is considered to occur when a time series data changes abruptly at a particular point of data due to occurrence of any major or sudden change in any parameters in the process that made up the time series data (Emmanuel and Maureen, 2022). The time series analysis is based on the assumption of stationarity which implies that the parameters of the econometric model are stable over time. When there is a change in at least one of the parameters at some point of time, there is a structural break in the series (Czech, 2016). Identifying this problem helps the researcher to obtain a precise estimate and forecast. If not addressed, it may lead to massive errors in forecasting which makes the model unreliable (Hansen, 2001; Czech, 2016). The researchers opt for systematic models to recognize and understand the structural break. One classic test is the chow test (Chow, 1960) where the data is split in two sub series and equality of the parameters of two sets is applied. But usually, chow test is applied when the break date is known in advance and identifying the exact break date is a hard task. Researchers believed that it is better to treat the break date as unknown. Therefore, Quand't statistic was introduced by Quandt (Quandt, 1960) where the largest chow statistic was selected over all possible break dates. Since the chi-square critical values are inappropriate if the break date is a priori unknown, the question arises about the critical values to be used. The critical value tables were provided by Andrews (1993); Andrews & Ploberger (1994), who also offered the solution to the issue. Bai & Perron developed a test to identify multiple structural changes in a series (Bai and Perron, 1998).

We have used dummy variable as an alternative to chow test as in our study the break year was known *i.e.*, 2010, the year the Organic Policy was introduced in Sikkim and we failed to reject the null hypothesis of equality of error variances for two regression equations corresponding to two different time periods which is pre-condition to use Chow test. Another problem with chow test is that it splits the data and structural instability/change may occur in the whole range of data (Parpiev 2016). Therefore, use of dummy variable is a common way for solving structural change as it does not involve splitting the data. The test is carried out by running regression by pooling all the observations and using dummies for both the periods. The variables consist of 0s and 1s where 0s were considered as the dummy for the period before 2010 and 1s were considered for the period after 2010. The coefficients and t-statistic can then be interpreted in usual way. The dummy variable regression model used as the following equation

$$Y_i = \alpha + \beta D_i + U_i \quad \text{... (iv)}$$

Where Y_i= dependent variable (*e.g.*, area, yield *etc.*), α= intercept, β= differential intercept, D_i= 0 (period before 2010) and D_i= 1 (period after 2010)

If the differential intercepts are statistically significant, then it suggests that the regression of two time periods are different *i.e.,* there is a structural change in between the time periods.

The gap between supply and recommended daily intake of food grains and oilseeds was calculated to understand the food security that exists in the state. Firstly, the total requirement of food grains and oilseeds based on the recommended daily intake (Indian Council of Medical Research, 2011) for the total population for the year 2016-17 in the state was estimated by multiplying total population with recommended daily intake. The total availability of the food grains and oilseeds in 2016-17 was recorded. The difference between the former and the latter derived us the surplus or deficiency if exists any. The per cent change of surplus/deficit was calculated by

$$\% \text{ change} = \frac{\text{Deficit / surplus}}{\text{Total requirement as per recommendation}} \times 100$$

RESULTS

About 62.70 ha of land in Sikkim was under food grains with average yield level of 1.62 MT/ha as in 2016-17 (Table 2). Maize, used for human consumption as well as fodder for livestock, was the major crop cultivated in 39 thousand ha which was 62.20 per cent of the area under total food grains in Sikkim. The yield was 1.76 MT/ha. Rice and pulses were cultivated in 10.70 and 5.70 thousand ha with average yields of 1.85 MT/ha and 0.96 MT/ha, respectively. Wheat and finger millets were other food grains cultivated in the State. Oilseeds *viz.*, rapeseeds, mustard and soybean were cultivated in about 7 thousand ha with average yield of 0.92 MT/ha. Total area under spices was 32.30 ha, out of which 23.31 ha was under large cardamom crop. Areas under vegetables and fruits were 24.30 and 18.21 thousand ha (Table 2).

Table 2: Present status, linear trend and CAGR for area and yield of different crops in Sikkim

Particulars	Area ('000 ha)					Yield (MT/ha)				
	Year		Trend		CAGR	Year		Trend		CAGR
	1981-82	2016-17	Coeffi-cient	p-value		1981-82	2016-17	Coeffi cient	p-value	
Rice	15.10	10.70	-0.16***	0.00	-1.11	0.80	1.85	0.02***	0.00	1.84
Wheat	9.50	0.30	-0.30***	0.00	-7.90	1.36	1.08	-0.02***	0.00	-1.19
Maize	30.90	39.00	0.09**	0.02	0.25	0.99	1.76	0.02**	0.00	1.23
Pulses	4.90	5.70	-0.18**	0.03	-1.56	0.80	0.96	0.00	0.09	0.54
Barley	0.50	0.40	-0.01**	0.02	-1.60	1.00	1.07	-0.01***	0.00	-0.73
Finger millet (2003-04 to 2015-16)	4.15	2.85	-0.12***	0.00	-3.49	0.86	1.02	0.01***	0.00	1.34
Total food grains	65.90	62.70	-0.47***	0.00	-0.59	0.97	1.62	0.01***	0.00	1.05
Rape and mustard	3.70	3.70	-0.06***	0.00	-1.06	0.60	0.87	0.00	0.07	0.45
Soybean	2.60	3.30	-0.01	0.37	-0.13	0.81	0.98	-0.01**	0.04	-0.56
Total oilseeds	6.30	7.00	-0.07**	0.01	-0.69	0.68	0.92	0.00	0.90	0.02
Cardamom (1996-97 to 2017-18)	23.60	23.31	0.07	0.61	0.39	0.19	0.19	-0.01	0.21	-1.40
Ginger (1996-97 to 2017-18)	4.59	12.30	0.37***	0.00	5.48	0.87	4.54	0.19***	0.00	7.40
Turmeric (2003-04 to 2015-16)	0.51	0.95	0.12***	0.00	12.41	3.34	2.91	-0.03	0.10	-0.94
Total spices (2006-07 to 2016-17)	34.00	32.30	0.59	0.18	2.26	1.23	2.06	0.05	0.14	2.85
Vegetables	14.20	24.30	0.74***	0.00	3.79	4.20	5.28	0.06***	0.00	1.43
Fruits	12.31	18.21	0.61***	0.00	4.73	0.80	1.48	0.03**	0.04	3.05

** & *** indicate $p<0.05$ and $p< 0.01$, respectively

The areas under all the food grain crops have declined over the years except maize crop which has registered marginal increase (β_2 =0.09, $p<0.05$) during 1981-82 and 2016-17 (Table 2). The area under total food grains in Sikkim has exhibited significant negative linear trend (β_2 =-0.47, $p<0.01$). The linear trend coefficients and compound annual growth rates (CAGR) are negative and significant for nearly all the food grain crops. The decline in area under wheat crop was highest among the food grains (7.90%), followed by finger millet (3.49%). Similarly, the CAGR is negative for total oilseed (-0.69%) and the linear trend is also negative and significant (β_2 = -0.07, $p<0.05$) which is primarily decline in rape and mustard seeds area in the State (Table 2).

It seems that the farmers gradually shifted from food grains to other crops or focused on other crops *viz*., spices, vegetables and fruits. The calculated CAGR for fruit was highest (4.73%), followed by vegetables (3.79%) and spices (2.26%). The linear trends for fruits (β_2 = 0.61, $p<0.01$) and vegetables (β_2 =0.74, $p<0.01$) are positive and significant but for spices the positive linear trend is not significant (Table 2). Mixed cropping system was followed by the farmers in Sikkim in which vegetables were either grown as main crop or subsidiary crops. Sikkim is also known for its spices and with the increase in demand for it, spices cultivation has been taken up intensively. The area under the large cardamom has not seen significant change but turmeric (β_2 = 0.12, $p<0.01$) and ginger (β_2 = 0.37, $p<0.01$) got priority from the farmers. The areas under turmeric and ginger have grown annually by 12.41 per cent and 5.48 per cent in the State, respectively. It becomes clear that the farmers in the state are becoming relatively more interested in cultivating cash crops than the food grains as they diverted their lands from food grains to other high income earning crops.

In 2010, Sikkim withdrew the use of chemicals and stepped towards chemical free organic state. To understand if there is any variation in the structural change because of the transition, dummy variable regression model was used as an alternative to the chow test. It means that the regressions for two time periods are different and a change must have taken place. The dummy coefficients for area under totals food grains (β_2 = -13.08, p<0.01) and all the cereals, except maize turned out to be negative and significant. But, the coefficients for dummy variables *viz*., area under ginger (β_2 = 4.21, p<0.01), turmeric (β_2 = 0.76, p<0.01), vegetables (β_2 =5.33, p<0.05) and fruits (β_2 = 6.21, p<0.01) are positive and significant. The coefficient for total oilseeds (β_2 = -2.01, p<0.05) and rapeseed and mustard (β_2 = -1.71, p<0.01) are found to be negative and significant. The dummy coefficients for yields of wheat (β_2 = -0.41, p<0.01) and barley (β_2 = -0.17, p<0.05) are negative and significant whereas the coefficients are positive and significant for yields of rice, maize, finger millet and total food grains. The dummy coefficients for yield of rapeseed and mustard (β_2 = 0.58, p<0.01) and vegetables (β_2 = 0.10, p<0.05) also showed a positive and significant increase in yield post 2010.

Table 3 reveals that decline in area under different food grains except maize can be attributed to the organic policy of the state but favourable policy effect is observed in case of yields of all food grains crops in the State. The effect of policy change is positive for yield of all the food grains, except wheat and barley. No structural beak is observed in case of pulse production in the State. In case of spices the area increase in ginger and turmeric can be linked to the policy but no such effect can be attached for large cardamom crop. The policy had positive effect on area expansion for vegetables and fruits but negative effect on total oilseeds and rape and mustard area. The yield of rapeseed and mustard and vegetables are positively influenced by the organic policy decision.

The positive influence on area of crops *viz*., ginger, turmeric, vegetables and fruits are reflective of farmers' preference towards the commercial cash crops over the food grains as the organic spices, vegetables and fruits have higher potential to fetch premium prices in

Table 3: Dummy variable approach to measure the structural difference in area and yield

Particulars	Area				Yield			
	Dummy coefficient	Standard error	p value	R square	Dummy coefficient	Standard error	p value	R square
Rice	-4.40***	0.51	0.00	0.68	0.42***	0.10	0.00	0.34
Wheat	-7.31***	0.83	0.00	0.70	-0.41***	0.09	0.00	0.37
Maize	1.35	1.02	0.20	0.05	0.33***	0.06	0.00	0.45
Finger millet	-0.99***	0.12	0.00	0.86	0.07***	0.02	0.00	0.57
Barley	-0.49***	0.13	0.00	0.28	-0.17**	0.07	0.03	0.13
Food grains	-13.08***	3.67	0.00	0.27	0.26***	0.05	0.00	0.43
Pulses	-3.54	2.07	0.10	0.08	0.05	0.06	0.41	0.02
Large cardamom	2.81	1.77	0.13	0.11	-0.07	0.06	0.32	0.05
Ginger	4.21***	0.65	0.00	0.68	1.61	0.78	0.05	0.17
Turmeric	0.76***	0.17	0.00	0.64	-0.14	0.13	0.29	0.10
Total spices	2.37	2.85	0.43	0.07	0.37	0.17	0.06	0.34
Rapeseed and mustard	-1.71***	0.49	0.00	0.26	0.10**	0.04	0.02	0.14
Soybean	-0.02	0.09	0.84	0.00	-0.26	0.24	0.29	0.03
Total oilseeds	-2.01**	0.70	0.01	0.20	0.06	0.05	0.23	0.04
Vegetables	5.33**	1.86	0.01	0.37	0.58***	0.09	0.00	0.74
Fruits	6.21***	0.81	0.00	0.81	0.20	0.14	0.2	0.12

** & *** indicate p<0.05 and p< 0.01, respectively

the domestic as well as export markets. Organic policy's positive effect on crop yields may have been possible due to introduction of improved organic scientific package *viz.,* nutrient mobilization, use of off-farm organic waste, crop residues, practicing crop rotations *etc.* by the State government. Moreover, the use of fertilizers and other chemicals was at low level even before the introduction of the organic policy in Sikkim, so, smaller effort can yield better results in comparison to the other states of the country.

To understand the gap between demand and supply of the food grains in the state, a comparison was made between the total availability of the food grains (estimates) and recommended daily intake of food grains per head as on 2024-25 (Table 4). The projected population was estimated to be 730506 as on 2024-25. The calculations show that there would be a shortage of supply for every food grain in the state. The supply of rice, wheat, maize, pulses, barley, finger millet and oilseeds would fall short significantly than the requirement of the State to feed its population behind by 92.10 per cent, 100.77 per cent, 74.21 per cent, 90.13 per cent, 99.82 per cent, 99.31 per cent and 71.87 per cent, respectively. This showed that Sikkim needs to buckle and take precautionary or improvement measures to avoid the wrath of food insufficiency in the state.

This paper was an effort to understand if there was any structural change in the area and yield of the crops after the policy intervention of "Organic Mission" in the state of Sikkim in 2010. It was found that the State's organic policy led to the decline in the area under different food grains, with the exception of maize, but that the policy had a positive impact on the yields of all food grain crops in the State, whereas, no structural break was visible in case of pulse production. In the case of spices, the change was evidenced by increase in the area of ginger and turmeric crops after 2010. Vegetable and fruit growing areas expanded favourably as a result of the programme, but the total area used for rape and mustard and oilseeds suffered. The policy choice in favour of organic farming has a positive and significant impact on vegetable and rape seed and mustard productivity. We also found that there was a shortage of supply for food grains in the state than what the State needs to feed its population.

It can be concluded that the organic mission was found to have its effect mostly on food grains, vegetables and rapeseed and mustard which are mainly staples and was a good sign as the yield was improved but on the contrary, it was evident by the disparity between demand and supply of food grains that the State would end up becoming fully dependent on the imports of stables from neighboring states recreating the situation of India in the first decade of independence (Ranjan, 2021).

Therefore, to further improve the yield of these crops effective package of practices *viz.,* proper irrigation facility, efficient biofertilizers, intercropping practices need to be adopted by the farmers. Initiatives should be taken up by the research institutes to develop effective bio-pesticides to tackle the persistent insect infestation. Establishing specific organic market with premium prices and developing organic supply chain for the organic produce can help the farmers to afford a better standard of living and improve the local economy. It would also act as an incentive to continue organic farming which would further help the country to achieve Sustainable Development Goals (SDGs).

Table 4: Demand and availability of food grains and oils seeds

Commodity	Recommended daily intake per head (kg)	Requirement (kg) as per 2024-25 projected population	Forecasted supply (kg)	Deficit (%)
Rice	0.40	292202	23076	-92.10
Wheat	0.40	292202	-2262	-100.77
Maize	0.40	292202	75347	-74.21
Pulses	0.08	58440	5770	-90.13
Barley	0.40	292202	540	-99.82
Finger millet	0.40	336033	2310	-99.31
Oil seeds	0.03	21915	6166	-71.87

Although organic farming has dubious potential to improve food security in terms of availability; it undoubtedly helps to provide safe food and sustainable food production (Schoonbeek *et al*., 2013).

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Development of a Test to Measure Knowledge Level of Women Farmers towards Climate Resilient Dairy Farming Practices

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ABSTRACT

Climate resilient agriculture (CRA) encompasses the incorporation of adaptation and resilient practices in agriculture, which increases the capacity of the system to respond to various climate-related disturbances by resisting damage and ensures quick recovery. Accordingly, climate resilient dairy farming practices were identified and recommended by the research organization. Therefore, understanding and adoption of these practices is very much crucial to build the resilience capacity of dairy farmers in the country. Developing a sound knowledge test by adopting a scientific procedure, gaps in knowledge can be known, which would help in formulating future policies for better adaptation. For developing a suitable knowledge test, standard protocol was followed. Appropriate items were collected and scrutinized for further item analysis. A total of 35 statements were administered to 60 women respondents for item analysis. Based on the standardized cut-off of difficulty and discrimination indices as well as point biserial correlation coefficient, 15 items were retained for the final test. Validity and reliability of the instrument have been established through expert opinion and spearman brown coefficient using split half method, respectively.

Keywords: Knowledge test, Climate resilient, Dairy farming, Women farmer

INTRODUCTION

Climate change has become a major threat to the livelihoods of farmers across the globe and India is no exception to it. The impact of climate change on dairy animals can be seen from two aspects i.e., direct effects of climate change and indirect effects of climate change on dairy farming. Reduced productive, reproductive and health profile of dairy animals come under direct effects while adverse effects of climate change on availability of feed, fodder and water may be regarded as indirect effects (Seijan, 2015). Resilience is the ability of the system to bounce back and essentially involves judicious and improved management of natural resources, land, water, soil, and genetic resources through adoption of best practices (UNFCC, 2011). The concept of resilience is central to an understanding of the vulnerability of agriculture sector to climate change. Agriculture depends on the resilience of both social and ecological systems. In social systems, resilience pertains to households, communities, and regions, the degree of which depends both on the assets and knowledge the farmers can mobilize and the services provided by governments and institutions. Climate resilient agriculture (CRA) encompasses the incorporation of adaptation and resilient practices in agriculture, which increases the capacity of the system to respond to various climate-related disturbances by resisting damage and ensures quick recovery (Srinivasa Rao *et al.*, 2019). Research institutes identified several climate resilient dairy farming practices and suggested to use these identified practices to cope up with the changing climatic scenario. Hence, adoption of these identified practices is very much crucial to build the resilience capacity of dairy farmers in the country as dairying is providing gainful employment and steady income to the rural households.

In India, involvement of women in livestock management is a long standing tradition and dairy

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farming has been an integral part of their day to day life. Women constitute 71 per cent of the labour force in livestock farming and 75 million women are engaged in dairy farming as against 15 million men in dairying (Thakur and Chander, 2006). As women play a very prominent role in managing the dairy animals, it is very imperative to understand their knowledge level about the available climate resilient dairy farming practices to formulate effective extension strategies to promote adoption of these the practices among the women dairy farmers. Therefore, developing an appropriate psychometric tool like knowledge test is the need of the hour to identify the knowledge gap of the women dairy farmers which would help in formulating future policies for better adaptation. Moreover, adequate knowledge about impacts of climate change and climate resilient dairy farming practices shall be instrumental in developing a positive attitude towards climate resilient dairy farming practices (Sarkar *et al.*, 2014).

MATERIALS AND METHODS

This paper was aimed at developing a suitable test to assess the knowledge levels of women farmers about climate resilient dairy farming practices. The following procedure has been followed in developing an appropriate instrument to measure the same:

Collection of items: Suitable items for the test were collected by reviewing the existing literature like past research papers, annual reports of ATARIs and NICRA project, consulting experts, personal experiences of the authors and also through a pilot study. Initially a total of 50 items that are related to various climate resilient dairy farming practices were collected. After screening, fine tuning and editing based on the opinion of the concerned experts, 35 items were retained. The 35 items were subjected to item analysis to screen some more items based on the opinion of the respondents in non-sampling area.

Item analysis: Item analysis was carried out by administering the pre-tested items to 60 women dairy farmers in the non-sampling area of Karnal district of Haryana. These 60 women dairy farmers were selected from the four villages of Karnal and Indri block of Karnal district, Haryana. Women dairy farmers were actively involved in the activities of dairy farming of their respective households. All the 35 items were presented to the women dairy farmers in different question format like open-ended, multiple-choice questions and True/False type to extract the knowledge levels of farmers in an accurate way as much as possible. A score of 1 was awarded when response was correct and 0 for the incorrect answer. Finally, item analysis was carried out by calculating item wise difficulty index and discrimination index which are as follows:

Item difficulty index: The item difficulty index was defined as the proportion of the farmers giving correct answer to that particular item. Here underlying assumption was that difficulty was linearly related to the level of respondent's knowledge about climate resilient dairy farming practices. The difficulty level of each item was assessed using the following formula:

$$P_i = \frac{n_i}{N_i}$$

Pi = Difficulty index for i^{th} item

n_i = Number of respondents who correctly answered the i^{th} item

N_i = Total number of respondents to which i^{th} item was administered

Finally, the items with score between 0.30 to 0.95 were selected for the final test based on the recommendations of Linda A. Atthouse (2000).

Discrimination index: The discrimination index of an item indicates how well a particular item is able to distinguish between respondents who are knowledgeable and those who are not. Method of $E^{1/3}$ was adopted for this study to calculate the discrimination index of item by using the following formula:

$$E^{1}/_{3} = \frac{(S_1 + S_2) - (S_5 + S_6)}{N/_3}$$

Where, S_1, S_2, S_5 and S_6 were the frequencies of the correct answer in groups G_1, G_2, G_5 and G_6 (all the 60 women dairy farmers were divided into six equal groups, each having 10 respondents and were arranged in descending orders of total scores obtained by them. These groups were named as G_1, G_2, G_3, G_4, G_5 and G_6). N= total number of sample in the study.

Criteria of selection of items: Finally, point biserial correlation coefficient was calculated for each statement

as an additional criteria of selection of items for knowledge test. The items with difficulty index score between 0.3 to 0.9 (based on the recommendations of Althouse, 2000) and discrimination index of more than 0.2 (based on recommendations of Matlock-Hetzel, 1997) as well as point biserial correlation coefficient significant at 5 percent level of significance were selected for the final test.

Reliability and validity: Content validity of the test was ensured by taking the opinion of experts who have been working in the area of climate resilient dairy farming practices and they have judged the representation of the content, relevance and its appropriateness.

Split half method was employed to know the reliability coefficient as the method was considered as the best for measuring a test reliability (Garrett, 2007) and measured by calculating the Spearman Brwon reliability coefficient as proposed by Thompson (2018) which is as follows:

$$r_c = \frac{2r}{1+r}$$

Where, r_c = Spearman Brown reliability coefficient of the whole test and r = Reliability coefficient of the half test

RESULTS AND DISCUSSION

All the thirty-five screened items were presented to the 60 women dairy farmers for item analysis. Collected data were subjected to calculation difficulty index, discrimination index and coefficient of point biserial correlation. Item wise value of the difficulty index, discrimination index and coefficient of point biserial correlation is presented in Table 1. Value of difficulty index of each item was ranged between 0 to 1. Total 15 items were appraised as too easy that all the women dairy farmers responded them correctly and graded as difficulty index value 1. Accordingly, value towards zero indicated as the tough items to answer. These 15 items were also unable to discriminate higher knowledgeable person to lower knowledgeable person. Therefore, discrimination index of these items was calculated as zero. The same table also clearly depicts that 15 items were having difficulty index score between 0.3 to 0.9 and discrimination index of more than 0.2 as well as point biserial correlation coefficient significant at 5 per cent level of significance. Hence, items no 5, 9, 12, 15, 16, 17, 18, 19, 20, 21, 23, 29, 30, 31 and 32 were selected for the final knowledge test and presented in the Table 2 with their respective difficulty index, discrimination index and point biserial correlation coefficient.

Selected items were presented to 10 subject matter specialists working in the area of climate resilient dairy farming practices for content validity of the developed test. Every one of them confirmed content, relevance and its appropriateness of the items of the developed test. The calculated Spearman Brown reliability coefficient of 0.707 proved that the developed knowledge test had a good internal consistency.

Scoring pattern of the response options of the selected items clearly depicts that a highly knowledgeable women dairy farmer may score up to maximum of 33. But, average knowledge score obtained by a group of 60 women dairy farmers of non-sample region, to whom the developed knowledge test was administered, was 13.01 which was lower than the half of the maximum possible score. Item wise score was scrutinized to understand the reasons behind the lower level of scoring capacity of the developed knowledge test. It was found that average score of all the respondents was very less (i.e. 0.2) on the item when they were asked to name the drugs used controlling the ecto parasites. Majority of the farmers were not practicing the control of ecto parasites and were not aware of any methods. Farmers did not have any knowledge about the products which would help in prevention and controlling of mastitis and average score of farmers on the particular item was 0.2 on a maximum score of 1. The next lowest mean score (0.25) was recorded on the item related to maximum level of Temperature Humidity Index (THI) for which special care for the animals was required. Women famers in the study area felt that high levels of humidity had nothing to do with the heat stress of dairy animals. A mean score of 0.85 was recorded when farmers were posed with a question on climate change and its relation with vector borne diseases. Very few farmers have answered partially. When farmers were asked about the feeding practices that would help in alleviation

Table 1: Item analysis of the screened items of the knowledge test

Item	Difficulty index	Discrimination index	Point biserial correlation coefficient
Have you heard about climate change and explain about it?		1	0 0
What do you mean by climate change from the following?	1	0	0
Which of the following is human induced cause of climate change?	1	0	0
Effect of unfavourable climate variability on distribution of rainfall over the year will be	1	0	0
Which of the following is true about vector borne diseases by impending climate change?	0.766	0.366	0.423**
Due to climate change, milk production of dairy animals will be	1	0	0
Which type of animals are more sensitive to climate change?	1	0	0
Indigenous breeds are preferred for rearing against climate change due to	1	0	0
Which of the following is true about impacts of climate change on dairy animals?	0.8	0.3	0.364**
Which of the following is resistant to diseases due to adverse climate?	1	0	0
What is the adverse effect of heat stress on animal feed intake?	1	0	0
What are the impacts of heat stress on productivity performance of animals?	0.633	0.666	0.680**
What will be the impact of climate change on fodder availability?	1	0	0
Due to the effect of climate change, grazing and pasture land areas will be	0.955	-0.0333	-0.76
Which of the following is true about the agronomic practices related to sowing or planting of fodder crops in wake delayed monsoon?	0.688	0.633	0.681**
What will be the impact of climate change on soil erosion?	0.9	0.2	0.333**
Higher incidence of mastitis is observed during periods of	0.633	0.666	0.680**
Which of the following will help in reducing the incidence of mastitis	0.377	0.333	0.334**
Warm winters & high humidity conditions provide favourable environment for parasites to lay eggs and infect dairy animals easily	0.833	0.3	0.364**
Which of the following is used for deworming in animals	0.6	0.666	0.673**
Name the drugs used for controlling ecto parasites in dairy animals	0.555	0.533	0.538**
Temperature humidity index is related to	0.022	0.066	0.186
Special care for dairy animals is required when THI crosses	0.6	0.733	0.740**
What are the general management practices that should be followed to avoid or reduce impact of heat stress in animals	0.944	0.1	0.229
What are the impacts of heat stress on animals	1	0	0
During hot sunny periods animals should be fed during	1	0	0
Which of the following should be followed during the times of hot sunny days?	1	0	0
During the times of heat stress in animals, following should be done	1	0	0
Which of the following is true regarding thermal stress?	0.9	0.266	0.392**
Which of the following practice increases conception rates in buffaloes?	0.566	0.433	0.446**
Which of the following feeding practice helps to alleviate heat stress and increases milk production?	0.911	0.233	0.363**
Which of the following causes deterioration of milk and milk products?	0.688	0.633	0.681**
What are the symptoms of heat stress in dairy animals?	1	0	0
Mastiguard is a technology related to?	0.033	0.1	0.229
Mastiguard contains?	0.033	0.1	0.229

Table 2: Selected Items and their respective difficulty and discrimination indices as well as point biserial correlation coefficient

Item	Difficulty index	Discrimination index	Point biserial correlation coefficient
Which of the following is true about vector borne diseases by impending climate change?	0.766	0.366	0.423**
Which of the following is true about impacts of climate change on dairy animals?	0.8	0.3	0.364**
What are the impacts of heat stress on productivity performance of animals?	0.633	0.666	0.680**
Which of the following is true about the agronomic practices related to sowing or planting of fodder crops in wake delayed monsoon?	0.688	0.633	0.681**
What will be the impact of climate change on soil erosion?	0.9	0.2	0.333**
Higher incidence of mastitis is observed during periods of	0.633	0.666	0.680**
Which of the following will help in reducing the incidence of mastitis	0.377	0.333	0.334**
Warm winters & high humidity conditions provide favourable environment for parasites to lay eggs and infect dairy animals easily	0.833	0.3	0.364**
Which of the following is used for deworming in animals	0.6	0.666	0.673**
Name the drugs used for controlling ecto parasites in dairy animals	0.555	0.533	0.538**
Special care for dairy animals is required when THI crosses	0.6	0.733	0.740**
Which of the following is true regarding thermal stress?	0.9	0.266	0.392**
Which of the following practice increases conception rates in buffaloes?	0.566	0.433	0.446**
Which of the following feeding practice helps to alleviate heat stress and increases milk production?	0.911	0.233	0.363**
Which of the following causes deterioration of milk and milk products?	0.688	0.633	0.681**

of heat stress and increases milk production, the mean score was 0.95 on maximum score of 3. Hence, findings were indicated that there is an utmost need to make women farmers aware about climate change and uses of climate resilient dairy farming practices which would help them cope up their animal from changing climatic scenario and sustain their livelihoods.

CONLUSION

A new test to measure the knowledge level of women dairy farmers about climate resilient dairy farming practices has been developed. The standard protocol was followed to develop the test and total 15 items were found to be significant to include in the final developed test. The test was administered to sixty women farmers and their average score was 13.01 on a maximum score of 33. The means score was less than half of the maximum score which indicate the necessity to take appropriate steps to make women farmers aware about climate change and existing climate resilient dairy farming practices.

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Constraints Perceived in Adoption of Landraces by the Beneficiaries of Global Environment Facilities Project

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ABSTRACT

This study was undertaken in Rajasthan state to delineate the constraints perceived in adoption of landraces by the selected 113 beneficiaries of project funded by Global Environment Facilities (GEF). Results revealed that high labour charges, natural calamities, unavailability of latest technology at village level and unavailability of proper storage place were perceived as most severe constraints. Correlation analysis of socio-economic antecedents with constraints revealed that strong and positive correlation was found between technological constraints and occupation. Financial constraints had significant and negative correlation with occupation, while significant and positive correlation with social participation. Storage constraints were strongly and positively associated with caste whereas strongly and negatively associated with income. General constraints had significant positive correlation with occupation, land-holding and income.

Keywords: Constraints, Landraces, Adoption, Socio-economic, GEF

INTRODUCTION

Agriculture is the primary source of livelihood for majority of country's population. This sector contributes 18.3 percent of GDP (Anonymous, 2023). During crop year 2019-20, food grain production was estimated to reach a record figure of 295.67 million tons (MT) (Anonymous, 2020). If we see in the context of production to productivity, we can see the clear-cut difference that the land has potential to grow more but somehow our farmers are not able to harness that potential due to lack of adoption of innovative technology and recommended package of practices. Government of India and ICAR is taking many initiatives to enhance the rate of adoption and trying to bridge the gap between what is and what ought to be. Technology dissemination and facilitation in adoption is a key activity, institutions which are playing major role in dissemination of technologies in India are ICAR, State Agriculture Universities (SAUs), State Agricultural Departments, KVKs, NGOs etc. Among these agencies, State agricultural universities (SAUs) are the main functionaries, responsible for the dissemination of new techniques by providing area specific recommendations, on and off farm research and by suggesting various package of practices (POPs).

Agriculture University Jodhpur is also implementing many research projects which are helping in the dissemination of recommended package of practices and developing area specific interventions for well-being of farming community. Out of them one project entitled "Mainstreaming agricultural biodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability" funded by UN Environment-Global Environment Facilities (GEF) is being implementing by Agriculture University, Jodhpur with the collaboration of CAZRI (Central Arid Zone Research Institute) and GRAVIS (Gramin Vikas Vigyan Samiti) under the guidance of

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ICAR, New Delhi. The main focus of the project is to mainstream the conservation and use of agricultural biodiversity for the resilience in agriculture, sustainable production to improve livelihood and to access the advantage sharing capacity of the farmer communities. The GEF project is being implemented in three districts of Rajasthan namely; Barmer, Jodhpur and Jaisalmer. Three types of villages were selected as per the letter of agreement (LOA) i.e. Core, Buffer and Control. The farmers of the core villages are considered as ultimate beneficiaries for the implementation of the project. Those farmers who voluntarily came forward to conduct performance trials of the selected landraces on their farms were named as Champion farmers. Three types of demonstrations were conducted namely Mother trails (MT), Baby trails (BT) and Seed multiplication trails (SMT) on the farms of selected farmers. The seeds of the landraces were collected from across the state and distributed to champion farmers of each selected village. The champion farmers cultivated the seeds of landraces on their farms under technical guidance of Agriculture University, Jodhpur to evaluate the performance in the selected area. Performance of the landraces is evaluated based on the different preferences of the farmers and their productivity. Hence, under this project a study had been conducted to delineate constraints faced by the beneficiary farmers of the project in adoption of recommended cultivation practices from field preparation to storage in all Kharif crops i.e. Moongbean, Mothbean, Sesame and Pearlmillet. The purpose of the study was to know the areas where farmers are facing problems so that with the help of extension activity, technical backup and some govt. policies we can ameliorate the problems which are hindering the rate of adoption and ultimately leading to the low productivity.

MATERIALS AND METHODS

The present study was conducted in Rajasthan state of India. Rajasthan was purposively selected because this research was carried out under the project entitled "Mainstreaming agricultural biodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability" funded by Global Environment Facilities (GEF), which is being implemented in the state. This project is implemented in three districts of western Rajasthan namely Jodhpur, Barmer and Jaisalmer. Out of these three districts two districts namely Jodhpur and Barmer were purposively selected for the study due to the fact that majority of project's beneficiaries belong to these districts. The project was implemented in only two tehsils of selected districts namely Osian - Jodhpur and Chohtan – Barmer. Hence, these tehsils were purposively selected for this study. The project implemented in the four core villages of selected tehsils, namely; Mansagar and Govindpura - Osian, Jodhpur and Dhok and Dhirasar - Chohtan, Barmer for implementation of selected project interventions. Therefore, these villages were selected purposively for the present study. A complete list of the project beneficiaries among the selected villages was collected from the project office and all beneficiaries who were selected in the initiation year of the project and were benefitted by kharif crops (Moongbean, Mothbean, Sesame and Pearl millet), were selected as respondents for the data collection. Hence, a total number of 113 farmers from selected villages were sort listed based on preset criteria which constituted the sample for the study.

The cross-sectional research design was applied in the present study. It was used for fact-finding with adequate interpretation. For the study, a face-to-face interview method by using an interview schedule was adopted. The schedule was first prepared in English and then translated to Hindi (native language) and then back to English to verify the consistency and content. Initially, information about perceived constraints was obtained to prepare the interview schedule through conducting focused group discussions, farmer scientist interactions, and first-hand information from the field visits during project activities. The constraints were conscripted in the consultation with subject matter specialists of Agriculture University, Jodhpur and the project staff. The listed constraints were categorized under four categories *viz.* technical, financial, storage and general constraints. In interview schedule responses were collected on three continuums viz. Most severe, severe and least severe and the scores of 3, 2 and 1 were awarded to them, respectively. To analyse the collected data, the total number of a constraint were summed up and they divided by total number of respondents to obtain the mean per cent score. The constraints were than ranked in descending order on the basis of mean per cent score. For getting the

constraint score of an individual respondent, the scores of all the constraints that the individual faced were summed up.

Further, correlation analysis was done to investigate the relationship between various socio-economic attributes of farmers and different types of constraints. The purpose of this analysis was to determine the extent to which these attributes are associated with the mentioned constraints. Positive and negative correlations were assessed, and the implications of these findings were discussed within the context of their research objectives.

RESULTS AND DISCUSSION

The results presented in the Table 1, reveals that among the technical constraints; unavailability of latest technology at village level was found to be most severe, followed by lack of knowledge about plant protection measures, inadequate knowledge of agriculture functionaries and lack of technical guidance, respectively. Lack of knowledge about spacing was observed least severe constraint based on their MPS. These findings are in accordance with the findings of Patodiya and Sharma (2014) and Das (2012).

Table 1: Distribution of respondents according to technical constraints (n=113)

S.No.	Technical constraints	MPS	Rank
1	Lack of technical guidance	58.33	IV
2	Inadequate knowledge of agriculture functionaries	70.00	III
3	Unavailability of latest technology at village level	74.67	I
4	Lack of knowledge about plant protection measures	71.67	II
5	Lack of knowledge about spacing	51.00	V

The data in Table 2 shows the financial constraints of the respondents, among which; high labour charges were found most severe followed by high cost of equipment, high cost of insecticides and pesticides and high cost of fertilizers, respectively. Moreover, lack of credit facility in the area was observed least affecting constraint. These findings are similar with the findings of Sharma *et al.* (2020) and Bheemudada and Natikar (2016).

Table 2: Distribution of respondents according to financial constraints (n=113)

S.No.	Financial constraints	MPS	Rank
1	High labour charges	80.33	I
2	Lack of credit facility in the area	69.00	V
3	High cost of equipment's	76.67	II
4	High cost of insecticides & pesticides	74.00	III
5	High cost of fertilizers	71.33	IV

This part includes several aspects which are related to the storage of the produce. Each aspect is assigned with a particular rank and data in this regard are presented in Table 3. The Table 3 revealed that most affecting constraint was unavailability of proper storage place which was followed by inaccessibility to fumigants for storage. Constraint related to unavailability of storage bags and high losses during storage were ranked 3rd and 4th, respectively. Lack of technical knowledge about storage was found to be least severe constraint. Findings of the study are in conformity with the findings of Jakkawad *et al.* (2017).

Table 3: Distribution of respondents according to Storage constraints (n=113)

S.No.	Storage constraints	MPS	Rank
1	Lack of technical knowledge about storage	57.67	V
2	Inaccessibility to fumigants for storage	66.67	II
3	Unavailability of proper storage place	68.33	I
4	Losses during storage	62.00	IV
5	Unavailability of storage bags	64.33	III

The results in Table 4 revealed general constraints of the respondents, constraints about natural calamities were found most severe; which is followed by resource poor farmers, lack of transportation facilities due to lack of pucca road and fragmented and undulated land, respectively. Lack of motivating agencies in the area is the least affecting constraint. These findings are in accordance with the findings of Iyagbe *et al.* (2017) and Parsa *et al.* (2014).

The data in Figure 1 reveals that among four categories of constraints the financial constraints were perceived with the highest intensity by the respondents; followed by general and storage constraints. Technical constraints were perceived with the least intensity and found to be least severe.

Table 4: Distribution of respondents according to general constraints (n=113)

S.No.	General constraints	MPS	Rank
1	Natural calamities	75.67	I
2	Fragmented and undulated land	64.33	IV
3	Resource poor farmers	70.67	II
4	Lack of motivating agencies in the area	58.33	V
5	Lack of transportation facilities due to lack of pucca road	67.00	III

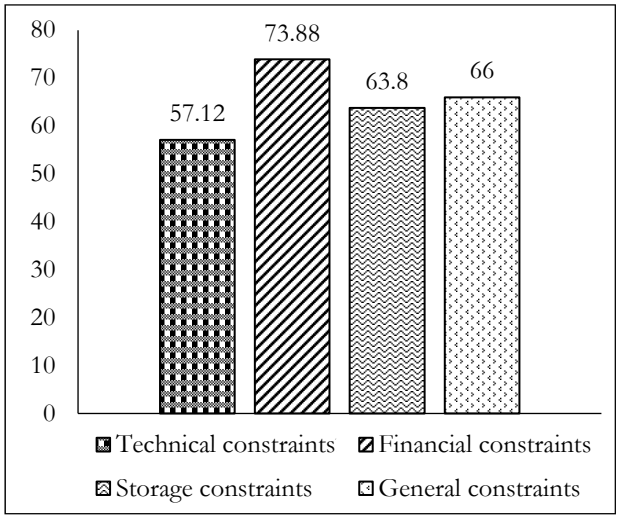

Figure 1: Relative position of different categories of constraints (n=113)

The Table 5 represents the results of a correlation analysis that explores the relationship between various socio-economic attributes of farmers and their constraints in adopting landraces. The interpretation of Table 5 shows that negative correlation coefficients for Age (-.068), Family type (-.059), Education (-.082) and Social participation (.057) indicate a weak negative association with constraints in adopting landraces. This means that as these attributes increase, the constraints decrease, and vice versa.

The positive correlation coefficients for Caste (.0202*), Occupation (.194*), Land holding (.106) suggest a weak positive association with constraints in adopting landraces. This means that as these attributes increase, the constraints also increase, and vice versa.

The highest correlation coefficient is seen between Storage Constraints and Caste (.202*), which is significant at the 0.05 level. This suggests a moderate positive association between Caste and Storage constraints, which means that farmers belonging to certain castes face more storage constraints in adopting landraces.

Similarly, the highest correlation coefficient is observed between General constraints and Income (.237**), which is significant at the 0.01 level. This indicates a moderate positive association between Income and General constraints, which means that farmers with higher income face more general constraints in adopting landraces.

Overall, this analysis highlights the importance of socio-economic attributes in understanding the constraints faced by farmers in adopting landraces. The findings can be used to design interventions and policies that address the specific constraints faced by farmers belonging to different socio-economic groups.

Table 5: Correlation analysis of socio-economic attributes with constraints (n=113)

Antecedents	Technological constraints	Financial constraints	Storage constraints	General constraints
Age	-.068	-.141	-.040	-.153
Caste	.011	.021	.202*	.107
Family type	-.059	.049	.078	-.073
Occupation	.194*	-.172*	.043	.158*
Education	-.082	.049	.111	.062
Land holding	.106	.103	-.098	.218*
Income	-.073	.025	-.230**	.237**
Social participation	.014	.162*	.081	-.057

*. Correlation is significant at the 0.05 level (1-tailed); **. Correlation is significant at the 0.01 level (1-tailed).

CONCLUSION

We can conclude by saying that financial constraints were the major hindrance in the adoption of landraces as perceived by the farmers. General and storage constraints were also acting as roadblocks in the adoption. High labour charges, natural calamities, unavailability of latest technology at village level and unavailability of proper storage place were found to be most severe constraints in the adoption. The new agricultural technologies are considered to be the prime mover to the process of agricultural development in India. Understanding farmers' perceptions of a given technology is crucial in overcoming the challenges and increasing rate of adoption of any technology. The present study highlights the need of extension organizations boosting their different programs to improve farmer adoption rates. Researchers, state agricultural department personnel, extension agencies, and commercial firms should consider the constraints expressed for non-adoption of recommended package of practices in order to better align their infrastructure for higher adoption of recommended technology for maximum production. Farmers should be given proper direction and awareness through practical skill-oriented training, field visits, field demonstrations, and other extension literatures. To avoid technological failures, farmers must be included as much as possible in the technology development process as well as in productivity enhancement strategies. Likewise, to get rid of financial constraints, it is suggested that rural regional banks and cooperative societies should come forward and help the poor farmers by providing loans and other financial assistance.

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Effect of Sowing Environments and N-levels and their Interaction on Growth and Yield of Wheat Varieties under Irrigated Conditions of Lower Hills of J&K UT

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ABSTRACT

Experiments were conducted at Agromet Research Farm, SKUAST-J, Chatha, J&K UT in *rabi* 2015-16 and 2016-17, to evaluate the effect of sowing environments and N-levels on growth parameters, their interactions and yield of wheat (*Triticum aestivum* L.) varieties. Three wheat varieties (HD 2967, RSP 561 and WH 1105), 3 sowing environments (25th October, 14th November and 4th December) and 3 N-levels (100, 125 and 150 kg/ha) were laid out in split plot design with 3 replications. The results revealed that variety WH 1105 observed significantly superior growth parameters *viz.* plant height, no. of tillers/m row length, crop growth rate, relative growth rate and grain and straw yields of wheat as compared to the varieties HD 2967 and RSP 561. Variety RSP 561 recorded lowest values of growth parameters and yield. Among the sowing environments, the early sown (25th October) wheat crop envisages significantly higher values of growth parameters and grain yield. Whereas, statistically notable values of the same recorded in higher dose of nitrogen (150 kg/ha), but the values were at par with 125 kg N/ha.

Keywords: Wheat, Varieties, Sowing environments, Growth parameters, CGR, RGR, Yield

INTRODUCTION

Wheat, a major cereal crop of the world being grown in about all the countries of the world across the six Continents and is the staple food crop of India; cultivated in about 31.87 mha with production of 99.70 MTs (ICAR-IASRI, 2023). Selection of improved varieties and optimum sowing time play a remarkable role in exploiting the yield potential of the crop under particular agro climatic condition. The accumulated temperature is also considered as the principal factor which affects the year-to-year variation in development of various phenophases (Gupta *et al*., 2020). Advance or delay in sowing date, increasing N application and choice of suitable variety with the best thermal requirement represent the main agronomic manipulations which help to maintain existing crop production levels (Ventralla *et al*., 2012; Gupta *et al*., 2021). The unfavourable environments created by high temperature mostly during reproductive stages especially grain filling stage could be minimized by adjusting the sowing time to an optimum time for different varieties, which are suitable for early, normal and late sown environmental conditions for assured higher yield (Gupta *et al*., 2020a). Current estimates indicated that wheat crop grown on around 13.5 m ha in India is affected by heat stress (Sareen *et al*., 2012). It is also reported by the various researchers that the cool period for wheat crop in India is shrinking, while the threat of terminal heat stress is expanding (Gupta *et al*., 2021; Gupta *et al*., 2022a). Nitrogen is a key element for plant nutrition and other management practices which ultimately increases the yield of wheat crop (Cui *et al*., 2010). High yielding new varieties can never be fully exploited with the existing fertilizer practice and thus fails to provide growth and adequate yield. In the present era of limited land and water resources the only possibility left to increase the wheat production is evaluation of high yielding varieties and proper sowing time so as to increase the growth parameters and

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ultimately the yield of wheat crop under irrigated conditions (Gupta, 2019). Since the information about the performance of alternation in sowing environments and N-levels regarding wheat varieties under irrigated sub-tropical region of lower Shivalik zone of Himalayas of J&K UT is lacking with regards to the growth parameters, their interactions and yield of wheat varieties. To overcome these circumstances, an experiment was proposed with recommended wheat varieties sown under various sowing environments and enhanced N-levels.

MATERIALS AND METHODS

Experiments were conducted at Research Farm of Agromet Research Centre, SKUAST-Jammu (Latitude 32°39/ N, longitude 74°58/ E and altitude 332 m amsl) during *rabi* 2015-16 and 2016-17 seasons under irrigated conditions. The experiment consisted of three wheat varieties namely HD 2967 (V_1), RSP 561 (V_2) and WH 1105 (V_3) which were planted in three sowing environments 25th October (D_1-early), 14th November (D_2-normal) and 4th December (D_3-late) with three nitrogen levels (N_1--100, N_2-125 and N_3-150 kg/ha) replicated thrice under split plot design. Half of the nitrogen along with full dose of phosphorus and potassium applied at the time of sowing as basal dose and the remaining half of nitrogen was top dressed in two equal splits, *i.e.* at CRI and before booting stage of wheat crop. The recommended dose of P and K was 50:25 kg/ha for wheat crop. However, nitrogen was applied as per the treatment combinations.

Plant height of the five tagged plants measured periodically (at 30 days interval) with the help of metre scale from the ground surface to the tip of the upper most fully opened leaf till the emergence of ear in wheat and thereafter height of the wheat plants was taken from ground surface to the tip of the upper most ear of wheat crop and averaged to work out mean plant height of wheat plants and expressed in centimeters. The numbers of tillers/m row length were counted randomly in each plot leaving the two border rows on each side. Tillers were counted at 3-4 places in each plot at a regular interval of 30 days up to maturity. The mean of total numbers of tillers was then calculated.

For calculating dry matter accumulation the biomass of the plants cut near to the ground at different growth stages, sun-dried and thereafter kept in the oven for drying (65±5°C) till a constant weight obtained, thereafter dry matter was calculated. The data of dry matter accumulation was further used to calculate crop growth rate and relative growth rate as per the recommended formulae. The meteorological data, *viz.* maximum and minimum temperature for the *rabi* 2015-16 and 2016-17 were recorded at Agro-meteorological Observatory of SKUAST-Jammu which is situated at about 50 m from the experimental site (Figure 1).

The crop growth rate (g/m²/day) for each observational stage was calculated by substituting the corresponding dry matter accumulation value of these stages in the formula (Radford, 1967) to calculate the crop growth rate

$$\text{CGR (g/m}^2\text{/day)} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where, W_2 = dry weight of crop plant at time interval T_2, W_1 = dry weight of crop plant at time interval T_1

The relative crop growth rate (g/g/day) was calculated periodically and worked out by substituting the corresponding dry matter accumulation values of these stages in the formula (Radford, 1967).

$$\text{RGR (g/g/m}^2\text{/day)} = \frac{\text{Log e } W_2 - \text{log e } W_1}{T_2 - T_1}$$

Where, W_2= Dry wt. of crop plant at time interval T_2

W_1 = Dry weight of crop plant at time interval T_1

The treatment-wise data recorded for different growth and yield parameters were subjected to statistical analysis according to split design as per the procedure outlined by Cochran and Cox (1963).

RESULTS AND DISCUSSION

The data on plant height of wheat varieties revealed that height of the plants increased with the advancement in the age of the crop up to 120 DAS whereas, at harvest, it was nearly same as that on 120 DAS (Table 1). Attainment of maximum increase in growth between 60-90 DAS can be ascribed to the fact that for wheat crop at 60-90 days stage is termed as stage of their grand growth period. Significant changes in

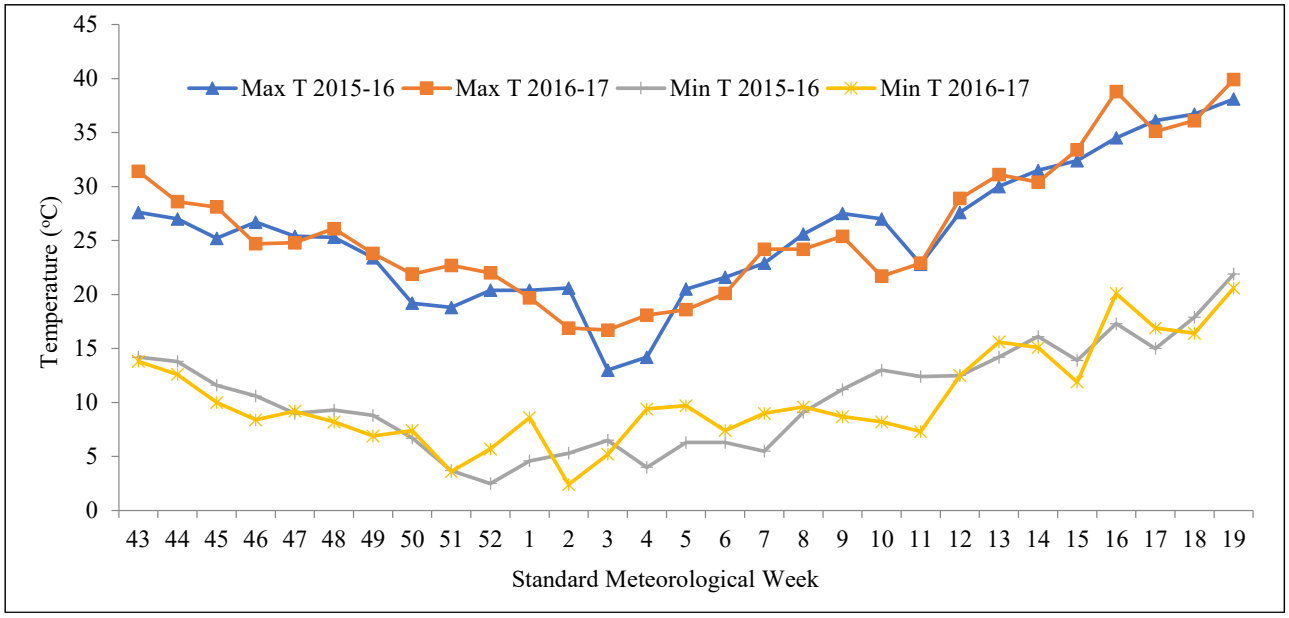

Figure 1: Maximum and minimum temperature during *rabi* 2015-16 and 2016-17

plant height of wheat varieties were noticed from 60 DAS to harvest and variety WH 1105 was statistically superior to HD 2967 and RSP 561 varieties. However, height of HD 2967 and RSP 561 varieties was statistically similar at all the stages of observations. Significant variations in plant height of different wheat varieties might be due to variation in their genetic makeup and thus responding variably to the prevailing climatic conditions and suitability of agro climatic conditions of Jammu. These results of variation in plant height of wheat varieties are in conformity with the results of Jat and Singhi (2004) and Tahir *et al.* (2009). Panwar *et al.* (2013) observed that WH 1105 variety has plant height of 100 cm under northwest plain zone

Table 1: Periodic plant height (cm) and no. of tillers/m row length of wheat varieties as affected by various sowing environments and N-levels (pooled data of 2 years)

Treatments	Plant height (cm)					No. of tillers/m row length				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Varieties										
V_1: HD 2967	24.3	44.5	81.2	100.2	99.9	35.7	74.9	89.2	86.6	83.6
V_2: RSP 561	23.0	42.8	78.5	98.2	97.9	34.8	70.4	80.7	81.3	79.3
V_3; WH 1105	25.6	49.0	86.8	105.3	105.0	38.5	84.9	101.8	98.7	95.4
CD (5%)	NS	4.2	5.3	4.9	5.5	NS	9.4	10.6	9.8	11.4
Sowing environments										
D_1: 25th October	27.6	50.6	88.6	106.2	105.6	40.8	93.4	108.1	106.1	102.0
D_2: 14th November	24.5	45.8	82.4	101.9	101.6	37.5	79.3	92.9	90.1	86.9
D_3: 04th December	20.9	39.8	75.9	95.5	95.2	30.8	57.7	70.5	70.1	69.5
CD (5%)	3.5	4.2	4.9	3.8	3.1	2.9	6.6	7.5	6.2	7.8
Nitrogen levels										
N_1: 100% RDN (100 kg N/ha)	22.8	42.8	78.9	98.2	97.9	34.2	69.4	80.9	81.4	78.9
N_2: 125% RDN (125 kg N/ha)	24.7	46.1	83.1	102.1	101.8	37.2	78.8	92.3	90.1	87.4
N_3: 150% RDN (150 kg N/ha)	25.4	47.3	84.5	103.5	103.2	37.6	82.1	98.4	95.1	92.1
CD (5%)	1.5	3.1	3.7	3.8	3.6	NS	6.3	7.0	6.4	6.9

(NWPZ) conditions. Significant taller wheat plants were recorded at about all the stages in early sown environment (D_1: 25th October) which was followed by normal (D_2: 14th November) and late (D_3: 4th December) sown environment. Early sowing provides more time for growth and thus crop gets full period for its proper vegetative growth and development; hence resulted in production of taller plants. Rise in temperature during the vegetative growth of late sown crop forced early flowering by cutting short the vegetative growth, leading to significantly lesser height (Dhyani, 2010; Jatti, 2013). Tomar *et al.* (2014) and Shivani *et al.* (2003) also recorded significant variations in plant height of wheat due to different sowing environments.

Numerically higher values of plant height were observed with 150 kg N/ha (50% higher over RN); which were statistically similar to the values obtained with 125 kg N/ha (25% higher over recommended dose of nitrogen-RN) at all the growth stages. Wheat crop under 100 kg N/ha (RN) treatment recorded statistically lowest plant height. This significant variation in plant height may be due the fact that modern high yielding varieties vary widely and thus applied N has got differential response. Also the full vigour of modern varieties can never be fully exploited with the existing fertilizers especially N; which is required by different varieties of wheat crop. Similar results were also reported by Patra and Ray (2018); Patel *et al.* (2012) and Kaur *et al.* (2015) in wheat, who reported that by increasing the levels of nitrogen there is a significant increase in plant height.

Among the varieties, WH 1105 recorded significantly higher no. of tillers/m row length, as compared to the values obtained with HD 2967 and RSP 561 varieties at all the growth stages except 30 DAS (Table 1). However, the values recorded with RSP 561 were at par with HD 2967 variety. This may be attributed to inherent capacity of the varieties to tiller at varied growth stages (Ram *et al.*, 2012). Jat and Singhi (2004) and Suleiman *et al.* (2014) also recorded significantly different number of tillers among the varieties.

Wheat crop sown on 25th October observed statistically higher number of tillers/m row length followed by the values obtained with 14th November (normal) sowing. Wheat crop sown on 4th December (late sowing) observed the lowest number of tillers. The higher number of tillers during early sowing environment over delayed ones could be attributed to availability of optimum conditions for growth and development of the crop. Early and timely sowing environments provides more time for growth and the crop gets full period for its development and thus crop attains good vegetative growth due to the conducive environmental conditions. Similar findings were also recorded by Singh *et al.* (2003), Hameed *et al.* (2003) and Ram *et al.* (2012) who also observed higher number of tillers in early sown conditions and thereafter a significant reduction in number of tillers was recorded.

Levels of nitrogen showed a remarkable difference in number of tillers/m row length. Significantly higher tillers/m row length noticed in 150 kg N/ha from 60 DAS onwards; but the values were statistically at par with those obtained at N-level of 125 kg/ha. However, statistically lowest numbers of tillers were obtained with 100 kg N/ha. This may have occurred due to the fact that applied nitrogen increased the proportion of protoplasm of cell wall material which caused an increase in the cell and ultimately increased the growth parameters such like as tillers. Similar results of increment in number of tillers with increasing dose of nitrogen were also reported by Kaur *et al.* (2015) and Patra and Ray (2018).

The interaction effect of varieties of wheat and sowing environments (Tables 2 and 3) showed significant influence on tillers number at 60 and 90 DAS. A progressive increase in sowing of wheat crop from 25th October (early) onwards produced significantly lesser number of tillers in all varieties. WH 1105 exhibited significantly higher tillers when sown on 25th October but the values decreased significantly under later sowing environments *i.e.,* 14th November and 4th December. The differential performance of wheat varieties may be due to their genetic behaviour. Interaction effects of sowing environments and varieties were also recorded by Sardana *et al.* (2002); Kumar and Pal (2009); Kumar (2012) and Jatti (2013).

Crop growth rate (CGR) is an indicative of the pattern of rate of growth of crop plants during the growing period and it also determines the successive

Table 2: Interaction effect of varieties and sowing environments on no. of tillers/m row length of wheat at 60 DAS (pooled data of 2 years)

Varieties	Dates of sowing			Mean
	D_1: 25th October	D_2: 14th November	D_3: 04th December	
V_1: HD 2967	95.9	75.4	53.5	74.9
V_2: RSP 561	82.6	69.6	59.1	70.4
V_3: WH 1105	101.6	92.8	60.5	84.9
Mean	93.4	79.3	57.7	
CD (5%)		11.4		

Table 3: Interaction effect of varieties and sowing environments on no. of tillers/m row length of wheat at 90 DAS (pooled data of 2 years)

Varieties	Dates of sowing			Mean
	D_1: 25th October	D_2: 14th November	D_3: 04th December	
V_1: HD 2967	109.8	91.5	66.3	89.2
V_2: RSP 561	94.1	77.7	70.1	80.6
V_3: WH 1105	120.6	109.6	75.1	101.8
Mean	108.2	92.9	70.5	
CD (5%)		12.9		

accumulation of dry matter at different periods of crop growth (Table 4). Wheat varieties at various growth stages showed non-significant differences with respect to CGR values except at 0-30 and 30-60 DAS. Crop growth rate of wheat varieties increased with the advancement in age of the crop and reached the peak values at 90-120 DAS; however, WH 1105 recorded numerically highest CGR values at all the periods of observations followed by HD 2967 and RSP 561. Alam *et al.* (2013) also observed statistically similar crop growth rate among the different varieties.

Statistically higher CGR values noticed in 25th October sown crop and followed by 14th November and 4th December sown wheat. Crop growth rate increased slowly at early stages of growth and reached the peak at about 90-120 DAS and thereafter, it declined. This was due to the maximum production of dry matter at early stages of plant growth at Jammu (Singh *et al.*, 2017).

The periodic crop growth rate of wheat significantly influenced by different N-levels at 0-30 and 30-60 DAS only and non-significant effects noticed during 60-90, 90-120 DAS and 120 DAS-at harvest. Significantly higher values of CGR recorded in 150 kg N/ha which were followed by statistically similar values of CGR at 125 kg N/ha and the lowest CGR values were observed in 100 kg N/ha. The fact behind these results might be that application of nitrogen resulted in increasing the proportion of protoplasm of cell wall material which caused an increase in the size of cell, which ultimately increased the growth parameters like dry matter accumulation (Alam, 2013).

Among the varieties; though the effect was not significant but numerically higher RGR values were recorded in WH 1105 which were followed by HD 2967 and RSP 561 varieties at all the growth stages (Table 4). Like CGR, RGR values were also increased upto 90-120 DAS stage and thereafter, it decreased rapidly upto physiological maturity. A remarkable difference was noted among various wheat varieties with respect to RGR by Alam (2013). Singh *et al.* (2017) also observed a non significant response of HD 2967, RSP 561 and Raj 3077 varieties with regard to RGR values under the conditions of Jammu.

Like CGR, RGR values increased with the advancement of crop age in different sowing environments, however, the effect was statistically noticeable up to 60-90 DAS. Significantly higher values of RGR were registered in wheat crop sown on 25th October followed by 14th November and 4th

Table 4: Periodic crop growth rate (g/m²/day) and relative growth rate (g/g/day) of wheat varieties as affected by various sowing environments and N-levels (pooled data of 2 years)

Treatments	Crop growth rate (g/m²/day)					Relative growth rate (g/g/day)				
	0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	120 DAS-Har	0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	120 DAS-Har
Varieties										
V_1: HD 2967	2.14	5.42	9.90	15.00	3.98	0.139	0.169	0.189	0.203	0.139
V_2: RSP 561	2.14	5.17	8.69	14.30	4.95	0.138	0.167	0.188	0.201	0.143
V_3; WH 1105	2.32	6.37	11.59	15.10	3.84	0.141	0.175	0.194	0.204	0.160
CD (5%)	0.17	0.65	NS	NS	NS	NS	NS	NS	NS	NS
Sowing environments										
D_1: 25th October	2.49	6.50	12.00	15.20	5.25	0.143	0.176	0.196	0.203	0.162
D_2: 14th November	2.18	5.73	10.28	14.80	4.75	0.139	0.170	0.190	0.202	0.153
D_3: 04th December	1.93	4.73	8.91	14.40	2.77	0.134	0.164	0.185	0.201	0.126
CD (5%)	0.12	0.59	1.13	NS	1.68	0.002	0.005	0.006	NS	NS
Nitrogen levels										
N_1: 100% RDN (100 kg N/ha)	2.05	5.27	9.98	14.20	3.76	0.137	0.167	0.189	0.201	0.141
N_2: 125% RDN (125 kg N/ha)	2.22	5.76	10.54	15.00	4.22	0.139	0.171	0.191	0.203	0.151
N_3: 150% RDN (150 kg N/ha)	2.32	5.93	10.66	15.20	4.79	0.141	0.172	0.192	0.204	0.152
CD (5%)	0.09	0.36	NS	NS	NS	NS	NS	NS	NS	NS

December. The values of RGR increased towards advancement of age of wheat in early, normal and late sewing environments. Higher crop growth rate in early sowing was due to long duration to overall improvement and better crop growth rate and thus resulted in significant higher RGR in early sown wheat followed by other sowing environments (Singh *et al.*, 2017; Gupta *et al.*, 2023).

Among the N-levels, 150 kg N/ha registered significantly higher values of RGR and followed by statistically similar values of RGR recorded in 125 kg N/ha at 0-30 and 30-60 DAS. At other growth stages, again the RGR values were higher in 150 kg N/ha followed by 125 and 100 kg N/ha but the values were statistically not significant. RGR is mainly dependent upon dry matter accumulation that is the accumulation of photosynthates and the total nutrient uptake by the plant up to stimulated growth period. It also indicates the photosynthetic-efficiency of crop. Alam (2013) also recorded a significant increase in RGR at 0-30 and 30-60 DAS with increase in N up to 150 kg/ha.

Grain yield of wheat was significantly influenced by varieties, sowing environments and nitrogen levels in both the crop growing seasons and also second year crop marked an improvement in grain yield over that of first year (Table 5).

Among the varieties, WH 1105 recorded significantly superior grain yield as compared to the other two varieties. However, varieties HD 2967 and RSP 561 were statistically similar during both the years of experimentation. Similar trend was noticed for straw and biological yield of wheat crop.

The higher grain, straw and biological yields of wheat could be attributed to greater genetic potential with efficient utilization of radiation by leading to production of maximum leaf area and dry matter which in turn results into higher yields. Similar results were also reported by Jatti (2013) and Gupta *et al.* (2022). Variety WH 1105 performed significantly superior to HD 2967 at various locations as reported in the report of AICWBIP (Tiwari *et al.,* 2015-16).

Grain yield of wheat crop was affected to a great extent due to different sowing environments. Delayed sowing adversely affected the yield of wheat crop. Significant higher grain yield was observed in early sown conditions (25th October) and followed by statistically lower values registered with normal and late sowings

Table 5: Performance of different wheat varieties as affected by various sowing environments and N-levels

Treatments	Grain yield (kg/ha)		Straw yield (kg/ha)		Biological yield		Harvest index (%)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Varieties								
V_1: HD 2967	4160	4395	5858	6378	10017	10773	41.5	40.8
V_2: RSP 561	3975	4255	5923	6488	9898	10743	40.2	39.6
V_3: WH 1105	4573	4617	6271	6748	10844	11365	42.1	40.5
SEm±	85	47	84	72	127	86	0.54	0.3
CD (5 %)	332	184	329	281	501	338	NS	NS
Sowing environments								
D_1: 25th October	4707	4857	6614	7272	11321	12130	41.5	40.0
D_2: 14th November	4313	4649	5959	6696	10272	11346	42.0	41.0
D_3: 04th December	3687	3759	5479	5645	9166	9405	40.3	40.0
SEm±	66	59	84	82	112	129	0.44	0.25
CD (5 %)	202	182	258	254	345	397	1.36	0.78
Nitrogen levels								
N_1: 100 % RDN (100 kg N/ha)	3955	4179	5652	6263	9607	10441	41.1	40.0
N_2: 125 % RDN (125 kg N/ha)	4313	4471	6103	6605	10416	11076	41.3	40.4
N_3: 150 % RDN (150 kg N/ha)	4440	4616	6297	6747	10737	11363	41.3	40.6
SEm±	47	49	70	55	86	90	0.35	0.24
CD (5 %)	135	141	201	156	248	259	NS	NS

in both *rabi* 2015-16 and 2016-17. These two latter sowing environments also differed statistically significant from each other. Normal and late sown wheat recorded about 9.1 and 27.6 per cent less grain yield than early sown crop. Similar trend was noticed for straw and biological yield of wheat crop.

The possible reason behind the significant higher yield values in early sowing might be the availability of optimum environmental conditions for growth and development of crop which could have enhanced accumulation of photosynthates from source to sink and thus resulted in higher yield values (Ram *et al*., 2012; Gupta *et al.,* 2021a).

Wheat crop when applied 150% RN (150 kg/ha) performed outstanding with respect to grain yields in both years of experimentation but the values were at par with that of 125% RN (125 kg/ha). Recommended dose of nitrogen (100 kg/ha) also performed well but the values were significantly inferior to other two doses of nitrogen. Similar trend was noticed for straw and biological yields of wheat crop.

Higher wheat yield in enhanced N levels (125 kg/ha) could be traced to adequately N fertilized crop benefitted from higher rates of N nutrition that might have resulted into more vigorous and extensive root system of crop leading to increased vegetative growth means for more sink formation and greater sink size, greater carbohydrate translocation from vegetative growth (Hameed *et al*., 2003).

From the data, it can be inferred that among the wheat varieties, the values of harvest index were statistically non-significant. However, sowing environments had a significant effect on harvest index values of wheat crop. Wheat crop sown on 14th November recorded higher values of harvest index but were statistically similar to the values recorded with earlier sown wheat. Different N levels also had non-significant effect on harvest index of wheat crop. However, numerically higher values of harvest index observed in 150 kg N/ha which was followed by the values recorded in 125 and 100 kg N/ha in the years 2015-16 and 2016-17.

Decline in HI in later sowings as compared to early sowing might be due to higher temperature during reproductive stages in normal and late sowings (Dhyani, 2010).

CONCLUSION

Wheat variety WH 1105 recorded significantly higher growth parameters, yield and yield attributes over HD 2967 and RSP 561 varieties. Among sowing environments, 25th October sown wheat crop registered significantly higher values of the entire yield attributing characters, grain and straw yield followed by normal and late sowing environments. The application of 150 kg N/ha recorded significantly higher yield attributes and yield of wheat crop as compared to the other N levels *viz* 125 and 100 kg/ha, but the values recorded in 125 kg N/ha remained at par with that of 150 kg N/ha. Under late sown conditions, all the three varieties showed similar yield. However, variety RSP 561 performed similarly during early and normal sowing environments.

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Reactions of ADOs Towards the Content of PAU Kisan APP

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ABSTRACT

Punjab Agricultural University took the initiative for the dissemination of newly evolved technologies and other information through mobile app named 'PAU Kisan App' in September 2019. The current study was conducted with the objective to find the pattern of usage and to get the reactions of ADOs towards the content of PAU Kisan App. The sample constituted total thirty ADOs. The results revealed that more than half (60%) of them consulted the app only when they needed some information. Almost two third (63.33%) felt the sentences used was short in length and the language was easy to understand (70%). More than half of the respondents (56.66%) were highly motivated to adopt and recommend the practices provided in the app but majority (73.33%) were only somewhat satisfied with the overall performance of the app. more than half of the respondents (53.33%) opinionated the content had high level of understandability and timeliness (73.33%). At the same time nearly half of them felt low level of trustworthiness (43.33%) and high and medium level of relevancy with equal percentage (46.66%).

Keywords: Pattern of usage, Understandability, Timeliness, Relevancy, Trustworthiness

INTRODUCTION

Punjab is known as the "Granary of India" or India's bread-basket which produces 20 per cent of wheat and 9 per cent of rice among India's total production (Anonymous, 2013). Since Punjab contributes significantly in India's food security, ensuring proper information dissemination in agriculture sector have greater importance. One of the major platforms where a farmer may get all information and solutions with a single click is a smartphone application. These apps are improving information sharing between stakeholders and conveying information about agricultural research and extension to farmers and other stakeholders. Farmers require timely information to address their immediate requirements. There are mobile applications that offer the most recent agricultural information on methods, equipment, technology, and trends being utilised in the industry, assist in identifying pests and diseases, providing real-time meteorological data, storm warnings, the best local marketplaces for buying seeds and fertiliser, etc. (Manobharathi and Anandaraja, 2021). In light of above facts compared to other industries, the agricultural industry currently has a modest but growing demand for mobile applications (Kumar and Karthikeyan, 2020).

The function and skills of agricultural development officers are dynamic in both agricultural and community development. This is because of the interaction entails between community developers, who serve as change agents, and their clients i.e., farming community, who are recipients of agricultural and technological breakthroughs. There is a two-way relationship between innovators and recipients of innovation which is facilitated by extension workers. Agricultural development officers play substantial role in serving farmers through finding structure of communities and social action process, implementing need-based development programmes, ensuring participatory planning, timely information dissemination etc. (Syarifuddin *et al.,* 2021). Agricultural development officers found mobile applications as the most useful ICT tool (Ramjattan and Strong, 2016).

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The major organisation in India for agricultural research and Extension is Indian Council of Agricultural Research (ICAR), which operates through a broad network of its institutes, including National Research Centres, All India Coordinated Research Projects, State Agricultural Universities, Krishi Vigyan Kendra, and other institutes. The ICAR and the organisations that make up its constituent parts have created numerous apps (Raman *et al.,* 2021). As a part of this Punjab Agricultural University have launched PAU Kisan App on September 2019 which provides a better platform for farmers and other beneficiaries to access latest information related to Agriculture. In order improve the utility of app the feedbacks of users are necessary. The current study was focused on the pattern of usage and reactions of Agricultural Development Officers towards the content of PAU Kisan App.

MATERIALS AND METHODS

The research was conducted among the Agricultural Development Officers residing within the territorial jurisdiction of the Punjab state. The research was conducted among users of PAU Kisan App from different districts. The two districts having maximum area of cultivation under each crop was purposively selected for the study. Thus, the districts, Sangrur and Ludhiana for Rice, Hoshiarpur and Rupnagar for Maize, Bathinda and Ludhiana for Wheat, Hoshiarpur and Rupnagar for Sugarcane, Fazilka and Bathinda for Cotton were selected. The list of ADOs was procured from Integrated Human Resource Management System (iHRMS). From the list three ADOs from each district selected randomly. Thus, total sample constituted of thirty ADOs.

RESULTS AND DISCUSSION

The information regarding socio-personal characteristics of the respondents with respect to their age, educational qualification, gender, marital status, family type, area and residence, farming experience, annual income etc were analysed in the study.

The data presented in Table 1 showed that the half of respondents belonged to the age group of 35 to 41 years. While, 26.66 per cent belonged to age group of 42 to 49 years and 23.33 per cent belonged to 28 to 34 years age group. So overall, the respondent's age varied between 28 to 49 years. Similar findings were revealed in the study conducted by Kabir *et al.* (2022) and Sunidhi *et al.* (2023). As regard to education more than half (56.66%) of the respondents were post graduates. Other 30 percent of them had graduate level qualification and 13.33 per cent had doctoral degree. Contrarily Lakshmi *et al.* (2018) reported that 72.8 per cent of the extension officers were graduates while 24.4 per cent were post graduate and 2.80 per cent had doctoral degree. Regarding gender study found that 70 per cent were male and the rest 30 per cent were female and all of the respondents were married. A further look into the table regarding family type revealed that 53.33 per cent belonged to joint family and rest 46.66 per cent belonged to nuclear family.

Table 1: Socio-personal characteristics of respondents (n=30)

Socio personal characteristics	Frequency	Percentage
Age (years)		
28- 34	7	23.33
35 to 41	15	50.00
42- 49	8	26.66
Educational qualification		
Graduate	9	30.00
Post graduate	17	56.66
PhD	4	13.33
Gender		
Male	21	70.00
Female	9	30.00
Marital status		
Married	30	100
Unmarried	-	-
Family type		
Joint	16	53.33
Nuclear	14	46.66
Family background		
Rural	19	63.33
Semi urban	4	13.33
Urban	7	23.33
Annual income (lakh)		
7- 10	24	80.00
10 -14	3	10.00
14-17	3	10.00

The findings were in line with Kaur *et al.* (2021). Furthermore, almost two third (63.33%) of the respondents resided in rural area and the rest 36.66 per cent belonged to urban area. The annual income of respondents varied from 7 lakhs to 17 lakhs. Majority of respondents (80%) belonged to the range 7 to 10 lakhs. While, by 10 per cent of them had income within the range 10 to 14 lakhs and rest 10 per cent had income from 14 to 17 lakhs.

The respondents were categorised based on the number of years they have been using PAU Kisan App. The opinion of respondents those were using PAU Kisan App for more years which will be more valid and accurate.

The data shown in Table 2 revealed that less than half of them (43.33%) were using the app for one to two years. Other 26.66 per cent of them used app for two to three years and 16.66 per cent uses for less than one year and only 10 per cent used app for more than three years. Contrarily the study conducted on Uzhavan App by Mathuabirami *et al.* (2019) reported that all respondents used app for past six months.

Table 2: Number of years of using PAU Kisan App by respondents (n=30)

Range (Years)	Frequency	Percentage
< 1	5	16.66
1 – 2	13	43.33
2 – 3	8	26.66
> 3	3	10.00

The data presented in Table 3 explains about the sources from which the respondent got awareness about PAU Kisan App. The results showed that, major source of information for nearly half of the respondents was PAU website (46.66%) which is regularly followed by ADOs. The other 30 per cent got information about PAU Kisan App from colleagues and the rest 23.33 per cent got from PAU experts.

Table 3: Source of information about PAU Kisan App (n=30)

Sources	Frequency	Percentage
Colleagues	9	30.00
Website	14	46.66
PAU experts	7	23.33

The other major agricultural apps used by respondents for getting agricultural information were Plantix, Apni kheti and Mausam. It is evident from the data presented in Table 4 that Plantix app was the most used (70%) among all agricultural app. Apni Kheti and Mausam were the other apps used for getting agricultural information by 63.33 per cent and 56.66 per cent of respondents respectively. And they also opinioned that these other apps were more responsive and useful than PAU Kisan App.

Table 4: Status of subscription to other agricultural app (n=30)

Category	Response	Frequency	Percentage
Subscription to	Yes	27	90.00
other agricultural apps	No	3	10.00
Other agricultural	Plantix	21	70.00
apps*	Apni Kheti	19	63.33
	Mausam	17	56.66

***Multiple responses**

Pattern of usage of app was measured in terms of frequency of using app, pattern of consulting the app, content reading pattern of users and sharing of information obtained from PAU Kisan App.

The overview of data shown in Table 5 revealed that 60 per cent of respondents used the app rarely only. The reason for this was, majority were subscribed to other mobile agricultural apps which they found more convenient. While only 23.33 per cent used frequently for getting information and the rest 16.66 per cent of respondent sometimes used the app. Also, more than half of the respondents (60%) used when they needed some information. While others used when there was free time (12%) and 16.66 per cent checked the information randomly. The data on content reading pattern revealed that less than half (46.66%) of the respondents read the whole information regarding particular crop and 30 per cent read the information of interest only while 18.66 per cent preferred quick reading of the whole information given. Because the respondents were ADOs and they are obliged to serve farmers in all possible ways, all the respondents shared all type of the information with farmers and other beneficiaries according to their need.

Table 5: Reactions of respondents towards pattern of usage of PAU Kisan App (n=30)

Particulars	Category	Frequency	Percentage
Frequency of using PAU Kisan App	Frequently	7	23.33
	Sometimes	5	16.66
	Rarely	18	60.00
Pattern of consulting the app	When there is free time	5	23.33
	Check the information randomly	7	16.66
	When you need some information	18	60.00
Content reading pattern	The information of interest only	9	30.00
	The whole information regarding specific crop	14	46.66
	Quick reading of whole information	7	23.33
Sharing of information with others	Yes	30	100
	No	-	-

The data exhibited in Table 6 deals with general reactions of users towards the length of sentences used, easiness of language, extent of motivation in adopting the recommendations given in app and level of overall satisfaction with the app. More than half of the respondents (63.33%) felt the length of sentences used in app as short. The rest 36.66 per cent opinioned that they were moderate in length. None of the respondents felt the sentences as lengthy. And 70 per cent of them found the language used in app as easy and 30 per cent of them found it as somewhat difficult to understand. Because the respondents are educated in the field of agriculture, they may find the terms and language easy to understand. Among respondents 56.66 per cent were highly motivated and the rest 43.33 per cent were somewhat motivated to suggest the information for famers. It was also evident from the table that majority (73.33%) were somewhat satisfied with the overall performance of the app. Similar findings were reported by Suresha (2019) that medium degree of satisfaction was reported by 60.83 per cent of the respondents, followed by high (20.83%) and low (18.34%) levels of satisfaction respectively. The reason for the above responses were generally depended on the educational level and the exposure towards other agricultural apps and ICT tools. Compared to farmers ADOs will be familiar with technical terms and scientific language, also they are trained enough to efficiently use ICT tools.

The effectiveness of the app was measured in terms of understandability, trustworthiness, timeliness

Table 6: General reactions of respondents towards PAU Kisan App (n=30)

Particulars	Reaction	Frequency	Percentage
Length of sentences used	Short	19	63.33
	Moderate	11	36.66
	Long	-	-
Easiness of language used	Easy	21	70.00
	Somewhat difficult	9	30.00
	Difficult	-	-
Extent of motivation for adopting	Highly motivated	17	56.66
recommendations from app	Somewhat motivated	13	43.33
	Not at all motivated	-	-
Level of satisfaction	Highly satisfied	4	13.33
	Somewhat satisfied	22	73.33
	Not at all satisfied	4	13.33

Table 7: Reactions of respondents towards effectiveness of PAU Kisan App

Category	Range	Frequency	Percentage
Understandability (n=30)			
High	32- 36	16	53.33
Medium	28- 32	5	16.66
Low	24- 28	9	30.00
Trustworthiness (n=30)			
High	18 - 21	7	23.33
Medium	16 – 18	10	33.33
Low	13 – 16	13	43.33
Timeliness (n=30)			
High	18 - 21	22	73.33
Medium	14 – 18	3	10.00
Low	11 - 14	5	16.66
Relevancy (n=30)			
High	13 – 15	14	46.66
Medium	10 - 13	14	46.66
Low	8 – 10	2	6.66

and relevancy. Table 7 deals with the reactions of respondents towards effectiveness of PAU Kisan App.

The close examination of data revealed that, among respondent 53.33 per cent agreed that the information given in app had high level of understandability. At the same time 30 per cent opinioned low level and 16.66 per cent felt medium level of understandability. It was also evident that less than half of the respondents (43.33%) felt low level of trustworthiness while 33.33 per cent felt medium level and only 23.33 per cent felt high level of trustworthiness towards the information given. Analysis of data regarding timeliness revealed that majority (73.33%) found the information provided had high level of timeliness. Also, 16.66 per cent felt low level of timeliness and rest 10 per cent felt medium level of timeliness. The opinion about relevancy of app showed that equal percentage of respondents felt high (46.66%) and medium (46.66%) relevancy. And only 6.66 per cent opinioned that content given in app had only low level of relevancy.

CONCLUSION

According to the opinion of respondents the features of PAU Kisan App should be improved to compete with other agricultural apps used by them. The superiority of other apps was the reason for low usage found among respondents. Training should be given to all the beneficiaries in order to increase the trustworthiness of the information provided in the app and it will also help to make the users understand about the relevancy of the app in current scenario. Through this approach the acceptance and diffusion of the app can be facilitated. Because Agricultural Development Officers act as the connecting link between the researchers and ultimate users i.e., farmers and other stakeholders, their perception about PAU Kisan App will significantly influences the diffusion and usage of app among farming community. So that in light of the results of the study the app should be modified and it should be properly communicated to ADOs and other extension agents.

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Extent of Adoption Among Farmers Practicing Organic Farming in Haryana

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ABSTRACT

Organic farming is more than just avoiding the use of agrochemicals in agriculture; it is a technique for establishing a healthy agro-ecosystem on a farm. Organic agriculture arose from the purposeful efforts of inspired people, who wanted to build the finest possible relationship between man and the land. The present study was conducted in Sirsa and Karnal districts of Haryana, with an objective to analyze the socio-economic profile of farmers and their adoption towards organic farming. The sample of 120 respondents was selected from a cluster of villages from two districts through systemic random sampling techniques. Analysis revealed that majority of respondents (53.20%) had organic land up to one hectare, 39.20 per cent had one – two hectares of organic land and 7.50 per cent had two -four hectares of organic land. 45 per cent of the organic farmers had medium level of adoption followed by low (40.80%) and high (14.20%) level of adoption of organic farming. Education, Subsidiary occupation and Mass media exposure was found highly significant with the level of adoption of organic farming whereas caste, family type and land holding were significantly associated with the level of adoption of organic farming.

Keywords: Organic farming, Adoption, Socio-economic profile, Association

INTRODUCTION

Organic farming is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, so as to keep the soil alive and in good health. In the Indian context organic farming is also termed as "Jaivik Krishi". Walia (2004) reported that the organic farming system helped to improve soil health as indicated by more organic carbon content (more than 0.9%), significant improvement in NPK status and cumulative infiltration rate. Organic farming is helpful in maintaining the biological cycle and genetic diversity of the agricultural system and its surroundings including the protection of plant and wildlife habitats. It allows agricultural procedures, adequate returns and satisfaction from their work including a safe working environment and wider social and ecological impact of the farming system (IFOAM).

Organic farming is centered on using external inputs as few as possible, such as fertilizers, insecticides and pesticides (Morshedi *et al.,* 2017). This is a holistic approach to farming and one of the alternatives that has been focused at long-term agricultural production in India as well as internationally. Organic farming has fewer pre-requisites than chemical farming, hence in a country like India, where agriculture is heavily influenced by unexpected changes in various biotic and abiotic elements and capable of providing economic certainty to farmers (Narayanan, 2005).

A study conducted by Azam and Shaheen (2019) revealed that five major factors that affect the adoption of organic farming in India were economic, social, marketing, cultivation and government policy. It was also observed that marketing and policy implications were most crucial in influencing all types of farmers irrespective of their educational level. The farmers with more farming experience were more concerned about social factors. But there are some problems in progress of organic farming like the inability of the government

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policy to promote organic agriculture, lack of awareness, shortage of biomass, marketing problems of organic inputs, and lack of financial support etc. (Gaur, 2016). So, there is a need to promote organic farming. Farmers are hesitant to convert to organic production due to lack of adequate quantities of organic manures and other organic inputs in the local market, a lack of comprehensive knowledge of organic farming principles, practices and benefits, complex and costly certification procedures and the risks of marketing organic produce at premium rates in domestic markets.

MATERIALS AND METHODS

There are two agro-climatic zones i.e. dry zone representing south- western region and wet zone representing eastern regions in Haryana state. Further, Sirsa and Karnal districts were selected purposively from dry and wet zones respectively. Sixty farmers from each district who were practicing organic farming were identified. A sample of 120 respondents was selected randomly from Karnal and Sirsa districts. Sixty farmers from each district who were practicing organic farming were identified. Further, from each district a cluster of villages were selected purposely i.e., villages in which farmers were adopting organic farming (Kharian, Dhottar, Alipur titukhera and Rishalia khera villages from Sirsa district and Sangohi, Churni, Barsat, Khanpur, Sambhali, Khera Chapra, Baragaon, Kunjpura and Landora villages from Karnal district). The data were collected through personal interview technique with the help of structured interview schedule and analyzed using MS Excel and Statistical Package for Social Sciences (SPSS) for computing frequency, percentage. For measuring the profile of farmers, thirteen variables were selected viz, age, education, caste, subsidiary occupation, family type, family size, land holding, annual income, size of organic land holding, annual income from organic farming, mass media exposure, social participation and extension contact. In order to measure the farmers' adoption towards organic farming, they were given eight statements which were further sub categorized and the responses were obtained on a three-point continuum (Likert-type) scale representing full adoption, partial adoption and no adoption. Further, all positive statements were given scores in the order of 2,1 and 0 with 2 for full adoption while 1 partial adoption, and 0 for no adoption. The scores for all of the statements were added and the respondent was categorized as low, medium and high based on his total score using mean and standard deviation.

RESULTS AND DISCUSSION

Table 1 depicts the background profile of the respondents in terms of age, education, caste, type of family, size of family, size of land holding, size of organic land holding, annual income, annual income from organic farming, subsidiary occupation, social participation, mass media exposure, and extension contacts. The analysis revealed that three-fifth of the respondents (60.80%) hailed from age group of 36-50 years followed by above 50 years age group (30.80%) and up to 35 years age group (8.40%). The findings indicate that 43.30 per cent of the respondents were well educated as education improves an individual's decision-making ability to adopt advanced technologies and social change as reported by Baskaur *et al.* (2021).

Table 1: Distribution of farmers on the basis of their socio-economic traits

Independent variables	Karnal (N=60)	Sirsa (N=60)	Total (N=120)
Age			
Up to 35 years	07(11.70)	03(5.00)	10(8.40)
36-50 years	39(65.00)	34(56.70)	73(60.80)
Above 50 years	17(28.30)	20(33.30)	37(30.80)
Education			
Illiterate	3(5.00)	5(8.30)	8(6.70)
Up-to middle school	5(8.30)	7(11.70)	12(10.0)
Secondary school	28(46.60)	20(33.00)	48(40.0)
Senior Secondary & above	31(51.10)	21(35.00)	52(43.30)
Caste			
General	43(71.70)	42(70.00)	85(70.80)
Backward	17(28.30)	18(30.00)	35(29.20)
Family type			
Nuclear	26(43.30)	24(40.00)	50(41.70)
Joint	34(56.70)	36(60.00)	70(58.30)
Family size			
Small (up to 4 members)	21(35.00)	20(33.30)	41(34.20)
Medium (5-8 members)	30(50.00)	28(46.70)	58(48.30)
Large (above 8 members)	09(15.00)	12(20.00)	21(17.50)

Table 1 contd...

Independent variables	Karnal (N=60)	Sirsa (N=60)	Total (N=120)
Size of land holding			
Marginal (Up to 1 ha)	01(01.70)	04(06.70)	05(04.20)
Small (>1-2 ha)	06(10.00)	18(30.00)	24(20.00)
Semi Medium (>2-4 ha)	22(36.70)	19(31.60)	41(34.20)
Medium (>4-10 ha)	26(43.30)	13(21.70)	39(32.40)
Above 10 ha	05(08.30)	06(10.00)	11(09.20)
Size of organic land holding			
Up to 1 ha	30(50.00)	34(56.70)	64(53.30)
>1-2 ha	25()41.70	22(36.60)	47(39.20)
>2-4 ha	05(08.30)	04(06.70)	09(07.50)
Annual income (Rs.)			
Up to 1,50,000	17(28.30)	24(40.00)	41(34.20)
Between 1,50,001-3,00,000	33(55.00)	30(50.00)	63(52.50)
Above 3,00,000	10(16.70)	06(10.00)	16(13.30)
Annual income from organic farming (Rs.)			
Up to 1,50,000	45(75)	40(66.60)	85(70.80)
Between 1,50,001-3,00,000	13(21.70)	17(28.40)	30(25.00)
Above 3,00,000	2(3.30)	3(5.00)	5(4.20)
Subsidiary occupation			
Nil	39(65.00)	41(68.30)	80(66.60)
Service	03(05.00)	04(06.70)	07(05.80)
Small scale enterprises	18(30.00)	15(25.00)	33(27.60)
Social participation			
Low (1)	50(83.30)	48(80.00)	98(81.70)
Medium (2)	10(16.70)	12(20.00)	22(18.30)
Mass media exposure			
Low (7-10)	23(38.30)	25(41.70)	48(40.00)
Medium (11-13)	26(43.40)	20(33.30)	46(38.30)
High (14-16)	11(18.30)	15(25.00)	26(21.70)
Extension contacts			
Low (5-7)	13(21.70)	11(18.30)	24(20.00)
Medium (8-10)	35(58.30)	46(76.70)	81(67.50)
High (11-13)	12(20.00)	3(5.00)	15(12.50)

Figure in the parenthesis denote percentage

The data revealed that according to the distribution of respondents across different castes, it was found that more than three-fifth of the respondents (70.80%) belonged to general castes and 29.20 per cent of the respondents belonged to the backward castes. Further results revealed that majority of the respondents (58.30%) were from joint families and 41.70 per cent were from nuclear families which were similar to the findings of Baskaur *et al.* (2021).

Along with the type of family, the size of family also plays an important role in social and economic development of an individual. Analysis revealed that nearly half of the respondents (48.30%) had 5 to 8 members followed by 34.20 per cent who had members up to 4 and 17.50 per cent had more than 8 members in their families. The findings indicate that maximum number of the respondents (34.20%) were semi medium farmers and 53.30 per cent of the farmers had organic land upto one hectare and the findings are in line with that of Aulakh *et al.* (2009). Analysis revealed that majority of respondents (53.20%) had organic land up to one hectare, 39.20 per cent had one – two hectares of organic land and 7.50 per cent had two -four hectares of organic land.

It was found that maximum number of respondents (52.50%) had annual income between Rs.1.5 lakh- 3 lakhs followed by the respondents who had income up to Rs. 1.5 lakh (34.20%) and above Rs.3 lakh (13.30%). Results further revealed that 52.50 per cent of the organic farmers had medium annual income whereas 70.80 per cent had low annual income from organic farming which may be due to low premium prices of organic products and low yield in organic farming, as stated by Baker *et al.* (2012).

Analysis revealed that more than 60 per cent of the respondents (66.60%) had no subsidiary occupation, 27.60 per cent had small scale enterprises and 5.8 per cent were in service. It was found that an overwhelming majority of respondents (81.70%) had low social participation while the remaining respondents had the medium social participation (18.30%). Forty per cent of the respondents had low mass media exposure and 67.50 per cent had medium level of extension contacts and the findings were also supported by Benal *et al.* (2010) and some of the organic farmers had low extension contacts owing to busy schedule of farmers.

The results given in Table 2 revealed that 45 per cent of the respondents had medium level of adoption followed by 40.80 per cent who had low level of adoption and 14.20 per cent had high level of adoption regarding organic farming, supported by the study of Yadav (2020).

Table 2: Level of Adoption about organic farming (N=120)

Adoption level	Frequency	Percentage
Low (50-58)	49	40.80
Medium (59-67)	54	45.00
High (68-75)	17	14.20

Table 3 clearly stated that 81.70 per cent of the respondents had fully adopted the organic farming for the wheat crop, 95.80 per cent partially adopted for the vegetables and 90 percent had no adoption for the commercial crops (cotton).

For the pattern of adoption, the data in Table 3 revealed that among the rabi crops, an overwhelming majority of the respondents (91.80%) had fully adopted organic farming for wheat crop whereas 38.30 per cent and 50 per cent had partial and no adoption for mustard and gram crop, respectively. Further it was also observed that under the category of kharif crops, half of the respondents had fully adopted the rice crop (50.80%), 38.30 per cent partially adopted maize crop and 96.70 per cent had no adoption for the cotton crop in organic farming. Regarding the application of FYM/compost, majority of the respondents (81.70%) had full adoption, 10.80 per cent had partial and rest (7.50%) had no adoption. More than 60% of the respondents (67.60%) had fully adopted the compost during field preparation followed by it can be used at any time and with any method (36.80%).

For the methods of FYM preparations, an over whelming majority of the respondents (98.40%) had

Table 3: Statement wise adoption about organic farming

Nature and extent	Full adoption (2)	Partial adoption (2)	No adoption (0)
Nature of adoption			
Fruits	-	103(85.80)	17(14.20)
Vegetables	-	115(95.80)	05(04.20)
Wheat	98(81.70)	13(10.80)	9(7.50)
Rice	59(49.20)	32(26.70)	29(24.10)
Sugarcane	05(04.20)	47(39.20)	68(56.60)
Commercial crops(cotton)	5(4.10)	7(5.90)	108(90.00)
Pattern of adoption			
Rabi crops			
Wheat	110(91.80)	8(6.60)	2(1.60)
Mustard	46(38.30)	15(12.50)	59(49.20)
Gram	14(11.70)	46(38.30)	60(50.00)
Kharif crops			
Rice	61(50.80)	29(24.20)	30(25.00)
Maize	03(02.50)	46(38.30)	71(59.20)
Bajra	25(20.80)	32(26.70)	63(52.50)
Cotton	03(02.50)	01(00.80)	116(96.70)
Guar	26(21.70)	32(26.70)	62(51.60)
Sugarcane	07(05.80)	48(40.00)	65(54.20)
Organic manures			
Application of FYM/compost	98(81.70)	13(10.80)	9(7.50)
Application time and method of FYM/compost			
Broadcast and included during field preparation	81(67.60)	37(30.80)	2(1.60)
Broadcast but not implemented	09(07.50)	108(90.00)	3(2.50)
Can be used at any time and with any method	44(36.80)	69(57.40)	7(05.80)

Table 3 contd....

Nature and extent	Full adoption (2)	Partial adoption (2)	No adoption (0)
Method of FYM preparation			
In pits and properly covered	21(17.60)	97(80.80)	2(1.60)
In pits but not properly covered	03(02.50)	100(83.4)	5(4.10)
Without pits	113(94.30)	5(4.10)	2(1.60)
Green manure crop at sowing time	118(98.40)	1(00.80)	1(00.80)
Incorporate a green manure crop into your field at this stage	117(97.60)	2(1.60)	1(00.80)
Use of biofertilizer			
Bio fertilizer in main crop	09(07.50)	51(42.50)	60(50.00)
More use of bio fertilizers as compared to chemical fertilizers	60(50.00)	51(42.50)	09(07.50)
Seed is treated with bio fertilizer	09(07.50)	55(45.80)	56(46.70)
Bio-fertilizer solution dipping seedlings	09(07.50)	51(42.50)	60(50.00)
The amount of biofertilizer that was applied.	12(10.00)	48(40.00)	60(50.00)
Biofertilizers acquired from a reputable supplier	60(50.00)	10(8.40)	50(41.60)
Vermicompost			
Vermicompost application	111(92.60)	7(5.80)	2(1.60)
Vermicompost preparation method	46(38.40)	70(58.30)	04(03.30)
Application of vermi wash	45(37.50)	64(53.30)	11(09.20)
Earthworms in fields	30(25.00)	77(64.20)	13(10.80)
Crop residue management			
Burning plant residue after harvesting	02(1.60)	8(6.70)	110(91.70)
Incorporated in the soil/field	115(95.90)	2(1.60)	3(02.50)
Chemical herbicides (Hexazinone, Fosamine ammonium, Glyphosate)	3(02.50)	6(05.00)	111(92.50)
Organic / solid waste management	110(91.70)	6(05.00)	04(03.30)
Weed management			
Crop rotation and shallow ploughing were used to keep weeds at bay	107(89.20)	13(10.80)	-
Flooding a field to keep weeds at bay	69(57.60)	49(40.80)	2(1.60)
transplanted two seedlings per hill for closer spacing and weed control	85(70.80)	31(25.90)	04(03.30)
Manual weeding labour was hired	20(16.70)	60(50.00)	40(33.30)
Weed management with a bio-herbicide	03(02.50)	19(15.80)	98(81.70)
Pest management			
Summer ploughing was practiced.	119(99.20)	01(00.80)	-
Proper spacing was maintained	110(91.70)	8(6.70)	2(1.60)
Crop residue must be appropriately managed to keep major pests and diseases at bay	105(87.50)	14(11.70)	01(00.80)
Fields are flooded and drained to keep larvae at bay	40(33.30)	76(63.40)	4(3.30)
Adult pests were killed using light traps and pheromone traps	03(02.50)	80(66.70)	37(30.80)
Crop rotation is important for pest management.	117(97.60)	02(1.60)	01(00.80)
Weeds are cut down to keep pests and illnesses at bay	14(11.70)	81(67.50)	25(20.80)
For proper storage, indigenous/traditional methods were used	18(15.00)	86(71.70)	16(13.30)

Figure in the parenthesis denote percentage

fully adopted the green manure crop followed by partial adoption of pits but not properly covered (83.40%). According to the use of biofertilizers the table revealed that half of the respondents (50%) had fully adopted biofertilizers as compared to chemical fertilizers, more than forty per cent (45.80%) of the respondents had partial adoption of seed treated with biofertilizer Analysis revealed that application for the vermicompost was fully adopted by an overwhelming majority (92.60%) of the respondents followed by partial adoption of earthworms in fields (64.20%) and no adoption for the use of earthworms in the fields (10%).

Regarding crop residue management it was revealed that an over whelming majority (95.90%) of the respondents had full adoption for incorporation of residues in soil followed by 92.50 per cent of the respondents who had not adopted the chemical herbicide for crop residue management. Only 6.70 per cent of the respondents had partial adoption of burning plant residue after harvesting.

For the weed management, full adoption was observed of crop rotation and shallow ploughing (89.20%), fifty percent of hiring labour for weeding manually and no adoption (81.70%) of weed management with a bio herbicide. With regard to pest management, an overwhelming majority (99.20%) of the respondents had full adoption of summer ploughing, partial adoption (71.70%) of proper storage and indigenous methods and no adoption for killing of adult pests by using light traps and pheromone traps (30.80%).

The factors in association with adoption level of respondents regarding organic farming were showed in Table 4. Education was found highly significant with the level of adoption at chi-square value 19.15. Seventy-five per cent of the respondents who were illiterate and 50 per cent who had education upto secondary school had low level of adoption whereas 65.40 per cent who had education senior secondary and above had medium level of adoption.

A significant association was found between caste and level of adoption at chi-square value 7.61. Fifty-seven per cent of the respondents belonging backward class had low level of adoption whereas 52.90 per cent belonging to general caste had medium level of

Table 4: Association of socio-economic variables with level of adoption

Socio-economic variables	Level of adoption of organic farming			
	Low adoption (50-58)	Medium adoption (59-67)	High adoption (68-75)	Total (n=120)
Age				
Up to 35 years	4(40.00)	6(60.00)	0	10(8.40)
36-50 years	25(34.2)	38(52.10)	10(13.70)	73(60.80)
Above 50 years	20(54.10)	10(27.00)	7(18.90)	37(30.80)
Total	49(40.80)	54(45.00)	17(14.20)	120(100)
				χ^2=8.34
Education				
Illiterate	6(75.00)	0	2(25.00)	8(6.70)
Upto middle school	5(41.70)	5(41.70)	2(16.70)	12(10.0)
Secondary school	24(50.0)	15(31.30)	9(18.80)	48(40.00)
Senior Secondary and above	14(26.90)	34(65.40)	4(7.70)	52(43.30)
				χ^2=19.15**
Caste				
General	29(34.10)	45(52.90)	11(12.90)	85(70.80)
Backward	20(57.1)	9(25.70)	6(17.10)	35(29.20)
				χ^2=7.61*

Table 4 contd...

Socio-economic variables	Level of adoption of organic farming			
	Low adoption (50-58)	**Medium adoption (59-67)**	**High adoption (68-75)**	**Total (n=120)**
Family type				
Nuclear	13(26.00)	33(66.00)	4(8.60)	50(41.70)
Joint	36(51.40)	21(30.00)	13(18.60)	70(58.30)
				χ^2=15.3*
Family size				
Up to 4 members	17(41.50)	19(46.30)	5(12.20)	41(34.20)
Between 5-8 members	26(44.80)	25(43.10)	7(12.10)	58(48.30)
Above 8 members	6(28.60)	10(47.60)	5(23.80)	21(17.50)
				χ^2=2.77
Size of Land holding				
Marginal Farmer (Up to 1 ha)	4(80.00)	1(20.00)	0	5(4.20)
Small Farmer (>1-2 ha)	10(41.70)	7(29.20)	7(29.20)	24(20.00)
Semi Medium Farmer (>2-4 ha)	19(46.30)	21(51.20)	1(2.40)	41(34.20)
Medium Farmer (>4-10 ha)	11(28.20)	22(56.40)	6(15.40)	39(32.50)
Above 10ha	5(45.50)	3(27.30)	3(27.30)	11(9.20)
				χ^2=17.9*
Size of organic land holding				
Up to 1 ha	30(46.90)	25(39.10)	9(14.10)	64(53.30)
>1-2 ha	14(29.80)	26(55.30)	7(14.90)	47(39.20)
>2-4 ha	5(55.60)	3(33.30)	1(11.10)	9(7.50)
				χ^2=4.41
Annual income (Rs.)				
Up to 1,50,000	18(43.90)	15(36.60)	8(19.50)	41(34.20)
Between 1,50,000 - 3,00,000	25(39.70)	31(49.20)	7(21.10)	63(52.50)
Above 3,00,000	6(37.50)	8(50.00)	2(13.50)	16(13.30)
				χ^2=2.41
Subsidiary occupation				
Nil	28(35.0)	44(55.0)	8(10.0)	80(66.60)
Service	2(28.60)	2(28.60)	3(42.90)	7(5.80)
Small scale enterprises	19(57.60)	8(24.20)	6(18.20)	33(27.60)
				χ^2=13.9**
Social participation				
Not member of any organization	37(37.80)	49(50.00)	12(12.20)	98(81.70)
Member of one organization	12(54.50)	5(22.70)	5(22.70)	22(18.30)
				χ^2=5.6
Mass media				
Low (7-10)	13(27.10)	31(64.60)	4(8.30)	48(40.00)
Medium (11-13)	20(43.50)	18(39.10)	8(17.40)	46(38.30)
High (14-16)	16(61.50)	5(19.20)	5(19.20)	26(21.70)
				χ^2=15.27**

Table 4 contd...

Socio-economic variables	Level of adoption of organic farming			
	Low adoption (50-58)	**Medium adoption (59-67)**	**High adoption (68-75)**	**Total (n=120)**
Extension contacts				
Low (5-7)	10(41.70)	13(54.20)	1(4.20)	24(20.00)
Medium (8-10)	33(40.70)	32(39.50)	16(19.80)	81(67.50)
High (11-13)	6(40.00)	9(60.00)	0	15(12.50)
				χ^2=7.35
Socio-economic status				
Low (8-11)	12(48.00)	7(28.00)	6(24.00)	25(20.80)
Medium (12-15)	26(41.30)	31(49.20)	6(9.50)	63(52.50)
High (16-19)	11(34.40)	16(50.00)	5(15.60)	32(26.70)
				χ^2=5.38

Figure in the parenthesis denote percentage; *Significant at 5% level of significance; **Highly significant at 1% level of significance

adoption. Family type was found significant with the level of adoption (chi-square value 15.3). Sixty-six percent of the respondents from nuclear families had medium level of adoption whereas 51.40 per cent from joint families had low level of adoption. Land holding was found to be significant with level of adoption at chi-square value 17.90. Eighty per cent of the respondents who were marginal farmers (had land up to 1 ha) had low level of adoption, 56.40 per cent who were medium farmers had medium level of adoption and 45.50 per cent who had land above 10 ha had low level of adoption.

Subsidiary occupation was found highly significant with the level of adoption at chi-square value 13.9. Majority of the respondents (57.60%) who had small scale enterprises had low level of adoption, 55 per cent who had no subsidiary occupation had medium level of adoption followed by 42.90 per cent who had service as their subsidiary occupation had high level of adoption. Mass media exposure was found highly significant with the level of adoption at chi-square value 15.27. Majority of the respondents (64.60%) who had low mass media exposure had medium level of adoption and 61.50 per cent who had high mass media exposure had low level of adoption.

CONCLUSION

It was concluded that nearly half of the respondents (45%) had medium level of adoption regarding organic farming followed by high (40.80%) and low (14.20%) level of adoption. The association of relationship between profile of respondents with adoption towards organic farming revealed that education, subsidiary occupation and mass media were found highly significant with the level of adoption towards organic farming. The study recommends building of proper channels of communication for the farmers regarding information about organic farming. This will help farmers in increase in their knowledge level and adoption of organic farming practices. Additionally, the farmers expressed scepticism about how difficult it is to access information about different organic farming practices. Proper training for package of practices is the need of hour for the farmers.

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Farmers' Feedback Associated with Accessibility and Usability of Agromet Advisory Services Disseminated in Thiruvananthapuram District

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ABSTACT

Effective weather and climate information in the form of agromet advisory services, may improve farmers' decision-making and help them to mitigate climate related risks. But, availability of climate services is always a matter of concern. Therefore, the present study was designed to assess the farmers' feedback on accessibility and usability of agromet advisory services. A total 120 farmers were randomly selected from the two blocks namely Nemom and Athiyanoor of the Thiruvananthapuram district of Kerala. Selected farmers were further divided into two groups i.e. control and beneficiary group. The beneficiary farmers in the experimental villages were provided with treatment i.e., block level agromet advisory bulletins disseminated from the AMFU, Thiruvananthapuram regularly for 6 months (1st Jan – 30th June 2021) through WhatsApp. It was found that majority of the farmers found the agromet advisory services relevant to make appropriate decisions regarding fertilizer application, scheduling of irrigation and plant protection measures in crop farming while the services were more relevant for decisions related to shelter management and feed management for dairy farmers. There was a significant improvement in the percentage of experimental farmers who realized the utility of agromet advisory services in day-to-day management of various farm activities after receiving the messages continuous for six months. Hence, wide coverage of the agromet advisory services may improve the coping capacity of the farming community in changing climatic scenario.

Keywords: Agromet Advisory Services, Accessibility, Feedback, Usability

INTRODUCTION

Accurate and timely agrometeorological advises and weather forecast information have been recognized as an effective tool for crucial decision making in routine farm operations. Manjusha *et al.* (2019) reported that majority of farmers believe that early warnings regarding environmental changes should be conveyed to farmers, therefore raising awareness to the farmers about appropriate adaptation measures against climate change and development. Nesheim *et al.* (2016) revealed that awareness regarding agrometeorological information services were limited, and subscriber did not imply information consumption. It was also revealed that uptake of agromet information appears to be poor in India, and subscribers most likely not realized its full potential. Subscribers appreciated agromet data in circumstances when it allowed them to take preventative measures, such as avoiding insect infestations or protecting the crop. Due to the lack of vibrant agromet advisory service format and non-photographic information of crop, crop type, growth stage, disease and pest attack and control measures, intercultural activities, use of implements, and adverse weather condition mitigation practices, as well as its non-picturesque nature, only a small number of farmers in India were using agromet advisory services (Rao and Manikanandan, 2008).

Gopalakrishnan and Subramanian (2020) reported that advisories did not combine weather and agriculture data always, lacking of a common platform for data collation, lack of micro-scale advisories and trained agro

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meteorologists were the major concern. Hence, accessibility and usability of the agromet advisory services is need to be studied based on its subscribers' response to improve its quality and to improve adaptive capacity of the farming community in changing climatic scenario.

MATERIALS AND METHODS

The study was conducted in conducted in purposively selected Thiruvananthapuram district of Kerala. Two blocks namely Nemom and Athiyanoor were selected randomly and from each block two experimental and two were selected after verifying that villages were not receiving any kind of agromet advisory services from Agromet Field Unit (AMFU) located at Thiruvanantha-puram. Respondents were the crop and dairy farmers with smart phone and internet connectivity and 15 such respondents were selected from each village following random selection making a sample of 120 respondents. The beneficiary farmers in the experimental villages were provided with treatment i.e., block level agromet advisory bulletins disseminated from the AMFU, Thiruvanantha-puram regularly for 6 months (1st Jan – 30th June 2021) through Whatsapp. The experimental and control group was undergone pre-test as well as post-test, before and after the intervention. A semi-structured interview schedule was developed by incorporating appropriate statements related to agromet advisory services to collect farmers' feedback. Statement related to preferred sources of information utilized for weather related advices, preferred weather parameters and relevant farm operations required in the services, preferred time for accessing the information and utility of the services were included in the semi-structured interview schedule.

RESULTS AND DISCUSSION

Results displayed in the Table 1, it can be summarized that all the farmers in experimental as well as control had access to TV and newspaper. The farmers were using these two mass media sources as the most preferred source for obtaining weather forecast and other required farm advisory services. Significant percent of farmers in experimental group (26%) and control group (26%) were using WhatsApp as a preferred and easiest source for accessing weather related as well as other relevant information required for their farming activities. It was also evident that very few farmers (6.67%) were using website for accessing weather related information and advices. It can be concluded that all the farmers belonging to both control as well as experimental group were using mass media sources for the purpose of accessing weather related information and other relevant farm advisory services.

It is revealed from the below Table 2 that before and after intervention all the farmers in the experimental group as well as control group reported rainfall and heavy rainfall were one of the relevant climatic parameters that should be included in the weather forecasting information as well as agromet advisory services. Before the intervention, 18.33 per cent and 20.00 per cent farmers in the experimental group and control group, respectively reported high temperature was also a required parameter in weather advisory services. But, after the intervention 21.67 and 26.67 per cent for experimental and control group farmers reported high temperature was a preferred weather parameter. Before the intervention 41.67 and 38.33 per cent farmers in the experimental and control group, respectively and after intervention 50.00 and 40.00 per cent farmers in the experimental and control group, respectively reported wind as an important weather parameter.

Thunder storm was also reported as important by 8.33 per cent farmers from experimental group and 8.33 per cent farmers from control group before intervention as well as after intervention 21.67 and 13.33 per cent farmers from experimental and control group respectively. It can be concluded that most of the respondents reported

Table 1: Preferred sources of weather forecast and agromet advisory services before and after the intervention

Treatment	Experimental group (n=60)		Control Group (n=60)	
	Pre-treatment F(P)	Post-treatment F(P)	Pre-treatment F(P)	Post-treatment F(P)
TV	60(100)	60(100.00)	60(100.00)	60(100.00)
SMS	11(18.33)	11(18.33)	12(20.00)	12(20.00)
Newspaper	60(100)	60(100.00)	60(100)	60(100)
Whatsapp	26(43.33)	60 (100.00)	21(35.00	21(35.00)
website	4(6.67)	4(6.67)	3(5.00)	3(5.00)

Table 2: Preferred weather parameters for various farm operation before and after the intervention

Treatment	Experimental group (n=60)		Control Group (n=60)	
	Pre-treatment F(P)	Post-treatment F(P)	Pre-treatment F(P)	Post-treatment F(P)
Rain	60(100)	60(100)	60(100)	60(100)
Heavy Rain	60(100)	60(100)	60(100)	60(100)
High Temperature	11(18.33)	16(26.67)	12(20.00)	13(21.67)
Wind	25(41.67)	30(50.00)	23(38.33)	24(40.00)
Thunderstorm	5(8.33)	13(21.67)	5(8.33)	8(13.33)

rainfall, heavy rainfall and wind as important parameter for decision making in farm operations as most of the Kerala's agriculture is rain-fed and is highly affected by erratic rainfalls and high speed winds causing severe crop damages. Only few farmers reported high temperature and thunderstorm as important for decision making in farm operations.

From the results depicted in the Table 3, it is revealed that 50.00 per cent of the farmers in the experimental and 45.00 percent of the farmers in the control group reported agromet advisory services were relevant for fertilizer application before treatment while 68.33 and 50.00 per cent farmers in the experimental and control group respectively reported agromet advisory services were relevant for fertilizer after intervention. Before intervention, 53.33 per cent and 46.67 per cent farmers in the experimental and control group, respectively and after intervention 66.67 and 53.33 per cent farmers in experimental and control group, respectively reported agromet advisory services were relevant for pesticide application. It can be also seen that before intervention, 31.67 per cent and 25.00 per cent farmers in the experimental and control group respectively and after intervention 40.00 and 25.00 per cent farmers in experimental and control group, respectively reported agromet advisory services were relevant for shelter management in dairy animals. It can be summarized that majority of the farmer reported agromet advisory services were relevant for decisions regarding plant protection measures in crop farming while shelter management was more relevant in case of dairy farming.

According to the Table 4, 15.00 per cent, 23.33 per cent and 61.67 per cent of farmers before intervention from the experimental group perceived that weather forecast as highly useful, partially useful and not useful, respectively. While 10.00 per cent, 26.67 per cent and 63.33

Table 3: Various farm operations for which weather forecast and agromet advisory services are relevant before and after the intervention

Treatment	Experimental group (n=60)		Control Group (n=60)	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
	Various farm operations for which agromet advisory services is relevant		Various farm operations for which weather forecast is relevant	
	F(P)	F(P)	F(P)	F(P)
Sowing	6(10.00)	12(20.00)	4(4.67)	9(15.00)
Irrigation	9(15.00)	18(30.00)	4(4.67)	6(10.00)
Fertilizer application	30(50.00)	41(68.33)	27(45.00)	30(50.00)
Pesticide application	32(53.33)	40(66.67)	28(46.67)	32(53.33)
Harvesting	10(16.67)	15(25.00)	9(15.00)	10(16.67)
Post-Harvest management	10(16.67)	19(31.67)	6(10.00)	6(10.00)
Water management	15(25.00)	21(35.00)	14(23.33)	14(23.33)
Feeding	18(30.00)	23(38.33)	15(25.00)	15(25.00)
Shelter management	19(31.67)	24(40.00)	15(25.00)	15(25.00)
Vaccination	5(8.33)	13(21.67)	2(3.33)	4(6.67)

Table 4: Feedback about relevance of weather forecast and agromet advisory services before and after the intervention

Treatment	Experimental group (n=60)		Control Group (n=60)	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
	Relevance of agromet services		Relevance of weather forecast	
	F(P)	F(P)	F(P)	F(P)
Highly useful	9(15.00)	21(35.00)	6(10.00)	11(18.33)
Partially useful	14(23.33)	19(33.33)	16(26.67)	18(30.00)
Not useful	37(61.67)	20(31.67)	41(63.33)	31(51.67)

per cent farmers from the control group reported it as highly useful, partially useful and not useful, respectively. But, after intervention from the experimental group 35.00 percent, 33.33 percent and 31.67 per cent farmers reported agromet advisory services as highly useful, partially useful and not useful respectively, while 18.33 per cent, 30.00 per cent and 51.67 per cent farmers from the control group reported it as highly useful, partially useful and not useful, respectively. It can be observed from the result that the percentage of farmers who reported agromet advisory services highly useful and partially useful in the experimental group had increased from 15.00 per cent during pre-treatment to 35.00 per cent during post-treatment and 23.33 per cent during pre-treatment to 33.33 per cent during post-treatment, respectively. Hence it can be concluded that there was a visible improvement in the percentage of farmers who realized the utility of agromet advisory services in day-to-day management of various farm activities.

From the Table 5, it is clearly evident that 83.33 per cent farmers in the experimental and 76.67 per cent in the control group prefered morning time for accessing weather related information from various media sources while 16.67 per cent and 23.33 per cent farmers in the experimental and control group prefer night time for accessing the information.

From the Table 6, it can be inferred that before the intervention, 68.33 per cent and 71.67 per cent farmers belonging to experimental and control group, respectively reported greater than 40.00 per cent loss in the average production during the crop season due to bad weather while 23.33 per cent and 18.33 per cent farmers from experimental group and control group respectively reported 20-30 per cent loss in the average production during the crop season due to bad weather. Very few farmers from experimental (8.33%) and control group (10.00%) reported less than 20 per cent loss in the average production during the crop season due to bad weather. It was also found that after the intervention, 43.33 per cent and 56.67 per cent farmers belonging to experimental and control group respectively reported more than 40.00 per cent loss in the average production during the crop season due to bad weather while 33.33 per cent and 26.67 per cent farmers from experimental group and control group

Table 5: Preferred time for accessing weather forecast and agromet advisory services before and after the intervention

Treatment	Experimental group (n=60)		Control Group (n=60)	
	Pre-treatment F(P)	Post-treatment F(P)	Pre-treatment F(P)	Post-treatment F(P)
Morning	50(83.33)	50(83.33)	46(76.67)	46(76.67)
Night	10(16.67)	10(16.67)	14(23.33)	14(23.33)

Table 6: Average percentage of production lost during the crop season due to bad weather before and after the intervention

Treatment	Experimental group (n=60)		Control Group (n=60)	
	Pre-treatment F(P)	Post-treatment F(P)	Pre-treatment F(P)	Post-treatment F(P)
Greater than 40 percent	41(68.33)	26(43.33)	43(71.67)	34(56.67)
20-30 percent	14(23.33)	20(33.33)	11(18.33)	16(26.67)
Less than 20 percent	5(8.33)	14(23.33)	6(10.00)	10(16.67)

respectively reported 20-30 per cent loss in the average production during the crop season due to bad weather. Only 23.33 per cent farmers from experimental and 16.67 per cent farmers from control group reported less than 20 per cent loss in the average production during the crop season due to bad weather after the intervention. Majority (68.33%) of the experimental group farmers reported more than 40.00 per cent loss in average production due to bad weather before the intervention while only 43.33 per cent reported more than 40.00 per cent loss in average production due to bad weather after the intervention.

CONCLUSION

The present study revealed that the farmers belonging to both control as well as experimental group were using most common mass media sources such as TV and Newspaper for the purpose of accessing weather related information and other relevant farm advisory services and most of the respondents reported rain, heavy rain and wind as an important parameter for decision making in farm operations as most of the Kerala's agriculture is rain-fed and is highly affected by erratic rainfalls and high speed winds causing severe crop damages. The study also reported that majority of the farmers found the agromet advisory services relevant for the decisions regarding fertilizer application, scheduling of irrigation and plant protection measures in crop farming while the services were more relevant for decisions related to shelter management and feeding management for dairy farmers. There was a significant improvement in the percentage of experimental farmers who realized the utility of agromet advisory services in day-to-day management of various farm activities and able to minimize production loss due to the climate extremities after the treatment. The study suggested that providing farmers with regular access to a credible sources of agromet advisory will drive them to utilize it, and it should be paired with frequent awareness and training programmes to help farmers realize the full potential of agromet advisory services.

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Impact of Diploma in Agricultural Extension Services for Input Dealers (DAESI) Programme in Disadvantaged Districts of Madhya Pradesh

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ABSTRACT

The study assessed the impact of Diploma in Agricultural Extension Services for Input Dealers (DAESI) Programme in Disadvantaged Districts of Madhya Pradesh. The study was conducted in 2019-20 and the data was collected from 200 DAESI and Non-DAESI input dealers from Balaghat and Mandla district of M.P. It was revealed from the data that higher percentage (56.00%) of DAESI input dealers had medium level of knowledge followed by 40.00 per cent of dealers with high level of overall knowledge. Just contrary of that, in case of Non-DAESI dealers 50.00 per cent of dealers had low level of knowledge followed by (48.00%) of input dealers had medium level of knowledge. Also it was reported there is significant difference in the knowledge level of the DAESI and Non-DAESI input dealers. The DAESI dealers had more knowledge on different fields of agriculture as compared to Non-DAESI input dealers. Therefore it could be concluded that there is a positive and significant impact of DAESI programme in increasing the overall level of knowledge of input dealers on various fields of agriculture.

Keywords: DAESI, Non-DAESI, Disadvantaged, Knowledge

INTRODUCTION

Agriculture and farmers are the backbone of our country. This sector contributes almost 16.50 per cent of India's GVA and has estimated a record production of 291.95 million tonnes food grains in 2019-20 (Anonymous, 2020). In order to continue with this sustaining growth of agriculture in India and to achieve the targeted value, multi-prolonged strategy, including effective and efficient delivery of farm information, is a prerequisite. Public extension service is somehow blamed for not being able to disseminate technical agricultural knowledge on time and handle the diverse demands of the farming community as per their need. National Agricultural Policy (NAP) stressed the need for reforms in agricultural extension of the country. Ministry of Agriculture, Government of India emphasized to have multi agency extension services viz., Input Dealers, Producers Association, NGOs, Corporate sector etc. have entered the extension scenario. Among all, agri-input dealers play major role for disseminating agri–farm information. Agri-input dealers facing challenge while developing new skills and knowledge to make pace with rapid innovation as the new knowledge demands of farmers is highly dynamic and concerned with technology-driven environment. Therefore, it is essential to analyze the potential impact of DAESI programme among the diploma holder input dealers in order to drag maximum benefits from the programme. Hence, the present study was undertaken to know the "Impact of Diploma in Agricultural Extension Services for Input Dealers (DAESI) Programme in Disadvantaged Districts of Madhya Pradesh".

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MATERIALS AND METHODS

The study was carried out in two disadvantaged districts, Balaghat with semi tribal population and Mandla with tribal population of Madhya Pradesh. Balaghat had three nodal training. i) Farmers training center, ii) COA, Balaghat and iii) KVK, Badgaon and Mandala has only one training center at KVK, Mandla. All these institutes were selected for the study. These 4 centers consisting total of 160 input dealers (40 in each center) from the batch 2019-20 under DAESI programme. Also 100 non DAESI input dealers were selected randomly from the list obtained from DDA office from the selected districts. Thus, making a total sample size of 200. For the purpose of data collection, a structured interview schedule was developed and data were entered in Microsoft Excel spreadsheets and were analysed using mean and percentage distribution of respondents among different categories. the input dealers who had undergone through DAESI programme were considered as experimental group and those who have not gone through the DAESI programme but having similar profile were considered as control group. Both the input dealers group were asked same type of questions to test their knowledge level related to DAESI curriculum and score was given to each answer. Any difference or change in knowledge level between the experimental group and control group could be attributed as the impact of DAESI programme. The impact of DAESI programme was also assessed through comparison of average knowledge of DAESI input dealers w.r.t all components of curriculum with the non DAESI input dealers and the Z test was applied to know, if there existed any significant mean difference of knowledge level or not.

RESULTS AND DISCUSSION

The input dealers were asked to test the knowledge regarding the components included in the curriculum and categorised into three categories, namely low, medium and high level of knowledge. It is revealed from the Table 1 and Figure 1 that, higher percentage (56.00%) of total DAESI input dealers had medium level of overall knowledge; followed by 40.00 per cent and 4.00 per cent of DAESI input dealers had high and low level of overall knowledge respectively whereas, in case of Non-DAESI dealers, higher percentage 50.00 per cent of input dealers had low level, followed by medium level (48.00%) of knowledge, and only 02.00 per cent dealers who had high level of overall knowledge respectively. The study is in conformity with Jally (2018).

It was very much evident from Table 1 and Figure 2 that, higher percentage (52.00%) of total input dealers were having medium level of overall knowledge regarding the course curriculum given, followed by low and high level of overall knowledge with 27.00 per cent and 21.00 per cent share of total input dealers.

The DAESI programme consisting of different modules for theory sessions. Those are agro ecological situation, Soil health management, rainfed farming, seed and seed production, irrigation techniques and their management, weed management, pest and disease control in agriculture, farm implements and machinery, crop production technology, acts, rules and regulation related to agricultural inputs schemes related to agricultural sectors, extension approach method and other optional areas based on requirement. Based on the course structure of DAESI programme, set of

Table 1: Distribution of input dealers according to their level of overall knowledge

Knowledge	DAESI Dealers		Non -DAESI Dealers		Total input Dealers	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Low (<10.33)	4	4	50	50	54	27
Medium (10.33-26.39)	56	56	48	48	104	52
High (>26.46)	40	40	2	2	42	21
Total	100	100	100	100	200	100
Mean = 18.40; SD = 8.07						

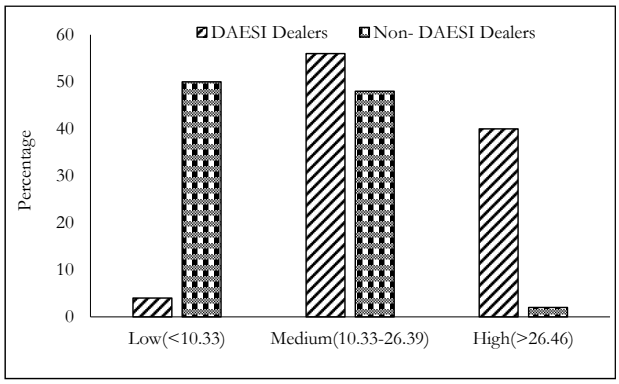

Figure 1: Distribution of DAESI and Non-DAESI dealers according to their level of overall knowledge

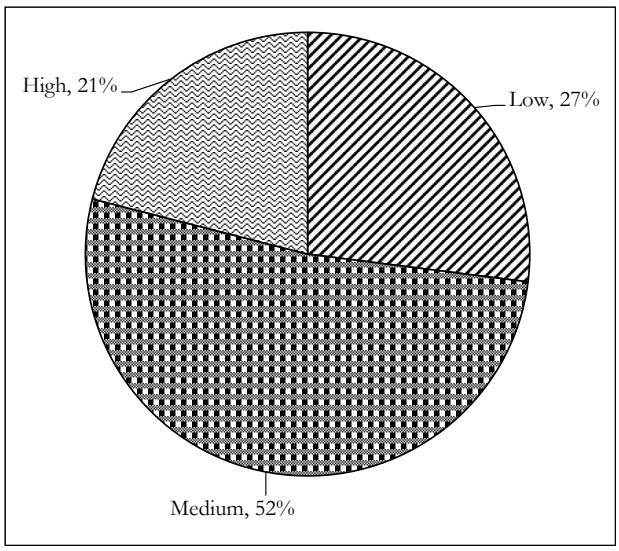

Figure 2: Distribution of total input dealers according to their level of overall knowledge

questions was framed covering different modules and was asked and scores were given for each answer. The maximum achievable and average obtained scores of both DAESI and Non-DAESI dealers were presented in Table 2.

It was reported that maximum difference in knowledge scores occurred in Soil health and Acts rules regulation related to agricultural schemes in agricultural sector + Extension approaches + others i.e., (53.75%) followed by seed and seed production technique (51.00%) and Pest and disease control in agriculture (49.50%). The difference in knowledge score recorded in Crop production Technology + Rainfed Farming +Irrigation Techniques and their Management + Agro ecological situation (19.2%). Overall change in total knowledge scores obtained by DAESI dealers over Non-DAESI dealers in various components included in the curriculum of DAESI Programme was 41.5 per cent. This difference in knowledge scores could be attributed to the DAESI diploma course.

In order to study the significant difference in the score of knowledge on different components between the DAESI and Non-DAESI input dealers, "Z" test was applied. The size of sample, mean and standard deviation of the two groups were given in Table 3.

It was clearly evident that the difference in knowledge was found highly significant at 0.01 level of probability i.e., the DAESI dealers had more knowledge on different fields of agriculture as

Table 2: Knowledge score obtained by DAESI and Non-DAESI input dealers in various components included in the curriculum of DAESI programme

Questions framed in different set of subjects	Maximum obtainable score	Average score obtained by DAESI dealers	Average score obtained by non-DAESI dealers	Difference in knowledge score
Crop Production Technology + Rainfed Farming + Irrigation Techniques and Their Management + Agro ecological situations	10(100%)	9.46(94.6%)	7.54(75.4%)	1.92(19.2%)
Seed and Seed Production	8(100%)	7.28(91%)	3.2(40%)	4.08(51.00%)
Soil Health	4(100%)	2.87(71.75)	0.72(18%)	2.15(53.75%)
Pest and Disease control in agriculture	4(100%)	2.41(60.25)	0.43(10.75%)	1.98(49.5%)
Acts, Rules and Regulation related to Agricultural Schemes related to agricultural sectors + Extension Approaches + Others	4(100%)	2.6(65%)	0.28(7%)	2.32(53.75%)
Total	30(100%)	24.62(82.06%)	12.17(40.56%)	12.45(41.5%)

Table 3: Comparison of knowledge level of DAESI and Non-DAESI input dealers

Z-Test: Two sample for means	DAESI input dealers	Non-DAESI input dealers
Mean	24.62	12.17
Known variance	18.7	33.8
Observations	100	100
Hypothesized mean difference	0	
Z test value	17.18263242**	

**Significant at 0.01 level of probability (Z_{tab} = 2.32)

compared to Non-DAESI input dealers. This is in line with the study of Gajbhiye (2020). After analysis, it may be concluded that there is a positive and significant impact of DAESI programme in increasing the overall level of knowledge of input dealers on various fields of agriculture like, agro ecological situation, soil health management, rainfed farming, seed and seed production, irrigation techniques and their management, weed management, pest & disease control in agriculture, farm implements and machinery, crop production technology, acts, rules & regulation related to agricultural inputs and schemes related to agricultural sectors.

CONCLUSION

It was revealed higher percentage (56.00%) of DAESI input dealers had medium followed by 40.00 per cent of dealers with high level of overall knowledge. Just contrary of that, in case of Non-DAESI dealers 50.00 per cent of dealers had low level of knowledge followed by (48.00%) input dealers with medium level of knowledge. It was also reported that majority (52.00%) of total input dealers were having medium level of overall knowledge. The Z-test found to be significant by indicating, that significant difference in the knowledge of the DAESI and Non-DAESI dealers.

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Level of Satisfaction of Stakeholders from Atma Kisan Bazaar Ludhiana

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ABSTRACT

ATMA Kisan bazaar helps farmers in bringing and selling their produce directly to consumers without the involvement of middlemen. The present study was conducted in Ludhiana district of Punjab with 130 respondents (10 Organizers, 20 Progressive farmers, and 100 Consumers) to find out the level of satisfaction regarding ATMA Kisan bazaar. The findings of this study revealed that majority (90%) of the organizers were satisfied with facilities provided to farmer producers and consumers and Number of sellers present in the ATMA *Kisan* bazaar, Ludhiana. Moreover, majority (75%) of progressive farmers were satisfied with the Facilities provided by organizers in ATMA *Kisan* bazaar. In case of consumers, 64 per cent of them were satisfied from Quality of products in ATMA Kisan bazaar.

Keywords: ATMA, Kisan bazaar, Organizers, Progressive farmers, Consumers, Satisfaction

INTRODUCTION

Agriculture Technology Management Agency (ATMA) is a registered society at the district level, which works with different agriculture related institutions for sustainable agriculture development. The main objective of this body is to coordinate the various research and extension activities at the district level (Saibaba and Vadde, 2009). ATMA *KISAN* BAZAAR' is a booster for progressive farmers and self-help groups (SHGs), direct marketing of agricultural products at farmer's markets has become an important sales outlet for small and marginal farmers nationwide. Enhancing income of farm families through value addition and product diversification has been one of the thrust areas of ATMA (Kathirvel, 2009).

ATMA handhold the entrepreneurs to create brands, register them, obtain licenses and advertise. It established a unique facility, namely, ATMA *KISAN* BAZAAR to display its branded value-added products and to attract the buyers. ATMA *Kisan* bazaar is giving them an opportunity to introduce their products to public and obtain consumer feedback (Gupta and Rahman, 2011). Farmer's Interest Groups (FIGs), Common Interest Groups (CIGs) and progressive farmers, in which more than 20 farmer organizations were registered with ATMA in Ludhiana district of Punjab State for marketing of their produce with this approach. Farmers are able to sell their products on this platform, initiated by the district administration since April 2018. The market is set up in the premises of the District Agriculture Office from 3 pm to 7 pm every Sunday.

This innovation was seen as a way to provide a profitable market outlet for small scale producers and processors and a strategy to increase customer interest in local food products within a growing global market place. The motive behind starting this bazaar is to provide a place to progressive farmers and registered SHGs for selling their products without the presence of middlemen under the ATMA programme. Farmers sell products within the range of Rs. 5 to Rs 2000. Farmers usually sell products viz. vegetables, pickle, honey, wheat flour, pulses, dairy, chutney, spices and other products and the SHGs sell various types of bags. No rent is taken from farmers and SHGs for

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installing their stalls in the market. Most products are organic which are safe to use. The city residents have also given energetic response to the market and about 150 to 200 people visit ATMA *Kisan* bazaar each Sunday and it is increasing day by day (Anonymous, 2018).

MATERIALS AND METHODS

This study was conducted in Ludhiana district of Punjab state. A list of all of the stakeholders' of the ATMA *Kisan* bazaar namely; Progressive farmers (SHGs CIGs and FIGS members), Consumers and Organizers ATMA *Kisan* bazaar was prepared. With the help of this list 20 progressive farmers, 100 consumers and 10 organizers of ATMA *Kisan* bazaar were selected randomly. Thus, constituting a sample of 130 respondents for present investigation. The level of satisfaction of each stakeholder (Progressive farmers, Consumers and Organizers) regarding various aspects of ATMA *Kisan* bazaar was measured as well as described and discussed.

RESULTS AND DISCUSSION

It is observed from the Table 1 that 60 per cent of respondents were satisfied with the participation of farmer sellers and consumers in the ATMA *Kisan* bazaar while 40 per cent of them were highly satisfied. From the facilities which organizers provided in ATMA *Kisan* bazaar the majority (90%) of respondents were satisfied while 10 per cent of respondents were neutral. Moreover, 50 per cent of respondents were satisfied with administrative of authorities in the bazaar and 40 per cent of respondents were highly satisfied whereas 10 per cent of respondents were neutral.

In the case of the location of ATMA *Kisan* bazaar 50 per cent of respondents were satisfied, 40 per cent were highly satisfied, and 10 per cent were neutral. For marketing facilities provided by them to the farmer producers and consumers in ATMA *Kisan* bazaar 50 per cent, 30 and 20 per cent of respondents were; highly satisfied, neutral and satisfied, respectively. Half (50%) of respondents were highly satisfied with their involvement in decision-making while rest half were satisfied from their involvement.

From farmer producers loyalty to the ATMA *Kisan* bazaar 50 per cent of respondents were highly satisfied, and 50 per cent of respondents were satisfied. From consumer's loyalty to the bazaar 50 per cent of the respondents were highly satisfied, 30 per cent were satisfied and 20 per cent were neutral. With the out-reach of ATMA *Kisan* bazaar 60 per cent of

Table 1: Distribution of respondents according to their level of satisfaction from ATMA *Kisan* bazaar (n=10)

Level ofSatisfaction	Neutral		Satisfied		Highly satisfied		Score	Rank	Mean score & S.D.
	f	%	f	%	f	%			
Participation of farmer sellers and consumers in ATMA *Kisan* bazaar	0	0	6	60	4	40	24	3	2.4±0.516
Facilities which provided to farmer producers and consumers in ATMA *Kisan* bazaar	1	10	9	90	0	0	19	6	1.9±0.316
Administrative	1	10	5	50	4	40	23	4	2.3±0.674
Location of ATMA *Kisan* bazaar	1	10	5	50	4	40	23	4	2.3±0.674
Marketing facilities	3	30	2	20	5	50	22	5	2.2±0.918
Your involvement in decision making	0	0	5	50	5	50	25	2	2.5±0.527
Farmer producers loyalty to the bazaar	0	0	5	50	5	50	25	2	2.5±0.527
Consumers loyalty to bazaar	2	20	3	30	5	50	23	4	2.3±0.823
Out-reach of ATMA *Kisan* bazaar Ludhiana	0	0	4	40	6	60	26	1	2.6±0.516
Behavior of sellers and consumers in ATMA *Kisan* bazaar	0	0	6	60	4	40	24	3	2.4±0.516
Number of sellers present in the ATMA *Kisan* bazaar	1	10	9	90	0	0	19	6	1.9±0.316

respondents were highly satisfied while 40 per cent of them were satisfied. Furthermore, 60 per cent and 40 per cent of respondents were satisfied and highly satisfied, respectively with the behavior of sellers and consumers in ATMA *Kisan* bazaar. From the number of sellers present in ATMA *Kisan* bazaar majority (90%) of respondents were satisfied and 10 per cent were neutral.

It can be seen in the Table 2, that majority (75%) of the respondents were satisfied and 15 per cent of them were very satisfied with the facilities provided by organizers in ATMA *Kisan* bazaar, whereas 10 per cent were neutral. With the administration of organizers 60 per cent of respondents were satisfied, 15 per cent were very satisfied, 20 per cent were neutral and 5 per cent were unsatisfied. In context of Location of ATMA *Kisan* bazaar 65, 25 and 5 per cent of respondents were satisfied, neutral, very satisfied and unsatisfied, respectively. From marketing strategies provided by organizers 55 per cent of respondents were satisfied, 40 per cent were neutral and 5 per cent were very satisfied.

In case of involvement in decision making by organizers 60 per cent of respondents were satisfied, 25 per cent were neutral, 10 per cent were unsatisfied and 5 per cent very satisfied. Moreover, with the Consumers' loyalty 50 per cent of respondents were satisfied, 25 per cent of them were very satisfied, 15 per cent were neutral and 10 per cent were unsatisfied. With behavior of organizers 65, 20, 10 per cent and 5 per cent of respondents were satisfied, neutral, very satisfied and unsatisfied.

From good profits of ATMA *Kisaan* Bazaar 45 per cent of the respondents were very satisfied, 40 per cent of them were satisfied and 15 per cent have shown neutral responses. Furthermore, regarding the Growth of ATMA *Kisan* bazaar, Ludhiana 55, 30, 10 and 5 per cent of the respondents were found to be satisfied, neutral, very satisfied and unsatisfied, respectively.

It is observed from the below table that 41 per cent of the respondents were satisfied with fixed prices in ATMA *Kisan* bazaar, 21 per cent were dissatisfied, 15 per cent were neutral, 14 per cent were highly dissatisfied and 9 per cent were highly satisfied. Regarding the arrangement of the bazaar 42 per cent of the respondents were neutral, 31 per cent were satisfied, 13 per cent were dissatisfied, 8 per cent were highly satisfied and 6 per cent were highly dissatisfied. In case of proper place 39 per cent of the respondents were satisfied, 38 per cent were neutral, 14 per cent were highly satisfied, 6 per cent were dissatisfied and 3 per cent were highly dissatisfied. From Locally produced products 54, 20, 18, 5 and 3 per cent of respondents were found to be satisfied, highly satisfied, neutral, dissatisfied and highly dissatisfied, respectively.

In context to ease in access of graded products 53 per cent of the respondents responded neutrally,

Table 2: Distribution of respondents according to their level of satisfaction toward ATMA *Kisan* bazaar (n=20)

Level of satisfaction	V-U		Uns		N		S		V-S		Score	Rank	Mean score
	f	%	f	%	f	%	f	%	f	%			& S.D.
Facilities provide, by organizers in ATMA *Kisan* bazaar	0	0	0	0	2	10	15	75	3	15	81	2	4.05±0.510
Administration of organizers	0	0	1	5	4	20	12	60	3	15	77	4	3.85±0.745
Location of ATMA *Kisan* bazaar	0	0	1	5	5	25	13	65	1	5	74	6	3.7±0.656
Marketing strategies provide, by organizers	0	0	0	0	8	40	11	55	1	5	73	7	3.65±0.587
Involvement in decision making by organizers	0	0	2	10	5	25	12	60	1	5	72	8	3.6±0.753
Consumers loyalty	0	0	2	10	3	15	10	50	5	25	78	3	3.9±0.911
Organizer's behavior	0	0	1	5	4	20	13	65	2	10	76	5	3.8±0.695
Good profits	0	0	0	0	3	15	8	40	9	45	86	1	4.3±0.732
Growth of ATMA *Kisan* bazaar, Ludhiana	0	0	1	5	6	30	11	55	2	10	74	6	3.7±0.732

29 per cent were satisfied, 10 per cent were highly satisfied, 5 per cent were dissatisfied and 3 per cent were highly dissatisfied. With the healthy products at ATMA *Kisan* bazaar 57 per cent of respondents were satisfied, 20 per cent were neutral, 18 per cent were highly satisfied, 3 per cent were dissatisfied and 2 per cent were highly dissatisfied. Regarding better taste of ATMA *Kisan* bazaar produce 60 per cent of respondents were satisfied, 16 per cent were highly satisfied and neutral, 6 per cent were dissatisfied and 2 per cent were highly dissatisfied. With the timings of bazaar 45 per cent of respondents were satisfied, 35 per cent of them responded neutrally, 12 per cent were dissatisfied, 5 per cent were highly satisfied and 3 per cent were highly dissatisfied.

With the quality of products from ATMA bazaar 64, 16, 13, 6 and 1 per cent of respondents were found to be satisfied, neutral, highly satisfied, dissatisfied and highly dissatisfied, respectively. Regarding the products cheaper than local Mandi 25 per cent of the respondents were dissatisfied, 23 per cent were neutral, 21 per cent were satisfied and highly dissatisfied and 10 per cent were highly satisfied. In case of different variety of products 35 per cent of the respondents were highly dissatisfied, 30 per cent of them were dissatisfied, 26 per cent were neutral and 9 per cent were satisfied. Regarding cleanliness, hygiene and public utilities of ATMA Kisan Bazaar 50, 25, 18, 5 and 2 per cent of respondents were found to be neutral, satisfied, dissatisfied, highly satisfied and highly dissatisfied, respectively.

Moreover, 36 per cent of respondents responded neutrally about using less plastic as carry bags whereas 33 per cent were satisfied, 19 per cent were highly satisfied, 8 per cent were dissatisfied and 4 per cent were highly dissatisfied. With the behavior of sellers at ATMA Kisan Bazaar 50 per cent of respondents were satisfied, 35 per cent were neutral, 10 per cent were dissatisfied, 3 per cent highly satisfied and 2 per cent were highly dissatisfied. Regarding Location of bazaar

Table 3: Distribution of respondents according to their level of satisfaction from ATMA *Kisan* bazaar (n=100)

Level of satisfaction	HDS		DS		N		S		HS		Score	Rank	Mean score
	f	%	f	%	f	%	f	%	f	%			& S.D.
Fixed prices	14	14	21	21	15	15	41	41	9	9	310	16	3.1±1.243
Arrangement of the bazaar	6	6	13	13	42	42	31	31	8	8	322	13	3.22±0.980
Proper place	3	3	6	6	38	38	39	39	14	14	355	6	3.55±0.914
Locally produced products	3	3	5	5	18	18	54	54	20	20	383	3	3.83±0.910
Graded produce easy to access	3	3	5	5	53	53	29	29	10	10	338	8	3.38±0.850
Healthy produce	2	2	3	3	20	20	57	57	18	18	386	2	3.86±0.816
Better taste	2	2	6	6	16	16	60	60	16	16	382	4	3.82±0.845
Timings of bazaar	3	3	12	12	35	35	45	45	5	5	337	9	3.37±0.872
Quality products	1	1	6	6	16	16	64	64	13	13	382	4	3.82±0.770
Cheaper than local Mandi	21	21	25	25	23	23	21	21	10	10	274	17	2.74±1.284
Different variety of products	35	35	30	30	26	26	9	9	0	0	209	18	2.09±0.985
Cleanliness, hygiene, public utilities	2	2	18	18	50	50	25	25	5	5	313	15	3.13±0.836
Using less plastic as carry bags	4	4	8	8	36	36	33	33	19	19	355	6	3.55±1.018
Behavior of sellers	2	2	10	10	35	35	50	50	3	3	342	7	3.42±0.793
Location of bazaar	4	4	9	9	45	45	38	38	4	4	329	11	3.29±0.844
Management of bazaar	5	5	10	10	47	47	35	35	3	3	321	14	3.21±0.856
Freshness of products	1	1	2	2	9	9	61	61	27	27	411	1	4.11±0.734
Quantity of products	1	1	7	7	50	50	40	40	2	2	335	10	3.35±0.687
Certified products	2	2	14	14	26	26	41	41	17	17	357	5	3.57±0.997
Packaging of products	2	2	21	21	35	35	31	31	11	11	328	12	3.28±0.985

45 per cent of respondents were found to be neutral, 38 per cent were satisfied, 9 per cent were dissatisfied, 4 per cent were highly satisfied and highly dissatisfied. In context to management of bazaar 47 per cent of respondents were found to be neutral, 35 per cent were satisfied, 10 per cent were dissatisfied, 5 per cent highly dissatisfied and 3 per cent were highly satisfied. Majority (61%) of the respondents were satisfied with the freshness of products at ATMA Kisan Bazaar, 27 per cent were highly satisfied, 9 per cent were neutral, 2 per cent dissatisfied and 1 per cent were highly dissatisfied (Table 3).

Half (50%) of the respondents were found to be neutral about quantity of products at ATMA Kisan Baazar, 40 per cent were satisfied, 7 per cent were dissatisfied, 2 per cent were highly satisfied and 1 per cent were highly dissatisfied. In case of certified products 41 per cent of the respondents were satisfied, 26 per cent were neutral, 17 per cent were highly satisfied, 14 per cent were dissatisfied and 2 per cent were highly dissatisfied. Regarding packaging of products 35 per cent of respondents were neutral, 31 per cent were satisfied, 21 per cent were dissatisfied, 11 per cent were highly satisfied and 2 per cent were highly dissatisfied.

CONCLUSION

From the research it can be concluded that a large majority of the organizers were satisfied from the outreach of ATMA kisan bazaar Ludhiana, as well from their involvement in decision making and from famer producers from their loyalty to the bazaar. Also, in case of progressive farmers most of them were satisfied from earning good profits in the bazaar also from the facilities which provided by the organizers in the bazaar and from consumer's loyalty. Also, most of the consumers were satisfied from the freshness of the products as well from the healthy produce and from the locally produced of products. But majority of the organizers were dis-satisfied from the number of progressive farmers present in the bazaar, also majority of the progressive farmers were dis-satisfied from their involvement in decision making by organizers, as well majority of the consumers of the ATMA kisan bazaar were dis-satisfied from the unavailability of the different variety of products in the bazaar, so the authorities should take note of and provide it at the earliest.

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Socio Economic Profile of Dairy Farmers for Adoption of Scientific Clean Milk Production Practices

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ABSTRACT

Clean milk production is an important occupation of rural farmers in India. In this study data were collected from dairy farmers by using a structured, pretesting interview schedule by interviewing with the farmers at their home /farm at the time of milking. The present study reveals that 57.50 per cent of farmers were females and the majority of farmers were young and middle-aged and illiterate (29.16%), primary (17.50%) and middle (12.50%) level educated. 65.83 per cent had animal husbandry and agriculture as a source of income and up to 5.5 lakhs annual income. The majority of farmers had small to medium family sizes (up to 6 members) and nuclear family structure, not attended any training related to clean milk production practices. In general, farmers had poor extension contact and mass media contact.

Keywords: Clean milk production, Profile, Dairy farmers

INTRODUCTION

Clean milk can be defined as milk coming from a healthy milch animal obtaining normal flavor, free from dirt and filth containing permissible limit of bacteria and essentially free from pathogens, adulterants, different toxins, abnormal residues, pollutants and metabolites (Gupta, 2003 and Das, 2003). In India, mainly small and marginal farmers and a small unit of production play an important role in milk production in the dairy industry (Khatkar, 2007). Further, dairying is included as a supporting occupation to our farmers. Lack of mass media connectivity and illiteracy among our farmers are the important factors of ignorance of the quality norms and the advantages of producing clean milk (Kumar *et al.*, 2020). Thus, it is necessary to know the socio-economic profile of dairy farmers to increase clean milk production.

MATERIALS AND METHODS

The study was conducted in Hisar district of Haryana state purposively selected for being largest producer of milk and owing maximum population of cattle and buffalo in Haryana. Using a multistage random sampling method, total 120 dairy farmers were sampled as respondents from two blocks *i.e. Hisar-I and Hisar-II* from nine blocks, three villages from each block and twenty dairy farmers from a randomly selected village. Thirteen important independent variables reflecting the socio-economic, psychological and communication relation of the respondents which could influence the dependent variables of scientific clean milk production.

RESULTS

Age denotes the chronologically completed years by the respondents at the time of data collection. Table 1 indicated that 40 per cent of the farmers belonged to middle age group followed by 26.66 per cent with old age and 33.33 per cent were from the young age group.

According to findings, it can be concluded that middle age group farmers are more interested in the

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Table 1: Distribution of the farmers according to their age group (n=120)

Category	Frequency	Percentage
Young (below 37)	40	33.33
Middle age (37-51)	48	40.00
Old age (above 51)	32	26.66
Mean	41.96	
SD	11.68	

adoption of scientific clean milk production related practices as compare to young and old age farmers the probable reason might be that old age once were unable to do dairy farming and young once were interested in other occupation.

The respondents were categorized as male and female based on sex of respondents.

Table 2: Distribution of the farmers according to their gender (n=120)

Category	Frequency	Percentage
Male	51	42.50
Female	69	57.50
Mean	1.58	
SD	0.50	

Table 2 showing that the majority (57.50%) of farmers were females followed by 42.50 per cent males, so it might be due to animal husbandry practices were predominantly practiced by women and male counterparts were engaged in other activities than animal husbandry.

Generally, it is considered that formal education of farmers plays an important role in adoption of scientific clean milk production practices. Considering these aspects in mind the formal education of farmers were studied. The data in this respect are presented in Table 3.

The above findings indicate that 11.66, 12.50, 14.16, 15, and 17.50 per cent of the farmers were educated up to high school, middle, secondary, graduate-level and primary respectively. Whereas 29.16 per cent of the farmers were illiterate.

From the above data, it can be concluded that the majority of the respondents (55.82%) had either primary, secondary or high school and middle level of

Table 3: Distribution of the farmers according to their level of educational qualification (n=120)

Category (Education level)	Frequency	Percentage
Illiterate	35	29.16
Primary	21	17.50
Middle	15	12.50
High school	14	11.66
Secondary	17	14.16
Graduate and above	18	15.00
Mean	2.09	
SD	1.842	

education. This may be due to the availability of primary school and secondary school at village level and higher secondary school at nearby areas.

It refers to the engagement of respondents in different activities through which they earn their livelihood. Occupation is one of the important factors, which contributes to the annual income of the farmers. It also reflects the socio-economic status of an individual in society. The data of the present investigation regarding the occupation of the farmers are presented in Table 4.

Table 4: Distribution of the farmers according to their occupation (n=120)

Category	Frequency	Percentage
Animal Husbandry (AH)	15	12.50
AH + Agriculture	79	65.83
AH + Job (Govt. /private)	26	21.67
Mean	2.10	
SD	0.58	

It reveals that the majority (65.83%) of farmers had animal husbandry along with agriculture as a major occupation followed by 21.67 per cent of farmers were performing animal husbandry + Job (Govt./ private) occupation while only 12.50 per cent had only animal husbandry as an occupation. The attainable reason can be that the respondents might have found farming and farming as a dependent commercial enterprise and additional remunerative mixtures.

Family income refers to the total amount in rupees, earned in a year from the farm and non-farm sources

of all earning members of the respondent's family. Higher-income leads to high investment in dairy farming and thus reduces the technological gap. Multipurpose programme planning can only be possible when the money is available on hand. It also helps in the timely and optimum procurement of inputs for better management of the dairy farms. Keeping this in mind, the annual income of the farmers was studied and data are presented in Table 5.

Table 5: Distribution of the farmers according to their annual income (n=120)

Category (Annual income in lacs)	Frequency	Percentage
Low (below 3 lac)	32	26.66
Medium (3-5.5 lac)	54	45.00
High (above 5.5 lac)	34	28.33
Mean	4.40	
SD	2.00	

The Table 5 reveals that 45 per cent of the farmers belonged to medium level of annual income (3-5.5 lacs) group, whereas 28.33 percent of farmers families had high level of income (above 5 lacs) and 26.66 percent of farmers families had low level of income (below 3 lacs) group.

The probable reason behind this was might be that majority of the farm families were practicing animal husbandry along with agriculture as main occupation and this is a major source of income for majority of the respondents.

It represents the no. of members living together in one household or a group descended from a common ancestor. The data are presented in Table 6.

Table 6 indicates that 38.33 per cent of the farmers belonged to medium-sized families i.e. having 5-6 members, while 35 per cent of them belonged to small sized families having up to 4 members and 26.66 per cent of the farmers belonged to large sized families having above 6 members.

Table 6: Distribution of the farmers according to their family size (n=120)

Category	Frequency	Percentage
Small (Up to 4)	42	35.00
Medium (5-6)	46	38.33
Large (above 6)	32	26.66
Mean	5.47	
SD	1.78	

It refers to nuclear and joint families that have been included in the study. The nuclear family is consisted of the father/ mother and his/ her wife/ husband as one conjugal and their children as one unit. The joint family is referred to a group of persons in which all members live, cook and eat food together under one roof. In joint family, the earnings from all sources are pooled together and managed by one family head and also consists of two or more conjugal pairs. So types of the family as an independent variable was studied and data were categorized into two groups are presented in Table 7.

Table 7: Distribution of the farmers according to their type of family (n=120)

Category	Frequency	Percentage
Nuclear (1)	70	58.33
Joint (2)	50	41.66
Mean	1.42	
SD	0.50	

The Table 7 indicated that 58.33 per cent of the farmers belonged to nuclear families and 41.66 per cent of them belonged to joint families.

Training plays an important role to increase and update knowledge, improve skills, inculcate scientific attitudes and enhance the capabilities and capacities of individuals so that they continuously strive hard to become more productive, effective and meaningful in their pursuits.

The Table 8 indicates that majority (75%) of the farmers had not attended any type of training related to scientific clean milk production and animal husbandry practices and 25 per cent of the farmers had attended training. The probable reason might be

Table 8: Distribution of the farmers according to training attended (n=120)

Category	Frequency	Percentage
No	90	75.00
Yes	30	25.00
Mean	0.25	
SD	0.44	

due to lack of resources and awareness about importance of training.

It refers to the contact of respondents to the extension agency or extension personnel for getting information about scientific clean milk production practices.

Table 9: Distribution of the farmers according to their extension contacts (n=120)

Extension contact	Frequency	Percentage
Low (up to 1)	40	33.33
Medium (2-3)	51	42.50
High (above 3)	29	24.16
Mean	2.47	
SD	1.93	

The Table 9 indicate that 42.50 per cent of the farmers had medium level of participation in extension activity followed by 33.33 per cent and 24.16 per cent as low and high participation in extension activity, respectively.

Thus, it can be concluded that a majority (75.83%) of farmers were found with medium to low level of participation in extension activity.

Knowledge and adoption of scientific clean milk production practices of farmers might be influenced by the experience of farmers in dairy farming occupation as experience help in developing maturity and ability to face varied situations. The data regarding the experience of farmers in dairy occupation were collected and are presented in Table 10.

Table 10: Distribution of the farmers according to their experience in dairy farming (n=120)

Category	Frequency	Percentage
Low (below 5 years)	28	23.33
Medium (5-14)	40	33.33
High (above 14)	52	43.33
Mean	14.20	
SD	10.03	

The data presented in Table 10 indicates that 43.33 per cent of the respondents were found with high level (above 14 years) of experience followed by 33.33 per cent and 23.33 per cent with medium (5-14 years) and low (below 5 years) level of experience respectively in dairy farming.

The mass media exposure was operationalized as the frequency of exposure and the use of different mass media like radio, television, exhibition, clinical camp, magazines, newspapers etc. for getting information about dairy farming and the latest technologies in the field of dairy production by the dairy farmers. The data in this respect are presented in Table 11.

Table 11: Distribution of the farmers according to the mass media exposure (n=120)

Category	Frequency	Percentage
Low (below 2)	37	30.83
Medium (2-5)	48	40.00
High (above 5)	35	29.16
Mean	3.94	
SD	2.65	

The Table 11 indicates that 40 per cent of the farmers had medium level of mass media exposure about scientific clean milk production and animal husbandry practices, whereas 30.83 per cent and 29.16 per cent of them had low and high level of mass media exposure, respectively.

It refers to the number of dairy animals such as cows and buffaloes possessed by the respondents. Milch animals are most common in Indian rural communities for getting additional income through the selling of milk. It is also one of the important factors that determine the economic status of the farmers.

The Table 12 shows that 42.50 per cent of the farmers had medium herd size followed by 33.33 per cent of farmers found with medium herd size while 24.17 per cent of them had large herd size.

Table 12: Distribution of the farmers according to herd size (n=120)

Category	Frequency	Percentage
Small (1-2)	40	33.33
Medium (3-5)	51	42.50
Large (above 5)	29	24.17
Mean	3.46	
SD	1.73	

Table 13: Distribution of the farmers according to total milk production (n=120)

Category	Frequency	Percentage
Low (below 8 liters)	22	18.33
Medium (8-16 liters)	57	47.50
High (above 16 liters)	41	34.17
Mean	16.33	
SD	9.26	

It refers that total milk production by herd of animals possess by a family per day in liters**.** The data is presented in Table 13.

The Table 13 indicates that about majority of the respondents (47.5%) had medium level of milk production 8 to 16 liters per day followed by 34.17 per cent produced high level milk production above 16 liters per day.

DISCUSSION

The present study indicates that 57.50 per cent of farmers were females and 40 per cent of farmers belonged to middle age group followed by 33.33 per cent young and 26.66 per cent old age group with an average age of 41.97 years and range of age was 23-65 years. This study indicates that mature, progressive and innovative farmers were more involved in scientific clean milk production. The present findings were parallel with findings reported by Vekariya *et al.* (2016); Khare *et al.* (2020); Jacob and George (2013). While Ahmed *et al.* (2020) observed that most of the dairy farmworkers are adults with 54.70 per cent belong to the age group of 18–35 years. The majority of farmers were illiterate (29.16%), primary (17.50%) and middle (12.50%) level educated. This might be due to their lack of interest, unavailability of higher school and low level of socio-economic status. Similar findings were observed by Vekariya *et al.* (2016); Prasad *et al.* (2019); Khare *et al.* (2020).

The majority of farmers (65.83%) had animal husbandry and agriculture as a source of income. This finding supported by Vekariya *et al.* (2016); Prasad *et al.* (2017); Prasad *et al.* (2019). Majority of farmers belonged to low and medium levels of income up to 5.5 lacs annually. Majority of farmers had small to medium family sizes (up to 6 members) and nuclear family structures. These findings indicated that the farmers had not recognized the advantages of joint families helps in sharing animal husbandry and agriculture workload. Similar findings were reported by Khare *et al.* (2020); Prasad *et al.* (2017); Mande and Thombre (2009); Surkar *et al.* (2014) while Kathiriya *et al.* (2013) recorded 65 per cent were joint families. Majority of farmers (75%) were not attended any training related to clean milk production practices.

In general, farmers had poor extension contact and mass media contact. This might be due to poor education level, lack of knowledge about when and where to connect the extension worker, busy farm schedule and lack of awareness about the production of clean milk. Similar findings were reported by Khare *et al.* (2020); while Vekariya *et al.* (2016) reported medium level extension contact. About just more than half of the total farmers had low to medium level of farming experience up to 16 years. Similar findings were also observed by Jacob and George (2013) and Ahmed *et al.* (2020). Majority of farmers had low to medium levels of herd size up to 6 animals. Similar results were also observed by Jacob and George (2013); Vekariya *et al.* (2016) and Prasad *et al.* (2019). About 65 per cent of farmers produced up to 16 liters of milk per day. Prasad *et al.* (2017) observed similar result.

CONCLUSION

The overall analysis of 120 farmers indicates that 57.50 per cent were females and majority of farmers were young and middle aged with an average age of 41.97 years. Majority of farmers were illiterate, primary and middle (59.76%) level educated, small to medium family size (up to 6 members), low and medium level of income up to 5.5 lacs annually and nuclear family structure.

In general farmers had poor extension contact and mass media contact. Majority of farmers (75%) were not attended any training related to clean milk production practices. About just more than half of the total farmers had low to medium level of farming experience up to 16 years. Majority of farmers had low to medium level of herd size up to 6 animals. About 65 percent of farmers produced up to 16 liters of milk per day.

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Information Seeking Behaviour of Small and Marginal Farmers Practicing Conventional and Integrated Farming System

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ABSTRACT

Agricultural information is useful for farmers to overcome their inadequacies in knowledge of certain basic practices that may include technical, marketing, social, and legal agricultural information. It often involves face-to-face communication, as well as passive reception through mass media. With the passage of time, different agricultural technologies have been developed for the welfare of the farming community but a few of them are found at farmer's field overtime. It is very important to timely disseminate useful agricultural information to the farmers for sustaining their livelihoods. On the other hands, the farmers should have good information seeking behavior to take farming decisions efficiently and ensure sustainability in the livelihoods. The present study was carried out in the two states of India namely Haryana and Uttar Pradesh and the finding of the study depicts that the proportion of respondents in mass media exposure, training exposure and exposure to e- services was higher in integrated farming systems as compared to conventional farming systems in both the states. Regarding the risk orientation of the respondents it was noted that medium scores were obtained in conventional farming systems, whereas it was found high in integrated farming systems irrespective of the states. Majority of the respondents had favorable opinion towards integrated farming systems in the study area. With respect to the reason for shifting towards IFS, it was found that majority of the respondents from both the states perceived IFS as relatively advantageous (88.33%), triable (87.33%), compatible (86.66%) and simple (84.33%) respectively. So, it is necessary to ensure adequate information supply to the farmers for their betterment as well as for sustainable agriculture development.

Keywords: Agriculture, Integrated, Conventional, Farmers, Behavior, Information

INTRODUCTION

Sustainable agriculture is a multi dimensional aspect. Protecting and improving the natural environment is the most important and fundamental concern, and issues like climate change, energy, water scarcity, soil degradation and biodiversity need to be addressed. In developing countries like India, agriculture plays a vital role in the economy and sustainability in the agricultural sector and must address the issues of food security, poverty alleviation, and stable income generation of rapidly growing population. To ensure social, economic and environmental sustainability, farmers must adopt different farm-level practices such as integrated farming system, integrated nutrient management integrated pest management, adequate irrigation and proper care of plant and animal health (Fusun *et al.,* 2008).

Information is the collection, processing, storage, and dissemination of new messages, facts, opinions, data, pictures and comments required to understand and react appropriately to personal, environmental and international conditions, as well as to be in a position to take informed and up to date decisions (David, 2006). Conventional farming system refers to farming system which incorporates the use of synthetic chemical fertilizers, herbicides pesticides, and other continual inputs, genetically modified organisms, concentrated animal feeding operations, heavy irrigation, intensive

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tillage, or concentrated monoculture production. Thus conventional farming system is normally highly resource and energy intensive, but also highly productive (Iqbal, 2010).

Farmers are more inclined towards their existing system of cultivation in spite of the fact that there is high risk of economic losses because of expansion in cost of High Yielding Variety seeds (HYVs), chemical fertilizer, decrease market value of produced goods and modernization and correspondingly repeated crop damage driving farmers to face a serious challenge in terms of profit. In this respects, with some practical instances and effective utilization of model integrated farming, it is suggested that it can definitely overcome such faced problems and help in decrease input cost, increment in agricultural outputs, improve consistency in income and provide better and cost-effective feasibility for decent rural livelihood security (Rahman *et al.,* 2019).

Dolli (2006) carried out an investigation on sustainability of Natural Resource Management (NRM) in watershed development project in Bijapur district of Karnataka and revealed that the impact of NRM project was positive and significant on livelihood of participating farm families. The significant impact was also noticed with respect to food security; physical, natural, human, social and also financial capitals of the participating farm families both in case of self help group and non-self help group members. Amsalu and Wendimu (2013) found that household heads' level of education had a positive impact on household food security and noticed that at least, intermediate level of education is a necessary condition to promise household food security. As being educated household head is more receptive to adopt technology to maximize the output he/she generated from farm activities.

Khatiwada *et al.* (2017) concluded that livelihood diversification to enterprise strategy adopted by 16 per cent of the farm families was the most remunerative strategy followed by commercial farming. Education, access to credit, land holding, agriculture and skill training and proximity to the road and market center are the most important influencing factors on the adoption of higher returning livelihood strategies by the farm families.

Singh *et al.* (2017) studied the usage pattern of the additional income from poultry farming to improve socioeconomic standards of marginal farmers and they found that farmers gave priority to essential facilities like electricity (23.48%), bathroom (23.40%), latrine (15.65%) and 12.66% of farmers converted their Kaccha houses to Pakka houses and some farmers also bought luxury things like mobile (26.96%) and washing machine 0.87 per cent.

Abukari (2014) conducted a study in the Northern region of Ghana and analyzed the livelihood strategies and the indicators of subjective well-being among different subsistence sampled households. The livelihoods of the subsistence households was characterized by scarcity and income poverty from many needs like food, health and low level of formal education. The strategies comprised of the adoption of agriculture and off-farm agriculture, agriculture alone and non-farm and agriculture, off-farm and non-farm strategies (mixed strategies).

Singh *et al.* (2011) concluded that net returns and gross under IFS averaged over the year were 1,35,820/ha/year and 3,29,400/ha/year, respectively, which were more than crops alone (1,24,230 and 74,430 /ha/year). This was possibly because of inclusion of different enterprising flowers and vegetables, crops, optimum utilization/recycling of farm waste and animal waste, better crop residues management strengthening of livestock and fishery units and better management of all the other enterprises of the IFS model contributed in maintaining higher level of production. With respect to livelihood security of the households, the IFS approach adopted in the model met almost all the needs of the family such as food, fodder, fuel etc. and contributed savings of money ranging from an average value of 46.66 thousands/-in first four years and 77.93 thousands in fifth year, respectively, to meet the additional liabilities of the family including health, education etc. This saving of the households was exclusive of all the fixed and running cost of IFS model and money required for households food requirements of a family.

MATERIALS AND METHODS

The study was conducted in two states of India namely Haryana and Uttar Pradesh, one district from each state

viz. Hisar district from Haryana and Lakhimpur Kheri district from Uttar Pradesh were selected. A total sample of 200 small and marginal farm families comprising of 100 small and marginal farm families practicing conventional farming and 100 practicing integrated farming were randomly selected from both the districts i.e. 50 small and marginal farm families practicing conventional farming and 50 practicing integrated farming from Hisar district of Haryana and 50 small and marginal farm families practicing conventional farming and 50 practicing integrated farming from Lakhimpur Kheri district of Uttar Pradesh. Data was collected with the help of pre - structured interview schedule by the investigator from head of the household of the farm families. The collected data was coded, classified and tabulated with the help of appropriate statistical tools to draw meaningful conclusions.

Social participation: It was operationally defined as the degree to which the respondents were involved in formal or non-formal organization such as village panchayat, farmer's club, Self help groups, Milk cooperative society, youth club etc. either as an office bearer or as member. Thus, social participation is voluntary sharing in person to group and group to group relationships beyond the immediate household. The frequency of participation was measured on 3 point continuum as regularly, occasionally and never with the score of 3, 2 and 1, respectively. Scores were summed up to get the total score for social participation of each respondent. Then the respondents were categorized into low, medium and high social participation.

Category	Score
Low (6-10)	1
Medium (11-14)	2
High (15-18)	3

Extension participation: It was operationally defined as the extent of participation of the respondent in different extension programmes such as kisan melas, front line demonstration of IFS models, field days, agricultural exhibitions, meeting with veterinary officer, meeting with subject matter specialists (Agriculture), demonstrations, exposure visits etc. The schedule was developed to measure extension participation of the respondents. The frequency of participation was measured on 3 point continuum as regularly, occasionally and never with the score of 3, 2 and 1, respectively. Scores were summed up to get the total score for extension participation of each respondent. Then the respondents were categorized into low, medium and high extension participation.

Category	Score
Low (10-16)	1
Medium (17-23)	2
High (24-30)	3

Access to the market facilities: It was operationally defined as the respondent's access to market facilities to sell their products such as source(s) of market information, place of selling produce, transport facility, terms and conditions of sell, opinion on market facilities and getting remunerative price of the produce. A schedule was developed to measure the variable, which consists of source of market information, place of selling, remunerative price, transport facilities, terms and conditions of sell and opinion on market facilities. Scores were summed up to get the total score for access to the market facilities of each respondent. The obtained scores were categorized into low, medium and high access to the market facilities and as follows:

Category	Score
Low (up to 6)	1
Medium (7-13)	2
High (14-18)	3

Communicational variables (Information source utilization)

Mass media exposure: It was operationally defined as the degree to which a respondent was exposed to the mass media such as SMS Service by SAUs/KVKs, farm radio, farm magazines, DD Kisan, YouTube, farm news reading in papers etc. for acquiring various types of information. It was measured on four point continuum. Scores 4 to 1 were accorded for the categories daily, weekly, rarely and never. The scores obtained were summed up and categorized as follows:

Training exposure: Training plays an important role in development of skill and attitude competence in

Category	Score
Low (10-20)	1
Medium (21-30)	2
High (31-40)	3

doing a particular job. The respondent's responses to the training exposure such as training on IPM (Integrated Pest Management), mushroom production, crop residue management, bee keeping, organic farming, processing of fruits and vegetables and value addition, poultry farming, vermiculture, Integrated Farming System and horticulture were noted in Yes or No format. Score of '2' was assigned to every number of respondent 'yes' response and score of '1' was assigned to every 'No' response. Then all training aspects were categorized into low, medium and high categories:

Category	Score
Low (10-13)	1
Medium (14-17)	2
High (18-20)	3

Exposure to e- services: It was operationally defined as the extent of use of online communication services by the respondents for receiving agricultural information such as e- Mandi, e-Chaupal, Farmer's Portal, HARIT project (Harnessing the Power of Agricultural Residues Through Innovative Technologies), Crop Insurance Portal, Soil health card, PMFBY (Pradhan Mantri Fasal Beema Yojna) and PM Kisan. The frequency of exposure to e- services was measured on 3 point continuum as regularly, occasionally and never with the score of 3, 2 and 1, respectively. Scores were summed up to get the total score for extension participation of each respondent. Then the respondents were categorized into low, medium and high exposure to e- services.

Category	Score
Low (10-13)	1
Medium (14-17)	2
High (18-20)	3

Psychological variables

Risk orientation: It referred to the degree to which respondents were oriented towards risk and uncertainty and has the courage to face the problem in adoption of latest technology such as Try out an entirely new methods of farming involve risks, but it is worth, A farmer who is willing to take greater risk than others, usually does better financially, It is good for a farmer to take risks when he knows his chance of success is fairly high, A farmer should adopt multi- cropping to avoid greater risk involved in adopting mono-cropping, It is better for farmers not to try new techniques of farming unless other fellow farmers have used them with success, A farmer takes risks in trying new innovation which fetch him more profit and Farmers prefer to attend training and demonstration on new IFS practices in KVK and universities. The information was gathered on three point continuum i.e. strongly agree (3), agree (2), disagree (1) and obtained scores were summed up accordingly the respondents were divided into three categories.

Category	Score
Low (7-11)	1
Medium (12-16)	2
High (17-21)	3

Opinion towards IFS: An opinion is a judgment, viewpoint, or statement that is not conclusive, rather than facts, which are true statements. It is the viewpoint expressed by the respondents. Opinion was operationally defined as the perception of respondents regarding integrated farming system. It was measured with the help of the scale developed by Dadabhau (2014) after slight modification. The statements are as follows, IFS helps to protect environment through recycling of animal waste, IFS helps to achieve optimum production through integration, IFS ensures food and nutritional security of farm family, IFS helps to increase income diversification, IFS reduces vulnerability of farmers in adverse conditions, The manure and organic waste obtained from IFS farms reduce fertilizer requirement, IFS provides enough scope to employ family members round the year, Maximizing profit by adopting improved IFS practices, IFS provide great opportunity to produce diversified products and Crop integration helps to mitigate weeds, pest and disease problems. The information was gathered on three point continuum i.e. agree, undecided and disagree. For positive statements, scores of 3, 2 and 1 was assigned to responses agree, undecided and

disagree and reverse scoring pattern for negative statements i.e.1, 2 and 3 respectively and score were calculated to have an insight of perceived responses regarding integrated farming system.

Reason for shifting to IFS: The attributes of new innovation given by Rogers (2003) was used to gather the information on the factors contributing towards the adoption of IFS by the respondents. Attributes of innovations were: relative advantage, compatibility, complexity and trialability. The responses were recorded on three point continuum i.e. agree (3), undecided (2), disagree (1) and obtained scores were summed up accordingly. Whereas Relative Advantage: defined as the degree to which an innovation is perceived as being better than the idea it supersedes. Compatibility: defined as the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. Simplicity/Complexity: defined as "the degree to which an innovation is perceived as relatively difficult to understand and use." Trialability: defined as the degree to which an innovation may be experimented with on a limited basis".

Category	Score
Agree	3
Neutral	2
Disagree	1

RESULTS

Data presented in Table 1 reveal that irrespective of the states more than half of the respondents (60.00%) had medium social participation followed by high (29.00%) and 11.00 per cent respondents occupied space in low level of social participation. However social participation was higher in all the integrated farming systems as compared to the farmers having conventional farming systems. Further exploration of Table 1 revealed that in pooled sample more than half of the respondents (60.00%) had medium level of social participation followed by high (29.50%) and low 11.00 per cent respectively in formal and non formal organization irrespective of farming systems.

Results regarding extension participation indicate that in both the states a sizable number (52.50%) of the respondents had medium level of extension participation followed by high (27.00%) and low level of extension participation 20.50 per cent. The proportion of respondents in integrated farming systems was more in medium and high level extension participation as compare to conventional farming systems in both the states.

Data regarding access to market facilities presented in the Table 2 depicted that in Haryana more than three fourths (76.00% of CFS and 84.00% of IFS) of the farm families from had medium level of access of market facilities followed by low (14.00% of CFS and 4.00% of IFS) and high (10.00% of CFS and 12.00% of IFS) respectively. Similarly in Uttar Pradesh most of the CFS (68.00%) and IFS (82.00%) farm families had medium level of access to market facilities followed by low (22.00% of CFS and 6.00 % of IFS) and high (10.00% of CFS and 12.00% of IFS) respectively. In aggregate, access to market facilities by

Table 1: Social participation, Extension participation and access to market facilities by the respondents

Variable	Category	Haryana		Uttar Pradesh		Total
		CFS (n=50)	IFS (n=50)	CFS (n=50)	IFS (n=50)	(n=200)
Social participation	Low (6-10)	7(14.00)	2(4.00)	9(18.00)	4(8.00)	22(11.00)
	Medium (11-14)	33(66.00)	23(46.00)	33(66.00)	31(62.00)	120(60.00)
	High (15-18)	10(20.00)	25(50.00)	8(16.00)	15(30.00)	58(29.00)
Extension Participation	Low (10-16)	11(22.00)	4(8.00)	16(32.00)	10(20.00)	41(20.50)
	Medium (17-23)	31(62.00)	17(34.00)	29(58.00)	28(56.00)	105(52.50)
	High (24-30)	8(16.00)	29(58.00)	5(10.00)	12(24.00)	54(27.00)
Access to market facilities	Low (up to 6)	7(14.00)	2(4.00)	11(22.00)	3(6.00)	23 (11.50)
	Medium (7-13)	38(76.00)	42(84.00)	34(68.00)	41(82.00)	155(77.50)
	High (14-18)	5(10.00)	6(12.00)	5(10.00)	6(12.00)	22 (11.00)

the respondents was observed at medium level (70.50%) in both conventional as well as integrated farming system in Haryana and Uttar Pradesh.

Data presented in Table 2 curtails the information on various communication variables used by farmers for information source utilization. It can be seen from the table t that majority of the respondents (66.00% of CFS and 72.00% of IFS) had medium mass media exposure, however 16.00 per cent respondents of CFS and 22.00% of IFS had high level of mass media exposure in Haryana and similar pattern was also observed in Uttar Pradesh. In case of pooled sample, three fourths (70.00%) of respondents had medium scores on mass media exposure followed by high (16.50%) and low 13.50 per cent respectively.

Data regarding training exposure presented in Table 2 show that more than half of the respondents (58.00% from CFS 66.00% from IFS) had medium level of training exposure, while 12.00 per cent respondents involved in CFS and 34.00 per cent in IFS had high level of training exposure in Haryana. However in Uttar Pradesh 56.00 per cent respondents practicing CFS and 26.00 per cent IFS had low level of training exposure, whereas 38.00 per cent respondents of CFS and 58.00 per cent of IFS had medium exposure to various training aspects and only 6.00 per cent CFS and 16.00 per cent IFS farmers had high level of training exposure. In aggregate 55.00 per cent of the respondents had medium level of training exposure followed by low (32.50%) and high exposure to training aspects by 17.00 per cent respectively.

Data regarding the exposure to e- services presented in the Table 2 depict that more than half of the respondents (54.00% and 64.00%) involved in CFS and IFS had exposure to e- services was up to medium extent, while 42.00 per cent CFS and 28.00 per cent IFS farmers had low exposure to e- services in Haryana. Similarly in Uttar Pradesh more than half of the respondents (56.00% and 62.00% performing CFS and IFS) were having exposure to e- services up to medium level. In pooled sample majority of the respondents (59.00%) had medium level of exposure to e- services, while 36.00 per cent had low and 5.00 per cent had high level of exposure to e- services.

The results in Table 3 revealed that 64.00 per cent respondents of CFS and 32.00 per cent of IFS had medium scores on risk orientation. However 36.00 per cent respondents from CFS and 68.00 per cent respondents from IFS had high level of risk orientation. Whereas in Uttar Pradesh, 72.00 per cent respondents performing CFS and 38.00 per cent IFS had medium risk orientation scores followed by high (22.00% CFS) and (60.00% IFS) respectively. Similarly, in case of pooled sample slightly more than half of respondents (51.50 %) had medium risk orientation followed by high (46.50%) and only 2.00 per cent had low scores on risk orientation.

The opinion of respondents towards IFS was observed on 10 parameters in Haryana and Uttar Pradesh. Table 4 elucidates that in Haryana more than three fourths (78.00%) of the respondents had favorable opinion towards IFS followed by neutral

Table 2: Mass media exposure, training exposure and exposure to e- services of the respondents

Variable	Category	Haryana		Uttar Pradesh		Total
		CFS (n=50)	IFS (n=50)	CFS (n=50)	IFS (n=50)	(n=200)
Mass media exposure	Low	9(18.00)	3(6.00)	11(22.00)	4(8.00)	27(13.50)
	Medium	33(66.00)	36(72.00)	34(68.00)	37(74.00)	140(70.00)
	High	8(16.00)	11(22.00)	5(10.00)	9(18.00)	33(16.50)
Training exposure	Low	15(30.00)	9(18.00)	28(56.00)	13(26.00)	65(32.50)
	Medium	29(58.00)	33(66.00)	19(38.00)	29(58.00)	110(55.00)
	High	6(12.00)	17(34.00)	3(6.00)	8(16.00)	34(17.00)
Exposure to e- services	Low	21(42.00)	14(28.00)	21(42.00)	16(32.00)	72(36.00)
	Medium	27(54.00)	32(64.00)	28(56.00)	31(62.00)	118(59.00)
	High	2(4.00)	4(8.00)	1(2.00)	3(6.00)	10(5.00)

Figures in parenthesis indicate percentage

Table 3: Risk orientation of the respondents

Category	Haryana		Uttar Pradesh		Total
	CFS (n=50)	IFS (n=50)	CFS (n=50)	IFS (n=50)	(n=100)
Low (Up to 6)	-	-	3(6.00)	1(2.00)	4(2.00)
Medium (7-13)	32(64.00)	16(32.00)	36(72.00)	19(38.00)	103(51.50)
High (14-18)	18(36.00)	34(68.00)	11(22.00)	30(60.00)	93(46.50)

Figures in parenthesis indicate percentage

Table 4: Opinion of the respondents towards Integrated Farming System

Category	Haryana IFS (n=50)	Uttar Pradesh IFS (n=50)	Total (n=100)
Favorable (21-30)	39(78.00)	36(72.00)	75(75.00)
Neutral (11-20)	9(18.00)	11(22.00)	20(20.00)
Unfavorable (Up to 10)	2(4.00)	3(6.00)	5(5.00)

Figures in parenthesis indicate percentage

(18.00%) and unfavorable 4.00 per cent. However in Uttar Pradesh little less than three fourths (72.00%) of the respondents had favorable opinion towards IFS followed by neutral (22.00%) and 6.00 per cent had unfavorable opinion towards IFS. In aggregate most of the respondents (75.00%) form both the states had favorable opinion towards IFS followed by neutral (20.00%) and only 5.00 per cent had unfavorable opinion towards integrated farming system.

For computing the reasons for shifting towards IFS, it was measured on four attributes of new innovation, containing 20 statements. As it is evident from the data given in Table 5 that the in Haryana farmers shifted towards IFS as they perceived it relatively advantageous 89.33 followed by compatible (88.00%), triable (86.66%) and simple 85.33 per cent over conventional farming .Whereas in Uttar Pradesh most of the respondents shifted to IFS as they perceived it triable (88.66 %) followed by relative advantage (87.33%), compatible (85.33%) and simple 83.33 per cent respectively. Thus it may be concluded from table-6 that farm families of Haryana and Uttar Pradesh perceived the integration of farming as relatively advantageous (88.33%), triable (87.33%), compatible (86.66%) and simple 84.33 per cent , over conventional farming. The results speak of high percentage of perception towards various attributes of new innovation i.e. shifting towards integrated farming system.

Table 5: Reasons for shifting to Integrated Farming System

Attributes	Haryana (n=50) PFI (%)	Uttar Pradesh (n=50) PFI (%)	Total (n=100)
Relative advantage	89.33	87.33	88.33
Compatibility	88.00	85.33	86.66
Trialability	86.66	88.66	87.33
Complexity/Simplicity	85.33	83.33	84.33

PFI: Perceived feasibility index

DISCUSSION

For information seeking and utilization of e-services by the farm families it was interesting to note that, proportion of respondents in mass media exposure, training exposure and exposure to e- services was higher in integrated farming systems as compared to conventional farming systems irrespective of the state. This might be due to the fact that the IFS farmers updated themselves through various mass media tools such as DD Kisan, farm magazine, e-chaupal and Youtube as well as different aspects of training. They participated in extension activities, hence succeeded in getting technical knowledge on crop production. Similar findings were arrived by Bharti (2014); Preeti (2018); Jodha (2018) and Khusbu (2020) they also reported that communication variables play important role in seeking timely information on agricultural aspects.

Psychological variables play important role in adoption and continuation of profitable technologies. In the study, psychological variables included risk

orientation, opinion towards IFS and reason for shifting towards IFS. Risk orientation of the respondents was recorded on six parameters on both the farming systems and it was noted that medium scores were obtained in conventional farming systems, whereas it was found high in integrated farming systems irrespective of the states. This seems to be logistic as integrated farming systems act as risk mitigation measure and livestock component play a major role in stabilizing the farmer's income during drought and in other natural calamities. The present findings are in tune with Yadav *et al.* (2016); Mukhils *et al.* (2018); Panwar *et al.* (2018) and Khusbu (2020) who reported that integrated farming systems act as risk mitigation measure.

Opinion of the respondents towards integrated farming systems was observed on 10 parameters and it was found that most of the respondents practicing integrated farming systems in both the states had favorable opinion towards integrated farming systems. This might be due to the reason that in situation of failure of one farming component, farmers can compensate the loss through another component. These findings were in line with the earlier address of Ayyappan (2016) who stated that location specific, commodity or resource based integrated farming system have shown two to four fold increase in net income level of farmers. Opportunity for IFS will include food, fodder, fibre, fuel, and fertilizers to generate more income, recycle unused farm output, generate employment and maintain stability to environment. The findings are also supported by Radhammani *et al.* (2003) who concluded that IFS helps in minimizing risk, increasing production and profits while improving the utilization of organic wastes and crop residues. Singh *et al.* (2011) concluded that IFS model provide a lot of opportunities of employment and keeps farmers and their family members engaged whole the year and as such can help in solving unemployment problem of the country mainly in rural youths and the findings are also supported by Dadabhau (2014) and Khusbu (2020).

For computing the reasons for shifting towards IFS, it was measured on four attributes of new innovation and most of the farm families of Haryana and Uttar Pradesh observed IFS as relatively advantageous (88.33%), triable (87.33%), compatible (86.66%) and simple (84.33%) by the farm families. Adoption of IFS approach with inclusion of various other enterprises like dairy, poultry, goat rearing, horticulture etc. along with existing cropping, the farming can be dramatically changed to a low risk and high income enterprises. This seems to be true because through integration of crops farmers could get increased profitability with small and marginal land holding. The present findings are in tuned with the Yadav *et al.* (2017); Mukhils *et al.* (2018) and Panwar *et al.* (2018).

CONCLUSION

The information needs of farmers vary from farmer to farmer due to various factors. Different farmers have different search behaviors. Based on the finding of the study it could be concluded that respondents use variety of information sources to meet their agricultural problems. Among the different information sources mass media, DD Kishan, exposure to e- services, training exposure, and meeting with extension personnel were found to be most important. The study also demonstrates that the IFS farmers were keeping abreast with latest technology in terms of knowledge up gradation, understanding and application in comparison to CFS farmers. So it is essential to crystallize knowledge on different farming components to produce mass information for practical application in rural areas. On farm trials, frontline demonstration and exposure visits are important ways to create awareness, to train and to educate farm families on the efficient management of resources to maximize the output. Moreover, the respondents have need of further information about different aspects of crop production, marketing of agricultural products and so on. So, it is necessary to provide the farmers with useful agricultural information for their betterment and it is also need to motivate farmers seeking more information from different sources.

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Achieving Sustainable Community Broadcasting through an Understanding of Participation of Community Members in Functioning of Community Radio Stations in India

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ABSTRACT

Community participation is an essential aspect of community radio stations. Community radios need collective participation and support of community for smooth and long run functioning. There are various factors affecting the community participation in CRS functioning. The present study is an attempt to assess the relationship between social, economic, communication and psychological characteristics of community radio listeners and their participation in community radio functioning. The results of the study indicate that some of these characteristics such as age, information seeking behaviour, mass media utilization, social participation, listening behaviour, attitude towards community radio station, perception about community radio programmes and communication skills had significant positive relationship with the community participation in community radio functioning. Whereas other characteristics like educational qualification and mass media exposure had significant negative relationship with the community participation in community radio functioning. In multiple linear regression analysis the R^2 value of 0.539 indicated that all the selected 16 independent variables put together explained about 53.90 per cent variation in the extent of community participation in community radio functioning.

Keywords: Community participation, Community development, Developmental communication, ICT for development and community radio station

INTRODUCTION

Communication of developmental information is considered to be the most important and irreplaceable factor to facilitate collective change process in the society. Development is not only social, economic and political process but it is also a psychological process. The mindset of the masses needs to be changed to make them welcome the new changes in their life. As successfully established by Lerner (1958), that the quickest way to change the 'mind set' of the traditional society was through the use of mass media. Since decades, various communication media are being used to communicate with the intended audience, among them mass media play a very critical role in bringing the social change. Utilizing the mass media for developmental purpose became very essential as the reach of these media is very vast within a short period of time.

Radio and television are considered as the most effective mass media in creating awareness among the audience and expanding the horizons of their thought. These media have very important role to play in transitioning the traditional societies into a modern one. Radio as a mass medium, has been serving the rural population since decades and still considered to be very effective mass medium. The radio programmes accentuated the cognitive enhancement of the listeners and enrich the knowledge in various domains, thus reaping the desired output (Kitty, 2001). For the rural masses, radio is considered as a very unique and

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effective mass medium. It has the capacity to reach large audience including those residing in the remote, underdeveloped and impoverished areas of the nations. Radio remains the most pervasive medium with the greatest potential for the participatory communication strategies due to its low cost and accessibility to illiterate populations, particularly in rural areas (Bosch, 2003). Thus radio can be used as a very effective and efficient means of communication in the present era of improved techniques in communication process.

The audience now realize their specific need for situation based information thus emerging the concept of community media. "Community media are understood as an independent, civil society based media that operate for social benefit and not for profit. They provide communities with access to information and voice, facilitating community-level debate, information and knowledge sharing and input into public decision making (Buckley, 2011)." Among various community media, community radio is considered to be very important for serving various communities having different socio-economic, cultural, political and environmental issues both in rural as well as urban areas.

Through community radio the people derive a new meaning of the word democracy. It leads to peoples' democratic communication and empowerment in a real sense. Community radio makes local officials to be subtly mindful of their actions and decisions (Singh, 2011). To be specific community radio broadcasting can be defined as small-scale decentralized broadcasting initiatives which are easily accessed by local people, actively encourage their participation in programming, and which include some element of community ownership or membership (Myres, 2000). Thus inculcating the feeling of affinity among the community members, community radio stations prove to be the closest mass medium to the community.

The concept of development usually refers to the improvement in the economic and social life of population. In case of community development it implies the better living of the whole community with the active participation of the community in the development process. However the process of development starts at individual level. The study of personal attributes of an individual becomes very important to initiate any developmental process in his/her surroundings. These attributes also decide the level of participation of an individual in his/her own development process. The community development can not be fully attained without understanding the different characteristics of the community itself. In research field, various socio-eonomic, psychological and communication characteristics are very essential in understanding the targeted respondents. Studying the basic characteristics of the respondents of any study facilitates the information related to type of respondents, the population that they represent and the extent of generalization of the findings of the study. In the present study a sample of community radio listeners was taken to analyse their participation in community radio functioning. Participation of community is very essential in community radio functioning. The community participate in need assessment, programming, broadcasting and feedback management of the community radio stations. Community radio is considered as a communication intervention strategy of choice for deepening participation and community ownership. Participation of the targeted population in their own development has seen very important to make the development long lasting. The government authority can take initiatives for the developmental work but sustaining this development over a long period of time cannot be achieved without participation of the grassroot people in the decisions concerning them.

MATERIALS AND METHODS

North India constitutes of seven states namely Punjab, Jammu and Kashmir, Haryana, Rajasthan, Himanchal Pradesh, Uttar Pradesh, Uttarakhand and two union territories (UTs) namely Delhi and Chandigarh. Among the 66 operational community radio station in northern region of the country, 45 stations are governed by different educational institutes and 21 governed by different NGOs. Twenty five percent of the community radio stations were selected for the present study by employing stratified random sampling method, thus by making a sample of 16 community radio stations from north India. Eight community radio stations from each strata i.e. NGO operated community radio stations (NGO-CRSs) and educational institution operated community radio stations (EI-CRSs) were selected randomly.

A list of listeners was availed from each community radio station containing the information of the listeners and volunteers. Fifteen listeners/volunteers were selected randomly from each CRS, to sum up to 240 from all community radio stations. The data was collected with the help of predesigned interview schedule by contacting community radio listeners. Statistical analyses were done using coefficient of correlation, multiple linear regression analysis.

RESULTS AND DISCUSSION

In order to study the nature of relationship between the selected independent variables and the community participation in CRS functioning, correlation coefficients (r) were computed and the values are presented in Table 1. This relationship between the scores of selected independent variables and community participation in CRS functioning were tested by null hypothesis and empirical hypothesis. Null hypothesis was there will be no relationship between the scores of selected independent variables and the scores of the community participation in CRS functioning. Empirical hypothesis was there will be a significant relationship between the scores of selected independent variables and the scores of the community participation in CRS functioning.

Table 1: Correlation between social, economic, psychological and communication profile of the listeners and community participation (n=240)

Variables	Coefficient of correlation (r)
Age	0.141*
Gender	0.054
Marital status	0.051
Educational qualification	-0.133*
Occupation	0.049
Information seeking behaviour	0.184*
Mass media exposure	-0.129*
Mass media utilization	0.167*
Social participation	0.134*
Achievement motivation	0.095
Economic motivation	-0.119
Listening behaviour	0.165*
Attitude towards CR	0.271**
Perception about CRS programmes	0.311**
Communication skills	0.128*
Change proneness	0.071

**significance at 0.01 level of significance; *significance at 0.05 level of significance

t_{tab}= 2.57 (1% level of significance); t_{tab}= 1.96 (5% level of significance)

The coefficient of correlation was calculated to find out the relationship between selected social, economic, psychological and communication profile of the community radio listeners with their participation in community radio functioning**.** The significance of coefficient of correlation was tested using t-test.

Data regarding the relationship between selected social, economic, psychological and communication profile comprising age, gender, marital status, educational qualification, occupation, information seeking behaviour, mass media exposure, mass media utilization, social participation, achievement motivation, economic motivation, listening behaviour, attitude towards CRS, perception about CRS programmes, communication skills and change proneness and their participation in community radio functioning is presented in the Table 1.

The value of coefficient of correlation at five percent level of significance was 0.141 (r=0.141). This indicates a significant positive relationship between age of community radio listeners and their participation in CRS functioning. Hence, null hypothesis is rejected. The older community members reported that they had much free time and were more interested in participating in cultural programmes of the community radio. The middle aged community members expressed that they feel confident while recording the community radio programmes and wanted to improve their communication and presentation skills. The finding of the study supported by Bhuvaneshwari (2005) and Kaur (2017) as they also reported positive association between age and their participation in community radio functioning.

In the present study, the value of coefficient of correlation between gender and extent of community participation is 0.054 at five percent level of significance (r=-0.054). This indicates a non significant positive relationship between gender and community participation in CRS functioning. Hence, null hypothesis is accepted. Both male and female community members reported that they enjoyed their time spent

while doing different community radio activities with the community radio functionaries.

At five percent level of significance, the value of coefficient of correlation was 0.051 (r= 0.051). This indicates a non significant positive relationship between marital status and community participation in CRS functioning. Hence, null hypothesis is accepted. The respondents expressed that they participated in different community radio related activities whenever they wanted as the CRS was easily accessible to them and mostly the CRS functionaries came their houses or working places to record the field interviews with them, so there was no influence of family engagement on the community participation in CRS functioning.

The value of coefficient of correlation at five percent level of significance was -0.133 (r= -0.133). This indicates a significant negative relationship between educational qualification and community participation in CRS functioning. Hence, null hypothesis is accepted. As the respondents had increased educational qualification and acquire good technical skills, they were more attracted to other mass media tools and less interested in participating in CRS functioning. It was also reported that the educated youth migrated to other places to acquire higher education or to search for employment opportunities. The finding of the study supported by Ilamparithi (2011) who reported that as the level of education increased people were less likely to listen to CRS programmes.

The value of coefficient of correlation at five percent level of significance was 0.049 (r=0.049). This indicates a non significant positive relationship between occupation of community radio listeners and their participation in CRS functioning. Hence, null hypothesis is accepted. As expressed by the respondents that carrying out different activities of community radio stations was not a full time job for most of the respondents, if they wanted to participate in CRS functioning, they did it in their spare time.

The value of coefficient of correlation at five percent level of significance was 0.184 (r=0.184). This indicates a significant positive relationship between information seeking behaviour and community participation in CRS functioning. Hence, null hypothesis is rejected. The respondents reported that the information related to local affairs was mainly fulfilled by the CRS and to acquire this information they either participated as caller or proposed different themes for CRS programmes.

The value of coefficient of correlation at five percent level of significance was -0.129 (r = -0.129). This indicates a significant negative relationship between mass media exposure and the community participation in CRS functioning. Hence, null hypothesis is rejected. As the respondents were more exposed to other mass media tools, they were interested in them due more attractive digital platforms.

The value of coefficient of correlation at five percent level of significance was 0.167 (r=0.167). This indicates a significant positive relationship between mass media utilization and community participation in CRS functioning. Hence, null hypothesis is rejected.

The value of coefficient of correlation at five percent level of significance was 0.134 (r =0.134). This indicates a significant positive relationship between social participation of community radio listeners and their participation in CRS functioning. Hence, null hypothesis is rejected. The findings of the study supported by Fernandaz (2009). It was observed during the study that the respondents who had more formal social participation participated as an expert in community radio programmes whereas the respondents with more informal participated as caller and provided feedback regarding the community radio programmes.

The value of coefficient of correlation at five percent level of significance was 0.095 (r=0.095). This indicates a non significant positive relationship between achievement motivation and community participation in CRS functioning. Hence, null hypothesis is accepted.

The value of coefficient of correlation at five percent level of significance was -0.119 (r=-0.119). This indicates a non significant negative relationship between economic motivation and community participation in CRS functioning. Hence, null hypothesis is accepted. The finding of the study contradicts the findings of Bhuvaneshwari (2005) and Fernandaz (2009) who found significant positive association between economic motivation and participation.

The value of coefficient of correlation at five percent level of significance was 0.165 (r=0.165). This

indicates a significant positive relationship between listening behaviour of community radio listeners and their participation in CRS functioning Hence, null hypothesis is rejected. The respondents reported that the more they listen the community radio programmes, the more they feel attracted to community radio programmes and willing to participate in different community radio activities.

The value of coefficient of correlation at one percent level of significance was 0.271 (r=0.271). This indicates a significant positive relationship between community radio listeners' attitude towards CRS and their participation in CRS functioning. Hence, null hypothesis is rejected.

The value of coefficient of correlation at one percent level of significance was 0.311 (r=0.311). This indicates a significant positive relationship between community radio listeners' perception about CRS programmes and their participation in CRS functioning. Hence, null hypothesis is rejected. The respondents reported that programming was the most attractive feature of the community radio programmes.

At five percent level of significance, the value of coefficient of correlation was 0.128 (r=0.128). This indicates a significant positive relationship between communication skills of community radio listeners and their participation in CRS functioning. Hence, null hypothesis is rejected.

The value of coefficient of correlation at five percent level of significance was 0.071 (r=0.071). This indicates a non significant positive relationship between change proneness and community participation in CRS functioning. Hence, null hypothesis is accepted.

In the present study, an attempt was made to model the relationship between the independent variables (social, economic, psychological and communication characteristics of community radio listeners) of the study and dependent variable (community participation) by fitting a linear equation to observed data. Multiple regression analysis was done to predict the values of the dependent variable on the basis of independent variables.

First partial regression analysis was done to find out how independent variables (age, gender, marital status, educational qualification, occupational, information seeking behaviour, mass media exposure, mass media utilization, social participation, achievement motivation, economic motivation, listening behaviour, attitude towards CRS, perception about CRS programmes, communication skills, and change proneness) are related with the dependent variable (extent of community participation). Then regression equation was developed between independent variables and dependent variable along with the values of coefficient of determination.

It can be observed from Table 2 that partial regression coefficient of independent variables such as educational qualification n, mass media exposure and economic motivation were inversely affecting the community participation. This indicates that a unit increase in the value of these independent variable will lead to corresponding decrease in the dependent variable. Whereas the other independent variables namely age, gender, marital status, occupational, information seeking behaviour, mass media utilization, social participation, achievement motivation, listening behaviour, attitude towards CRS, perception about CRS programmes, communication skills, and change

Table 2: Multiple linear regression analysis of independent variable and community participation

Independent variables	Partial regression coefficient values (b)
(Constant)	2.36
X_1 Age	0.152
X_2 Gender	0.009
X_3 Marital status	0.028
X_4 Educational qualification	-0.132
X_5 Occupation	0.095
X_6 Information seeking behaviour	0.147
X_7 Mass media exposure	-0.168
X_8 Mass media utilization	0.172
X_9 Social participation	0.095
X_{10} Achievement motivation	0.099
X_{11} Economic motivation	-0.094
X_{12} Listening behaviour	0.193
X_{13} Attitude towards CR	0.325
X_{14} Perception about CRS programmes	0.469
X_{15} Communication skills	0.287
X_{16} Change proneness	0.016

$R^2 = 0.539$

proneness were found to be positively affecting the extent of community participation. This indicates that a unit increase in the value of these independent variable will lead to corresponding increase in the dependent variable.

The R^2 value of 0.539 indicated that all the selected 16 independent variables put together explained about 53.90 per cent variation in the extent of community participation in community radio functioning. Thus it could be concluded that the selected independent variables, to a large extent explained the variation in the extent of community participation in community radio functioning. In other words the variables included in the study were relevant to the problem selected.

CONCLUSION

The It was found in the study that age, information seeking behaviour, mass media utilization, social participation, listening behaviour, attitude towards community radio station, perception about community radio programmes and communication skills had significant positive relationship with the community participation in community radio functioning. This relationship indicates that if there is increase in any of the above mentioned independent variables, it will increase the community participation in CRS functioning. Whereas educational qualification and mass media exposure had significant negative relationship with the community participation in community radio functioning. If there is increase in educational qualification and mass media exposure, the community participation in CRS functioning will also increase. It was also found in the study that few selected independent variables such as gender, marital status, occupation, achievement motivation and change proneness had non-significant positive relationship with the community participation in community radio functioning while economic motivation had non-significant negative relationship with the community participation in community radio functioning. In the present study, this relationship analysis gives us an idea about the change in independent variable will have on community participation in community radio functioning but to understand the extent of this change, multiple linear regression analysis was also done. Partial regression coefficient of independent variables such as educational qualification, mass media exposure and economic motivation were inversely affecting the community participation. This indicates that a unit increase in the value of these independent variable will lead to corresponding decrease in the dependent variable. Other independent variables namely age, gender, marital status, occupational, information seeking behaviour, mass media utilization, social participation, achievement motivation, listening behaviour, attitude towards CRS, perception about CRS programmes, communication skills, and change proneness were found to be positively affecting the extent of community participation. This indicates that a unit increase in the value of these independent variable will lead to corresponding increase in the dependent variable. The R^2 value of 0.539 indicated that all the selected 16 independent variables put together explained about 53.90 per cent variation in extent of community participation. Thus it could be concluded that the selected independent variables to a large extent explained the variation in extent of community participation in community radio functioning. In other words the variables included in the study were relevant to the problem selected.

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Response of Field pea (*Pisum sativum*) under Cluster Front Line Demonstration in Samastipur District, Bihar

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ABSTRACT

The Indian population is expected to rise to 1.68 billion by 2030 and therefore, the requirement of pulses will be 32 million tonnes for the same as reported in vision document of Indian Institute of Pulses Research. For meeting the requirement, the production growth rate of pulses is expected at 4.2 per cent. The field pea has been most preferred pulse in Samastipur to be grown in *rabi* season. The present study was conducted to revive the field pea cultivation employing new cultivars by KVK, Samastipur and carried out during *rabi* season in different blocks of the district during the years 2019-20 and 2020-21. The Cluster Front Line Demonstration (CFLD) on field pea varieties, namely, Azad3-120/IPFD-10-12 and Pulse type/Prakash were taken up during each year for 07 and 10 ha clusters, respectively. These demonstrations recorded higher average grain yield (15.35 and 14.30 q/ha) of field pea as compared to average yield obtained from farmers practice (10.25 and 10.20 q/ha) computed to increase in yield by 49.75 and 41.0 per cent during 2019-20 and 2020-21, respectively. Similarly, the benefit: cost ratio was 1.95 and 2.22, respectively. The technology gap (q/ha), extension gap (q/ha) and technology index (%) were 6.65, 5.10 and 30.22 during 2019-20 and 7.70, 4.10 and 35.00 were 2020-21. The significant increase in yield is attributed due to introduction of new varieties in cluster mode. This mode facilitates better crop management resulting in better quality production.

Keywords: Field pea, CFLD, Yield, B:C ratio, Technology index

INTRODUCTION

Field Pea (*Pisum sativum L.*) is a most important cool season food legume crop in world after common bean, cow pea and field pea with cultivated area covering 7.2 million hectares (FAO,2020). It is important source of human food, animal fodder income and soil fertility. It is grown primarily in rotation with cereals to capture the benefits of symbiotic nitrogen fixation and reduced crop water use (Lake *et al.*, 2021). Particular reference to field pea in Bihar, the area of field pea has declined due to growing popularity and public policy emphasis on rice-wheat system reduction in winter days. The major field pea growing states are Uttar Pradesh, Madhya Pradesh, Jharkhand and Assam. The area, production and productivity in Bihar are 0.17 lakh ha, 0.18 lakh tonnes and 1034 kg/ha, respectively (Annual Report, 2021-22). Nutrient management play a pivotal role that greatly affect the growth and yield of field pea because this crop do not suit well to warm climate. With increasing temperature and associated weather fluctuations due to climate change and shift in major field pea cultivable area from cooler regions of Northern India to warmer region of Central and Southern India, imparting drought and heat stress resistance in field pea has become indispensable. The main objective of CFLD was to demonstrate production technology and its management practices on farmer's field under different farming situations. These demonstrations were carried out under the supervision of agricultural scientists and feedbacks from the different farmers have been generated on the demonstrated technology. Keeping the importance of CFLD the KVK, Samastipur conducted demonstrations on field pea at farmer's field under irrigated condition. The present study has been

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undertaken to evaluate the difference between demonstrated technologies and farmers practice in chick pea crop.

MATERIALS AND METHODS

The study was carried out during rabi season from 2019-20 to 2020-21 by operational area of Krishi Vigyan Kendra, Birauli, Samastipur. Area were selected for cluster formation different villages (each of 0.2 to 0.4 ha) of the district (Table 1). The soil was sandy loam/loam in texture. Soil samples were collected from different farmers field of selected clusters. The surface soil samples were drawn up to 15 cm depth. The soil sample were air dried, grounded, sieved through a 2 mm sieve and stored in polythene bags for further chemical analysis as described by Jackson, 1973. The soils of farmers field of all blocks were medium in organic carbon, available phosphorous and available potash. The available nitrogen were low in all blocks (Table 2). All the farmers were trained for improved package of practices through training programme. Materials for the present study with respect to CFLD and farmers practices are given in Table 3. Many farmers grow this crop by their own methods kept as local broadcasting standard check. The critical inputs were supplied to the farmers by the KVK, other inputs like balanced fertilizers, additional agro-chemicals, weedicides, irrigation facility were managed by farmers himself as per recommendation of scientists of KVK. The field pea varieties IPFD-10-12/Azad 3-120 and Prakash/Pulse type were sown during first to second week of November in each year under demonstration in furrow at 30x10 cm spacing at a seed rate of 70 kg/ha (2019-20) and 75 kg/ha (2020-21) at all the sites. Before sowing the seed was inoculated with *Rhizobium* @ 20 g/kg seed and the treated seeds were dried in shade for an hour. The mean rainfall of 714 mm was received during the crop growth periods. All recommended practices were followed to raise a good crop.

In case of local check plots, existing practices being followed by the farmers. Regular visits by the KVK scientists to demonstration field were made to guide the farmers. These visits also helped to collect feedback information from different farmers for further improvement in research and extension programme. Field days, awareness camps and group meetings were also organized at the demonstration plots to provide the opportunities for near by farmers to witness the benefits of these demonstrated technologies, the improved technology included quality seed, seed treatment and maintenance of optimum plant population etc. Recommended weed control measure and irrigation were applied according to requirement of the crops. The crop was harvested at perfect maturity with suitable method. Desired yield data were

Table 1: Details of farmers and cluster in different blocks of Samastipur district under CFLD programme

Year	No. of	Name of selected blocks of Samastipur Districts						
	farmers	Pusa	Patori	Samastipur	Mohadinagar	Kalyanpur	Vidyapatinagar	Singhiya
2019-20	36	20 (03)	-	01(01)	15 (04)	-	-	-
2020-21	25	-	03(01)	03(01)	03 (01)	12(04)	02(01)	02 (01)

Parenthesis indicate number of cluster in each block

Table 2: Soil test parameters from demonstrated fields in selected blocks (Pooled data of farmers)

Blocks	Name of Blocks of Samastipur Districts					
	pH (1:2)	EC (dSm^{-1})	Organic carbon (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Pusa	7.7-8.1	0.73	0.64	268	44	139
Samastipur	7.8-8.1	0.68	0.69	279	45	134
Mohaddinagar	8.0-8.3	0.76	0.56	263	46	156
Kalyanpur	7.8-8.3	0.77	0.61	274	38	167
Vidyapatinagar	7.7-8.2	0.79	0.63	279	40	161
Singhiya	8.0-8.3	0.74	0.59	262	50	157

Table 3: Comparison of cultural practices adopted by farmers and CFLD

Cultural operations	Prevailing Practices	CFLD employing improved cultivation practices
Seed	Use of local seed	IDFA-10-12, Azad 3-120 and Prakash, Pulse type
Seed quality	Small non-graded seed	Bold graded seed
Seed treatments	-	Treated with Bavistin followed by *Rhizobium*
Method of sowing	Broadcasting	Line sowing by seed drill
Fertilizer application	-	100 kg DAP + 33 kg MOP + 125 kg Phospho-gypsum per ha
Control measures	Single spray of pesticide when severe problem occurs	Two spray of insecticides to control of insects and application of micronutrients for more branches and healthy plants as well as grains

collected through field observations. Gross return was calculated by multiplying yield into prevalent local market price of the crop obtain by the farmers. For cost estimation the Cost A1 has been followed incorporating input cost, the sum of expenditure on land preparation, planting method, fertilizer, insecticide, fungicide, herbicide, irrigation cost, labour harvesting cost etc. were calculated form each demonstration (Reddy and Reddy, 2010). Further net return and benefit cost ratio were calculated from these data. To estimate the technology gap, extension gap and technology index formulae were used as follows: (Samui *et al.,* 2000).

Technology gap = Potential yield – Demonstration yield,

Extension gap = Demonstration yield – Farmers yield,

Technology index = Technology gap /Potential yield x 100.

RESULTS AND DISCUSSION

In Samastipur district soil texture is sandy, sandy loam to loamy sand which varies according to blocks. The study conducted clearly indicated that soil fertility plays a significant role to achieve higher yield of field pea crops (Table 2). Higher grain yield in demonstrated plots with improved cultivation that soil fertility enhanced the capability of soil to produce more which plays a pivotal role in yield. As we know that exhaustive cereal – cereal system has deleterious effect on soil quality from last few decades and agricultural sustainability has been confronting a big challenge in future. Therefore, change in cropping pattern can play a big role to enhance and revitalize soil health by fixing atmospheric nitrogen in soil which also benefits to the succeeding crops (Kaur *et al.,* 2019).

The results of 61 demonstrations conducted during *rabi* 2019-20 and 2020-21 at farmers' field in Samastipur district are presented in Table 4 as per the proforma provided by ICAR Agricultural Technology Application Research Institute (ATARI), Patna (Zone-IV). Results indicated that use of high yield varieties, balance use of fertilizers and micronutrients and control of insect and disease during 2019-20, maximum number of farmers were motivated to take up field pea next years under strict supervision of scientists from KVK, Samastipur. The data revealed that the CFLD reflects good impact over the farming communities.

A comparison of productivity levels between local check and demonstrated varieties are shown in Table 4. The grain yield of field pea obtained among demonstrations were 15.35 and 14.30 q/ha as compared to that from farmers field as 10.25 and 10.2 q/ha during 2019-20 and 2017-18, respectively. Demonstration plot resulted in 33.22 and 28.67 per cent, respectively higher grain yield from local check. Similar finding has also been observed by Rajashekar *et al*., (2022). The major differences observed between demonstration package and farmers' practices were introduction of seed treatment with biofertilizer, method and time of sowing, fertilizer doses and method of its application and plant protection measures. The branches were more and the number of flowers and pods per plant increases. The reason of low yield of field pea at farmers field was that optimum sowing time was not followed due to non-availability of quality seed. More than 90 per cent of farmers practiced broadcast method and as in most of the cases the plant population at farmers field was two – three times higher than that of recommended seed rate. Lack of popularization of seed cum fertilizer drill for sowing and use of inadequate and imbalanced dose of fertilizers, especially the nitrogenous and phosphatic fertilizers by farmers, wouldn't make it

possible to fetch potential yield. Mechanical weed control was costly and chemical control was quite uncommon in Samastipur. This finding is similar to Singh *et al.* (2022). It is evident from the results that the yield of demonstration was found better than the local check (farmer's practice) under the similar environmental conditions.

The technology gap evaluated were 6.65 and 7.70 q/ha during 2019-20, and 2020-21, respectively. The observed technology gap presented in Table 4 was due to various constraints such as soil fertility, availability of low moisture content, seed treatment method, sowing time, fertilizer application and climatic hazards etc. Hence, to reduce the yield gap location specific recommendations for varieties, soil testing and timely sowing appears to be necessary. The 5.10 q/ha extension gap found in 2019-20 whereas 4.10 q/ha was in 2020-21. There is a need to decrease this wider extension gap through latest techniques. The finding are similar to the finding of Rajashekar *et al.* (2022). The technology index showed the suitability of varieties at farmers' field. Lower technology values indicated that feasibility of variety among the farmers is more. The technology index was 30.22 and 35 per cent during 2019-20 and 2020-21, respectively. This finding was in corroboration with the findings of Singh *et al.* (2022) and Kumar *et al.* (2022).

The economics of field pea production under CFLD have been presented in Table 5. Economics analysis of the yield performance revealed that CFLD recorded higher gross return (Rs. 46050/ha during 2019-20 and Rs. 54340/ha in 2020-21) respectively with higher benefit-cost ratio 1.95 and 2.22 as compared to 1.37 and 1.68 of local check. The net return increased were Rs. 22380/ha and Rs. 29890/ha during 2019-20 and 2020-21, respectively. Singh and Singh (2020) and Kumar *et al.* (2022) also found the similar results in which demonstration plot gave higher net return from the farmers' practice.

It is concluded from the study that to realize the potential yield of a crop, farmers should adequately be acquainted with scientific knowledge through training and demonstration. This will make them aware of quality input for yield components. Thus, it is imperative to impart training to large number of farmers to improve the benefits of technologies

Table 4: Yield, technology gap, extension gap and technology index of Field pea in Samastipur

Year	Name of variety	No of demonstration	Yield (q/ha)						Yield increase (%)	% increase over check	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
			Potential	Demonstration plots			Check plots						
				Max.	Min.	Av.	Max.	Min.	Av.					
2019-20	IPFD-10-12/Azad3-120	36	22	15.95	14.75	15.35	10.60	09.90	10.25	33.22	49.75	6.65	5.10	30.22
2020-21	Prakash/Pulse type	25	22	15.10	13.50	14.30	10.40	10.00	10.20	28.67	41.00	7.70	4.10	35.00

Table 5: Gross return, cost of cultivation, net return and B:C ratio of Field pea in Samastipur

Year	Expenditure and return								Net return increase (%)
	Check plots				Demonstration plots				
	Gross cost (Rs/ha)	Gross Return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Gross cost (Rs/ha)	Gross Return (Rs/ha)	Net return (Rs/ha)	B:C ratio	
2019-20	22460	30570	8290	1.37	23670	46050	22380	1.95	169.96
2020-21	23100	38760	15660	1.68	24450	54340	29890	2.22	90.86

Seed rate of field pea during: 2019-20: Rs 2800/q; 2020-21: Rs. 3800/q

recommended by Government institutions through FLDs. This will substantially increase the income as well as livelihood of the farming communities.

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Farmwomen-led Millet Based Recipes Development and their Sensory Evaluation: An Action Research from Uttar Pradesh

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ABSTRACT

The present investigation was carried out to comprehend the sensory evaluation of millet based products developed by the farm women and judged by local public representative across three block of district Pratapgarh (UP). The district Pratapgarh comprises 17 blocks, in which three blocks were selected purposively for organising recipe contest keeping the criterion of millets area in different blocks and categorized under i. Area < 500 ha in which kalakankar block, ii. Another block having area ranging between 500-1000 ha named Kunda and iii. Third block having area >1000 ha named Sandwa Shandrika was chosen for the study. From each of the above blocks, one village was selected named as Nayapurwa, Keshavpur and Pachkhara respectively from three blocks for organizing this contest. A group of farm women comprising 30 women who were mobilized in each village and three round of the contest were held at different point of time in all three villages. Thus 90 farm women participated in this contest. The prepared recipes were evaluated based on organoleptic test scoring (9-point hedonic scale) on different parameters (colour, texture, appearance, taste and aroma) made out of mostly from *bajra, ragi & makka* products. Delicious bajra based recipes *bajra laddo, bajra tikki, bajra biscuit, bajra khichdi and bajra ghughri; ragi based recipes ragi kachaudi (Menthi), ragi kachaudi (urad), ragi kachaudi (Aloo) ragi milk shake, and Makka based recipes makka ka halwa, makka pakaudi,* were prepared and presented. The local public representatives like village pradhan, school teachers, and other well reputed women of the locality judged the recipes. The results showed that Bajra chat was given maximum (8.4 marks) preferences among all bajra based products in all sensory parameters. While, the bajra ghughri was least (7.2 marks) popular. In ragi baed products ragi kachauri (Urad) was preferred to the maximum extent (8.8 marks) for all parameters. Makka pakaudi and makka gulgula was recorded maximum popularity (8.5 marks each) on makka base products across Kalakankar, Kunda and Sandwa Chandrika block of district Pratapgarh (U.P.).

Keywords: Appearance, Bajra chat, Ragi, Makka gulgula, Sensory evaluation and Taste

INTRODUCTION

Millets are sustainable and environment-friendly due to their low water requirements as compared to other traditional crops. Millets are superior over cereals as they are rich in calcium, dietary fiber, polyphenols and protein (Devi *et al.*, 2011). Millet packed with fibre, vitamins, minerals and oxidants contributes to a wholesome, healthy lifestyle. Millets are very nutritious and are reported to have various therapeutic functions (Obilana and Manyasa, 2002; Yang *et al.*, 2012). Harvesting millets has various benefits. It brings numerous economic opportunities, ensures food security, and enhances crop diversity, while empowering lower communities. Due to the contribution of millets to national food security and their potential health benefits, millet grain is now receiving increasing interest from food scientists, technologists and nutritionists

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(Bhat *et al.,* 2018). Short duration crops millets were among the first crops to be domesticated in India, they also find mention in several ancient texts dating back to Indus valley civilization. Millets are drought-resilient, heat tolerant and climate friendly crops that can be grown in almost all soil types, the top five millet growing states in India (in terms of area under cultivation) are Rajasthan, Maharashtra, Karnataka, Uttar Pradesh and Madhya Pradesh.

Millets are cultivated for thousands of years and are adaptable to various climatic conditions, making them a valuable food source in regions with challenging environments. Many studies have shown that the burden of micronutrient malnutrition is found to be very great among children with the adverse effect on their growth and development, mental and neuromotor performance, immune competence, physical working capacity, cognition, behaviour and overall reproductive performance of affected individuals (McCann and Ames, 2007; Stoltzfus, 2003; Stoltzfus *et al.*, 2001; Grantham-McGregor and Ani, 2001; Haas and Brownlie, 2001; Scrimshaw, 2000; Cook and Lynch, 1986). Hence there is an apparent need to provide millet based food products in the form of ready to use grains, convenience foods or mixes to meet the nutrient. Value addition of traditional food preparations using small millets is believed to not only improve health status but will offer variety, convenience and quality food to consumers and also help in revival of millet cultivation. Sensory evaluation is very important for assessing acceptability of developed, improved or modified foods.

It is a scientific discipline that is used to analyze and interpretation of consumer as related to the characteristics of products perceived through senses of sight, smell, touch, taste and hearing (Svensson, 2012). Sensory attributes of products include colour, aroma, taste, texture (mouth feel), and overall acceptability (Svensson, 2012). Sensory evaluation is also important in assessing acceptability of complementary foods as perceived by mothers or care takers (Phang and Chan, 2009). Tests conducted in sensory evaluation are used to quantify the consumer preference or degree of liking/disliking of a product (Lawless and Heymann, 2010). This study evaluated the sensory attributes of all indigenous products of millets purported to create awareness among rural women and including them in their diet.

MATERIALS AND METHODS

Pratapgarh district was selected for recipe contest based on the considerable millets area (18,171 ha) the district has. District comprises of 17 blocks, in which three blocks were purposively selected for organising recipe contest based on millets area and which was categorized using the criteria of area <500 ha block (Kalakankar), area between 500-1000 ha (Kunda) and block having area >1000 ha (Sandwa Chandrika). From three blocks, three villages were further selected named Nayapurwa, Keshavpur and Pachkhara in this programme. Rural women (n=90) of three villages between the age group of 18 to 57 years were identifies as the subjects.

Participants assembled in the primary school of villages with their variety of millet products for showing their talent and for demonstration. A four-member panel comprising of KVK scientist and village chairman and ICDS worker of the respective villages rated the recipes based on organoleptic test scoring (9 point hedonic scale) on different parameters, (colour, texture, appearance, taste, aroma) made out of mostly from bajra, ragi, makka, jowar. Delicious recipes *bajra laddo, bajra tikki, bajra biscuit, bajra khichdi, bajra ghughri, ragi kachaudi (urad), ragi shake, makka ka halwa, makka pakaudi,* etc were prepared and presented. The one who cooked the most nutritious variety from the local ingredients are encouraged with prize and certificates. From this competition top 15 recipes were come in front from selected three villages.

Sample were evaluated on the basis of colour, texture, appearance, taste, aroma and over all acceptability by semi trained panel of 4 judges using 9 point hedonic scale assigning score 9- like extremely, to 1-dislike extremely (appendixes) a score of 5.5 and above was considered acceptable (Amerine *et al.,* 1965).

RESULTS AND DISCUSSION

Three major millet based products came up which received the maximum preferences of the women farmer. All three products were documented with respect to their preparation protocol and a flow diagram was generated for the standardized process to cook them. The details are illustrated as below:

Appendices

Appendix A

Score card for Sensory Evaluation

Name: **Date:**

Product Name: **Time:**

Instructions:

- Please evaluate each of the following samples using scoring system given below.
- Write the preferred number score in the column as per evaluation
- Rinse your mouth in between evaluating each sample.

Code	Appearance	Colour	Texture	Aroma/ Flavour	Taste	Overall Acceptability

Scoring system:

9-Like extremely 8-Like very much 7-Like moderately 6-Like slightly 5-Neithe like nor dislike
4-Dislike slightly 3-Dislike moderately 2-Dislike very much 1-Dislike extremely

Remarks/Comments:

Signature

SECTION-B: HEDONIC SCOING

Instruction: You are provided with foxtail millet beverage sample. Please evaluate the samples using 5 point hedonic scale. Write the preferred score in the column as per evaluation.

Hedonic rating system for the level of acceptance for the beverage:

Hedonic rating for level of acceptance	Corresponding descriptor
5	Like very much
4	Like moderately
3	Neither Like nor Dislike
2	Dislike Moderately
1	Dislike Very much

Hedonic Rating						
Sample Code	Color	Appearance	Flavor	Taste	Consistency	Overall acceptability
FCM3						

Preparation of Bajra Khichdi

Clean Bajra
↓
Soak for 4-5 hours
↓
Drain water
↓
Grind in mixer to soft
↓
Heat ghee in a pan
↓
Add cumin, ginger, green chilli and stir
↓
Add bajra, rice and moong dal in tadka
↓
Add water, salt, turmeric powder and mix properly
↓
Cover it with lid
↓
Cook it till it becomes very soft.
↓
Bajra Khichdi ready to serve

Preparation of Ragi Kachori (Aloo)

Ragi atta
↓
Add mashed potato, salt, ajwain, green chilli, ghee
↓
Mix very well.
↓
Knead with potato
↓
Take oil in a kadhai and heat on medium heat
↓
Make small puris
↓
Deep fry till golden color.
↓
Ragi Kachori (Aloo) ready for serve

Preparation of Makka Gulgula

Makka ka atta
↓
Add hot water, sugar in it.
↓
Let the sugar dissolve
↓
Let it cool down.
↓
Combine, sugar and water in order to make smooth paste.
↓
Add fennel seeds and mix the mixture
↓
Rest this mixture 2 hours.
↓
Now heat oil in the kadhai
↓
Drop mixture one by one with the help of a spoon in the kadhai.
↓
Deep fry the gulgulla.
↓
Keep in mind to fry it till golden brown from both the sides.
↓
Ready to serve makka gulgula

The data presented in tables revealed that differential preferences of *Bajra, Ragi* and *Makka* based products developed and judged by the women farmers from across three blocks having area <500 ha in Kalakankar, area having 500-1000 ha in block Kunda and area having > 1000 ha in block Sandwa chandrika district Pratapgarh (UP).

A four-member rural public representative panel comprising of KVK scientist and village chairman and ICDS worker of the respective villages rated the recipes based on organoleptic test scoring (9 point hedonic scale) on different parameters, (colour, texture, appearance, taste and aroma) of bajra based recipes,

Table 1: Preferences parameters for bajra based products developed and judged by the women farmers from across three sampled blocks (N=90)

S.No.	Block having area <500 ha (Kalakankar)						Block having area (500-1000 ha) (Kunda)						Block with area >1000 ha (Sandwa chandrika)	
	Bajra Chat	Bajra Laddu	Bajra Tikki	Bajra Ghughari	Average score	Rank	Bajra khichdi	Bajra ghughri	Bajra biscuit	Average score	Rank		Bajra khichdi	Rank
Appearance	8	9	7	6	7.5	2	8	7.5	7.5	7.66	4		7	3
Colour	8	8	8	8	8	1	8	7.5	7.5	7.66	4		7.5	2
Texture	8	7	9	7	7.75	3	8.5	8	8	8.166	3		8	1
Aroma	9	8	7	8	8	1	8.5	8.5	7	8.66	2		8	1
Taste	9	8	7	7	7.75	3	8.5	8	7.5	8.83	1		8	1
sum	42	40	38	36	39	10	41.5	39.5	37.5	39.5			38.5	8
Mean	8.4	8	7.6	7.2	7.8	2.0	8.3	7.9	7.5	7.9			7.7	1.6
SD.S	0.548	0.707	0.894	0.837	0.7465		0.274	0.418	0.354	0.348667			0.447	
CV	6.521	8.839	11.769	11.620	9.68725		3.300	5.295	4.714	4.436333			5.808	

viz. *bajra laddo, bajra tikki, bajra biscuit, bajra khichdi & bajra ghughri etc.*

It is vivid from the data of bajra based product in block kalakankar, maximum average marks (8.4) was recorded under bajra chat, followed by bajra laddu (8.0) and bajra tikki (7.6). However, minimum average marks were noticed under bajra ghughari (7.2) among all products. The appearance of bajra laddu showed the maximum marks (9.0) followed by bajra chat (8.0) and bajra tikki (7.0), while the bajra ghughari appearance was recorded lowest (6.0) popularity. The colour of all bajra products was maintained similar marks (8.0), there was colour and aroma rank first among all judging parameter of bajra products. The texture of bajra tikki was recorded highest popularity (9.0 marks) followed by bajra chat (8.0 marks) and bajra laddu & bajra ghughari showed similar lowest marks (7.0). Bajra ghughari was maintain the highest taste value (9.0 marks), followed by bajra laddu (8.0 marks) whereas, the lowest taste in bajra tikki and bajra ghughari (7.0 marks) evaluated by the judging team. About the all over parameters bajra chat was found superior among all bajra products in the block.

In block kunda bajra khichdi was recorded average maximum popularity (8.3), followed by bajra ghughari (7.9) and bajra biscuit (7.5). The appearance, colour, texture, aroma and taste of bajra khichdi showed maximum popularity (8.0, 8.0.8.5 8.5 & 8.5) followed by bajra ghughari (7.5, 7.5, 8.0, 8.5 & 8.0) and bajra biscuit (7.5, 7.5, 8.0, 7.0 & 7.5). The taste of bajra products was rank first in all parameters declared by judging team. However, bajra khichdi was found superior from rest of the other products.

Only bajra khichdi prefer by the women farmers of block sandwa chandrika, in which parameters texture, aroma and taste was recorded maximum average marks (8.0 marks each) followed by colour (7.5 marks) and appearance (7.0 marks).

Bajra chat was maximum (8.4 marks) preferences for developed all bajra based products by the women farmers from across kalakankar, kunda and sandwa chandrika block district Pratapgarh (UP).

The recipes were judged on organoleptic test scoring (9 point hedonic scale) on different parameters, (colour, texture, appearance, taste & aroma) of ragi

Table 2: Preferences parameters for Ragi based products developed and judged by the women farmers from across three sampled blocks (N=90)

	Block having area <500 ha (kalakankar)		Block having area (500-1000 ha) (kunda)		Block with area >1000 ha (sandwachandrika)			
S.No.	**Ragi Kachauri (Menthi)**	**Rank**	**Ragi Kachauri (Urd)**	**Rank**	**Ragi Milk Shake**	**Ragi Kachauri (Aloo)**	**Average**	**Rank**
Appearance	9.0	1	9.0	1	8.0	8	8.0	3
Colour	8.0	2	8.5	2	8.5	8.5	8. 5	2
Texture	8.0	2	9.0	1	8.5	8.5	8.5	2
Aroma	8.0	2	8.5	2	8.5	8.5	8.5	2
Taste	9.0	1	9.0	1	9.0	9.0	9.0	1
sum	42		44		42.5	42.5	42.50	
Mean	8.4		8.8		8.5	8.5	8.5	
SD.S	0.548		0.274		0.354	0.354	0.354	
CV	6.521		3.112		4.159	4.159	4.159	

based products, *viz.* ragi kachauri (menthi), ragi kachaudi (urad), ragi kachaudi (aloo), ragi milk shake.

The data presented in table revealed that various performances of ragi based products developed and judged by the women farmers from across three blocks having area <500 ha in kalakankar, area having 500-1000 ha in block kunda and area having > 1000 ha in block sandwa chandrika.

The perusal of data clearly indicated that for ragi based product only ragi kachauri (Menthi) was preferred in block kalakankar, in which some parameters appearances and taste was recorded maximum average marks (9.0 marks each) and maintain first rank, followed by colour, texture and aroma (8.0 marks each).

Only ragi kachauri (Urd) prefer by the women farmers of block kunda, in which parameters appearance, texture and taste was recorded maximum average marks (9.0 marks each) and whereas colour and aroma recoded second rank (8.5 marks each).

In block sandwa chandrika ragi milk shake and ragi kachauri (Aloo) both was recorded average equal popularity (8.5 marks each). The parameter for evaluation, in which, taste of ragi milk shake and ragi kachauri (Aloo) showed maximum popularity (9.0 marks each) and recorded first rank, followed by colour, texture and aroma (8.5 marks each). Whereas, the lowest popularity was recorded in appearance (8.0 mark).

The taste of ragi kachauri (Menthi), ragi kachauri (Urd), milk shake and ragi kachauri (Aloo) preferred maximum marks (9.0) among all parameters of ragi based products and developed by the women farmers from across kalakankar, kunda and sandwa chandrika block of district Pratapgarh (U.P.).

Makka based products, *viz.* Makka gulgula, makka pakaudi and makka ka halwa recipes evaluated based on organoleptic test scoring (9 point hedonic scale) on different parameters (colour, texture, appearance, taste and aroma).

The data presented in table revealed that various performances of Makka based products developed and judged by the women farmers from across three blocks having area <500 ha in Kalakankar, area having 500-1000 ha in block kunda and area having > 1000 ha in block Sandwa chandrika. In which block kalakankar have no any makka based products by the women farmers.

The colour parameter of makka guglgula was recorded highest popularity (9.0 marks) and rank first of all makka based products in block kunda. Appearances texture and taste parameter recorded second rank receiving 8.5 marks each. Whereas, the aroma of makka gulgula was show lowest value (8.0 marks) among all parameters.

The average data showed significantly on appearance and texture of makka pakaudi (8.5 marks) followed by makka ka halwa (8.1 marks) of makka

Table 3: Preferences parameters for maize based products developed and judged by the women farmers from across three sampled blocks (N=90)

S.No.	Block having area (500-1000 ha) Kunda		Block with area >1000 ha (Sandwa chandrika)			
	Makka Gulgula	Rank	Makka Pakaudi	Makka Ka Halwa	Average	Rank
Appearance	8.5	2	8.5	8.5	8.5	1
Colour	9	1	9	8	8.5	1
Texture	8.5	2	8	8.5	8.25	2
Aroma	8	3	8.5	7.5	8	3
Taste	8.5	2	8.5	8	8.25	2
sum	42.5	10	42.5	40.5	41.5	9
Mean	8.5	2.0	8.5	8.1	8.3	1.8
SD.S	0.354		0.354	0.418	0.386	
CV	4.159		4.159	5.165	4.662	

based products in block Sandwa chandrika. The appearance and colour parameter of makka pakaudi and makka ka halwa had recorded first rank among other all parameters, similarly, on the bases of pooled mean data of texture and taste parameter was second rank. While, the aroma of makka pakaudi and makka ka halwa was observed lowest popularity.

The average data showed significantly influenced by colour of makka pakaudi and makka ka halwa products both recorded maximum popularity among those products of block kalakankar, kunda and sandwa chandrika district Pratapgarh (U.P.).

CONCLUSION

On the basis of above results, it is concluded that the Bajra chat was maximum (8.4 marks) preferences, whereas, the bajra ghughri was lowest (7.2 marks) popular among all bajra based products in all parameters. Followed by ragi based products ragi kachauri (urad) was preferred maximum (8.8 marks) among all parameters. Makka pakaudi and makka gulgula was recorded maximum popularity (8.5 marks each) on makka base products across kalakankar, kunda and sandwa chandrika block of district Pratapgarh (U.P.). It could be also inferred that such participatory contest shall prove as an effective tool for creating awareness among rural farm women towards usage of millet based value added products and also such platform shall act as the learning forum for them through sharing of experiences and local wisdom.

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Assessing Constraints Perceived by the Beekeepers of North-Western Himalayas Using Garrett's Ranking Technique

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ABSTRACT

The present study was conducted in district Baramulla of Jammu and Kashmir, India. Exploratory research design was used with an objective to identify the constraints perceived by the beekeepers. Garrett's ranking technique was used as statistical technique to rank these constraints. High cost of tools and equipments, migration of bee colonies, shortage of forage, lack of honey processing units and lack of support of existing beekeepers to the upcoming beekeeper were found to be major constraints perceived by the beekeepers. It was concluded that through need based trainings, the technical and managerial capacities of the beekeepers will strengthen and lead to economic and sustainable development of beekeeping.

Keywords Beekeepers, Beekeeping, Constraints, Garrett's ranking technique

INTRODUCTION

Honey bee (*Apis spp.*) is a beneficial social insect known not only for honey but other important products like, bee wax, propolis, royal jelly, bee venom, etc. It is essential for ensuring food and nutritional security, economic security, health, environmental protection and plant pollination (Van der Sluijs and Vaage, 2016). Pollination holds utmost importance for crop productivity (Patel *et al.,* 2021). In a very balanced way, it contributes to rural development, hence leading to sustainable livelihood (Ahmad *et al.,* 2007). Honey bees act as bioindicators of disturbances in environment and ecosystem (Famuyide *et al.,* 2014). India is the eighth largest producer of honey in the world and has exported 74.413.05 MT of natural honey to the world worth 1221.17 crore during 2021-2022 (Agricultural and Processed Food Products Export Development Authority, 2022). In Jammu and Kashmir, beekeeping has established itself as an economic venture since long. Jammu and Kashmir ranks eleventh in the country in terms of total honey production (National Horticulture Board, 2021). Even as Kashmir has a huge potential for honey production, the valley produces only 4000 quintals of honey every year. There are only 2367 beekeepers registered with Kashmir's Apiculture department. Kashmir has only 64391 bee colonies which is less than half of the potential of the valley that has a diversity of flora. Kashmir has a potential to sustain one lakh bee colonies. On an average, a bee colony produces 15 kilograms of honey and thus, we have a potential to produce 150000 quintals of honey every year (Directorate of Agriculture, Kashmir, 2020). So, this sector needs to be viewed from multiple dimensions as beekeepers keep facing various constraints (Kumar *et al.,* 2020).

MATERIALS AND METHODS

The proposed study was undertaken in district Baramulla of Jammu and Kashmir, India during 2021 in which exploratory research design was used. List of registered beekeepers was obtained from Directorate of Agriculture, Kashmir. A total of 102 registered

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beekeepers who reared Italian bee (*Apis mellifera* L.) were considered for the study. Primary data regarding different constraints perceived by the beekeepers were collected through personal interview method using a well - structured interview schedule. The constraints were divided into five categories, *viz.,* economic, technical, infrastructural and administrative, post-harvest and socio-cultural constraints. The constraints were ranked based on Garrett's ranking technique. In this technique, first of all, beekeepers were asked to rank the constraints as 1, 2, 3 and 4 with rank 1 given to the most serious constraint and rank 4 given to the least serious constraint as given in Table 1. In Table 2, per cent position was calculated using the following formula:

$$\text{Percent position} = \frac{100\ (Rij - 0.5)}{Nj}$$ where, R_{ij} = rank given for the i^{th} constraint by the j^{th} beekeeper

N_j = Number of constraint ranked by j^{th} beekeeper

Per cent position was converted into Garrett value using conversion table given by Garrett and Woodworth (1969). In Table 3, for each constraint, the scores of individual beekeepers were added together and then divided by total number of beekeepers to obtain mean score. Ranks were assigned based on descending order of mean score i.e., rank I to the highest mean score and rank IV to the lowest mean score. All the calculations were done using Windows Statistical Package of Social Sciences (SPSS) version 16.0.

RESULTS AND DISCUSSION

Data presented in Table 1 revealed the constraints perceived by the beekeepers. It revealed the preference of constraints from 1, 2, 3 and 4. In economic constraints, out of 102 beekeepers, 57, 32 and 13 beekeepers ranked "Insufficient subsidy" as 1st, 2nd and 3rd respectively. 42, 35, 18 and 7 beekeepers ranked "Inaccessibility to financial resources for the purchase of new colonies" as 1st, 2nd, 3rd and 4th respectively. For "High cost of tools and equipments", 27, 16, 22 and 37 beekeepers ranked it as 1st, 2nd, 3rd and 4th respectively. For "Low price of honey", 38, 26, 20 and 18 beekeepers ranked it as 1st, 2nd, 3rd & 4th respectively.

Among technical constraints, out of 102 beekeepers, 37, 28, 34 and 3 beekeepers ranked "Inadequate knowledge about new technologies" as 1st, 2nd, 3rd and 4th respectively. 73 and 29 beekeepers ranked "Diseases, pests and enemies of honeybees" as 1st and 2nd respectively. In "Migration of bee colonies", 79, 16 and 7 beekeepers ranked it as 1st, 2nd and 3rd respectively. 61, 35 and 6 beekeepers ranked "Off-season management of food for bee colonies" as 1st, 2nd and 4th respectively.

Among infrastructural and administrative constraints, out of 102 beekeepers, 9, 28 and 64 beekeepers ranked "Shortage in availability of bee colonies" as 1st, 3rd and 4th respectively. "Shortage of forage" was ranked as 1st, 2nd, 3rd and 4th by 47, 31 and 24 beekeepers respectively. "Insufficient space" was ranked as 1st, 2nd, 3rd and 4th by 20, 9, 19 and 54 beekeepers respectively.

Among post-harvest constraints, out of 102 beekeepers, 63, 38 and 1 beekeeper ranked "Lack of honey processing units" as 1st, 2nd and 4th respectively. "Scarcity of skilled labour" was ranked as 1st, 2nd and 3rd by 57, 39 and 6 beekeepers respectively. "Non-availability of storage and packaging material" was ranked as 1st, 2nd, 3rd and 4th by 19, 6, 35 and 48 beekeepers respectively.

Among socio-cultural constraints, out of 102 beekeepers, 26, 3, 29 and 44 beekeepers ranked "Non availability of family labour after establishment" as 1st, 2nd, 3rd and 4th respectively. 31, 25 and 46 beekeepers ranked "Pressure from family to quit beekeeping" as 1st, 2nd and 3rd respectively. In "Lack of support of existing beekeepers to the upcoming beekeeper", 40, 6, 18 and 38 beekeepers ranked it as 1st, 2nd and 3rd respectively. 15, 2, 8 and 77 beekeepers ranked "Disputes arising due to bee sting" as 1st, 2nd and 4th respectively.

Table 3 presented calculated Garrett values and overall ranking of constraints based on their preference. Among economic constraints, "High cost of tools and equipments" was ranked I with mean score of 71.54, "Insufficient subsidy" was ranked II with mean value of 63.97, "Inaccessibility to financial resources for the purchase of new colonies" was ranked III with mean score of 58.89 and "Low price of honey" was ranked IV with mean score of 54.86.

Under technical constraints, "Migration of bee colonies" was ranked I with mean score of 68.34,

Table 1: Ranking of constraints by beekeepers (N = 102)

Economic constraints	1st	2nd	3rd	4th
Insufficient subsidy	57	32	13	0
Inaccessibility to financial resources for the purchase of new colonies	42	35	18	7
High cost of tools and equipments	27	16	22	37
Low price of honey	38	26	20	18
Technical constraints				
Inadequate knowledge about new technologies	37	28	34	3
Diseases, pests and enemies of honeybees	73	29	0	0
Migration of bee colonies	79	16	7	0
Off-season management of food for bee colonies	61	35	0	6
Infrastructural and administrative constraints				
Shortage in availability of bee colonies	9	0	28	64
Shortage of forage	47	31	24	0
Insufficient space	20	9	19	54
Inadequate effective government policies on beekeeping	43	28	20	11
Post-harvest constraints				
Lack of honey processing units	63	38	0	1
Scarcity of skilled labour	57	39	6	0
Non-availability of storage and packaging material	19	6	35	48
Problem of transport facility	42	21	3	36
Socio-cultural constraints				
Non availability of family labour after establishment	26	3	29	44
Pressure from family to quit beekeeping	31	25	0	46
Lack of support of existing beekeepers to the upcoming beekeeper	40	6	18	38
Disputes arising due to bee sting	15	2	8	77

Table 2: Per cent positions and their corresponding Garrett Table values

Rank	Per cent position		Garrett Score
1	100 (1-0.5)/4	12.5	73
2	100 (2-0.5)/4	37.5	56
3	100 (3-0.5)/4	62.5	44
4	100 (4-0.5)/4	87.5	27

"Diseases, pests and enemies of honeybees" was ranked II with mean value of 68.16, "Off-season management of food for bee colonies" was ranked III with mean score of 64.46 and "Inadequate knowledge about new technologies" was ranked IV with mean score of 57.31.

Among infrastructural and administrative constraints, "Shortage of forage" was ranked I with mean score of 61, "Inadequate effective government policies on beekeeping" was ranked II with mean value of 57.68, "Insufficient space" was ranked III with mean score of 41.74 and "Shortage in availability of bee colonies" was ranked IV with mean score of 35.46

Under post-harvest constraints, "Lack of honey processing units" was ranked I with mean score of 66.21, "Scarcity of skilled labour" was ranked II with mean value of 64.79, "Problem of transport facility" was ranked III with mean score of 52.41 and "Non-availability of storage and packaging material" was ranked IV with mean score of 44.69.

"Lack of support of existing beekeepers to the upcoming beekeeper" was ranked I with mean score of 49.74, "Pressure from family to quit beekeeping"

Table 3: Calculated Garrett values and ranks of constraints

Economic constraints	1st	2nd	3rd	4th	Garret score	Mean score	Rank
Insufficient subsidy	4161	1792	572	0	6525	63.97	II
Inaccessibility to financial resources for the purchase of new colonies	3066	1960	792	189	6007	58.89	III
High cost of tools and equipments	1971	3360	968	999	7298	71.54	I
Low price of honey	2774	1456	880	486	5596	54.86	IV
Technical constraints							
Inadequate knowledge about new technologies	2701	1568	1496	81	5846	57.31	IV
Diseases, pests and enemies of honeybees	5329	1624	0	0	6953	68.16	II
Migration of bee colonies	5767	896	308	0	6971	68.34	I
Off-season management of food for bee colonies	4453	1960	0	162	6575	64.46	III
Infrastructural and administrative constraints							
Shortage in availability of bee colonies	657	0	1232	1728	3617	35.46	IV
Shortage of forage	3431	1736	1056	0	6223	61.00	I
Insufficient space	1460	504	836	1458	4258	41.74	III
Inadequate effective government policies on beekeeping	3139	1568	880	297	5884	57.68	II
Post-harvest constraints							
Lack of honey processing units	4599	2128	0	27	6754	66.21	I
Scarcity of skilled labour	4161	2184	264	0	6609	64.79	II
Non-availability of storage and packaging material	1387	336	1540	1296	4559	44.69	IV
Problem of transport facility	3066	1176	132	972	5346	52.41	III
Socio-cultural constraints							
Non availability of family labour after establishment	1898	168	1276	1188	4530	44.41	III
Pressure from family to quit beekeeping	2263	1400	0	1242	4905	48.08	II
Lack of support of existing beekeepers to the upcoming beekeeper	2920	336	792	1026	5074	49.74	I
Disputes arising due to bee sting	1095	112	352	2079	3638	35.66	IV

was ranked II with mean value of 48.08, "Non availability of family labour after establishment" was ranked III with mean score of 44.41 and "Disputes arising due to bee sting" was ranked IV with mean score of 35.66 in socio-cultural constraints. These findings are in consonance with Monga and Manocha (2011) where they found that majority of the beekeepers faced challenges in the form of diseases and pests of honey bees, migration problems, shortage of bee forage and financial resources, etc.

SUGGESTIONS TO OVERCOME THESE CONSTRAINTS

There is certainly no doubt about the beekeeping industry's potential in economy. Therefore, to exploit the full potential of beekeeping, following suggestions are given:

- Beekeepers, researchers, and other beekeeping industry participants should join associations and networks that could help them gain access to information.
- Improved technologies, improved hive tools, biological control agents, at the worst safer antibiotics available in different parts of the world should be introduced in Kashmir valley.
- Plantation alongside roads to boost the bee flora availability throughout the valley.
- Regular need - based training sessions should be conducted in local language by the concerned department and agricultural university.
- Establishment of public floral gardens across the valley.

- Provision of better quality hives, medicine for bee colonies.
- Improve community education and extension services for bees to reduce the impact of pesticides, enhance good management practices and protect critical habitats.
- Provision of insurance to bee colonies just like crop insurance.
- Awareness campaigns to motivate youth and others for taking up beekeeping as enterprise.
- License should be provided to the beekeepers for ease in the migration of bee colonies to other states.

CONCLUSION

The study has clearly depicted major economic, technical, infrastructural and administrative, post-harvest and socio-cultural constraints perceived by the beekeepers. The major constraints include high cost of tools and equipments, migration of bee colonies, shortage of forage, lack of honey processing units and lack of support of existing beekeepers to the upcoming beekeeper. These perceived constraints need to be addressed by the government of Jammu and Kashmir, apiculture department and agricultural universities so that beekeepers can realize the full potential of beekeeping.

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Differential Behaviour Pattern of Farmers at different Growth Stages of Farmer Producer Organizations (FPOs) in Bihar

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ABSTRACT

Farmer Producer Organizations (FPOs) are recognized as pivotal institutional mechanisms for stimulating agricultural development in developing countries, particularly among the smallholder farmers. The viability and prosperity of FPOs are significantly influenced by various psychological factors, including farmers' attitudes being member of FPOs, their information-seeking behaviour, and their level of progressiveness, which collectively play a pivotal role in determining the sustainability and success of FPOs. Present study was carried out in eight randomly selected FPOs, categorized based on their functioning stages, viz., duration of <1-3 years, >3-6 years, >6 years, and non-functional FPOs. A sample of 320 farmer members, with 40 from each FPO was surveyed. It is revealed that farmers in well-established FPOs, functioning for more than 6 years, exhibited higher levels of progressiveness towards FPOs and hold a more favourable attitude towards their contributions to agricultural development. Furthermore, these farmers demonstrated a greater interest in obtaining prompt and accurate information on farming-related matters. In contrast, farmers in FPOs of lesser duration and non-functional FPOs displayed lower levels of progressiveness and were less inclined to actively seek information through FPO communication networks. The results emphasize the importance of nurturing and establishing FPOs to ensure that farmers have access to the vital information needed for informed decision-making. Policymakers, authorities, and FPO management can leverage these insights to design targeted interventions and supportive frameworks that promote a culture of progressiveness and active participation within FPOs, ultimately reinforcing their role in agricultural development.

Keywords: Information seeking behaviour, Farmer's attitude, Farmers' progressiveness, Farmer producer's organizations

INTRODUCTION

More than half of the India's rural population (58%) depends on farming as their primary source of income. A significant majority of farmers in the country, exceeding 85 per cent, fall under the small-scale or marginal category, each owning less than one hectare of land (Census, 2011; Singh, 2012). The fragmentation of land holdings results in the addition of 15 to 20 lakh small and marginal farmers annually (Singh *et al.*, 2022). These small-scale farmers suffer financial losses due to the uneconomical scale of their operations, both in input and output markets (Sawairam, 2015). Additionally, challenges such as inadequate handling of pre and post-harvest produce, lack of processing facilities, and insufficient logistics and export infrastructure further burden these farmers (Kumar *et al.*, 2019; Deka *et al.*, 2020; Sahu *et al.*, 2021; Shreya *et al.*, 2023). Reflecting on prior experiences with farmers' cooperatives, the Indian government introduced the concept of Farmer Producer Companies (FPCs) by amending Section IX A of the Indian Companies Act 1956. These FPCs are entities owned and operated by farmers, receiving financial support from the government and managed by professionals. Policymakers have taken steps to ensure that FPCs maintain a cooperative while conforming to a regulatory

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framework similar to that of private limited companies (Mukherjee *et al.*, 2020; Mwambi *et al.*, 2020; Sawairam, 2015). The primary objective of an FPO is to tackle the challenges faced by smallholder farmers by consolidating their agricultural produce to secure better prices in the market hence, treated now as the panacea for all the ills that ail the plight of farming community (Kumari *et al.*, 2022). By achieving economies of scale in various aspects like input procurement, transportation, primary and secondary processing, FPOs can significantly reduce the costs associated with production and marketing (Partiban *et al.*, 2015; Vinayak *et al.*, 2019; Mukherjee *et al.*, 2020). Despite the growing attention and advocacy for FPOs at both the central and state levels (Gorai *et al.*, 2022), it has been observed that the establishment and expansion of FPOs throughout the nation have not displayed consistent progress (Manaswi *et al.*, 2018). There are not many examples of FPOs and cooperatives being viable (Phansalkar and Paranjape, 2021). Consequently, the long-term sustainability of a large number of FPOs raises questions. However, when farmers exhibit progressive qualities, the prospects for FPO stability tend to improve (Gorai *et al.*, 2022). The success and long-term viability of FPOs are closely linked to several key factors: the active engagement of progressive farmers, their positive outlook toward FPOs, and their proficiency in information-seeking behaviour (Elizabeth, 2020; Singh *et al.*, 2021; Suman *et al.*, 2023). In this context, the present study has attempted to explore the psychological traits associated with the farmer-members in FPOs at varied growth stages, that included their information-seeking behaviour, level of progressiveness, and attitude of farmer member's towards FPO. These attributes underscore the importance of creating and nurturing FPO's member access to the vital information necessary for making well-informed decisions.

MATERIALS AND METHODS

The study was conducted in the purposefully selected state of Bihar, which is one of the six major states promoting FPCs in India. The compilation of registered and functioning FPOs in Bihar was sourced from multiple institutions, including the National Bank for Agriculture and Rural Development (NABARD), Krishi Vigyan Kendra (KVK), and Indian Council of Agricultural Research (ICAR) institutes. Eight FPOs were randomly selected, which were dealing with the agricultural and horticultural produce, with varying durations of functioning, ranging from 1-3 years, more than 3 to 6 years, more than 6 years, and non-functional during the present study. A total of 320 farmer-members were selected as respondents, with 40 farmers randomly chosen from each of the eight FPOs. The study focused on three psychological domains: farmer's attitude, progressiveness, and information-seeking behaviour. To evaluate these aspects, the researchers used a scale developed by Mukherjee *et al.* (2018) with some required modifications. This scale included 12 and 10 statements for attitude and progressiveness, respectively, rated on a 5-point continuum. For information-seeking behaviour, eight statements were measured on a 3-point continuum interval scale. Statistical analysis, like mean and SD were derived to assess the level of selected variables; z-tests was conducted to revealing significant differences between FPOs in similar growth stage with respect to selected psychological domains. A comprehensive psychological index was devised to compare the member-farmers of selected eight FPOs.

RESULTS AND DISCUSSION

The study delved into farmers' attitudes towards FPOs across different stages of functionality, including non-functioning FPOs. These FPOs had varying durations of operation, with two FPOs functioning for 1-3 years- Saraiya Kishan Farmer Producer Company Ltd. (SKFPCL) and Jay Mata Di Makhana Kisan Utpadak Sangadhan Sahkari Swawlambi Samiti limited (JMDKUSL). Another two FPOs were operational for more than 3 to 6 years- Makhana Mithila Farmer Producer Company Ltd. (MMFPCL), Champaran Krishak producer company limited. (CKPCL); while other two were functioning for more than 6 years- Satyam Shivam Farmer Producer Company Ltd. (SSFPCL) and Aranyak Agri-producer company Ltd. (AAPCL). There were also non-functional FPOs named Mansahi Katihar Agro producer company limited. (MKAPCL) and Katihar kisan Krishi producer company limited (KKKPCL).

It is evident from the Table 1 that mean scores across various FPOs range from 1.83 to 4.85, shedding light on the degree of influence attributed to FPOs in promoting collective action through capacity building.

Table 1: Attitude of Farmers towards their FPOs

Statements related to Attitude of Farmers towards FPOs	Mean(SD)							
	1-3 years		>3-6 years		>6 years		Non-functional	
	SKFPCL	JMDKUSL	MMPCL	CKPCL	SSFPCL	AAPCL	MKAPCL	KKKPCL
FPOs influence better collective action through capacity building	4.50(0.60)	4.40(0.63)	4.50(0.60)	4.45(0.71)	4.73(0.45)	4.85(0.36)	1.93(0.57)	1.83(0.78)
FPOs provide financial management support by linking with financial institutions/banks	4.00(0.82)	4.38(0.77)	4.58(0.55)	4.45(0.60)	4.65(0.53)	4.55(0.64)	2.10(0.44)	1.93(0.83)
FPOs makes available inputs in right quantity and on time	4.73(0.45)	4.15(0.83)	4.28(0.82)	4.65(0.48)	4.93(0.27)	4.78(0.42)	1.63(0.74)	1.60(0.59)
The FPOs have helped in increasing the equitable access to product markets for poor farmers	4.18(0.64)	4.30(0.69)	4.58(0.55)	4.60(0.55)	4.80(0.41)	4.95(0.22)	1.38(0.49)	1.35(0.48)
Working in FPOs help to overcome production and operational risks	4.65(0.48)	4.48(0.55)	4.58(0.50)	4.45(0.55)	4.75(0.44)	4.80(0.41)	1.43(0.50)	1.45(0.50)
As a member of FPOs farmers get better opportunities of getting latest agricultural technologies	4.10(0.81)	4.23(0.62)	4.33(0.73)	4.40(0.63)	4.83(0.45)	4.85(0.43)	1.65(0.53)	1.58(0.59)
Conflicts are straightforwardly resolved in FPOs	3.85(1.23)	4.38(0.54)	4.38(0.63)	4.43(0.64)	4.50(0.75)	4.75(0.54)	1.63(0.63)	1.73(0.72)
Leadership strongly influences performance of FPOs	4.80(0.41)	4.63(0.49)	4.85(0.36)	4.33(0.62)	4.88(0.33)	4.93(0.27)	4.58(0.50)	4.13(1.09)
It is matter of pride to be member of FPOs	4.60(0.59)	4.55(0.68)	4.58(0.64)	4.50(0.55)	4.70(0.46)	4.90(0.30)	1.85(0.66)	1.50(0.51)
All members enjoy equal powers and privileges in FPOs	4.60(0.63)	4.48(0.60)	4.50(0.72)	4.25(0.74)	4.73(0.55)	4.85(0.36)	1.73(0.72)	1.78(0.66)
There is participatory decision making in FPOs	4.65(0.58)	4.68(0.53)	4.15(0.77)	4.55(0.50)	4.75(0.49)	4.83(0.38)	3.80(0.76)	3.48(1.50)
In case of any difficulties help is extended by fellow members of FPOs	4.73(0.60)	4.73(0.45)	4.88(0.33)	4.58(0.59)	4.83(0.38)	4.93(0.27)	1.48(0.51)	1.23(0.42)
Overall	4.44(0.25)	4.45(0.21)	4.51(0.18)	4.47(0.20)	4.75(0.16)	4.82(0.17)	2.09(0.28)	1.96(0.37)
Farmers Attitude Index (%)	88.96	88.92	90.25	89.38	95.08	96.58	41.92	39.25
Z -test	0.023		1.053		-2.176*		3.464**	

** significant at 1% level and * significant at 5% level

A higher mean score signifies a stronger positive attitude towards the role of FPOs. Remarkably, in the category of FPOs with more than six years of operation, AAPCL stands out with the highest score of 4.85, signifying that the farmers within this group express a highly positive perception of AAPCL's role in fostering collective action followed by SSFPCL (4.73), MMPCL and SKFPCL (both score 4.50), CKPCL (4.45), JMDKUSL (4.40), MKAPCL (1.97), and KKKPCL (1.83). This array of mean scores highlights the diversity in attitudes of member-farmers towards FPOs across different time periods. When it comes to financial management support provided by FPOs, as reflected in mean scores, ranged from 1.93 to 4.65. A higher score suggests a more favourable attitude towards FPOs' assistance in financial matters. Notably, the FPO, SSFPCL operating for more than six years obtained the highest mean score other functional FPOs also receives more than 4. Regarding the availability of inputs in the right quantity and on time, scores ranging from 1.60 to 4.93 were used to represent this aspect. A higher score reflects a more positive perception of the effectiveness of FPOs in providing inputs. FPO like SSFPCL, which has been operating for more than six years, received the highest score of 4.93. This suggests that farmers in this category hold a particularly favourable view of the FPO's performance in this regard. On the other hand, the lowest scores were observed in MKAPCL (1.63) and KKKPCL (1.60), indicating that these FPOs were perceived less favourably in terms of input provision by the farmers. Farmers' attitudes toward FPOs, which facilitate fair access to product markets, exhibited varying trends, as evidenced by mean scores ranging from 1.35 to 4.95. A higher score signifies a stronger belief in the ability of FPOs to enhance market access. Notably, the FPOs like AAPCL and SSFPCL with over six years of operation, achieved the highest scores of 4.95 and 4.80, respectively, reflecting a highly favourable perception of their impact on market access. Subsequently, companies with a functioning stage gets more than 4 score. In contrast, non-functional organizations like MKAPCL (1.38) and KKKKPCL (1.35) received the least favourable scores, suggesting a less positive outlook on their market access impact. AAPCL achieved the highest mean score (4.80) for assisting farmers in mitigating production and operational risks. SSFPCL followed closely with the second-highest score (4.75), and rest all functioning FPOs score more than 4 in this aspect. In terms of access to agricultural technologies, AAPCL led the way with the highest mean score (4.85), providing farmers with opportunities to access the latest agricultural technologies. Rest all functional FPOs scores more than 4 except the non-functional FPOs which exhibit low score less than 2 respectively.

Regarding Conflict Resolution, AAPCL received the highest with score of 4.75, indicating effective conflict resolution within this FPO. Except SKFPCL all functional FPOs score more than 4, highlighting its proficiency in handling conflicts whereas non-functional scores, low ranges from 1.63 to 1.73. When it comes to Leadership Influence within an organization, AAPCL and SSFPCL emerged as the FPOs where leadership strongly impacts performance, with mean scores of 4.95 and 4.85, respectively. All functional and non-functional FPOs closely followed with a score of more than 4.00, underscoring the leadership's role in all these organizations. In terms of Member Pride in FPO Membership, AAPCL achieved the highest mean score (4.90), followed by SSFPCL at 4.70, indicating a strong sense of member pride. Except non-functional all functional FPOs perform well in this category. Regarding Equal Powers and Privileges, SSFPCL led the way with a score of 4.85, demonstrating that members feel they have equal powers and privileges within this FPO, except non-functional all functional FPOs closely followed with a score of more than 4.00. In terms of Participatory Decision-Making in FPOs, FPOs which is more than 6 years of working received the highest score, rest all receives more than 4 except non-functional ranges from more than 3 respectively, indicating a prevalence of participatory processes in these FPOs. Regarding the extension of help by fellow members, AAPCL achieved the highest score (4.93), and rest all FPOs receives more than 4 underscoring the strong sense of community and support among FPO members. But non-functional FPOs scored ranges 1.96 to 2.06., very low in all aforesaid perspectives.

In the dynamic landscape of FPOs, a clear pattern emerges: certain FPOs excel in specific areas, shining a light on the agricultural sector with their impactful initiatives. SSFPCL demonstrates outstanding leadership influence, financial support, and member pride. Specifically, AAPCL, SSFPCL and MMPCL

garnered relatively high overall mean scores, indicating positive attitudes among their members, while CKPCL also received a favourable overall mean score, though slightly lower. In contrast, SKFPCL and JMDKUSL received notably lower overall mean scores, suggesting less positive attitudes among their members. MKAPCL and KKKPCL exhibited the lowest among overall mean score, signifying the least positive attitude among the studied FPOs. A pessimistic or adverse attitude among members towards FPOs could potentially limit or harnessing of the FPOs' potential (Singh *et al*., 2021). AAPCL stands out as a pillar of support, helping farmers overcome challenges and fostering a strong sense of community. These FPOs not only represent progress but also symbolize the collaborative spirit that propels agricultural transformation. As farmers unite under the banner of these FPOs, they discover not just organizations but allies who illuminate the path to a brighter and more prosperous agricultural future. The Farmers Attitude Index is a measure of farmers' attitudes towards FPOs and is expressed as a percentage. It ranges from 39.25 to 96.58 per cent. Farmers who have been members of FPOs for more than 6 years exhibited the highest attitude scores (>95%). Z-test results indicate the significant differences between FPOs in similar growth stage like more than 6 years of functioning and non-functioning.

The study explores the progressiveness of farmers associated with FPOs at different stages of functionality. Table 2 illustrates notable differences in how farmers belonging to diverse FPO functioning stages perceive and engage with various aspects of farming and decision-making processes. For instance, in the statement "Keeping updated with new farming practices and government policies," AAPCL exhibited the highest score (4.78), indicating a strong commitment to staying informed followed by while the CKPCL also showed a proactive approach with a score of 4.45, followed by SSFPCL (4.43), SKFPCL (4.38), MMPCL (4.05), and JMDKUSL (4.00); while farmers of KKKPCL and MKAPCL perceived low with mean score of 3.58 and 2.50, respectively. AAPCL stands out with the highest mean score (5.00) regarding experimentation in farming. This indicates a strong belief in the importance of innovation and suggests that this FPO is particularly open to trying new ideas and practices followed by SSFPCL (4.05). In contrast, the CKPCL, which is functional for >3-6 years, have a relatively high mean score 4.60 showing a proactive approach with new ideas in farming but KKKPCL and MKAPCL reported the lowest mean scores (2.65 and 2.55, respectively) for this statement, indicating a relatively conservative approach to experimentation and change. Regarding seeking explanations before making decisions, the AAPCL perceived the highest mean score. This suggests that members of this FPO, exhibit a comprehensive and thoughtful approach to decision-making. On the other hand, the CKPCL and KKKPCL FPOs scored the lowest, implying a propensity to make decisions with less emphasis on seeking explanations. AAPCL had the highest score (4.85) with respect to "Attending training opportunities whenever available," showcasing their proactive approach to training, rest all FPOs received more than 4 score except SKFPCL, MKAPCL and KKKPCL had the lowest scores ranges from 2.88 and 3.93 respectively. Farmers in the SSFPCL and AAPCL FPOs demonstrated the highest commitment to "Following through with plans" with mean scores of 4.85 and 4.78, respectively, followed by SKFPCL (4.48). Both SKFPCL and AAPCL had the highest mean score (4.75) with respect to "Hard work for good returns," indicating a strong work ethic, followed by SSFPCL (4.73) while MKAPCL and KKKPCL had the lowest scores of 3.00.

In terms of choosing crops based on higher market demand, the AAPCL displayed the highest mean score of 4.73, indicating a strong focus on aligning their crop choices with market trends followed by SSFPCL and JMDKUSL with score of 4.53 and 4.38 respectively. The willingness to switch professions if an alternative job opportunity arises was most pronounced in the MMPCL with highest mean score of 4.75. This suggests that members of this FPO are relatively open to exploring alternative career paths followed by SSFPCL (4.65), SKFPCL (4.55), CKFPCL (4.50), JMDKUSL (4.30) and AAPCL (4.30), respectively. Both AAPCL and MMPCL FPO demonstrated a commitment to "Keeping farm records for resource management" with the highest means of 4.68, followed by SKFPCL (4.65), JMDKUSL (4.63) while MKAPCL and KKKPCL had the lowest scores 2.13 and 1.93, respectively. Lastly, the JMDKUSL demonstrated a strong focus on planning at the beginning of the season with the highest

Table 2: Farmers Progressiveness being Members of the selected FPOs g Members of the selected FPOs

Statements related to Farmers progressiveness towards FPOs	Mean (SD)							
	1-3 years		>3-6 years		>6 years		Non-functional	
	SKFPCL	JMDKUSL	MMPCL	CKPCL	SSFPCL	AAPCL	MKAPCL	KKKPCL
I keep myself updated with new farming practices and government policies	4.38 (0.70)	4.00 (0.00)	4.05 (0.45)	4.45 (0.68)	4.43 (0.50)	4.78 (0.42)	2.50 (1.43)	3.58 (1.36)
I think a good farmer should experiment with new ideas in farming	4.80 (0.41)	3.90 (0.74)	4.03 (0.16)	4.60 (0.59)	4.05 (0.22)	5.00 (0.00)	2.55 (1.47)	2.65 (1.55)
I seek explanation for everything before taking a decision	4.80 (0.41)	4.15 (0.36)	4.25 (0.44)	4.58 (0.68)	4.70 (0.46)	4.85 (0.36)	3.68 (1.12)	3.10 (1.62)
Whenever I get opportunity, I go for trainings to update my knowledge and skills in emerging areas in agriculture.	3.93 (1.31)	4.80 (0.41)	4.63 (0.63)	4.65 (0.53)	4.75 (0.44)	4.85 (0.36)	2.88 (1.49)	3.30 (1.54)
When I make plans, I follow through with them and do not quit in between	4.48 (0.60)	4.10 (0.63)	4.20 (0.56)	4.30 (0.61)	4.85 (0.36)	4.78 (0.42)	3.00 (1.40)	3.18 (1.75)
I do hard work in my field and get good returns	4.75 (0.44)	4.18 (0.55)	4.28 (0.45)	4.35 (0.58)	4.73 (0.45)	4.75 (0.44)	3.00 (1.38)	3.00 (1.71)
I grow those crops which have higher market demand	2.38 (1.17)	4.38 (0.49)	4.33 (0.47)	3.13 (1.79)	4.53 (0.68)	4.73 (0.45)	2.03 (0.83)	1.65 (0.66)
I shall leave farming as a primary profession if I get alternative job	4.55 (0.81)	4.30 (0.46)	4.75 (0.44)	4.50 (0.60)	4.65 (0.48)	4.40 (0.63)	4.23 (0.83)	2.43 (1.43)
I always keep farm records for better resource management	4.65 (0.58)	4.63 (0.59)	4.68 (0.53)	4.38 (0.59)	4.58 (0.55)	4.68 (0.57)	1.93 (0.80)	2.13 (0.97)
I plan my course of action at the beginning of season	4.25 (1.24)	4.83 (0.38)	4.78 (0.42)	4.25 (0.95)	4.73 (0.68)	4.58 (0.93)	2.70 (1.38)	2.88 (1.11)
Overall	4.30 (0.27)	4.33 (0.16)	4.40 (0.14)	4.32 (0.31)	4.60 (0.18)	4.74 (0.16)	2.85 (0.50)	2.79 (0.61)
Farmers progressiveness Index (%)	85.90	86.50	87.90	86.35	91.95	94.75	56.95	55.77
Z test	-0.602		1.434		-3.628**		0.478	

** significant at 1% level and * significant at 5% level

mean score of 4.83 followed by MMPCL (4.78), SSSFPCL (4.73), AAPCL (4.58), CKPCL and SKFPCL with mean score of 4.25. This implies a proactive approach to setting out a clear course of action for the agricultural season. Conversely, the MKAPCL and KKKPCL FPOs had lower scores (2.70 and 2.88), suggesting that they may adopt a less structured approach to planning. When considering the overall mean scores, it is evident that the FPOs being functional for >6 years exhibits the highest overall mean score ranging from 4.60 to 4,75. This category represents farmers who have been engaged with FPOs for an extended period, showcasing their proactive attitudes and progressive approaches in various aspects of farming practices and decision-making. Following closely, the FPOs functioning for 1-3 years have mean scores ranging from 4.25 to 4.83 and FPOs of >3-6 years duration has overall mean between 4.25 and 4.78, indicating a relatively high level of progressiveness among these FPOs. In contrast, the non-functional FPOs demonstrates a lower overall mean score ranging between 2.70 to 2.88 suggesting that farmers in this FPO, despite excelling in specific areas, may face challenges in achieving a consistent and comprehensive approach to progressiveness. The FPOs functional for >6 years (AAPCL and SSFPCL) leads with the highest progressiveness index ranges 91.95 to 94.75 per cent, indicating their advanced adoption of progressive farming practices after prolonged engagement. FPOs of >3-6 years and 1-3 years shows the progressiveness index ranging from 85.90 to 87.90. While the non-functional FPOs, although displaying strengths in specific areas, exhibits a slightly lower overall progressiveness index (55.77 to 56.95%). This suggests the need for targeted interventions to enhance both their collective organizational structure and overall progressiveness. This indicates that prolonged engagement with FPOs significantly impacts progressiveness. So, the survival chances of a FPO are positively influenced by the progressiveness of its member- farmers (Suman *et al.*, 2023).

Table 3 presents a comprehensive analysis of information-seeking behaviour among members of various FPOs. Mean scores for eight key statements were compared across all FPOs to identify patterns and differences in their attitudes toward acquiring agricultural knowledge. In term of curiosity about new agricultural information, AAPCL displayed the highest score (2.78), indicating a strong desire to explore novel agricultural knowledge. In contrast, CKPCL showed a relatively lower curiosity level received score 2.68 rest all functional FPOs score more than 2 expect non-functional FPOs score low ranges from 1.7 to 1.93. Regarding gathering information with relative advantages, the mean scores across various FPOs range from 2.10 to 3. Both CKPCL and AAPCL displayed the highest mean score (3.00), emphasizing a proactive approach to acquiring information with clear benefits followed rest all FPOs even the non-functional FPOs score more than 2 in this aspect. On average, FPO members expressed mild confusion in finding authentic sources of information with mean score ranging from 1.93 to 2.85. When it comes to persistence in information seeking, SSFPCL exhibited the highest level of persistence (mean score 2.90), reflecting a determined effort to obtain particular information followed by AAPCL (2.83). rest all FPOs scored more than 2 except KKKPCL suggesting a relatively less persistent approach among its members. In term of focus on occupation-related information: FPO members, on average, showed a moderate inclination to focus on occupation-related information as evident from the mean scores ranging from 1.80 to 2.38. SKFPCL exhibited the highest focus (mean score 2.38), indicating a strong alignment of information-seeking behaviour with their occupation followed by KKFPCL (2.35), and MMPCL (2.33). Conversely, FPOs like AAPCL and SSFPCL displayed the lowest focus (mean score 1.80), suggesting a broader interest beyond occupation-related information. FPO like SSFPCL exhibited the highest mean score (2.73), indicating a strong motivation for continuous learning among its members followed by MKAPCL and AAPCL with mean scores 2.70 and 2.65, respectively, suggesting a relatively lesser emphasis on continuous learning for knowledge enhancement. When it comes in term of finding the right source of information and share it with others, AAPCL had the highest mean score (2.90), indicating a robust capacity to locate and disseminate relevant information followed by MMPCL (2.85) and CKPCL (268), respectively. In contrast, MKFPCL had a lower mean score (1.83), suggesting a comparatively limited ability to find and share information effectively. The mean score for staying up-to-date with new farming practices ranges from 2.20 to 3.00 across all

Table 3: Information Seeking Behaviour of the respondent member farmers of the selected FPOs

Statements related to information seeking behaviour	Mean (SD)							
	1-3 years		>3-6 years		>6 years		Non-functional	
	SKFPCL	JMDKUSL	MMPCL	CKPCL	SSFPCL	AAPCL	MKAPCL	KKKPCL
I am curious to know about new information related to agriculture	2.48(0.51)	2.58(0.50)	2.50(0.51)	2.68(0.47)	2.78(0.42)	2.98(0.16)	1.93(0.76)	1.7(0.82)
I try to gather information that has relative advantages	2.43(0.50)	2.70(0.52)	2.73(0.45)	3.0(0.00)	2.80(0.41)	3.0(0.00)	2.30(0.82)	2.10(0.98)
I get confused to find authentic sources of information	2.48(0.68)	2.43(0.50)	1.93(0.69)	2.10(0.78)	2.40(0.55)	2.85(0.36)	2.40(0.81)	2.30(0.94)
If I want particular information, I will anyway try to get it	2.60(0.55)	2.40(0.50)	2.48(0.51)	2.53(0.51)	2.90(0.30)	2.83(0.38)	2.30(0.56)	1.65(0.74)
I focus on only such information which are related to my occupation	2.38(0.67)	2.28(0.72)	2.33(0.80)	2.13(0.72)	1.80(0.76)	1.80(0.76)	1.88(0.79)	2.35(0.89)
I feel any information in one or the other way to improve my knowledge	2.43(0.75)	2.58(0.50)	2.70(0.46)	2.33(0.62)	2.73(0.45)	2.65(0.48)	2.25(0.67)	1.73(0.72)
I can find the right source of information and share it with others	2.48(0.68)	2.60(0.50)	2.85(0.36)	2.68(0.47)	2.48(0.51)	2.90(0.30)	1.83(0.64)	2.20(0.85)
I try to keep myself up to date with new farming practices	2.68(0.47)	2.65(0.48)	2.90(0.30)	2.75(0.44)	2.63(0.49)	3.0(0.00)	2.28(0.78)	2.20(0.82)
Overall	2.49(0.25)	2.53(0.21)	2.55(0.18)	2.53(0.20)	2.56(0.16)	2.75(0.17)	2.15(0.28)	2.03(0.37)
Information Seeking Behaviour Index(%)	83.02	84.17	85.00	84.06	85.42	91.67	71.46	67.71
Z -test	-0.664		0.638		-5.230**		1.552	

** significant at 1% level and * significant at 5% level

FPOs. AAPCL exhibited the highest mean score (3.00), emphasizing a proactive approach to staying informed about the latest agricultural techniques followed by MMPCL (2.90). In contrast, Non-functional FPOs had a lower mean score suggesting a relatively lower emphasis on keeping up-to-date with evolving farming practices.

With respect to overall information seeking behaviour in the FPOs, AAPCL showed the highest overall mean score (2.75), indicating strong information-seeking tendencies followed by SSFPCL (2.56), MMPCL (2.55), JMDKUSL and CKPCL (2.53) and SKFPCL (2.48), respectively. While FPOs like MKAPCL and KKKPCL displayed the lowest overall mean score, suggesting a relatively lower interest in seeking information. According to the information seeking behaviour index (%) for the member-farmers of the selected FPOs, AAPCL showed the highest index value (91.67%), indicating a strong information-seeking culture amongst the member-farmers. SSFPCL also exhibited robust information-seeking behaviour with an index of 85.42 per cent; hence considered as high information Seekers. FPOs in the early and intermediate stages (SKFPCL, JMDKUSL, MMPCL, and CKPCL) showed the index values ranging from 83.02 to 85.00 per cent. While, FPOs like MKAPCL and KKKPCL displayed comparatively lower index values of 67.71 to 71.46 per cent. Thus, results indicated that FPOs in advanced stages of functioning tend to have member-farmers with higher information-seeking tendencies, emphasizing the importance of organizational maturity in fostering a knowledge-seeking environment. This implies that FPOs in the advanced stage exhibit markedly different information-seeking behaviours compared to those in the early, intermediate stage and non-functional stages of FPOs. Members of functional FPOs exhibit greater enthusiasm for information-seeking behaviours, and they are more likely to enhance their knowledge when compared to members who are not part of FPOs or those in non-functional FPOs (Singh *et al.*, 2022; Suriyapriya and Kavaskar, 2021)

Overall psychological Index (%) ranges from 54.24 to 94.33 per cent across various categories of FPOs, reflecting the varied psychological characteristics of farmers as depicted in Figure 1. The data reveal

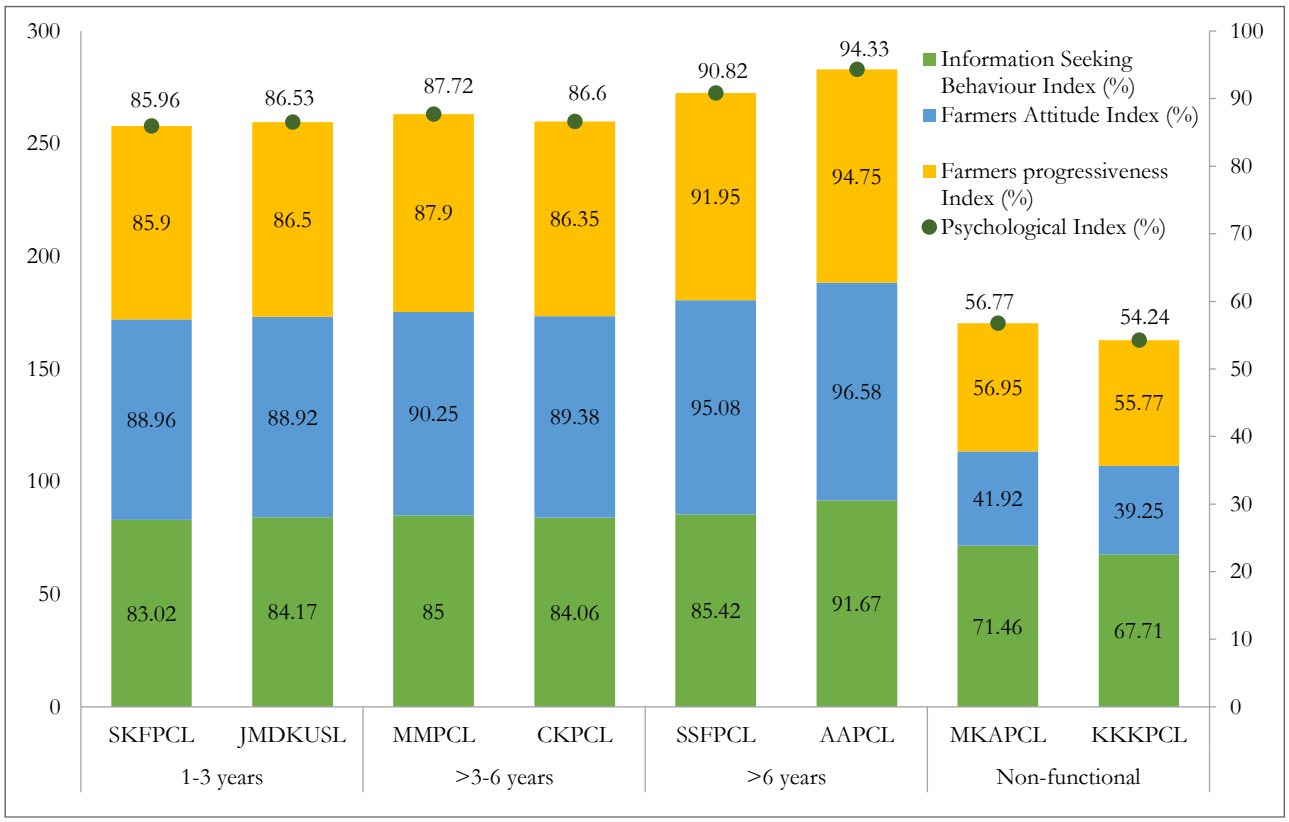

Figure 1: Comparative Psychological Profile of the Members of Selected FPOs

fluctuations in these indices based on different time periods of FPOs' functioning (1-3 years, >3-6 years, and >6 years) and non-functional categories, offering insights into changes and trends in farmers' behaviour, attitudes, and progress over time. The FPOs of >6 years duration (AAPCL and SSFPCL) exhibits the highest Psychological Index, ranging from 90.82 to 94.33 per cent. The FPOs of 1-3 years and >3-6 years of functioning, the index values range from 85.96 to 87.72 per cent. This suggests that psychological aspects of the member-farmers appear to improve over time. Conversely, non-functional FPOs show lower Psychological Index values, ranging from 54.24 to 56.77 per cent, indicating comparatively less progress in psychological aspects of the member-farmers.

An optimistic and supportive attitude among members towards FPOs has the potential to enhance the full capabilities of FPOs, and also progressiveness of member contributing to the increased survival chances of farmers (Singh *et al.*, 2021; Suman *et al.*, 2023). Conversely, active participation of members in well-functioning FPOs is associated with significantly higher levels of information-seeking behaviour, positive attitudes towards FPOs, and a progressive mindset, with index values exceeding 80%. Notably, FPOs with more functioning year, such as AAPCL and SSFPCL, exhibit the highest Psychological Index, ranging from 90.82% to 94.33%. This suggests that the extended operational experience of FPOs positively influences their performance across various dimensions, underscoring the beneficial impact of prolonged operational experience on FPO effectiveness (Simpson, 2010; Shreya *et al.*, 2023).

CONCLUSION

FPOs have a positive impact on farmers' attitudes, particularly when they function effectively and exhibit strong leadership. Effective FPOs with strong leadership have a positive influence on farmers, but there is room for improvement in areas like participatory decision-making and conflict resolution. A notable trend is that farmers with over six years of experience show higher levels of positivity and progressiveness compared to those with 1-3 years and >3-6 years of experience. Prolonged engagement with FPOs seems to deepen their appreciation of the benefits. Farmers engaged with FPOs for over six years exhibit the highest level of progressiveness, as seen in their scores across various statements. This reflects a positive impact on adopting new farming practices, seeking information, and resource management. They align their farming choices with market demand and maintain better farm records. The Farmers' Progressiveness Index helps assess and compare farmers in different functioning stage, with the >6 years category achieving the highest index. Overall information-seeking behaviours varies among participants with different years of agricultural experience. More experienced members (>6 years) are more inclined to seek agricultural information and exhibit the least confusion in finding authentic sources. However, challenges in finding authentic sources of information were consistent across all groups. The study emphasizes the need for improved guidance and resources for accurate information retrieval in agriculture, highlighting the importance of tailored information dissemination strategies. These findings are valuable for agricultural policymakers, FPOs, and extension services, as they can design targeted interventions, training programs, awareness campaigns, and incentives to support less proactive farmers and enhance their engagement with FPOs.

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Health Status of Golden Mahseer, *Tor putitora* in Anji Hatchery of District Reasi of Jammu Region

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ABSTRACT

Mahseer being the endangered species requires a lot of attention in order to increase its population. In some places, mahseer is still having its habitat, feeding and breeding ground intact, therefore, the knowledge of current status of fish in that particular habitat with respect to its health and other biological parameters is required to save and propagate its number. In present study, the hematological parameters of the Mahseer fish from water bodies of district Reasi, Jammu and Kashmir were observed to know its health status. The blood profile of fish provides accurate indications of any changes occur in the animal under stress or healthy, positive or negative impact similar to those of warm-blooded animals. The knowledge of the hematological characteristics helps in monitoring the physiological changes in the fishes and understanding of fish stress responses is essential to avoid stress-related problems. The blood samples were collected monthly and analyzed for a period of six months. Average hemoglobin content, total erythrocyte count, total leukocyte count and mean corpuscular values of fish indicated relation between the seasonal changes in environmental factors such as temperature and dissolved oxygen with various blood parameters. Mahseer being the endangered species requires a lot of attention in order to increase its population. In some places, mahseer is still having its habitat, feeding and breeding ground intact, therefore, the knowledge of current status of fish in that particular habitat with respect to its health and other biological parameters is required to save and propagate its number. Significant seasonal variations in the number of white and red blood cells, haemoglobin, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration have been observed. In general, higher values of RBC dependent parameters; viz, TEC, Hb, PCV were recorded during spring, summer, monsoon and autumn, and lowest during winter. White blood cells on other hand, exhibited gradual decline during monsoon and autumn upto winter only to rise again in spring and summer. The proportions of different leucocytes though variable but lymphocytes have been observed to be the chief contributor in TLC fluctuation. Thrombocyte count was significantly higher during autumn and winter season. Relation between seasonal changes in environmental factors such as temperature and dissolved oxygen with various blood parameters have been discussed. Accordingly, it can be concluded that hematological parameters are indicating healthy population with good health status of fishes in water body.

Keywords: Seasonal, Hematological parameters, *Tor putitora,* Fish health

INTRODUCTION

Fishes are a major source of food and income for thousands of people across the world. Many communities depend on fisheries for their economic and social benefits. Advances in fishing equipment and methods have made it possible for commercial fishing operations to capture more fish. This access is putting increasing pressure on fish stocks. Mahseer fish have suffered severe population declines in much of its distribution range, and are now considered threatened due to pollution, habitat loss and over-fishing. Illegal, unreported and unregulated fishing is also a major

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contributor to declining fish stocks and habitat destruction. *Tor Putitora*, the Himalayan Mahseer or the yellow fin Mahseer is the freshwater fish inhabiting mainly Himalayan Rivers in the foothills. There are about 46 species of Mahseer, of which 23 species belongs to genus *Tor,* 22 to *Neolissochilus* and one to *Naziritor* (Eschmeyer *et al.,* 2004). The findings on Golden Mahseer are larger as compared to that of other fresh water fish of Indian sub-continent. Many studies have been put forward by various researchers on this species (Hora, 1939; McDonald, 1948; Desai, 1972). Mahseer being a migratory fish initiates periodic upstream migration during pre monsoon and monsoon seasons from high order streams to the lower order streams for spawning, but due to overexploitation and rise of growing number of hydroelectric projects in its natural habitat (Nautiyal and Singh, 1989), Mahseer population is going through a rapid decline over last few decades and thus have been accorded 'threatened' status in India (Khan and Sinha, 2000). The threats have continued unremitting despite the abiding concern. As a result Golden Mahseer has been categorized as an 'endangered' species in IUCN red list (IUCN, 2015). Mahseer is a sensitive species that can barely tolerate a modified water environment. This is evident from the decrease in its size (length) recorded over the last century, size composition (predominance of young/ immature individuals) and reduced share in the catch (as low as 5% from 40-50%) from its distribution ranges.

The haematological parameters of fish provide accurate indications of any changes occur in the animal under stress or healthy, positive or negative impact similar to those of warm blooded animals. The knowledge of the hematological characteristics help in monitoring the physiological changes in the fishes and understanding of fish stress responses is essential to avoid stress-related problems in aquaculture to improve fish quality and productions. Hematological and biochemical parameters have been acknowledged as valuable tools for fish health monitoring (Sebastiao *et al*., 2011). Normal ranges for various blood parameters in fish have been established by different investigators in fish physiology and pathology (Naveen *et al.,* 2018; Xiaoyun *et al.,* 2009). The analysis of hematological and serological indices has established its importance in depicting the health status of animals.

Therefore, the present study was conducted to investigate any seasonal (winter, spring and summer) fluctuations in haematological parameters in the blood of Tor putitoraas this fish is still in abundant in natural water bodies of Reasi district of Jammu & Kashmir and as such there is no major information on haematological parameters of *Tor Putitora* of river Anji in Reasi district.

MATERIALS AND METHODS

The fishes were collected from Anji Hatchery, Department of Fisheries, Reasi, Jammu & Kashmir for haematological studies. Anji Hatchery covers an area of 1.8 hectares and consist of water filtration plant, hatchery unit, five concrete rearing ponds and a well-equipped laboratory. The water source to this hatchery is from Anji stream a tributary of river Chenab. Samples of *Tor Putitora* were collected monthly from the Anji Mahseer hatchery from January 2020 to June 2020.

The blood samples (heparinised 150 IU/ml) collected from the fishes we reanalyzed as per standard protocol for hemoglobin, total erythrocyte count (TEC), total leukocyte count (TLC), Hematocrit (Ht) and Erythrocyte sedimentation rate (ESR), and values for MCV, MCH, MCHC were calculated (Haney *et al.,* 1992). Hematocrit value (Ht) was determined by micro hematocrit capillary tube and ESR was estimated by using Wintrobe method. MCV, MCH and MCHC were calculated using the formulae. Hemoglobin (Hb) concentration was estimated by acid haematin method (Sahli, 1962).

The results were analyzed by one way analysis of variance (ANOVA), followed by Duncan's multiple comparison to determine significance difference. Statistical assessment of result was carried out using SPSS software 16 version (SPSS Inc, Richmond, CA, USA).

RESULTS AND DISCUSSION

During the experiment, water quality parameters viz. temperature 10.90 to 35°C, pH ranges 6.8 to 8.5 were under optimal range and insignificant difference. Body length and weight: The body length of the fishes was recorded before taking the blood. The highest mean body length was recorded 27.94 cm and the lowest

mean body length calculated was 18.54 cm. The body weight of the fishes was recorded during the experiment. The mean of body weights calculated in the month of January was 570g, and in the month of February mean weight was 230g, 189g in March, 289g in April, 570g and 590g in May and June respectively. The RBC count significantly differs in all the experimental months. In January it was calculated as 1.24, in Feb 1.50, in March 2.60, 2.92 in April, 2.42 in May, 3.10 in June. The mean of Hb content in the first month was 9.1, in February 8.8, in March 8.9, in April 9.7, in May 9.2, in June 9.6. The TLC count observed in the first month was 631000 muL, next month it was 1180 muL and 17465, 16765, 17860, 18189 in March, April, May, June respectively.

The water of the pond remained transparent throughout the experimental period of 6 months. The temperature of the water in January was at 10.9°C and in February it was calculated as 13°C. The pH of the water during the experimental period was recorded within the range of 6.8 to 8.5 (Table 1).

Table 1: Monthly water parameters

Month	Water temperature	DO
January	11	13.6
February	13	10
March	15.5	9.6
April	20	8.4
May	23	8.5
June	27	8.7

*All values are mean ± S.D for 6 fishes in each month

The body length of the fishes was recorded during different months. The highest mean body length was recorded 27.94 cm and the lowest mean body length calculated was 18.54 cm. The body weight of the fishes was recorded during the experiment. The mean of body weights calculated in the month of January was 570g, and in the month of February mean weight was 230g, 189g in March, 289g in April, 570g and 590g in May and June respectively. The RBC count significantly differs in all the experimental months. In January it was calculated as 1.24 x 10^6, in Feb 1.50 x 10^6, in March 2.60 x 10^6, 2.92 x 10^6 in April, 2.42 x 10^6 in May and 3.10 x 10^6 in June. The TLC count observed in the January month was 23.10 x 10^3, February month it was 11.08 x 10^3, while 17.47 x 10^3, 16.77 x 10^3, 17.86 x 10^3 and 18.19 x 10^3 in March, April, May and June respectively (Table 2&3).

The mean of Hb content in the first month was 9.1, in February 8.8, in March 8.9, in April 9.7, in May 9.2 and in June 9.6 (Table 4 & 5).

Table 2: Seasonal variations in total erythrocyte count and total leucocyte Count

Month	TEC (x10^6/cmm)
January	1.24±0.33
February	1.50±0.36
March	2.60±0.20
April	2.92±1.19
May	2.42±0.20
June	3.10±0.85

Table 3: Seasonal variations in total leucocyte Count

Month	TLC (x10^3/cmm)
January	23.100±0.31
February	11.080±0.06
March	17.465±0.23
April	16.765±0.17
May	17.860±0.22
June	18.189±0.11

Table 4: Seasonal variations in Haemoglobin and packed cell volume

Month	Hb (g %)	PVC (%)
January	9.1±0.24	23.1±0.34
February	8.8±0.85	36.1±3.2
March	8.9±1.20	35.3±0.57
April	9.7±1.48	45.4±3.2
May	9.2±0.68	39.3±2.2
June	9.6±1.46	34.9±3.0

Table 5: Seasonal variations in MCH, MCHC and MCV

Month	MCH (pg)	MCHC (%)	MCV (fl)
January	37.4±2.24	26.5±1.98	150±11.95
February	32.7±1.14	24.3±0.70	147.8±8.30
March	36.1±3.21	23.1±0.15	149±11.08
April	33.1±2.70	24.0±0.10	129.90±10.2
May	36.1±3.2	22.2±1.15	132.23±10.0
June	36.1±3.2	21.8±0.72	130.77±11.8

CONCLUSION

Conspectus of present result can be wrapped up with the view that the haematological parameters can be of great help to know any change in the health status of fish due to a variety of potential factors, including pollution, climatic change and human interference in a very short period of time, so that one can fix it up before it's too late. This will ameliorate the viability of the fish. The findings of this survey also let us know the health status of the fish in comparison with that of the previous one, helped us a lot to understand the loopholes well. These data can assist managers and policymakers in carrying out effective actions.

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Assessment of Farmers' Knowledge and Practices Adopted for the Safe use of Pesticides in Jammu

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ABSTRACT

India is the largest producer of pesticides in Asia with an annual production of 90,000 tons and currently ranks as the world's 12th-largest user of pesticides (Sharma *et al.,* 2019). The use of chemical pesticides is thought to be a contributing factor in close to 10,000 deaths per year, approximately three-fourths of which take place in developing nations (Horrigon *et al*., 2019) India's population is largely agriculturally based (56.7%), making it susceptible to the pesticides used in agriculture (Gupta, 2004). Humans can come into contact with pesticides that are present in environmental media (soil, water, air, and food) in a number of ways, including by inhaling, ingesting, or by dermal contact. The improper use of pesticides in agricultural fields causes health issues and, occasionally, fatalities (Grace *et al*., 2006). The purpose of this research is to evaluate public knowledge of pesticide use, practices, and their impact on human health. The study was conducted in the UT Jammu and Kashmir district of Jammu. A sample of 250 farmers was drawn at random from the five operating blocks of KVK Jammu in Jammu district, namely R. S Pura, Nagrota, Akhnoor, Mishriwala and Bishnah. Data was obtained using a structured interview schedule, and frequency and percentage were used as descriptive techniques for analysis. The findings indicated that the vast majority of farmers (81.6%) depend on farming for their livelihood, while traders make up only 3.2 per cent. More than half (58.3%) of respondents had small landholdings with an area of 4 to 8 ha, while only 17.5 per cent had land areas larger than 12 ha. The data showed that most respondents (72.8%) get their information from private sources. (Pesticide retailers and shops), and only about a third (36.4%) of farmers receive recommendations for the effective use of pesticide from the State Agriculture Department and KVK. In the new paradigm, ICT has evolved into a quick and reliable source of information, but only highly educated respondents (16.4%) use this readily available information tool or medium. The study also revealed that farmers disregard the pesticide safety recommendations and engage in unsafe and poor practices. The findings further showed that 40 per cent never store their pesticides in separate room; the majority of participants (54%) do not read the written instructions on pesticide bottles or containers. This is due to the fact that most farmers lack literacy. Adopting safety measures is necessary to prevent the negative effects of pesticides because improper pesticide application can have a negative impact on human health. Most of the region's older farmers, who are not aware of the risks associated with bio safety, seek advice from their neighbours. Farmers' awareness of pesticide safety is greatly influenced by factors like their level of education, their ownership of land, the total area of their land, and their exposure to pesticides.

Keywords: Adopted, Assessment, Farmer knowledge, Pesticides, Practices

INTRODUCTION

Pesticides are substances, either natural or synthetic, that are used in a variety of agronomic procedures to manage plant pests, weeds, and diseases. Herbicides, insecticides, fungicides, rodenticides, nematicides, and other chemicals are examples of pesticides. According to Dhaliwal *et al.* (2015), both developing and developed nations encounter serious crop losses as the outcome of insect pests. In order to protect crops and promote growth, pesticides have become a vital component of agricultural development (Sharma *et*

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al., 2019). Ingestion, inhalation, and skin contact with pesticides can all result in exposure. The kind of pesticide, the quantity and mode of exposure, as well as each person's health (such as dietary deficiencies and skin conditions), all have an impact on possible health effects (Abhilash and Singh, 2009; Yassi *et al.*, 2001). In both humans and animals, body fat can be used to metabolize, eliminate, store, or absorb pesticides. Chronic pesticide poisoning has been linked to an increase in the incidence of cancer, chronic kidney disease, immune system suppression, sterility in both sexes, hormonal imbalances, and neurological as well as behavioural disorders, especially in children (Sanbom *et al.*, 2007; Mnif *et al.,* 2011; Semchuk *et al.,* 1992). Furthermore, excessive exposure to pesticides at work, whether intentional or unintentional, can result in hospitalization and even fatalities (Gunnell, 2007).

According to GOI (2021), among all 293 pesticides that are registered, 104 pesticides that are banned in two or more other countries are still manufactured or used in India. According to Mooventhan *et al.* (2020), 50 per cent of all pesticides used in India for pest control are actually utilized for cotton pest control. Due to the overuse and careless application of insecticides, which has a number of negative effects such as substances in plant parts, insecticide resistance, secondary pest outbreaks, environmental pollution, health issues for people and wildlife, etc., it is critical to use natural pest control methods (Birthal and Sharma, 2004). Indian pesticide use in 2017 was extremely low, at about 0.31 kg per ha, compared to 19.6 kg per ha in Saint Lucia, 16.59 kg in Hong Kong, 13.9 kg in Ecuador, 13.3 kg in Taiwan, and 13.07 kg in China. America has also reduced pesticide use per acre by 2.54 kg (Roser, 2019).

In India, agricultural uses for insecticides, fungicides, and herbicides are common. While the global pesticide use pattern is herbicides > fungicides + bactericides > insecticides > other-pesticides, India's current pesticide use pattern is insecticides > herbicides > fungicides + bactericides > other-pesticides. India is currently the fourth-largest producer of pesticides in the world. According to Research and Markets, the Indian pesticides industry was worth Rs. 214 billion in 2019. By 2024, the market is anticipated to grow by 8.1 per cent annually, to reach Rs. 316 billion (TAAS, 2020). The most popular insecticide pesticide is chlorpyriphos. The amount consumed increased from 471 MT in 2014–15 to 1431 MT in 2019–20. The most frequently used fungicide is sulphur, with a consumption of 1548 MT in 2014–15 and a rise to 3878 MT in 2019–20. 2, 4-D amine salts are used in high concentrations as an herbicide (weedicide) in India. Its usage increased from 1 MT in 2014–15 to 1067 MT in 2019–20. The most widely used rodenticide is zinc phosphide, from 2014 to 2020 (GOI, 2020) ranged in consumption from 65 to 200 MT of e. Organophosphates are the insecticides that are used the most, followed by neonicotinoids and pyrethroids. In one study (Maurya and Malik, 2016; Yadav and Dutta, 2019; Nayak *et al.,* 2020), cotton was found to be the agricultural product that consumed the highest amount of pesticides (93.27%), followed by vegetables (87.2%), wheat (66.4%), millet (52.6%), and mustard (12.6%). Pesticide contributions are made up of 47.5 per cent herbicides, followed by 29.5 per cent insecticides, 17.5 per cent fungicides, and 5.5 per cent of other insecticide types (Zhang and Sharma). Acute and chronic health issues are brought on by pesticide exposure, ranging from short-term acute effects like eye irritation and excessive salivation to chronic diseases like cancer and reproductive and developmental disorders. 5 In Jammu, not many studies have been done on these issues. This study has been taken up to determine the awareness level and practices adopted by farmers in the Jammu district so that appropriate steps could be taken to raise awareness and programs could be planned to fill the gaps.

MATERIALS AND METHODS

This research is being carried out in the Jammu district of the UT Jammu and Kashmir. The district is divided into blocks. Five blocks are purposively selected where the KVK intervention is being going on. The cross-sectional data for this study are collected using a cluster sampling technique (because each block has a specific number of villages that form clusters). A total of 250 farmers are interviewed (50 farmers are interviewed from each block). A structured interviewed schedule was developed for this study to obtain the information regarding awareness, sources of information, reasons for pesticide usage and practices regarding safe pesticide usage. The demographic characteristics of the respondents are assessed using descriptive statistics, mainly through frequency distributions and percentages. The data was analysed through standard statistical methods.

RESULTS AND DISCUSSION

Table 1 represents that 40.8 per cent of respondents were over the age of 50, followed by 26.4 per cent of respondents in the 40–49 age group and 19.6 per cent of respondents in the 30-39 age group. The demographic of respondents aged 20 to 29 has the lowest percentage (13.2%). Regarding education, the majority of respondents (36.4%) in the sampled population are illiterate. Higher secondary and matriculation education came in second and third, with 30.4% and 22.4 per cent of respondents, respectively. Only 10.8 per cent of respondents are graduates or have higher education. Literate farmers comprehend the effects of pesticides on health and the environment better than illiterate ones, according to Rios-Gonzalez *et al.* (2013).

In Jammu, farming is the primary occupation, and the agricultural industry is a cornerstone of the state's economy. According to Table 1 data, farming is the sole occupation of 80.2 per cent of the respondents and 14.6 per cent of them also hold government jobs (clerical positions). The remaining respondents (3.2%) are identified as traders, with only 2% having other occupations. The majority of respondents (48.1%) have an annual income between 4 and 8 lakhs, followed by those with an income between 8 and 12 lakhs (23.2%), less than 4 lakhs (16.8%), and more than 12 lakhs (11.6%). Only a small percentage of respondents (11.6%) have an annual income over Rs. 12 lakh. The data shown in Table 1 show that roughly half of the respondents (51.6%) owned 5-8 ha of land, followed by those (24.4%) who had a landholding of 9–12 ha. Only 7.6 per cent of respondents had less than 4 ha of land under their ownership, compared to 16.4 per cent of those with more than 12 ha. A large percentage of the respondents (39.5%) had used pesticides for between 11-15 years. 32 per cent of respondents have between 16-20 years of experience using pesticides, while 20.2 per cent have more than 20 years of experience. Only 8.2 per cent of those surveyed have used pesticides for 5-10 years.

According to the responses shown in Table 2, the majority of respondents use pesticides to kill or eradicate weeds (91.6%), 95.2 per cent use them for insects and pest management, and 86.4 per cent use them to control diseases. According to research, weed infestations, insect and pest attacks, and disease outbreaks in field crops account for about 55 per cent of yield losses (Toxipedia.org, 2011). According to the aforementioned data, farmers are fully aware of the yield reductions caused by weeds, insects, pests, and diseases.

Table 2: Farmers' reasons for applying pesticides

Reasons for applying pesticides	No. of respondents	Percentage responses
To destroy/ eradicate weeds	229	91.6
To kill pest and insects	238	95.2
To control diseases	216	86.4

(N=250) multiple responses*

Table 1: Percentages response of the background profile of the respondents

Age of the respondents (Years)	20–29	30–39	40–49	> 50
Percentages (n)	13.2 (33)	19.6 (49)	26.4 (66)	40.8 (102)
Education level of the respondents	Illiterate	Matriculation	Higher Secondary	Graduation & above
Percentages (n)	36.4 (91)	22.4 (56)	30.4 (76)	10.8 (27)
Main Occupation	Farming	Trader	Govt. + farming	Others
Percentages (n)	80.2%	3.2%	14.6%	2%
Annual income (lakhs)	1-4	4-8	8-12	>12
Percentages (n)	16.8%	48.4%	23.2%	11.6%
Total land area (ha)	0-4	5-8	9-12	>12
Percentages (n)	7.6%	51.6%	24.4%	16.4%
Experience in using pesticide (years)	5-10	11-15	16-20	>20
Percentages (n)	8.4	39.6	32%	20%

(N=250) multiple responses*

The data about safe pesticide usage that the respondents learned from various sources is shown in the Table 3. In order to obtain information, the majority of respondents (72.8%) relied on retail store employees or pesticide distributors, indicating their dependence on retailers when making credit purchases. This may be a result of the respondents' low educational levels, as education is known to play a significant role in knowledge growth (Jensen *et al.,* 2011). Previous studies revealed that retailers lacked training and had inadequate knowledge of the toxicities of pesticides, their harmful effects, or safe spraying practices. About 19.6 per cent of farmers considered the government or any other agricultural authority a source of information, compared to 38.4 per cent of farmers who consulted other farmers. According to Rehman *et al.* (2013), farmers assisted other farmers in making pesticide selections and offered guidance on how to use and handle them safely. Only 10.4 per cent of respondents received information on safe pesticide usage from literature, and only 12.8 per cent used the Internet and media to obtain the latest knowledge regarding new pesticides and pesticide safety.

The majority of respondents (72%) state that they always buy pesticides for use on a single crop, while 13.2 per cent say they sometimes purchase pesticides to use on more than one crop, and 14.8 per cent say they buy pesticides as soon as they notice a pest attack on a specific crop and use them to address the problem. According to various studies on the opinions and knowledge of small landowners, common pesticide use practices in developing countries are unsafe, lead to health problems, and have a negative impact on the environment (Macharia *et al*., 2013; Abang *et al*., 2014; Damte and Tabor, 2015). Regarding the question of whether or not to store pesticides at home in a separate location, approximately 46 per cent of respondents indicated that they occasionally did so, 14 per cent that they always did so, and 40 per cent that they never did, indicating unhealthy practices. According to the findings of a study carried out in Tanzania by Lekei *et al.* (2014), the majority of respondents (81%) frequently kept their pesticides in residential rooms. According to Zhang and Lu (2007), farmers in China stored pesticides in bedrooms, granaries, and kitchens. The results of the current study show that the majority of participants (54%) do not read the written instructions on pesticide bottles or containers. This is due to the fact that most farmers lack literacy. 16.8 per cent of respondents said they always read the instructions, while 29.2 per cent said they sometimes read the instructions. According to Damalas and Khan (2016), 73 per cent of farmers did not read the pesticide instructions printed on the bottles or containers. Grey *et al.* (2006) found that the pesticide bottle labels were beneficial to farmers, but they were unable to read the instructions because of their lack of education (Shetty *et al*., 2010).

More than half (64.4%) responded that they don't wear gloves or masks for protection while applying pesticides, but 35.6 per cent said they always do so to protect themselves from direct pesticide exposure. According to Devi (2009), 80 per cent of Indian farmers kept their feet bare but covered their faces and heads with cloth. Only 15.2% of respondents mixed pesticides with their bare hands, compared to the majority (84.8%) who avoided doing so. Jintana *et al.* (2009) conducted research in Thailand and found that none of the respondents used personal protective equipment (PPE), and the majority of respondents (88.9%) mixed pesticides with their bare hands. This study also reveals that 68.4 per cent of respondents never use their mouths to clear a nozzle, in contrast to

Table 3: Respondents sources of information on safe pesticide usage

Information source on safe pesticide usage	No. of respondents	Percentage responses
Retail shop persons	182	72.8
Other farmers	96	38.4
Govt. Agriculture Department/ SAU/ KVKs	49	19.6
Literature provided by agriculture related authorities	26	10.4
Media and internet sources	32	12.8
Private distributers	77	30.8

(N=250) multiple responses*

Table 4: Percentage responses on awareness regarding safe pesticide usage

Awareness and behaviour pattern		Number of respondents	Percentage responses
Pesticide purchasing behaviour	Always for One crop	180	72
	Sometimes More than one crop	33	13.2
	Immediately purchase on pest attack	37	14.8
Pesticide storage at home in separate place	Always	35	14
	Sometimes	115	46
	Never	100	40
Read the instructions written on pesticide	Always	42	16.8
bottles/containers	Sometimes	73	29.2
	Never	135	54

(N=250) multiple responses*

31.6 per cent of respondents who occasionally do so to remove blockages. The study also reveals that 68.8 per cent of respondents use wires rather than their mouths to unclog nozzles when they become clogged. This indicates that they have a basic knowledge of pesticide safety.

In terms of wearing long clothing while spraying, the majority of respondents (81.2%) never do so and instead wear their regular clothing; only 18.8 per cent of respondents always do so. In Indonesia, a study by Sekiyama *et al.* (2007) found that most of the farmers smoked while applying pesticides and did not wear safety equipment, particularly respirators or masks, posing a serious threat to their health. According to Kachaiyaphum *et al.* (2010), 76 per cent of Thai farmers did not wear protective clothing, and about 75 per cent kept pesticides close to food. Similar findings were found in studies conducted in Turkey, the Philippines, Gaza, and Greece by Damalas *et al.* (2006), Isin and Yildirim (2007), and Yassin *et al.* (2002). About 54.8 per cent of respondents never wash their contaminated clothes separately, compared to the majority of respondents (45.2%) who do so. After spraying, about 20.4 per cent of respondents immediately take a shower, while the remaining 79.6 per cent never take a bath.

According to the respondents' eating and drinking habits, the majority of them (59.2%) do so while

Table 5: Responses of farmers regarding the practices adopted for safe pesticide usage

Respondents' practices regarding safe pesticide usage	Yes		No	
	Number	Percentage	Number	Percentage
Wear gloves and mask to protect hand and face	89	35.6	161	64.4
Mix with naked hands	38	15.2	212	84.8
Sometimes unblock the nozzle with mouth if needed	79	31.6	171	68.4
Use small wire to remove blockage	172	68.8	78	31.2
Wear safety long dress before starting a spray	47	18.8	203	81.2
Wash contaminated clothes in a separate load	113	45.2	137	54.8
Take shower after spraying	51	20.4	199	79.6
Eat and drink with or without washing hand with soap	102	40.8	148	59.2
Smoke during pesticide applications	133	53.2	117	46.8
Use empty container as a utensil for other purposes in the house	46	18.4	204	81.6
Dispose-off empty container according to the prescription	22	8.8	228	91.2
Pesticides stored in the animal shelter but in a separate room	120	48	130	52

(N=250) multiple responses*

spraying, with or without washing their hands. Only 40.8 per cent of them wash their hands first before eating or drinking anything. In the field, using hand sanitizer and washing your hands can help lower health risks (Coronado, 2012). Nearly all respondents showed good knowledge of this statement when asked about the use of empty pesticide containers for future use. Approximately 81.6 per cent of people assert that they never use empty containers at home. These results are at odds with those of Ibitayo (2006), who claimed that about 80 per cent of Egyptian farmers did not properly dispose of empty containers and instead kept drinking water in them. Only 18.4 per cent of respondents claim to occasionally use them on an animal farm.

The responses are not encouraging when it comes to the proper disposal of empty pesticide containers. Approximately 91.2 per cent of respondents never dispose of pesticide containers as directed but rather throw them away in the field and use them later. Only 8.8 per cent of people adhere to the disposal instructions written on pesticide bottles and containers. Pesticides were kept in a separate room in the animal shelter by more than half of the respondents (52%), but they were not kept in the same location by 48 per cent of the respondents. The data mentioned above indicates that farmers are hesitant to take the necessary precautions, and they attribute this reluctance to the difficulty of locating and the high cost of personal protection products, as well as the generally hot and humid weather. The responses were similar to those given by other developing nations.

CONCLUSION

Inappropriate handling of pesticides can have harmful effects on human health. To prevent the negative effects of pesticides, safety measures must be adopted and put into practice. The findings of this study indicate that middle-aged villagers are more involved in farming and agriculture than young people. Farmers frequently lack literacy, and as a result of their ignorance, they frequently rely on the advice of nearby farmers and do not receive information about bio-safety precautions from the Department of Agriculture and other government authorities like KVK and SAU's. The results of this study also show that farmers do not heed the advice of the extension service or the warnings on pesticide bottles and containers. Based on the findings of this study, it is suggested that more formal and informal educational initiatives as well as training in pesticide usage (Bio-safety) be planned to help farmers improve their knowledge and abilities and persuade them to adopt safety precautions.

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Engendering Entrepreneurship in Agriculture: Constraint Analysis and Conceptual Approaches

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ABSTRACT

Gender analysis in agricultural value chain provides comprehensive insights into the intervening points for developing a sustainable Gender-Sensitive approach for agri-entrepreneurship promotion and enhances our understanding about the Gender roles. The present study aims to comprehend the gender-based constraints in horticulture and dairy-based production systems along with gender-inclusive constraint analysis in agricultural value-chain development. The findings enabled in designing a Gender-Sensitive Extension Model for Entrepreneurship Development, which primarily focuses on fundamental aspects of self-actualization, breaking the glass ceiling and strengthening proficiency of farm women as the foundation for entrepreneurship promotion along with improving financial opportunities and market access through Institute-Industrial-stakeholder-linkage as a sustainable approach for sustenance of women agri-preneurship. The proposed model profoundly signifies the alignment of R & D organizations, primary stakeholders of agriculture (farm women) and Industries in order to establish a consistent linkage and a strong coherence for sustained engendering of agri-entrepreneurship.

Keywords: Gender, Agriculture value-chain, Entrepreneurship, Institute-Industry-stakeholder linkage

INTRODUCTION

The multiple dimensions in agriculture have encouraged several stakeholders to sustain their livelihoods. A huge gap in profit realization is witnessed amongst the various levels of stakeholders, primarily due to lack of institutional mechanism, appropriate policy and infrastructural support. As a result, the primary producers, even though pivotal in production, often sustain and foresee the ultimate loss with minimum profit realization. At this backdrop it is pertinent, to state that the poor marginal and women farmers are often the most vulnerable

communities who often face paramount intensities of gender discrepancies, livelihood instabilities, food and nutritional insecurities and hence often fall into the vicious circle of poverty. It's crucial to transform conventional agriculture into commercial venture through engendering entrepreneurship in agriculture by mainstreaming women farmers into commercial farming needs a focused approach which would involve analysis of their constraints and designing of structured orientation at grass root and community level through multi-stakeholder convergence (Das *et al.*, 2020). Realizing the potential of women farmers, it is pertinent to tap their full potential by acknowledging their strengths, working upon their weaknesses, providing them with ample opportunities and mitigating their threats (Srivastava *et al.*, 2020). Against this backdrop, the present study was conducted with the objectives to examine and document the gender-based physico-technological constraints in Horticulture and Dairy-based sectors, constraint analysis in value-chain development in Agriculture and formulation of conceptual approaches for engendering agri-entrepreneurship. Considering the profitability in Horticulture and dairy-based production system and substantial involvement of farm women, the sectors were chosen for gender-based constraint analysis. Since value chain development is pivotal for agri-entrepreneurship development, gender-inclusive constraint analysis in it provided the fundamental inputs

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for conceptualizing a framework/approach to institutionalize women agri-preneurship development. The study was undertaken at Khorda, Cuttack, Puri and Dhenkanal districts of Odisha. The sample comprised of 120 farmers (60 male farmers and 60 farm women), chosen through snow-ball sampling technique. The research instruments required for the study comprised of questionnaires and interview schedules, which were prepared on the basis of extensively collected secondary literature, focused group discussions and in-depth household surveys.

The constraint and situational analysis helped in formulating a structured framework by integrating all the stakeholders in the research and developmental outlay. The channels for entrepreneurship development through industry linkage were mapped by exploring the possible contributory interventions by each relevant stakeholder. The major functions of all stakeholders were sorted and a matrix was designed to develop the farm women agri-entrepreneurship framework, which will serve as the base for mapping and assessing the effectiveness of entrepreneurship development. Table 1 represents the 'Physico-technological constraints in Horticulture-based production system' as observed among the sample respondents from 4 districts of Odisha.

The gender-based constraint analysis indicated that women face more constraint than men with respect to various physico-technological constraints in Horticulture-based production system. Amongst all the identified constraints, men reported 'Inadequate market access' as a major constraint, which results in failure of assured profit realization in horticulture based production. While, for farm women, the major concern was 'huge post harvest losses', followed by 'insufficient post-harvest infrastructure' and 'inadequate market access'.

Table 1: Physico-technological constraints in horticulture-based production system

Physico-technological constraints	Men (%)	Women (%)
Unavailability of quality planting material	42.44	72.45
Inadequate farm tools and implements	35.67	85.33
Lack of knowledge on improved production technologies	40.32	80.77
Inadequate post-harvest infrastructure	55.21	90.23
Post-harvest losses	50.35	95.14
Inadequate market access	68.77	88.33
Poor linkages with agro-based industries	44.55	78.67
Mean	48.19	84.42
Standard deviation	11.12	7.69

Table 2 illustrates the gender-based physico-technological constraints in dairy-based production system. The major constraint perceived by both men and women is 'insufficient dairy-based industry linkage', followed by poor infrastructure facilities in shed management of dairy cattle. Additionally, for farm women, 'poor assured market', inadequate fodder availability'; followed by 'inadequate knowledge on improved management techniques' are some of the significant constraints.

Table 2: Physico-technological constraints in dairy-based production system

Physico-technological based constraints	Men (%)	Women (%)
Unavailability of good breed of dairy cattle	40.43	50.34
Inadequate fodder availability	45.67	65.23
Poor infrastructure facilities	50.23	70.77
Inadequate knowledge on improved management techniques	44.66	60.65
Irregular milk production	35.77	45.33
Poor assured market	42.33	66.67
Insufficient dairy-based industrial linkage	75.56	85.33
Mean	47.81	63.47
Standard deviation	13.04	13.25

Table 3 represents constraints in value-chain development in Agriculture Sector. The major constraint perceived by both men and women in value chain development is 'Inadequate access to market and industries'. Additionally, farm women perceived 'Insufficient capacity and skill development', followed by 'Poor access to innovative and improved technologies' and 'Economical constraints' as some of the major constraints in value chain development in Agriculture sector. The proportion of farm women perceiving constraints in various aspects in value-chain development in Agriculture sector is quite high in comparison to the male farmers. The entrepreneurship development in agriculture is primarily focused on

Table 3: Constraint in value-chain development in Agriculture Sector

Constraints	Men (%)	Women (%)
Socio-cultural	22.33	65.67
Poor access to innovative and improved technologies	52.67	75.45
Insufficient capacity and skill development	45.45	80.23
Economical constraints	42.33	75.33
Policy implication	40.37	68.46
Inadequate access to market & industries	65.43	95.16
Mean	44.76	76.72
Standard deviation	14.27	10.45

development and strengthening of value chain. Hence constraint analysis in this aspect will provide an insight into the intervening points required for promoting Agripreneurship among farm women.

The Figure 1 represents the Principal Component Analysis (PCA) map exhibiting the degree of association between the variables (Physico-technological based constraints) in Horticulture-based production system with the respondent's response. It is clearly evident that men find 'Inadequate market assess' as the prioritized constraint and women finds 'post-harvest losses' and 'inadequate post-harvest infrastructure' as the major concern as illustrated by the proximity of the variables with the respondents in the bi-plot (Figure 1).

The Figure 2 represents the Principal Component Analysis (PCA) map, illustrating the degree of

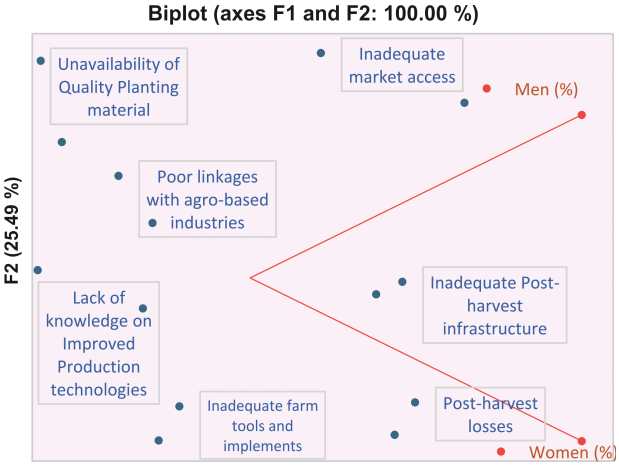

Figure 1: PCA map showing relationship among respondents with constraints in Horticulture-based production system

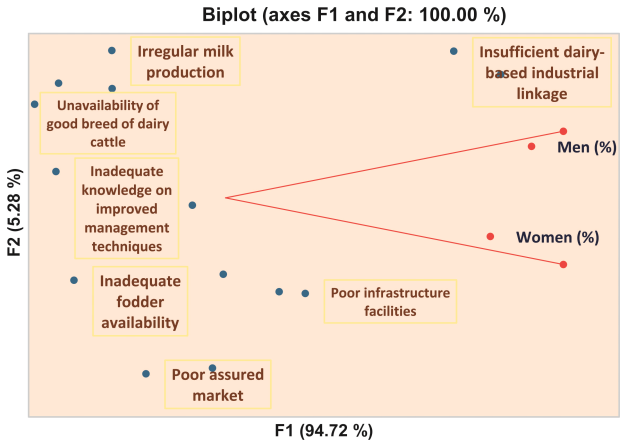

Figure 2: PCA map showing relationship among respondents with constraints in Dairy-based production system

association between the constraints in dairy-based production system with the response of respondents (men and women). It is evident that both men and women perceived 'insufficient dairy-based industrial linkage as the major constraint in dairy. Additionally, the bi-plot (Figure 2), illustrates the grouping of these constraints into 4 quadrants, indicating a commonality in the degree of perception with respect to various constraints. Joint response of both men and women has placed unavailability of good breed of dairy cattle and irregular milk production into one cluster. Likewise the clustering of inadequate knowledge on improved management techniques, inadequate fodder availability and poor assured market indicates cohesion in opinion of both men and women.

The Figure 3 represents the Principal Component Analysis (PCA) map indicating the correlation between

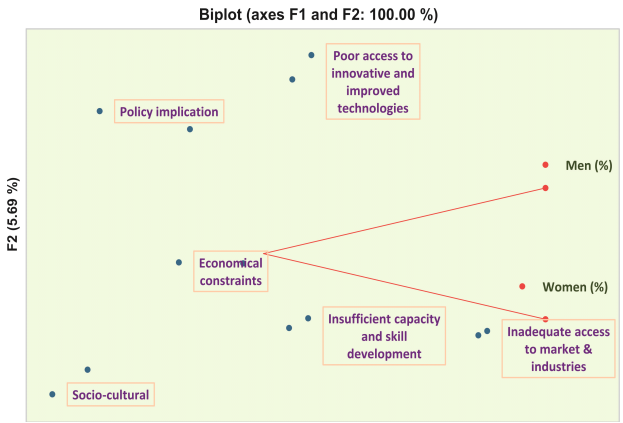

Figure 3: PCA map showing relationship among respondents with constraintsin value-chain development in Agriculture Sector

the constraints and view of both men and women farmers. As illustrated from the bi-plot, inadequate access to market and industries is the major perceived constraint by both men and women farmers. The grouping of variables indicate that socio-cultural and economical constraints appear to have some degree of positive association as they are grouped in one quadrant, while policy implication and poor access to innovative and improved technologies appear to be distinct as they are placed singly in two separate quadrants.

A 'Gender Sensitive Extension Model for Entrepreneurship Development' (Figure 4) was designed, keeping in view the gender-based constraints faced in agriculture. The model focuses a step-wise orientation of women farmers to women agripreneurs through initial process of '*self-actualization*', which focuses on believing the inner strength, coupled with a gender-friendly environment, which promotes the women farmers '*through breaking the glass ceiling'* of gender stereotypes and gender biases which are layered within the societal norms and regulations. ICAR-CIWA, Bhubaneswar which is in the forefront of such developmental initiative along with NGO partners and women groups can help in adequate gender-sensitization at grass root level. McClelland *et al.* (2005), categorized positive factors *viz.,* self-achievement, self-fulfillments the '*factors of choice'*, while the negative factors *viz.,* redundancy, unemployment and the prevalence of the glass ceiling, which cause developmental blocks should be obligatorily eliminated and were designated as '*factors of necessity'*.

The next developmental segment of the model focuses on '*Strengthening Proficiency*', which includes empowering women farmers with best agricultural practices, processing technologies, managerial abilities and entrepreneurial skills to re-define their roles and to help them to evolve as innovators with strategic outlook towards agri-business output. The aspects of self-actualization, breaking the glass ceiling and strengthening proficiency of farm women are considered as the foundation for entrepreneurship promotion among farm women. In addition, adequate policy support to supplement women farmers in form of Govt. schemes and subsidies should be facilitated through cooperative efforts of all R & D stakeholders. Provisioning of finance is a critical step to promote agri-ventures, especially for women farmers. In this model, NABARD and other co-operative banks were one of the significant stakeholders to assure financial assistance.

The culminating point of the model '*Market access'* was based upon industrial link through '*Institute-Industrial-stakeholder-linkage',* as the ultimate focal point for agri-preneurship sustenance among the women farmers. The proposed model profoundly signifies the alignment of R & D organizations, primary stakeholders of agriculture (women farmers in this case) and Industries in order to establish a consistent linkage and a strong convergence among all the stakeholders. In our study, the major stakeholders involved comprised of Research Organizations (ICAR institutes/ SAUs); Developmental organizations mostly Govt. based- APICOL (The Agricultural Promotion and Investment Corporation of Odisha Limited), OFMRDC (Odisha Farm Machinery Research and Development Centre), State Line Dept; financial institutions (NABARD and other Nationalized banks); NGOs (Nigam and Pradan); Women Farmer Groups and Producer Organizations: Women group OMFED (Orissa State Cooperative Milk Producers' Federation Limited), Ananya MahilaBikas Samiti, Paschimeswar WFPO and Women group ICARDA (International Center for Agricultural Research in the Dry Areas) and private Industries (Milk Mantra Dairy Industry, Kamal Enterprises, Art of Organic and Unicus Engineers Pvt. Ltd. and Odisha Milk Federation (OMFED).

Mattis (2004) reported that the number of women entering the agriculture workforce and becoming entrepreneurs has increased dramatically, however, agri-preneurship can be at stake due to lack of flexibility in system, lack of access to entrepreneurial opportunities and failure of organizational coherence to sustain and credit women's contributions. The developed Gender-Sensitive Entrepreneurship model is based upon collaboration among all the stakeholders, solely for the purpose of creating a gender-friendly environment to perpetuate the sustainability of women agri-entrepreneurship, in addition to mitigate the intricacies in agri-venture sustenance by overcoming the front-ended and back-ended challenges. The collective coherence amongst the collaborators will also enable in maintaining a continuous supply and demand chain,

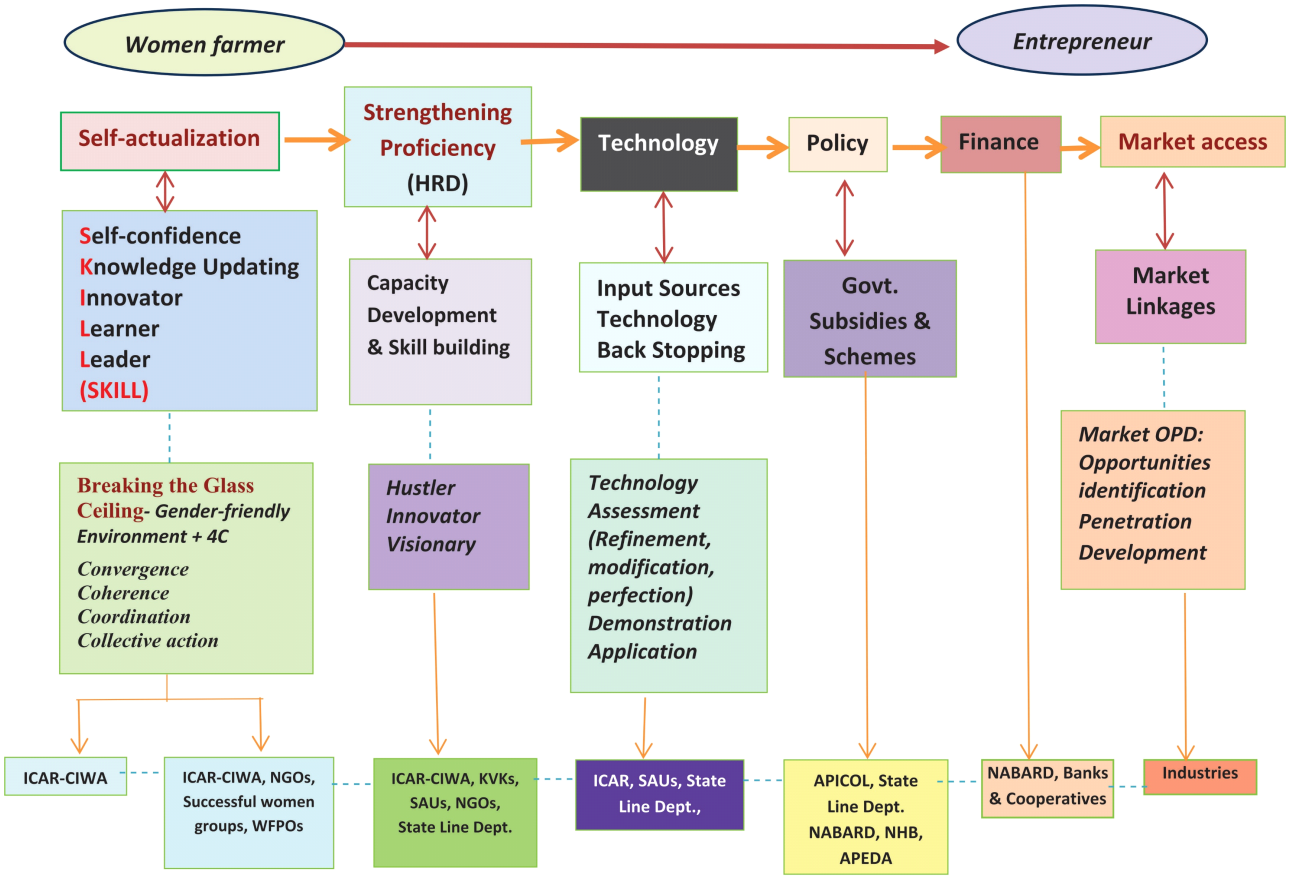

Figure 4: Gender Sensitive Extension Model for Entrepreneurship Development

APEDA: Agricultural & Processed food Products Export Development Authority
APICOL: The Agricultural Promotion and Investment Corporation of Odisha Limited
HRD: Human Resource Development
ICAR-CIWA: Indian Council of Agricultural Research- Central Institute for Women in Agriculture
KVKs: Krishi Vigyan Kendras
NABARD: National Bank for Agriculture and Rural Development
NGOs: Non-Governmental Organizations
NHB: National Horticulture Board
SAUs: State Agriculture Universities
WFPOs: Women Farmer Producer Organization

with women farmers as primary producers, agro-based industries as the final absorbers of production and other R & D organizations as facilitators in maintaining demand-supply continuum.

CONCLUSION

The 'glass ceiling' at each developmental step acts as the invisible barrier that block women from the leadership positions and prevent them from moving into the entrepreneurial levels. For bringing economic sustainability, it is pertinent to address the needs of both the gender. The Gender-Sensitive Extension Model for Entrepreneurship Development which is designed upon the critical developmental blocks for women agri-entrepreneurial promotion advocates a significant Institute-Industry-Stakeholder linkage as a key aspect to sustain entrepreneurial prospects among women farmers. The model can be useful to researchers, policy makers, extension workers and other stakeholders working in the field of women agri-preneurship.

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Consumer Acceptance About Millet Biscuits in Social Welfare Schools

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ABSTRACT

Millets are gaining popularity among the consumers. They are considered as nutritious and treasure house of many health benefits. Government of India proposed budget to these millets as nutria- cereals and encouraging millet production. Millet food entrepreneurs are also trying to promote and commercialize different millet-based products, thereby increasing the consumption of millets and ensuring nutritional security of the consumers. PJTSAU has taken up a unique initiative role to promote millets among different consumer groups by manufacturing different kinds of food products. With specific reference to the growing children, PJTSAU included few millet products like biscuits in the diet chart of 400 social welfare schools in Telangana. Based on the level of awareness regarding benefits of millet biscuits, maximum respondents (91.6%) were aware and only least proportion of sample (8.33%) were not aware. Level of acceptance regarding millet biscuits revealed that 62.50 per cent of the respondents were expressed average followed by 25 per cent high acceptance and very few (12.5%) were felt low level acceptance.

Keywords: Millet, Consumer, Awareness, Acceptance, Health and Social welfare schools

INTRODUCTION

In the world millet production was estimated at 27.8million tons. India is the largest producer with 41.04 per cent global market share. Food and nutritional security are the major challenges in developing countries like India and Africa, where Millets are highly popular. During 2019-2024, worldwide milletconsumption has declined at a rate of 0.9 per cent and India dominates global production while Africa dominates global consumption. In India, currently the Millet production is more than 50 per cent (Global research and markets, July 22, 2019). In India to encourage the millet production, Government proposed budget to the millets as nutria-cereals. Therefore, a Research study on "Consumer Acceptance about Millet biscuits in Social Welfare Schools" was taken up to understand consumer awareness about millet biscuits and to analyze the consumer acceptance in social welfare schools. To ensure nutritional security of the consumers and also to commercialize various millet-based products, the food entrepreneurs are trying hard to increase the consumption of Millets (Sulthana, 2014).

In China, India and other Asian countries Foxtail millet (*Setaria italica*) is generally grown as a rain- fed crop in India, besides China and Bangladesh. It is also called as tenai, kakun, kangni and navane. It is the major crop cultivating for food as well as feed and used as part of ayurvedic and unani products by the practitioners. It is non-glutinous, and non-acidic food, possesses the larger amount of proteins and minerals acts as a functional food ingredient and good supplementary protein source to most cereals, due to its high lysine, fibre content mostly known as easily digestible food (Sharma, 2015).

Millet production is popular in developing regions like India and Africa. It is essential to revert to traditional Telangana diet of millets to alleviate nutrition problems. The Professor Jayashanker Telangana State Agricultural University (PJTSAU) found that the result based on a

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study of "*Food consumption pattern in Telangana state*" as millet consumption is low at 0.03 per cent and 0.06 per cent of the total cereal consumption in urban and rural areas of Telangana respectively. According to the NIN, balanced diet is one that provides 40-60 per cent energy from Millets and rest from other cereals (*THE NEW INDIAN EXPRESS,* 2019). In order to address malnutrition issues with specific reference to the growing children, in Telangana - PJTSAU included few millet products like biscuits, cookies and vermicelli in the diet chart of nearly 400 social welfare schools. PJTSAU took initiative to promote and build awareness about millets and its nutritional benefits among consumers by manufacturing different varieties of food products by supplying snacks to TSWREIS (*The Hindu, 2017*).

Low awareness and habit of inculcating millets in our daily diet was less which might be a reason for low consumption of millets. Consumption of millets must be inculcated during childhood to avoid many health-related issues. The focus of the festival is to sensitize urban and rural communities to the benefits of incorporating millets into their daily diet and create market linkages for farmers producing these crops. The Millet Fest- 2013, 2014 and 2015 were organized by the Department of Agriculture, Government of Telangana, College of Home Science in collaboration with Prof. Jayashankar Telangana State Agricultural University (PJTSAU).

Awareness campaigns are being conducted regularly by the College of Home Science, Prof. Jayashankar Telangana State Agricultural University, Hyderabad, the rural and urban communities on the virtues of including millets in daily diet and ways to develop markets for millet farmers. The College of Home Science regularly performs research to create millet-based processing technologies for snack and meal items to promote consumption among rural women. Mostly in rural areas women were not aware of their health issues caused during menstruation period and pregnancy phase. Pregnancy and lactating women are well advised to consume millets to increase the production of breast milk. It leads to a healthy life for both mother and child. It is necessary to disseminate the lessons learned on millets to wider national and international audiences. This study helps us to know about the importance and consumer awareness about millets and its need for the present human to lead a healthy life.

Millets are minor cereals containing high nutritional value but its consumption is limited due to the lack of ready-to-eat or ready-to-cook foods. To improve its nutritional and economic value, processing of millets is best alternative to prepare RTC foods. In the world among most important cereals ranging from wheat, maize, rice and barley, Millet possess fifth place. Millet grains are used for traditional and novel foods as they are highly palatable and good for health (Devi and Sangeetha, 2013).

MATERIALS AND METHODS

Exploratory Research Design was adopted to conduct the study. Exploratory research design was conducted for a research problem when the researcher has no past data or only a few studies for reference. The Hyderabad and Nagarkurnool districts of Telangana state, both urban and rural areas. Multistage sampling technique was used for the study as investigator was familiar with the local language, which would help to build good rapport with respondents of the study and enables to conduct the survey efficiently. A total of one hundred and twenty students i.e., from Shaikpet - 30, Mahendrahills - 30, Achampet -30 and Mannanur -30 were selected in Hyderabad and Nagarkurnool districts to study the consumer acceptance and satisfaction of milletbiscuits in TSWREIS. The key informants for the study were the students.

The data was coded, tabulated and analyzed through percentages and Correlation test. The relationship between different independent and dependent variables was interpreted through the data that was collected through the interview schedule. Statistical analysis was carried out to find out the relationship and associations between the variables. The data thus collected was coded and analyzed with the help of the following Statistical methods. Frequency was used to know and understand the distribution pattern of the respondents according to the variables. Some of the data were subjected to frequencies and percentages and it is used to know the distribution of respondents according to their variables. Correlation test used to evaluate the potency of relationship between two quantitative variables. It is used mainly to quantify the degree to which two variables are related.

RESULTS AND DISCUSION

This chapter highlights the findings of the investigation and their interpretation. After collecting the data with regard to the objectives, profile characteristics of students, awareness and consumption level in relation to millet biscuits. Reasons were presented for acceptance was analyzed and tabulated. The results thus obtained are presented, along with interpretations under the following sections.

General profile of the students: This section deals with the findings and discussion regarding the profile characteristics of the respondents from two districts in Telangana. This refers to the information like education, occupation and monthly income of the head of the family. Profile also includes age and gender of the students; education, family type and family size. Distribution of the respondents under different categories was based on their profile characteristics were presented in the Figure 1.

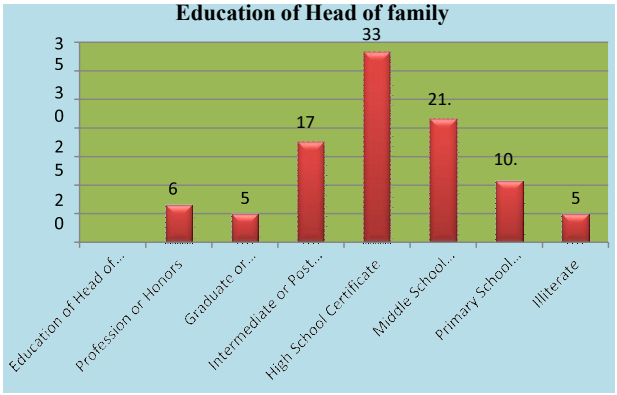

Figure 1: Distribution of respondents according to the education of the head of the family

The Figure 1 revealed that one third (33.30%) of the head of the families had education up to high school level followed by Middle School level (21.60%), Intermediate or Post High School Diploma (17.50%), Primary School level (10.80%), Profession or Honors (6.60%), Graduate or Postgraduate (5.00%) and only negligible proportion were Illiterates (5.00%).

From Figure 2, it is shown that one fourth of the head of the families were semi-skilled workers followed by (22.5%) clerical/shop-owners. More or less an equal percentage of respondents were (16.6%) skilled and (14.16%) unskilled workers, very less percentage were (9.16%) unemployed, (7.5%) semi-

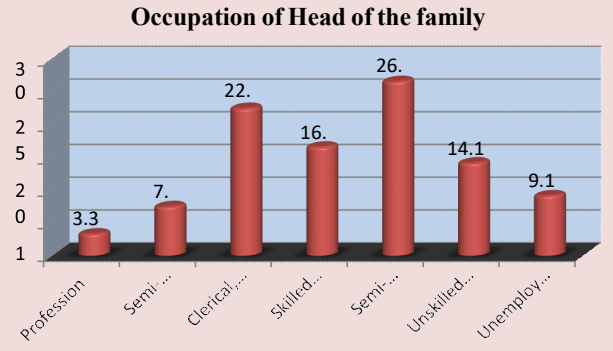

Figure 2: Distribution of respondents according to the occupation of the head of the family
(App Table. B - Kuppuswamy Scale, 2020)

professionals and only the negligible percentage were professionals (3.33%).

From the Figure 3, Monthly income of the family was calculated by considering the income of all the earning members. It indicates that nearly 40 per cent of the families were earning Rs. 20,000-50,000 pm and one-third of them were (30.83%) earning less than Rs. 20,000 pm while 15.83 per cent were earning greater than Rs. 1,00,000 pm and negligible proportion (14.16%) of the families were earning Rs. 50,000-1,00,000 pm.

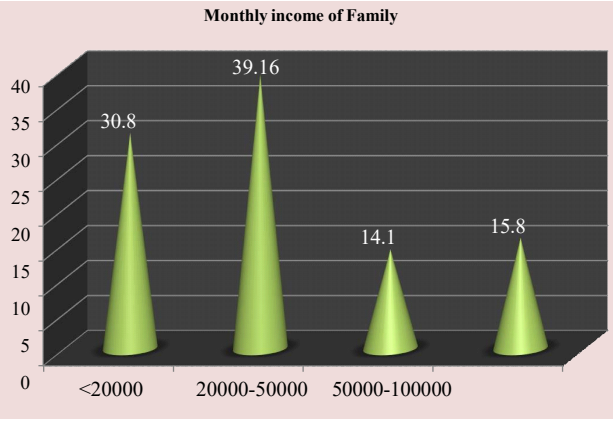

Figure 3: Distribution of respondents according to the monthly income of the family

Socio economic status was classified as upper, upper middle, lower middle, upper lower and lower class with their respective values as given in Kuppuswamy scale (Sharma, 2017). The Figure 4 concludes that majority of the families (47.5%) were from upper lower class followed by lower middle (45%), upper middle (5%) & only 2.5% families were from lower class & none of them belonged to upper class.

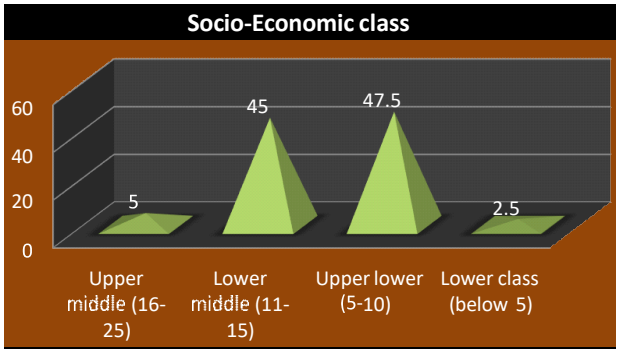

Figure 4: Distribution of respondents according to the socio-economic status of the family
(App Table. B - Kuppuswamy Scale, 2020)

From the Table 1, age of the students selected for the study was ranged between 12 to 19 years. Based on their age, the respondents were categorized into two categories namely 12-15 years and 16-19 years. Equal proportion of the respondents (50%) belonged to 12-15 years and 16-19 years. The data presented in Table 1 indicates that the educational level of the respondents was classified into two categories namely secondary school (8th class) and college (Intermediate

Table 1: Distribution of respondents according to their profile information (N=120)

Age (years)	Frequency	Percentage
12-15 years	60	50.00
16-19 years	60	50.00
Total	120	100.00
Educational level		
Secondary School	60	50.00
College Education	60	50.00
Total	120	100.00
Gender		
Male	60	50.00
Female	60	50.00
Total	120	100.00
Family type		
Nuclear	100	83.30
Joint	20	16.60
Total	120	100.00
Location		
Urban	60	50.00
Rural	60	50.00
Total	120	100.00

I[st] year) students. About half (50%) of the respondents belonged to secondary school education and the other half (50%) were studying in junior college. Thus, the data in the above table reveals that all the respondents were educated. TSWREIS provided millet biscuits as snacks for students because the students knew the importance of Millet biscuits as they were consuming millet biscuits regularly. The sample consisted of both male and female students. Equal number of male (60) and female (60) students were included in the sample. Thus, the sample consisted of fifty per cent of male and fifty per cent of female respondents. The findings of the study were similar with the study conducted by Jayawardana *et al.* (2020) who studied about consumer awareness and preference towards finger millet in Sri Lanka found nearly 45.4 per cent male and 54.6 per cent female in his study.

Based on the type of the family, the respondents were classified into two categories namely nuclear families and joint families. It is evident from the above Table 1, that 83.3 per cent of the respondents belonged to nuclear families while 16.6 per cent were joint families. The minimum number in nuclear families were 2 members and maximum 5 members, while joint families had minimum 6 members and maximum of 15 members. Based on the location, the sample was classified into two categories namely Urban (Hyderabad district) and Rural (Nagarkurnool district) respondents. The data presented in table indicates that equal percentage of sample belonged to urban (50%) and rural (50%) areas.

General awareness regarding millet products: This section deals with the findings and discussions regarding the awareness about Millet products. General awareness about millet products includes awareness level of millet products, knowledge about availability of millet products in market, aware of benefits of millet biscuits and millet products and source of information.

It was evident from Table 2, that the respondents were aware of various millet products like biscuits (100%), roti (90.8%), flour (87.5%), laddu (86.6%), murukku (73.3%), rawa (19.16%), rusk (16.6%), cookies (15%), flakes and ragi bites (11.6%), muffins (10.8%), vermicelli (7.5%), millet smoothix (4.16%) followed by negligible proportion knew about cakes (3.33%). Contrary to these findings, Jayawardana *et al.* (2020)

Table 2: Distribution of respondents according to the general awareness regarding millet products (N=120)

Aware of millet products*	Frequency	Percentage
Rusk	20	16.60
Cakes	4	3.33
Biscuits	120	100.00
Cookies	18	15.00
Muffins	13	10.80
Laddu	104	86.60
Flour	105	87.50
Roti	109	90.83
Muruku	88	73.30
Vermicelli	9	7.50
Rawa	23	19.16
Millet flakes	14	11.60
Ragi bites	14	11.60
Millet smoothix	5	4.16
Aware of benefits of millet products*		
High protein content	43	35.83
Lowers high blood pressure	18	15.00
Good for Diabetics	107	89.10
More fiber content	103	85.80
Gluten free and non-allergic	7	5.80
Rich in minerals vitamins	101	84.10
Sources of information*		
Family	69	57.50
Neighbors /Friends	18	15.00
Exhibitions	14	11.60
Publicity In T.V &Newspaper	105	8.00
Any Other (school/hostel)	110	91.60
Knowledge about availability of millet biscuits		
Yes	21	17.50
No	99	82.50
Total	120	100.00
Aware of benefits of millet biscuits		
Yes	110	91.60
No	10	8.33
Total	120	100.00

*Total exceeds cent percent due to multiple responses

stated that only 33.9 per cent of the respondents were aware of the finger millet flour incorporated food products available in the market. Data about awareness on benefits of millet products Table 2 revealed that 89 per cent perceived those millets were good for diabetes, as they had high fiber content (85.8%), rich in minerals and vitamins (84.1%), had high protein content (35.83%), lowers high blood pressure (15%) and were gluten free and non-allergic (5.8%).

The sources of information regarding millet biscuits were classified into five categories. Maximum respondents (91.6%) got information about millet biscuits from school/hostel, 57.5 per cent from family, 15 per cent from neighbors/friends, 11.6 per cent from exhibitions and only 8 per cent through publicity in T.V and newspaper. However findings reported by Harshitha and Jayaram (2019) revealed that 62.52 per cent were aware through newspapers/magazines, 48 per cent from by friends/relatives and only 43 per cent through TV/radio advertisements.

The Table 2 showed that more than half (82.5%) of the respondents were doesn't have knowledge on availability of millet products in the market. Based on the level of awareness regarding benefits of millet biscuits, maximum respondents (91.6%) were aware and only least proportion of sample (8.33%) were not aware. Jayawardana *et al.* (2020) concluded that 57.5 per cent of the respondents were aware of the nutritional benefits of finger millet.

Consumption pattern regarding millet biscuits: This section deals with the findings and discussions regarding the consumption pattern of millet biscuits. It includes period of consumption, preference about meal pattern for millet consumption, frequency of consumption, number of millet biscuits consumed per day and the constraints faced while consuming.

The period of consumption was classified into four categories namely below one year, 1-3 years, 3-6 years and above 6 years. Table 3 showed that 60 per cent of the respondents consumed for 1 to 3 years and 38.3 per cent of the respondents consumed for 3 to 6 years followed by consumption below one year were by very minor proportion i.e., 1.6 per cent. Period of consumption above six years was nil as supply of millet biscuits was delayed from 2020 due to Covid pandemic. Maximum (95.83%) preference about meal pattern for millet consumption was snacks and only few (4.16%) preferred millets as breakfast item. None of the respondents preferred millet products in their dinner. Frequency of consumption was classified into

Table 3: Distribution of respondents according to the period of consumption of millet biscuit (N=120)

Period of consumption	Frequency	Percentage
< 1 year	2	1.60
1-3 years	72	60.00
3-6 years	46	38.30
>6 years	-	-
Total	120	100.00
Preference about meal pattern for millet consumption		
Breakfast	5	4.16
Snacks	115	95.83
Dinner	-	-
Total	120	100.00
Frequency of consumption		
Daily once	-	-
Weekly twice	6	5.00
Once in a week	97	80.80
Once in a month	17	14.16
Total	120	100.00

four categories namely daily once, weekly twice, once in a week and once in a month. Results revealed that 80.8 per cent of the respondents were consuming millet biscuits weekly once and little more than one-tenth (14.16%) were consuming monthly once. Further analysis showed that only few (5%) of the respondents was consuming millet biscuits weekly twice. None of the respondents were consuming daily thus supported by the study of Jayawardana *et al.* (2020).

Number of biscuits consumed per day was categorized into four patterns i.e. 5-10 biscuits, less than five biscuits, greater than ten biscuits and not preferred. Among all the respondents 85.8 per cent of the respondents were consuming less than five biscuits per day and only 14.16 per cent were consuming nearly 5-10 biscuits per day (Figure 5).

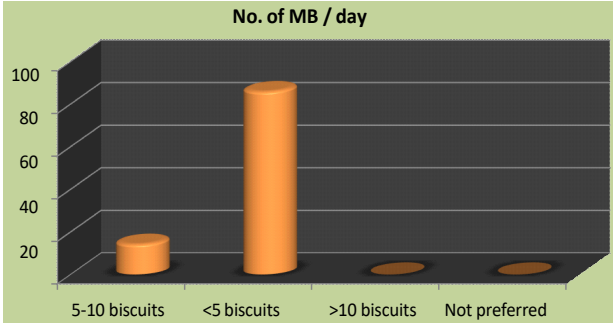

Figure 5: Distribution of respondents according to the frequency of consumption

Though the production and supply of biscuits possibly good, there could be little constraints faced while consuming millet biscuits i.e. most of the respondents (89.16%) were not aware, 83.3 per cent were facing non availability, 80.83 per cent of the respondents were facing limited recipes as one of the constraints, 12.5 per cent of the respondents felt that non acceptability by children was also a constraint. Very few (8.3%) of them stated that millet biscuits were expensive and a negligible proportion (5%) of the respondents expressed that poor taste as a constraint in consuming millet biscuits (Figure 6).

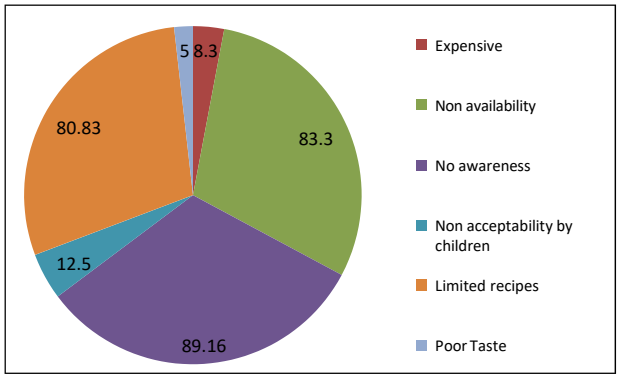

Figure 6: Distribution of respondents according to the constraints faced in availability

Factors influencing the acceptance of millet biscuits: Statements pertaining to the factors influencing the acceptance of millet biscuits were framed mainly to understand the factors or reasons that make the users to consume. This section primarily dealt with the factors for the acceptance of millet biscuits. Different factors for the acceptance of millet biscuits were elicited from the review of literature. The factors identified were health benefits, good taste, influence of neighbors and friends, interest towards innovative products, part of traditional diet, doctor suggestion, seller's promotional activities and interest towards new products. It also included product prices regarding millet biscuits and general maida biscuits.

Factors that have contributed to consume millet biscuits were discussed under Table 4, respondents were asked to report on a three point continuum scale i.e. high priority (3), medium priority (2) and low priority (1). Each point on the scale carried a score. These score

Table 4: Distribution of respondents according to the factors influencing the acceptance of millet biscuits

S.No.	Factors	High Priority (3)	Medium Priority (2)	Low Priority (1)	Total Score	Mean	Rank
1.	Health benefits	69	48	3	306	2.55	III
2.	Good Taste	100	20	-	340	2.83	I
3.	Influence	81	29	10	311	2.59	II
4.	Interest towards innovative products	2	69	49	193	1.60	VII
5.	Part of traditional diet	61	30	29	272	2.26	V
6.	Suggested by doctor	1	7	112	129	1.07	IX
7.	SellersPromotional activities	2	12	106	136	1.13	VIII
8.	Interest towards new products	7	88	25	222	1.85	VI
9.	Price of millet Biscuits	54	51	15	279	2.32	IV

values were not printed on the instrument but they were shown here just to indicate the scoring pattern. Each statement was scored by 120 respondents on a 3 point scale. The maximum score earned on that statement was 120x3=360 i.e. high priority and minimum score earned on each statement was 120x1 =120 i.e. low priority.

Hence, the score for each statement would fall between 120 and 360. Ranking was given to each statement based on the total score of that statement. The total score was calculated on each statement separately by multiplying the score with the number of responses on all three categories and added up. Each statement's mean score was also calculated by dividing the total score with 120 respondents. The same method was followed for each statement thus, for all the eight statements mean was calculated.

The results revealed that good taste was the factor that ranked as high (1st rank) for acceptance millet biscuits by the respondents. The most significant factor for consuming millet biscuits by influence of neighbors and friends (2nd rank), health benefits (3rd rank). The least important factor for consuming millet biscuits quoted was consumption as per doctor suggestion. Harshitha and Jayaram (2019) reported that average garret's ranking using the score i.e. 1st rank for health value (70.10), followed by nutritional value (64.80), brand (52.65), low price (46.50) and traditional consumption (36.03). Most of the respondents mentioned that millet biscuits price was high compared to general maida biscuits.

Table 5: Distribution of respondents according to the overall consumer acceptance in relation to millet biscuits

Category	Level of acceptance	F	%
>23	High	30	25.00
20-22	Average	75	62.50
Upto 19	Low	15	12.50

This section deals with the findings and discussion regarding the level of acceptance about millet products. Level of acceptance was calculated by considering frequency of consumption and factors influencing the consumption of millet biscuits.

Scores obtained on these two parameters was added up for each respondent. Thus the possible acceptance score that can be obtained by each respondent ranges between 10 and 32. However maximum and minimum scores obtained by the sample were 25 and 18 respectively. Based on maximum and minimum score, level of acceptance was categorized into three levels i.e. High, average and low acceptance. It is evident from Table 5, Level of acceptance regarding millet biscuits revealed that 62.50 per cent of the respondents were expressed average followed by 25 per cent high acceptance and very few (12.5%) were felt low level acceptance. The relationship between the scores of independent variables and acceptance level of the students was tested by alternate hypothesis. To facilitate the relationship between independent variables and acceptance level of the students, correlation coefficient, "r" values were computed and values were presented in the Table 6.

Table 6: Correlation between independent variables and dependent variable i.e. Acceptance level of the students

Independent variables	'r' value - Acceptance level of the students
Age	0.21 S*
Education	0.21 S*
Gender	-0.16 NS

S* = Significant at 0.05 level of probability NS = Non-significant

It was evident from Table 6, that coefficient of correlation of acceptance level of the students with the age and education was found to be r = 0.21 S*, which was more than the table value of "r" (0.172) at 5% level of significance. Hence the alternate hypothesis was accepted. Therefore, it can be concluded that there was a negative and significant relationship between the age, education and acceptance level of the students regarding millets biscuits. Perhaps due to increase in age and education, increases the increase in exposure might occur and knew about healthy food items, due to which millet acceptance increases. From the Table 6, it could be observed that the coefficient of correlation of acceptance level of the students with the gender was found to be r = -0.16 NS, which was less than the table value of "r" (0.172). Proving that alternate hypothesis was rejected. Hence, there was no significant relationship between the gender and acceptance level of the students regarding millets. Thus acceptance level was not depending on gender of the student. It might be due to the supply of millet biscuits by school was done equally for the genders.

CONCLUSION

From this Research study, it was concluded that the maximum respondents (91.6%) got information about millet biscuits from school/hostel, 57.5 per cent from family, 15 per cent from neighbors/friends, 11.6 per cent from exhibitions and only 8 per cent through publicity in T.V and newspaper. Maximum (95.83%) preference about meal pattern for millet consumption was snacks and only few (4.16%) preferred millets as breakfast item. None of the respondents preferred millet products in their dinner. Good taste was the factor that ranked as high (1st rank) for acceptance of millet biscuits by the respondents. The most significant factor for consuming millet biscuits by influence of neighbors and friends (2nd rank), health benefits (3rd rank). The least important factor for consuming millet biscuits quoted was consumption as per doctor suggestion. There will be significant relationship between the age, education and acceptance level of the students regarding millets biscuits. The implications of the present study was stated as only millet biscuits were supplied to students but along with that supply of other millet products like instant noodles, cookies, vermicelli etc. might give more satisfaction level regarding millets. More awareness campaigns need to be conducted to promote the consumption of millet biscuits/products from school level itself.

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Constraints Perceived by the Dairy Farmers about Adoption of Farm Waste Management Practices

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ABSTRACT

Present study was conducted in the two selected districts viz. Ludhiana and Pathankot of Punjab to evaluate constraints perceived by the dairy farmers in adoption of farm waste management practices. Data on the various constraints perceived by the respondents, comprising general, technical, training oriented, marketing, and socio-psychological, were received from a total of 160 respondents through personal interviews. These constraints were then analysed using Garrett's ranking technique. The results made from collected data revealed that "Poor knowledge of dairy farmers about advance waste management practices" (mean score: 62.75) was perceived as most severe general constraints. "Lack of trained, field oriented and experienced experts at village level" (mean score: 63.31) was found to be most severe training related constraints for dairy farmers. Among technical constraints "Lack of proper technical guidance and advice related to farm waste management" (mean score: 63.09) was perceived as most important. "No minimum support price policies, incentives, subsidies with respect value added products-based enterprises by the government and A.H. department" (mean score: 62.44) was considered as most severe marketing constraints. "Lack of risk-taking ability among dairy farmers" (mean score: 63.03), was perceived as most important socio-psychological constraints. In overall constraints "General constraints" (mean score: 50.22) was most important for dairy farmers for adoption of farm waste management practices. The issues faced by the dairy farmers will be very useful in assisting training organizations, policy makers and research institutions, animal husbandry officials to plan future actions for the dairy farm waste management practices more efficiently.

Keywords: Adoption, Constraints, Dairy farmers, Farm waste management, Garrett's ranking technique

INTRODUCTION

The most archaic livestock enterprises, dairy farming has been a cornerstone of our nation's rural communities for thousands of years. It has employed millions of rural residents either directly or as a side business, giving them an alternative source of income and job opportunities while also aiding in the advancement of their socioeconomic status. India has currently 193.46 million cattle and 109.85 million buffaloes (20th Livestock Census, 2019) and Punjab has 40.16 lakh buffaloes and 25.31 lakh cattle (Statistical Abstract of Punjab, 2020). In any livestock farm, organic wastes can account for nearly 80 percent of the total solid waste (Bharadwaj *et al.*, 2019). On a wet weight basis, manure production can reach up to 5.27 kg/day/1000 kg live weight (Bharadwaj *et al.*, 2019). Punjab is the productive state in livestock farming, which results in the production of huge quantity animal excreta like dung and urine, feed and fodder residues, bedding material, soiled silage, and biomedical wastes in the environment. A key issue preventing dairy farmers from adopting different farm waste management practices is the general, technical, training-oriented, marketing and socio-psychological constraints they faced.

MATERIALS AND METHODS

The study was conducted in the two selected districts viz. Ludhiana and Pathankot of Punjab, based on population of dairy animals i.e., maximum in Ludhiana

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district and minimum in Pathankot district (20th livestock census, 2019). Four blocks from each district were selected, for a total of eight blocks from both districts. Using records kept by the animal husbandry department and other relevant officials, two villages from each selected block were specifically designated as having the most dairy animals, for a total of 16 villages. 10 dairy farmers were chosen at random from each selected village in the district of Ludhiana, having a minimum herd size of 25 or more, at least five years of experience in dairy farming, and using at least one waste management practices. So, total of 80 respondents from the Ludhiana district were identified. The same was applicable for the district of Pathankot, where 10 dairy farmers from each identified village had a herd size of 5 to 25, at least five years of experience of dairying, and used at least one waste management technique for dairy farms that was chosen at random. Thus, 80 respondents in total were selected at random from the Pathankot district. Therefore, total 160 respondents were selected. Then the various constraints faced by the dairy farmers were recorded in five major types i.e., general, technical, training-oriented, marketing and socio-psychological constraints based on structured interview schedule. On the basis of their mean score, the various sets of constraints were ranked using Garrett's ranking method. Respondents were asked to list and rank numerous issues in accordance with Garrett's ranking technique, which was then applied in order to prioritise issues. The respondents' orders of merit were converted into rankings using the following formula:

$$\text{Percent position} = [100\ (R_{ij} - 0.50)] / N_j$$

Where,

R_{ij} = Rank given for i^{th} problem by j^{th} individual.

N_j = No. of problems ranked by the j^{th} individual.

As a result, using Garrett's Table as a reference, the percentage position of each rank was then converted into points. The scores of each responder for a particular issue were added up and divided by the total number of respondents. Rankings were given to the problems based on the mean score for each constraint, which was ranked as per importance.

RESULTS AND DISCUSSION

A constraint is something that restricts and hamper something from being done. For this study, the constraints were defined as "all those factors that restrict respondents' access to and management of various farm waste management practices at livestock farms." The main constraints faced by dairy producers were grouped into categories and addressed, including general, technical, training related, marketing, and socio-psychological constraints. These constraints were ranked according to their mean scores using Garrett's ranking method.

As the data presented by Table 1 that under general constraints "Poor knowledge of dairy farmers about advance waste management practices" (mean score: 62.75), "Lack of willingness to adopt new waste management practices" (mean score: 58.46), "Lack of awareness about subsidy facility on biogas plant and vermicomposting" (mean score: 52.94), "Poor availability of technological inputs and services" (mean score: 45.94), "Competitive environment for small farmers" (mean score: 31.03) were perceived by dairy farmers and ranked 1st, 2nd, 3rd, 4th, 5th respectively, similar findings were observed by (Kaur 2022). These constraints con sort out by awareness camps, distribution of extension literature etc., in research locale.

As represented in Table 2 revealed that "Lack of trained, field oriented and experienced experts at village

Table 1: General constraints

S. No.	Constraints	Garrett's mean score	Rank
1.	Poor knowledge of dairy farmers about advance waste management practices	62.75	I
2.	Lack of awareness about subsidy facility on biogas plant and vermicomposting	52.94	III
3.	Lack of willingness to adopt new waste management practices	58.46	II
4.	Competitive environment for small farmers	31.03	V
5.	Poor availability of technological inputs and services	45.94	IV

Table 2: Training oriented constraints

S. No.	Constraints	Garrett's mean score	Rank
1.	Lack of trained, field oriented and experienced experts at village level	63.31	I
2.	Lack of training facilities / training centres at village level	55.28	II
3.	Lack of awareness programmes about scientific dairy farm waste management practices at village level.	54.81	III
4.	Lack of transport facility to attend training programmes at training centres	38.68	IV
5.	Lack of proper demonstration units and facilities for learning practical skills related to farm waste management	37.90	V

level" (mean score: 63.31), "Lack of training facilities / training centres at village level" (mean score: 55.28), "Lack of awareness programmes about scientific dairy farm waste management practices at village level" (mean score: 54.81) were ranked 1st, 2nd, 3rd respectively as most serious training oriented constraints perceived by dairy farmers with respect to farm waste management practices. "Lack of transport facility to attend training programmes at training centres" (mean score: 38.68), "Lack of proper demonstration units and facilities for learning practical skills related to farm waste management" (mean score: 37.90) were ranked 4th, 5th respectively, these observations are in agreement with the findings of (Patil *et al.*, 2009), (Yadav and Sagar 2016), (Chadda 2019) and (Kaur 2022).

These constraints may be due to lack of training facilities related to farm waste management practices and lack of demonstration units for practical purpose. It may be resolved by establishment of demonstration units and organization of training programmes about farm waste management practices regularly in research locale.

As represented in Table 3 revealed that "Lack of proper technical guidance and advice related to farm waste management" (mean score: 63.09), "There is lack of advisory/SMS services for providing guidance with respect to waste management practices" (mean score: 56.37), "Poor technical knowledge of respondents about scientific waste management practices" (mean score: 54.06) were ranked 1st, 2nd, 3rd respectively as most serious technical constraints perceived by dairy farmers with respect to farm waste management practices. "Problem of repair of biogas plants" (mean score: 43.62) and "Lack of satisfactory results of farm waste management practices" (mean score: 33.59) were ranked 4th, 5th respectively which are in line with the findings of (Vyas and Patel 2001) and (Tiwari *et al.*, 2003).

These types of constraints may be due to lack of technical knowledge related to farm waste management practices and repairment problem related to biogas plants, that can be resolved by providing technical guidance and facilities of biogas plant repair.

Market has significant importance in dissemination and adoption of various advance technologies. It is indicated in Table 4 that "no minimum support price policies, incentives, subsidies with respect value added products-based enterprises by the government and A.H. department" (mean score: 62.44) was ranked first perceived as most serious marketing constraint by dairy

Table 3: Technical constraints

S. No.	Constraints	Garrett's mean score	Rank
1.	Lack of proper technical guidance and advice related to farm waste management	63.09	I
2.	Poor technical knowledge of respondents about scientific waste management practices	54.06	III
3.	There is lack of advisory / SMS services for providing guidance with respect to waste management practices	56.37	II
4.	Lack of satisfactory results of farm waste management practices	33.59	V
5.	Problem of repair of biogas plants	43.62	IV

farmers. The probable reason for problem in marketing of farm waste-based value-added products and by products that sale of them in market on reasonable price was a difficult task. "Insufficient marketing skills and insufficient knowledge regarding marketing policy" (mean score: 62.31), "Irregular demand of product" (mean score: 47.03), "Lack of organized marketing facilities" (mean score: 44.87), "Less focus on advertisement of value-added products" (mean score: 33.34) were ranked second, third, fourth, fifth respectively, these findings are in accordance with the findings of (Brar 2020) and (Kaur, 2022) they also studied that almost same type of constraints perceived by the dairy farmers. These constraints may be sort out by providing minimum support price for farm waste management practices and enterprises, well-structured market for value added products of dairy farm waste.

As indicated in Table 5 that "Lack of risk-taking ability among dairy farmers" (mean score: 63.03), "Preference for other enterprises rather than dairy waste-based enterprises" (mean score: 55.65), "Lack of social support to adopt farm waste management practices" (mean score: 54.72), "Lack of awareness about benefits of farm waste" (mean score: 39.91) "Shortage of time for farm waste management" (mean score: 36.68) were sociopsychological constraints and ranked 1st, 2nd, 3rd, 4th, 5th respectively. These constraints can minimize by improving risk bearing capacity ae well as minimize the risk by providing financial help from government or NGOs, by promoting dairy farm waste management as new venture in rural areas.

As presented in Table 6 that in overall constraints "General constraints" (mean score: 50.22), "Technical constraints" (mean score: 50.15), "Marketing constraints" (mean score: 49.99), "Socio-psychological constraints" (mean score: 49.99), "Training oriented constraints" (mean score: 49.98), were ranked 1st, 2nd, 3rd, 3rd, 4th respectively. General constraints may be sort out by improving awareness, knowledge and interest level of dairy farmers about dairy farm waste management practices through visit at successful progressive farms using these techniques like

Table 6: Overall constraints

S.No.	Constraints	Garrett's mean score	Rank
1.	General constraints	50.22	I
2.	Training oriented constraints	49.98	IV
3.	Technical constraints	50.15	II
4.	Marketing constraints	49.99	III
5.	Socio-psychological constraints	49.99	V

Table 4: Marketing constraints

S. No.	Constraints	Garrett's mean score	Rank
1.	Insufficient marketing skills and insufficient knowledge regarding marketing policy	62.31	II
2.	No minimum support price policies, incentives, subsidies with respect value added products-based enterprises by the government and A.H. department.	62.44	I
3.	Lack of organized marketing facilities	44.87	IV
4.	Irregular demand of product	47.03	III
5.	Less focus on advertisement of value-added products	33.34	V

Table 5: Socio-psychological constraints

S. No.	Constraints	Garrett's mean score	Rank
1.	Lack of risk-taking ability among dairy farmers	63.03	I
2.	Preference for other enterprises rather than dairy waste-based enterprises	55.65	II
3.	Lack of social support to adopt farm waste management practices	54.72	III
4.	Shortage of time for farm waste management	36.68	V
5.	Lack of awareness about benefits of farm waste	39.91	IV

vermicomposting, biogas plant and as enterprise, demonstration units, etc.

CONCLUSION

It could be concluded from the above study that to run successful dairy farming and construction of appropriate training organizations or institutes in the rural and peri-urban areas as well as promotion of other animal husbandry extension activities like awareness campaigns, demonstration units, scientist-farmer interactions, kisan melas, livestock shows and distribution of various type of literature material etc., regarding farm waste management practices are necessary to achieve the rapid and projected changes. The issues faced by the dairy farmers will be very useful in assisting training organizations, policy makers and research institutions, animal husbandry officials to plan future actions for the farm waste management practices more efficiently.

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Estimation of Different Sub-components of Head in the Total Pumping Head for Groundwater Irrigation in Rai Block of Sonipat District

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ABSTRACT

Pumping head is one of the most important factors affecting energy use in groundwater irrigated areas. This study was conducted in the Rai block of the Sonipat district to investigate different sub-components of pumping head. A total of 35 submersible pumpsets operated by electrical power were selected for the study. Different head losses were calculated using both primary data of farmers and actual parameters measured at the site. The total system head varied between 11.46-45.36 m for the selected pumpsets. Pumping water level accounted for 70.01 to 91.69 per cent of the total pumping head. Averaged over the selected pump sets, pumping water level accounted for 80.25 per cent of the total system head followed by friction losses (15.26%), height of the delivery pipe (3.02%) and velocity head (1.46%). Considering the importance of pumping water level in the total system head, it is suggested that groundwater level should be raised through suitable measures in the study area to reduce energy consumption. Additionally, suitable mechanical rectification measures should be undertaken to reduce friction losses and promote energy conservation.

Keywords: Energy conservation, Energy saving, Groundwater pumping, Pump efficiency

INTRODUCTION

Indian agriculture is presently challenged by a number of constraints like climate change, depleting natural resources, land fragmentation etc. Impact of climate change on agriculture will be one of the major deciding factors influencing the future food security of mankind on the earth (Hansra *et al.*, 2018). The environmental catastrophe world is facing now is mostly attributable to unsustainable levels of water and energy consumption. Worldwide the use of both fresh water and energy is expected to increase by over 50 per cent by 2050 (Ferroukhi *et al.*, 2015). Water and energy usage are intricately intertwined, with irrigation agriculture accounting for 70 per cent of global water use (Doll, 2009; Siebert *et al.*, 2010). Pumping systems are estimated to utilise approximately 20 per cent of the world's electrical energy (Gopal *et al.*, 2013). Groundwater plays an important role in irrigated agriculture and has become a mainstay in agriculture production systems globally (Jain, 2019). Nearly 2 billion people depend on groundwater for their daily needs, and it provides more than 40 per cent of the water used in agriculture globally (Thomas and Famiglietti, 2019). There is enough evidence that irrigated agriculture systems have been using groundwater injudiciously leading to a continuous decline of groundwater levels (CGWB, 2014; Narayanamoorthy, 2010; Saha *et al.*, 2018; Zeng *et al.*, 2016).

India has witnessed the most explosive growth of groundwater withdrawals in the last five decades (Rajan

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et al., 2020). Currently, the country accounts for one fourth of the global groundwater extraction with annual withdrawals of groundwater estimated at 230 cubic kilometres (World Bank, 2012). More than sixty percent of irrigated fields and eighty-five percent of municipal water systems use groundwater. Declining groundwater levels are a cause for concern not just because of the depletion of groundwater supplies, but also because of the increased energy required for pumping (Patle *et al.*, 2015; Singh *et al.,* 2023a; Singh *et al.,* 2023b). If the current pace of decline continues, sixty percent of India's aquifers will be in a critically poor condition of health in twenty years (World Bank, 2012). Efficient utilization of groundwater for irrigation needs special attention. It is essential to efficiently utilize every drop of water in agriculture to obtain higher crop yield. 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 (Singh *et al.,* 2023c). Submersible pumps are being installed at deeper and deeper depths to cope with declining water levels, leading to greater energy use. More than 90 per cent of electrically operated irrigation pumping sets in India were operating inefficiently due to operational, technical, managerial, financial and social problems (Singh, 2009). Reported energy efficiency of pump sets is less than 50 per cent (Beck *et al.*, 2018). An average audit of electrical pump sets at four field study locations in Haryana found the pump set efficiency of only 21-24 per cent and only 2 per cent of the pumps had efficiency level above 40 per cent (World Bank, 2001). Boosting pump efficiency from 20 to 30 per cent can cut energy use by 30 to 50 per cent (Nelson *et al.*, 2009).

Energy required for ground water pumping, per unit discharge, is a function of the total head involved in pumping and efficiency of the pump-set (motor and pump). Understanding the relative role of different components of pumping system on electricity consumption is crucial for formulating suitable interventions to minimize the involved energy consumption. Low efficiency of pump sets may be attributed to excessive pipe friction, sharp bends, inefficient foot valve, use of T-joints, and low pump speed (Koppad and Maurya, 1997). Drastic improvement in performance of pumps can be noticed by changing GI pipes by PVC and GI or CI foot valve by RPVC foot valve (Sharma and Gupta, 2016). There is need to identify different factors responsible for excessive energy use by pump sets, so as to take corrective measures to reduce unnecessary energy use. Total head is one of the important factors affecting energy requirement at a particular site. This study aims at quantifying the role of different sub-components of head on total pump head in one of the groundwater irrigated area in the North-Western state of Haryana

MATERIALS AND METHODS

The study was carried out in Rai block of Sonipat district of Haryana. A total of 35 pumping sets from 33 villages were selected for the study. All were equipped with submersible pumps and were being operated by electrical power. The present study was based on both primary data of farmers and actual parameters measured at electric submersible tube wells (Figure 1).

Components of system head of tube well pumpsets: The total pumping head (H) was determined as under:

$$H = H_{PL} + H_f + H_{DP} + \frac{V^2}{2g} + \frac{V^2}{2g}\sum_{i=1}^{n} K_{fi} \quad \ldots (1)$$

Where, H_{PL} is the depth (m) of pumping water level below ground surface, H_f is head loss (m) due to friction, H_{DP} is the height (m) of delivery pipe above ground surface, V is the velocity of flow (m/s) in the delivery pipe, g is the acceleration due to gravity (m/s^2), accordingly $V^2/2g$ represents the velocity head (m), K_{fi} represents the head loss coefficients for ith pipe fitting, n is number of pipe fittings. The value of K_f for different fittings was taken from published literature (Murty, 2011; Nourbakhsh *et al.*, 2007). The pumping water level in the tube well was measured with the help of electronic water level indicator. Height of delivery pipe from the ground surface (H_t) was measured with the help of measuring tape in (m).

Hazen-Williams equation as under was used to estimate H_f

$$H_f = 1.22 \times 10^{10} \times L \left(\frac{Q}{C}\right)^{1.85} \frac{1}{D^{4.87}} \quad \ldots (2)$$

Where, L and D are the length (m) and diameter (mm) of the tube well pipe, Q is the discharge (litre/s) of

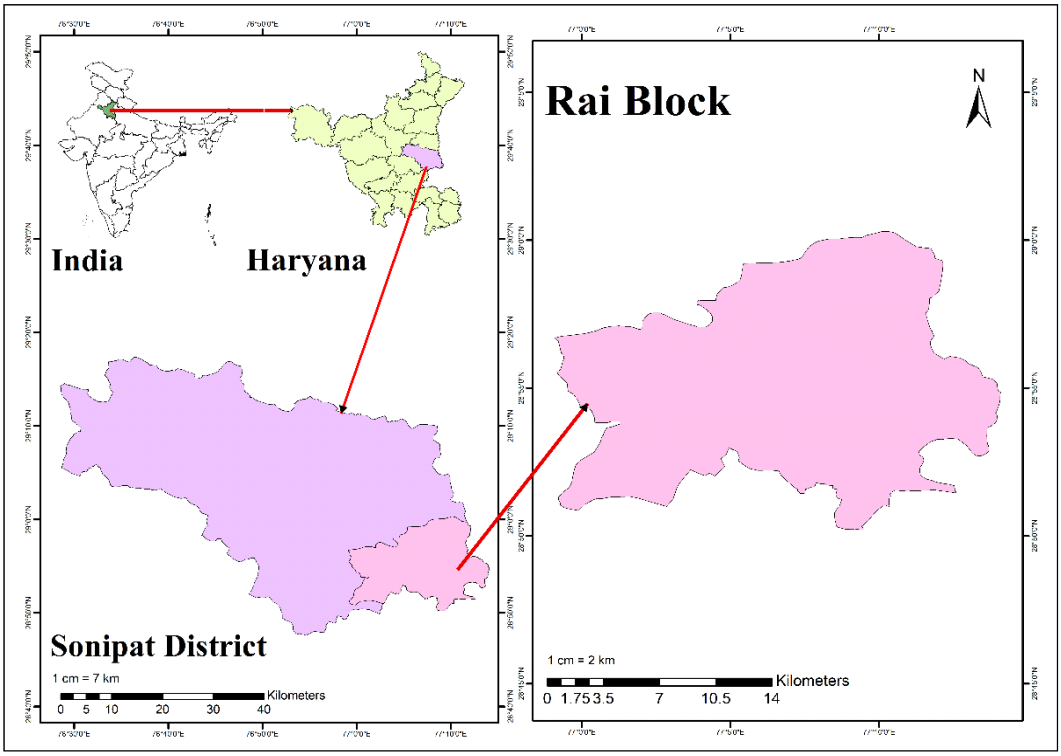

Figure 1: Map of study area

the tube well which was determined by coordinate method (Michael, 2008) and C is the Hazen-Williams constant which depends on the relative roughness of the pipe. The values of C was taken as 150 and 130 for HDPE and GI, pipes, respectively (Williams and Hazen, 1909). Further, the value of estimated head loss due to friction was increased/decreased by a factor depending on the age of installation of the tube well (Michael, 2008). The age of G.I. pipes (new/old) was noted down to decide the appropriate value of the factor to be multiplied to account for the age. Knowing different components of the total head, it is possible to quantify the proportion of different sub-components in the total pumping head

$$P_i = \frac{H_i}{H} \times 100 \quad \ldots (3)$$

Where, P_i is proportion (%) of a particular component 'i' of head and H_i is head due to particular component (m) *i.e.*, Pumping water level, head due to friction losses.

RESULTS AND DISCUSSION

Variation of system head for different tube wells in the study area is shown in Figure 2. The total system head varied from a minimum of 11.46 for TW-3 to a maximum of 45.36 m for TW-31.

The pumping water level, as measured during operation of selected tube wells varied from 9.35 to 32.80 m below ground surface in Rai block. The pumping water level accounted for 70.01 to 91.69 per cent of the total pumping head with an average value of 80.25 per cent. It is expected that deeper is the pumping water level, higher would be the percent of total head attributed to pumping water level.

In general, the percentage of head attributed to pumping water level increased with increasing depth of the pumping water level as shown in Figure 3. However, it can be seen that for some of the tube well, the percentage of head attributed to pumping water level was lower than the general trend for the selected tube wells, which suggest that other factors such as friction losses, delivery pipe height etc. may have contributed for relatively higher fraction of total head for such tube wells.

For instance, the pumping level in TW-5 & 12 was equal to 18.35 m, however, the percentage head attributed to pumping water level was 86.93 & 72.02 per cent for TW-5 & 12, respectively. Considering the depth of placement of pump which was 30.5 m in TW-5 & 24.4 m in TW-12, none would have expected relatively higher head loss due to friction in TW-12 as

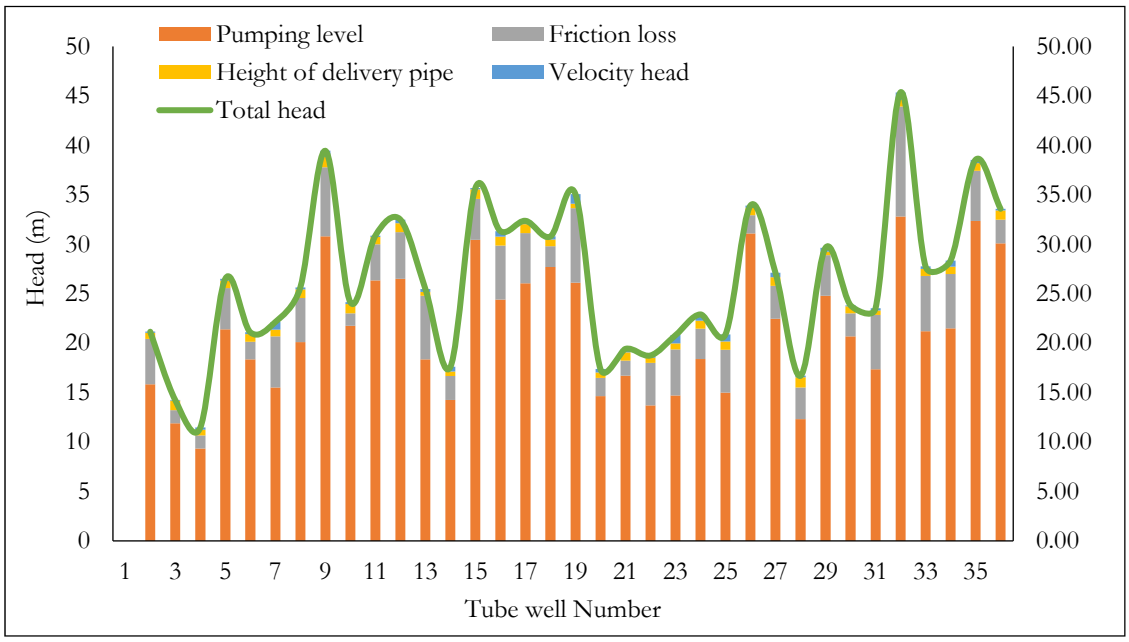

Figure 2: Variation of different system heads for various tube wells

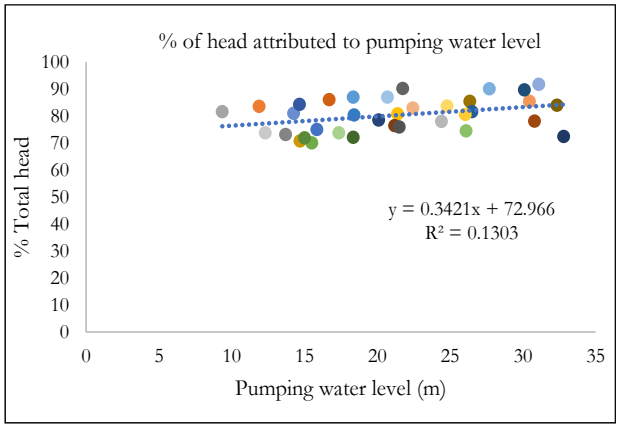

Figure 3: Variation of % of total head as attributed to pumping water level in Rai block

compared to TW-5. However, contrary to the above expectation, relatively higher head loss due to friction in TW-12 as a result of higher discharge & use of 90° bend was obtained. On the other hand, for TW-23, where the pumping water level was 18.40 m, the contribution of pumping water level was 80.31 per cent despite the fact that the discharge of the pump was 28.10 l s^{-1} as compared to 19.17 l s^{-1} for TW-12. This was due to use of higher column pipe dia. (10 cm) in TW-23 as compared to. Column pipe diameter of TW-12 (7.5 cm) cm dia. Therefore, it may be concluded that selection of suitable size of column pipe dia. is important to reduce the power consumption.

The total friction losses as measured during operation of studied tube wells showed that it ranged from 1.25 to 11.12 m. The total friction losses accounted for 5.16 to 25.28 per cent with a mean value of 15.26 per cent. Total head losses included head loss due to friction in column pipe, delivery pipe and accessories (bends, valves *etc.*). It was noticed that maximum share of head loss was recorded due to column pipe, which depends upon pump discharge, material of pipe, total length & diameter of column pipe used. As the length of column pipe increased, friction head loss increased, while increase in diameter of column pipe, head loss decreased. Head loss due to friction in delivery pipe and accessories varied as per the total length and material used in delivery pipe. Similarly, head loss in accessories was dependent upon different type of accessories used. In some tube wells, friction head loss due to delivery pipe was recorded as high while, in other tube wells, friction head loss due to accessories was measured to be high. The data related to variation of per cent of head attributed to total friction losses for Rai blocks is given in Figure 4.

The lowest % of total head attributed to total friction losses was recorded 5.16 per cent in TW-9. This was due to very less head loss in column pipe because of using higher diameter (10 cm) column pipe. Highest value of percentage of total head attributed to total friction losses in Rai block was 25.28 per cent

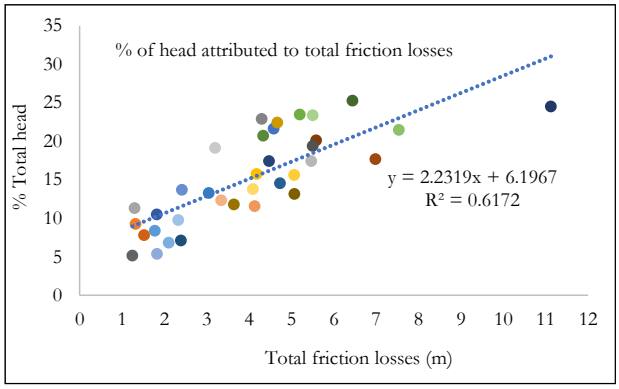

Figure 4: Variation of % of total head as attributed to total frictional losses in Rai block

in tube well No. 12. The reason behind this was the use of 90° bend in delivery pipe, higher head loss in column pipe and longer total length of delivery pipe that has contributed 1.32 m, 4.81 m and 0.31 m head losses, respectively. Higher head loss in delivery pipe was due to use of 90° bend of 10 cm size and pipes used in column were having 7.5 cm dia. that has contributed higher head losses.

Height of delivery pipe as measured in selected tube wells of Rai block during the study varied from 0.36 to 1.04 m. Height of delivery pipe accounted for 1.20 to 6.78 per cent of total head with an average value of 3.03 per cent. Variation of percent head attributed to the height of delivery pipe Rai Block is depicted in Figure 5.

TW-8 and TW-27 both were having delivery pipe height as 1.04 m above ground surface but it accounted for 2.64 and 6.24 % of the total head in TW-8 and TW-27, respectively. This is due to the fact that the total head at TW-8 was 39.45 m (pumping level = 30.8 m bgl) and at TW-27 was 16.70 m (pumping level 12.30 m bgl).

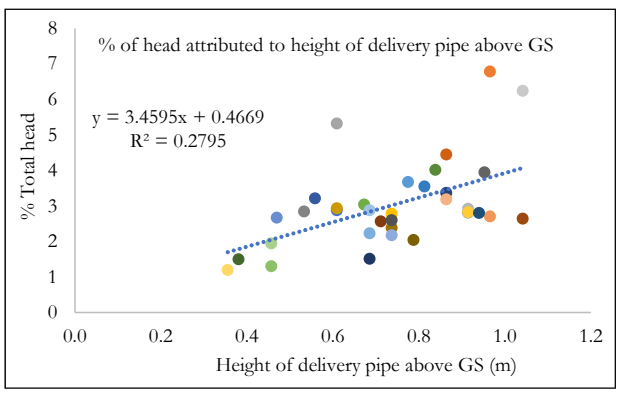

Figure 5: Variation of % of total head as attributed to height of delivery pipe in Rai block

Velocity head loss as recorded during operation of selected tube wells varied from 0.06 to 0.98 m. in Rai block. The velocity head loss accounted for 0.39 to 3.99 per cent of the percentage of total head for groundwater pumping in Rai block with an average value of 1.46 per cent. Variation of per cent head attributed to velocity head loss for Rai block is depicted in Figure 6.

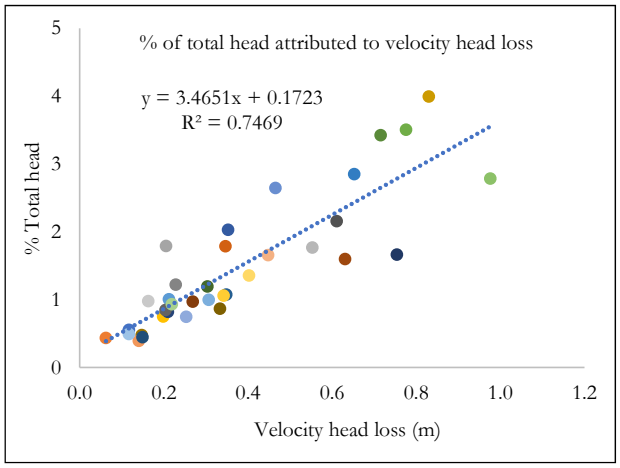

Figure 6: Variation of % of total head as attributed to velocity head loss for Rai block

Minimum percent of total head (0.39%) attributed to velocity head loss was observed in TW-14 having total velocity head of 0.14 m, whereas, lowest value of velocity head loss (0.06 m) was observed in TW-2 which accounted for 0.44 per cent of the total head at TW-2. This difference is due to variation in total head of TW-2 and TW-14, which were having 14.24 and 35.69 m total head, respectively. The maximum percentage of total head (3.99%) attributed to velocity head loss was observed in TW-22 having total velocity head of 0.83 m, whereas, highest value of velocity head 0.98 m was observed in TW-18 which contributed to 2.78 per cent of total head at TW-18. This difference is due to variation in total head of TW-22 & 18 which were recorded 20.80 m and 35.07 m, respectively.

On an average percentage of total system head attributed to pumping water level, friction losses, height of delivery pipe and velocity head was observed as 80.25, 15.26, 3.02 and 1.46 per cent, respectively (Figure 7). It may be noted that the energy consumption involved in pumping out a certain amount of

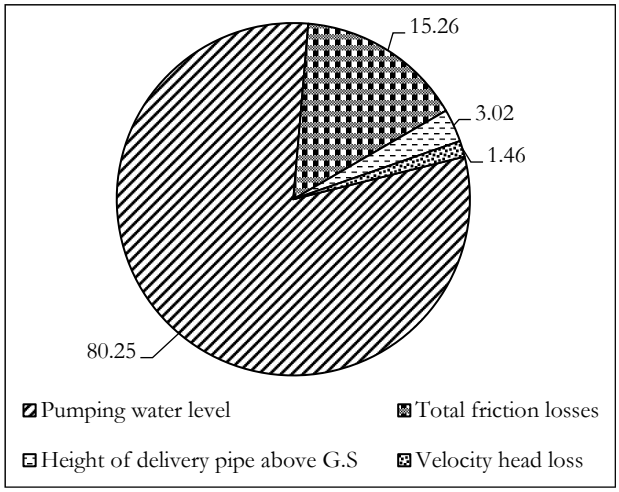

Figure 7: Percentage of total head attributed to different sub components in Rai block

groundwater is directly proportional to the total system head. Knowing that largest contributor to total head is the pumping level, it is imperative to raise the groundwater level in the study are through suitable water conservation measures. Further, site specific attention also need to paid for the reduction of friction losses in the pipes and fittings, particularly where these account for a larger proportion than the average value in the study area. Similarly, farmers need to be educated to keep the delivery height as low as possible to reduce the energy consumption.

CONCLUSION

Pumping water level, friction losses, height of delivery pipe and velocity head, respectively, accounted for 80.25, 15.26, 3.02 and 1.46 per cent of total system head in the selected tube wells in the Rai block of Sonipat district. In order to reduce the energy consumption for groundwater pumping in the study area, it is imperative to raise the groundwater level through suitable water conservation measures. Suitable mechanical rectification measures need to be undertaken at tube wells having relatively higher proportion of friction losses in the total system head.

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Assessment of Existing Conditions and Ergonomically Designing Elderly Bathroom in Housing to Age in Place

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ABSTRACT

The bathroom is an important area to be considered while planning elderly housing as it is the place where elderly people might encounter falls and injuries. The study aimed at ergonomically designing an elderly bathroom that facilitates Age in place for elderly people. The objectives of the study were to study the needs of elderly in terms of bathroom features, to identify the gap between the existing bathroom features and the needs of the elderly people and to design a bathroom that enables the safety of elderly people. The ex-post facto research design was adopted for the study. Sixty elderly women aged 60 and above were taken as sample for the study from the selected localities of Kurnool district of Andhra Pradesh, India. Purposive sampling method was adopted to draw the sample. Standard design guidelines that enable the elderly people to use the bathroom equipment without any difficulty proposed by various researchers, Government and Non-government organizations served as a base for identifying the features to measure the existing bathroom design conditions in the houses. The results indicated that the bathrooms in existing elderly houses were found lacking in features like sufficient space for a wheelchair, grab bars, wall-hung sanitary fixtures that ensure safety and convenience in usage. The respondents were asked to state their recommendations and need to design a bathroom to enable them to use comfortably in old age. The respondents expressed to have a bathroom with ergonomically designed elderly-friendly fittings and fixtures that enable safety and hinders fall-related injuries in their old age. It was found that while designing houses due thought was not given to planning bathrooms to accommodate the needs that may arise in old age. Taking into consideration the housing needs and requirements of the elderly bathroom designs were developed keeping in view the ergonomic standards.

Keywords: Age in place, Elderly people, Standard design guidelines, Bathroom design

INTRODUCTION

The phenomenon of population ageing is becoming a major concern all over the world. As people get older they strongly aspire to have their own place. This tendency is called as "Age in place" (Abramsson and Andersson, 2012). In the ageing process, the cognitive decline, weakness and lack of motor coordination obstruct the elderly from attending to their everyday schedule safely (Fielo and Warren, 2001). Bathroom in elderly housing is considered a hazardous place as most elderly people encounter difficulties. Normal design features become obstructions for the elderly. Older people feel safer being in a ergonomically well-designed environment with physical features and organized furniture arrangement (Ishihara *et al.*, 1997; Alcantara *et al.*, 2005). The aged people who reside in houses with more environmental hazards such as poor lighting, uneven and slippery flooring surfaces, absence of grab bars or handholds, have a 2.8 times greater risk of experiencing at least one injury (Carter *et al.*, 2000). The planning and designing requirements of elderly people bathroom should be based on bathroom design needs of the residents of the house as this will allow the elderly to use the bathroom without any harm and discomfort as bathroom safety is essential for

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independent living. Therefore, it should be provided with assistive fixtures and fittings such as grab bars, sink at the proper height, faucets to have maximum efficiency for the elderly to operate. The study was aimed to ergonomically design an elderly-friendly bathroom that facilitates age in place in elderly housing.

MATERIALS AND METHODS

Kurnool district of Andhra Pradesh state in India was selected purposively. A total of 60 elderly women in the age of sixty and above who were able to carry out their daily chores independently and living in a separate dwelling without children with or without spouse was the criteria for the selection of sample for the study. The study was conducted during the year 2019-2020. Expost-facto research design was taken up for the study. Random sampling method was adopted to select the locations to draw the sample. Purposive sampling method was adopted to draw the sample. Standard design guidelines that enable the senior citizens to use the bathroom equipment without any difficulty proposed by various researchers, Government and Non-government organizations served as a base for identifying the features to measure the existing bathroom design conditions in the house.

The houses of the elderly selected for the present study were physically observed and gathered the information on provisions made in the housing. The existing bathroom design conditions in the houses of the respondents was evaluated against the recommended guidelines. To quantify the responses, score 3 was given in case the existing feature was 'above the recommended guidelines, score 2 was given in case the existing feature was 'exactly as per the recommended guidelines' and score 1 was given in case the existing features was 'below the recommended guidelines'. The respondents were asked to state their recommendations and need to design a bathroom to enable them to use comfortably in old age. Design needs of the bathroom were quantified in terms of essential, preferred and neutral with a score of 3, 2 and 1.

Frequencies and percentages were calculated for the existing bathroom design and needs of the elderly people. Chi-square analysis was done to find out the gap between existing bathroom design conditions and design needs of the elderly.

Standard design guidelines of bathroom: Ergonomically given guidelines for designing bathroom fixtures were proposed by Parker (1987), Welfare housing policies for senior citizens (2007), Model guidelines for regulation and development of retirement homes (2019); Amie Clark (2016) and National Building Code (2016). The standard guidelines are: The minimum size of the bathroom should be 5 feet by 5 feet 8 inches. The ergonomically designed bathroom has to be large enough with a radius of 5 feet to allow the complete rotation of the wheelchair. Doors of bathrooms and toilets should open outward or both ways. Provision of Grab bars/Supporting rails/handholds. All grab bars and handholds of non-corrosive materials. Soap bar holders and grab bar should be located at a height of 4 feet 3 inches above from the floor. Towel racks and rods should also be strong and securely mounted in reach. Vertical surfaces of bathrooms should be free from sharp corners and edges, unnecessary projections and breakable materials. Water closet in bathrooms. Maximum height from the surface of the floor to shelf or cupboards should be 4 feet 7 inches. Space around the sides of a washbasin to accommodate a helper should be 2 feet. Clearance space for knees under the washbasin should be 2 feet 3 inches to 2 feet 10 inches. Washbasins should be provided with grab rails on either side. Sanitary fittings that facilitate the cleaning of the room e.g., wall-hung fixtures. Provision of alarm systems and exhaust fans. Direct accessibility has to be provided to the bedroom. Indirect accessibility has to be provided to the living room. Easily operable bathroom fixtures. Provision of non-slippery flooring. Light switches should be installed at reachable height.

RESULTS AND DISCUSSION

Existing bathroom design: The existing bathroom design was evaluated in terms of standard design guidelines identified in the study (Table 1). Houses with a standard size bathroom were found to be only 31.67 per cent. A majority (90%) of the bathrooms were below the suggested guidelines and these were lacking minimum area, door width, a radius of 5 feet for complete rotation to accommodate crutches or wheelchair users.

Fifty-five per cent of the houses were with supporting rails installed at a height above the

Table 1: Distribution of respondents by existing bathroom design features (n=60)

Recommended Design guidelines	Status of existing design features against the guidelines						Total	
	Above the recommended guidelines		Exactly as per the recommended guidelines		Below the recommended guidelines			
	N	%	N	%	N	%	N	%
5 feet x 5 feet 8 inches minimum size of bathroom area	19	31.67	4	6.67	37	61.67	60	100
Area 50-60 square feet approximately 7-8 feet x 7-8 feet required to accommodate crutches or wheelchair users	3	5	3	5	54	90	60	100
2 feet 6 inches to 3 feet door width to accommodate wheelchair users	0	0	2	3.33	58	96.67	60	100
Bathroom large enough with a radius of 5 feet to allow the complete rotation of wheelchair	4	6.67	6	10	50	83.33	60	100
Doors of bathrooms & toilets open outward or both ways	4	6.67	2	3.33	54	90	60	100
Grab bars/Supporting rails/handholds	5	8.33	53	88.33	2	3.33	60	100
Non-corrosive materials are used for all grab bars and handholds	5	8.33	52	86.67	3	5	60	100
The diameter of a grab bar/handholds was between three fourth inch to 1 inch and be capable of withstanding a pulling or hanging load of 136 kilograms	0	0	12	20	48	80	60	100
Grab bars and vertical/horizontal handrails had minimum clear space of 1.9 inches to 2.9 inches from the wall	23	38.33	7	11.67	30	50	60	100
Grab bars were installed at a height of 2 feet 3 inches to 3 feet from floor level	33	55	6	10	21	35	60	100
The soap dish was conveniently located at a height of 4 feet 3 inches above from the floor	46	76.67	11	18.33	3	5	60	100
Towel racks and rods were strong and securely mounted	4	6.67	24	40	32	53.33	60	100
Vertical surfaces of bathrooms were free from sharp corners and edges.	31	51.67	27	45	2	3.33	60	100
The seat height of the water closet was 1 foot 5 inches to 1 foot 7 inches	15	25	32	53.33	13	21.67	60	100
Walls were strong enough to support safety bars on both sides of the water closet	9	15	38	63.33	13	21.67	60	100
Maximum shelf or cupboard height from the floor was 4 feet 7 inches	40	66.67	12	20	8	13.33	60	100
A washbasin was installed at a height of 2 feet 7 inches for wheelchair users	41	68.33	8	13.33	11	18.33	60	100
2 feet space around the washbasin to accommodate a helper	6	10	11	18.33	43	71.67	60	100
Washbasins in bathrooms were firmly supported to with stand pulling or leaning loads of 136 kilograms	15	25	35	58.33	10	16.67	60	100
2 feet 3 inches to 2 feet 10 inches clearance space for knees under the washbasin	4	6.67	20	33.33	36	60	60	100
Washbasins were provided with a provision of grab rails	0	0	1	1.67	59	98.33	60	100
Wall hung sanitary fittings to facilitate the cleaning of the room	3	5	30	50	27	45	60	100
Presence of an alarm system	0	0	0	0	60	100	60	100
Presence of exhaust fans	35	58.33	0	0	25	41.67	60	100
Direct accessibility to bedroom	46	76.67	3	5	11	18.33	60	100
Indirect accessibility between bathroom and living areas	48	80	7	11.67	5	8.33	60	100

recommended guidelines. In the majority (80%) of the bathrooms supporting rails had diameter and capacity to withstand hanging load below the recommended guidelines and same was pursued by of half of the total sample about clearance space of supporting rail from the wall. Seventy-one per cent of the washbasins had no clearance spaces to accommodate a helper. Fifty-eight per cent of the houses had washbasins that can withstand the load of persons taking the support of it. Little excess than one-third of the bathrooms had soap dish holders at no proper height. Two-thirds of the cupboards and washbasin were located at the proper height as per the guidelines. Slightly more than half (53.33%) had a water closet at no proper height as per the recommended guidelines.

A majority (98.33%) of the bathrooms had washbasins without grab rails. Forty-five out of hundred bathrooms were not provided with wall-hung sanitary fittings. None of the bathrooms had an alarm system. More than half (58.33%) of bathrooms were provided with an exhaust fan. Three fourth of the bathrooms had direct access to the bedroom. Very few bathrooms (18.33%) had no accessibility. The majority (80%) had indirect accessibility between bathroom and living room. The bathrooms in the elderly housing were found lacking in recommended space to allow wheelchair users and elderly using crutches to take a rotation and enter into or exit out comfortably. In some of the bathrooms where grab bars or supporting rails were installed, they were installed at a height above the recommended guidelines that may cause discomfort in use. The diameter and capacity to withstand a hanging load of these supporting rails were below the recommended guidelines.

The bathrooms in existing elderly houses were found lacking in features like sufficient space for wheelchair, fittings and fixtures to ensure safety and convenience in usage. A study conducted by Andes and Beamish (2008) also found similar lacking features in the bathroom. While designing houses due thought was not given to planning bathrooms to meet requirements that may come up in old age.

Design needs in the bathroom: The respondents were asked to state their recommendations and needs to design a bathroom to enable them to use comfortably in old age (Table 2).

Forty-six per cent of the elderly preferred a bathroom with a size of 5 feet by 5 feet 8 inches. More than half (60%) of the elderly preferred to have a bathroom that accommodates wheelchair users and bathroom doors that open both inward and outward manner. Sixty-six per cent of the elderly felt essential to provide grab bars, supporting handrails or handholds of non-corrosive materials in elderly bathrooms. More than half (60%) of the elderly felt essential to provide soap bar holders and grab bars at the proper and reachable height from the floor level.

Total sample felt it was essential to provide ergonomically designed bathrooms with water closets, non-slippery flooring and to avoid vertical surfaces that have sharp corners and projections. More than three fourth of the elderly felt it was essential to provide space around the sides of the washbasin to accommodate helper other than the user. Fifty-three per cent of the elderly felt neutral in providing clearance space for knees under the washbasin and 40 per cent preferred space under the washbasin. Nearly 50 per cent of the elderly felt essential to provide washbasin with grab bars or supporting rails. More than half (53%) of the elderly preferred to have wall-hung sanitary fixtures and one fourth stated as essential. Sixty-three per cent of the elderly preferred to have an alarm system in the bathrooms. Provision of exhaust fan was stated as essential by sixty-six per cent of the elderly. Slightly less than three fourth of the elderly felt it was essential to provide direct access to the bedroom. More than half (55%) of the elderly felt neutral and more than one fourth preferred to provide indirect accessibility to living areas. Three fourth of the respondents preferred to have easily operable bathroom fixtures. Provision of lever type faucets was felt neutral by 60 per cent of the elderly. More than half (53%) preferred to have bathrooms with light switches at reachable height. Nearly 60 per cent preferred chair or stool in the bathroom and one fourth felt essential to have a chair or stool in the bathroom.

The elderly people recommended having space to allow wheelchair users and elderly using crutches to take a rotation and to enter or exit out comfortably. Bathrooms with grab bars or supporting rails at reachable height were felt as essential by the respondents. The elderly desired to have bathrooms with features like sufficient space for wheelchair, fittings

Table 2: Distribution of respondents by their needs in designing a bathroom (n=60)

Housing needs of the elderly	Adequacy of housing needs						Total	
	Essential		Preferred		Neutral			
	N	%	N	%	N	%	N	%
The minimum size of the bathroom should be 5 feet by 5 feet 8 inches	18	30	28	46.67	14	23.33	60	100
The bathroom has to be large enough with a radius of 5 feet to allow the complete rotation of wheelchair	10	16.67	36	60	14	23.33	60	100
Doors of bathrooms and toilets should open outward or both ways	0	0	33	55	27	45	60	100
Provision of Grab bars/Supporting rails/handholds	40	66.67	20	33.33	0	0	60	100
All grab bars and handholds of non-corrosive materials	40	66.67	20	33.33	0	0	60	100
Soap bar holders & grab bar should be conveniently located at a height of 4 feet 3 inches above from the floor	36	60	10	16.67	14	23.33	60	100
Towel racks and rods should also be strong and securely mounted in reach	4	6.67	24	40	32	53.33	60	100
Vertical surfaces of bathrooms should be free from sharp corners and edges, unnecessary projections and breakable materials	60	100	0	0	0	0	60	100
Water closet in bathrooms	60	100	0	0	0	0	60	100
Maximum height from the surface of the floor to shelf or cupboards should be 4 feet 7 inches	33	55	6	10	21	35	60	100
Space around the sides of a washbasin to a accommodate a helper should be 2 feet	46	76.67	11	18.33	3	5	60	100
Clearance space for knees under the washbasin should be 2 feet 3 inches to 2 feet 10 inches	4	6.67	24	40	32	53.33	60	100
Washbasins should be provided with grab rails on either side	31	51.67	27	45	2	3.33	60	100
Sanitary fittings that facilitate the cleaning of the room e.g., wall hung fixtures	15	25	32	53.33	13	21.67	60	100
Alarm systems	9	15	38	63.33	13	21.67	60	100
Exhaust fans	40	66.67	12	20	8	13.33	60	100
Direct accessibility has to be provided to bedroom	42	70	10	16.67	8	13.33	60	100
Indirect accessibility has to be provided to the living room	9	15	18	30	33	55	60	100
Easily operable bathroom fixtures	15	25	45	75	0	0	60	100
Provision of Lever-type faucets	4	6.67	20	33.33	36	60	60	100
Non-slippery flooring	60	100	0	0	0	0	60	100
Light switches should be installed at a reachable height	3	5	32	53.33	25	41.67	60	100
Provision of chair or stool in bathroom	15	25	37	61.67	8	13.33	60	100

and fixtures to ensure safety and convenience in usage. So while designing houses thought should be given to planning bathrooms to accommodate the needs that lessen their difficulties in old age.

Association between existing bathroom design and needs of the elderly people: Chi-square analysis was done to find out the association between existing bathroom design and needs of the elderly and results were presented in Table 3. The null hypothesis formulated was H_0. There exists no significant association between existing bathroom design and needs of the elderly about bathroom design to age in place. The ergonomic design guidelines for a comfortable bathroom proposed by designers specified the provision of space for wheelchair users,

Table 3: Association between existing design features of bathroom and needs of the elderly (n=60)

Existing Bathroom features	The design needs about bathroom					
	Preferred		Essential		Total	
	N	%	N	%	N	%
Below the recommended guidelines	3	5.00	0	0	3	5.00
Exactly as per the recommended guidelines	52	86.67	5	8.33	57	95.00
Total	55	91.67	5	8.33	60	100.00
χ^2 value				0.2871		
Probability value				0.5921		

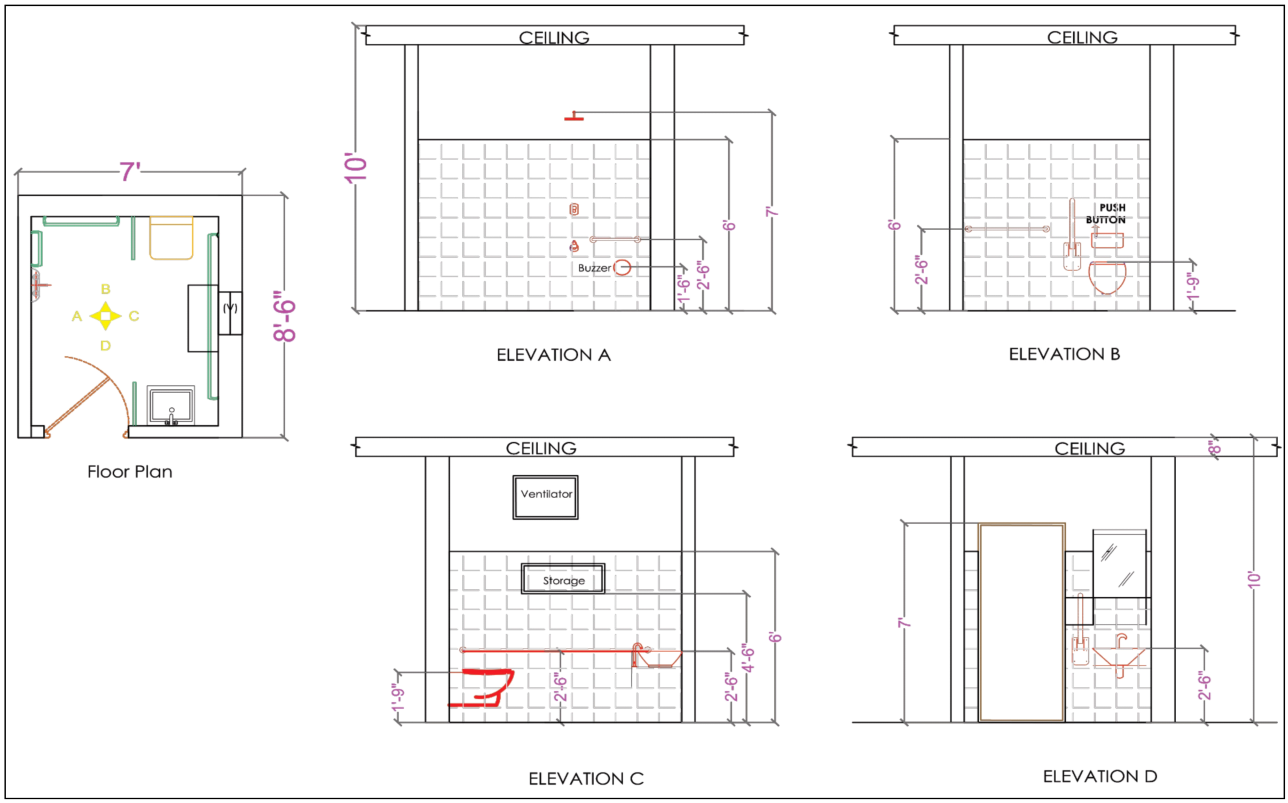

Figure 1: Floor plan and Elevation drawings of Bathroom

provision of fittings and fixtures that help the elderly to manage by themselves and prevent accidents. The almost total sample selected for the study preferred bathroom design as per the standard design guidelines with the provisions for safety and comfortability. The chi-square value was found to be non-significant. There is no association between the existing bathroom design and the needs of the respondents to age in place about bathroom design. The bathroom design in the existing households was found to be deficient in space allowances for wheelchair users. Irrespective of the existing design, the elderly respondent wanted a bathroom as per the recommended design guidelines. The results of the research are supported by the findings of the study by Dekker *et al.* (2005); Kutintara *et al.* (1997); June *et al.* (2003) had revealed that bathroom with the provision of support systems that ensure safety was preferred by the elderly.

Ergonomically designing an elderly-friendly bathroom: The association between existing housing conditions and design needs of the respondents to age in a place served as a base to develop the design of the bathroom for the elderly to age in place. Taking into consideration the housing needs and requirements of the elderly bathroom design (Figure 1) was developed using Auto cad software.

CONCLUSION

The bathroom design in the existing households was found to be deficient in space allowances for wheelchair users. Irrespective of the existing design, the elderly respondent wanted a bathroom as per the recommended design guidelines. The elderly people recommended having space to allow wheelchair users and elderly using crutches to take a rotation and to enter or exit out comfortably. Bathrooms with grab bars or supporting rails at reachable height were felt as essential by the respondents. The elderly desired to have bathrooms with features like sufficient space for wheelchair, fittings and fixtures to ensure safety and convenience in usage.

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