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of
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Beyond 4.0

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 1400 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 current era is witnessing tech-based revolutions in all sectors. Historically, the agriculture sector has been versatile in incorporating technological advancements into its applications to propel production baskets sustainably. Agriculture underwent four revolutions from the neolithic period to the current technocratic period. The nomadic hunter-gatherers gave way to agrarian settlements, and then the very first agricultural revolution, known as Agriculture 1.0, occurred. The flickering of the industrial revolution's outcome in technological innovation (tractors, seed drillers, irrigation systems, harvesting equipment) when transformed agriculture into a mechanized sector, second revolution (Agriculture 2.0) happened. The third revolution in agriculture (Agriculture 3.0) is marked by the achievement of food sufficiency by most of the developing nations through the adoption of green revolution technologies like high yielding crop varieties, quality planting materials, chemical and synthetic fertilizers, plant protection measures coupled with regular and scientific monitoring of the field. Agriculture is now in the midst of its fourth revolution, known as Agriculture 4.0. It includes a wide range of prospective futures in agriculture developed with digital farming, vertical and soil-less framing, bioeconomics, and other factors. Nanotechnology, the internet of things (IoT), robotics, sensors, 3D food printing, blockchain, artificial intelligence (AI) and machine learning, gene editing, etc., are just a few of the game-changing technologies that have the potential to drastically alter how food is produced, managed, harvested, processed, traded, and consumed. Being a multidisciplinary professional society, the Society for Community Mobilization for Sustainable Development (MOBILIZATION Society) always provides platforms to the ignited minds to share and sharpen the new ideas and innovations capable of contributing to sustainable developmental initiatives at the research, policy, and field level. The 10th National Seminar on "Agriculture and More: Beyond 4.0," announced by the MOBILIZATION Society in partnership with SKUAST-Kashmir and SKUAST-Jammu, held during 26th -28th May 2022, is one such leap. In this regard, society is highly fortunate to publish two Seminar-special issues (Vol-I and Vol-II) of the Journal of Community Mobilization and Sustainable Development, each containing a handful of quality articles submitted by professionals.

The volume-I (Vol-I) of the seminar-special issue of the journal covers studies about the availability of ICT tools for crop practices, Artificial Intelligence (AI), high-tech agriculture tools and techniques, use of mobile applications in digital agriculture; adoption studies of innovative farmers' led climate-smart agriculture practices, super seeder versus conventional methods, improved production technology among orange growers; micro-entrepreneurship development initiatives; constraints faced by the direct-seeded rice growers and difficulties of potato growers in adopting paddy straw management; price model for summer and winter tomato crop, evaluation of marketing structure and sustainability of mustard; climate change and mitigation strategies and so on. I am convinced that this special issue will give you a sense of the intellectual experience and strategic concepts that are presented at the conference.

The commitment shown by the dedicated editorial team deserves my deepest thanks and appreciation. I sincerely thank all the active readers, critics and authors whose contributions make our journal skilful enough to improve its structure and content. I am thankful to the authors who offered an overwhelmed enthusiasm and interest to respond to the conference-special call.

J.P. Sharma
Chief Editor

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Adoption and Impact of Innovative Farmers' Led Climate Smart Agriculture Practices in India

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ABSTRACT

Agriculture sector produces serious greenhouse gas (GHG) emissions in the developing countries. Hence, to address this issue, priorities should be given to climate-smart agriculture (CSA) practices for sustainable productivity with reduced emissions and enhanced resilience. Further, several CSA initiatives in various developing countries increased agricultural productivity and build resilience on climate-change risks in smallholder farming systems. But, sustainable adoption of CSA practices requires needful institutional and public policies' attentions to make an enabling environment at farmers' level for their capacity building interventions, extension of knowledge, skill and attitude orientation towards the technologies on CSA at the local social system level. At the same time, the innovative farmer leaders of the social systems have played desirable social change through sustainable adoption of agricultural technologies in the respective social systems under diversified agro-climatic, geographical and socio- economic settings. Hence, for recognizing the nations' innovative farmers; every year, the ICAR-IARI has identified innovative farmers across the country for various technology development and adoption process. Among the various technologies; majority of farmers adopted CSA practices for climate resilience, sustainable production and reduced emission. Under this background, the research study was conducted by using an interview schedule through telephonic, video call and social media based sources across the country from 306 innovative farmers. In that, 208 farmers were climate smart innovative farmers, 98 farmers were non-adopters. - The study found that, among the various CSA practices adopted farmers, 83.17% of farmers adopted location specific integrated farming systems practices; followed by intercropping (58.65%), crop rotation (46.15%), organic farming (42.30%), crop diversification (41.82%) and weather based agro advisories for agricultural operations (40.38%) respectively. Further, the CSA adopted farmers' net income increased by reduced cost of cultivation and sustainable agricultural production systems.

Keywords: Climate smart agriculture, Innovative farmers, Adoption, Impact

INTRODUCTION

Climate change is one of the foremost environmental challenges of the world. Climate change is related with various adverse impacts on agriculture, water resources, forest, biodiversity and coastal ecosystems (Balasubramanian, 2012). Globally, agriculture sector generates 19–29 per cent of total greenhouse gas (GHG) emissions is critical to meet the ecological and climate related sustainable development goals; particularly in the less developed and developing countries (Smith, 2014). Hence, to address this issue, priorities should be given to integrated climate-smart agriculture (CSA) initiatives for enhanced production, adaptation and resilience with reduced emissions through the farming system approach for addressing food and nutrition security in one dimension and climate vulnerabilities in another dimensions (Vincent, 2021). Moreover, several CSA initiatives and schemes in various developing countries increased agricultural productivity and build resilience on climate-change risks in smallholder farming systems (Victor, 2022). It is possible with the support of the innovative farmer leaders of the social systems for making a desirable social change through sustainable adoption of CSA practices in the respective social systems.

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In India, it has around 157.35 million hectares of agricultural land with wider agro-climatic, geographical and socio- economic settings with diversified farming households (Yadav, 2018). Hence, the role of innovative farmers plays very important role in agricultural technology diffusion and adoption process (Sacha, 2021). According to diffusion and innovation studies, around 2.5 per cent farmers comes under innovator categories and 13.5 per cent farmers comes under early adopter categories (Rogers, 1983). Hence, for recognizing the nations' innovative farmers; every year, the ICAR-IARI has identified innovative farmers across the country for various technology development and adoption process. Among the various technologies; majority of the farmers adopted CSA practices for climate resilience and other benefits. Under this background, the research study was conducted about the successful adoption Innovative farmers' led climate smart agriculture practices and its impacts' to encourage water harvesting, agriculture- horticulture led farming practices, Integrated farming system practices, natural farming practices and natural resource conservation perspectives, improving the access on climate information services etc. for increased productivity, enhanced resilience and for reduced emissions.

Innovative farmers' led climate smart agriculture practices: The Indian small and marginal landholding farmers face various challenges such as decreased land area, decline in soil fertility, low socio-economic status, low crop productivity, climate related vulnerabilities and poor market access affects their agricultural livelihoods. Further, many farmers are constrained by poor credit access and physical infrastructure (Jayne, 2014). Hence, the CSA practices based production systems can support to boost farm output, despite changes in climatic condition (Lipper, 2014). Hence, the core agricultural practices of CSA practices support land use based cropping pattern, soil and water conservation, and efficient residual management to get enhanced income, household food security, enhanced resilience and for reduced emissions (Maguza-Tembo, 2017). Based on the literature studies and Indian agro-ecological specific farming system based agricultural practices; the following practices viz. soil and water conservation; Eco-friendly and environmental innovative conservation strategies; Crop diversification and Integrated farming system based innovations; Weather information based cropping services; Importance of integrating indigenous knowledge; Natural farming practices were majorly listed as a CSA practices; either in a separate or comprehensive adoption of the practices. These CSA listed practices adopted farmers were considered as CSA farmers (Peterson, 2014). Hence, these practices majorly addressing the three pillars of CSA such as increase in agricultural productivity and incomes, building social-ecological resilience and minimizing agriculture's contribution to greenhouse gas emissions (FAO, 2013; FAO, 2017).

MATERIALS AND METHODS

The research study was conducted by using an interview schedule through telephonic, video call and social media based sources across the country's ICAR-IARI awardee innovative farmers, Among the 513 numbers of ICAR-IARI awardee innovative farmers; the data was collected from 306 farmers. In that, 208 farmers were climate smart innovative farmers, 98 farmers were non-adopters. The ex-post facto research design was used for this study. The farmer respondents from all over the states of country. Hence, it acts as a representative sample to the country. From each state 10 to 12 farmers were selected purposefully among the awardee farmers to collect the required data using semi-structured survey schedules. Thus, the total sample size of the respondents for the study was three hundred and six (n = 306). Under this study, the following activities of documentation of on-farm appropriate climate smart technologies for climate risks management and mitigation, identifying the determinants of adoption of climate smart agricultural practices and assessed the case studies about climate smart agricultural practices. The field data relating to climate-resilience (drought tolerance, pest and disease resistance/tolerance, etc.), yield potential were collected from farmers. Finally, the farmers' data were validated by the scientists, and then the reliable and valid information was finally utilized for impact assessment.

RESULTS AND DISCUSSION

The profile characteristics plays very important role in the sustainable adoption of Climate Smart Agricultural practices to ensures the agro ecosystem's health, including biodiversity, biological cycles and sustainable agricultural production. The sampled farmers were mostly in the innovative farmers' categories. Hence,

Table 1: Profile characters of the innovative farmers (N =306)

Profile	Low	Percentage	Medium	Percentage	High	Percentage
Social Participation	38	12.43	116	37.90	152	49.67
Economic motivation	73	23.85	127	41.50	106	34.64
Risk taking ability	56	18.30	158	51.63	92	30.07
Scientific orientation	72	23.52	147	48.03	87	28.43
Information seeking behaviour	37	12.10	93	30.39	176	57.51
Training undergone	44	14.37	79	25.83	183	59.80
Perception on climate resilience	57	18.63	138	45.10	111	36.27
Innovativeness	38	12.42	114	37.25	154	50.33
Contact with extension agency	36	11.45	133	43.46	138	45.09
Leadership abilities	39	12.76	151	49.34	116	37.90

relevant variables only taken consideration for the study. It could be observed from the Table 1 that majority of the respondents' profile characteristics with respect to socio- economic and psycho-social variables with respect to innovative farmers revealed that (49.67%) had high level of social participation followed by medium (37.90%) and low (12.43%) levels of social participation. Also in information seeking behavior with (57.51%) had high level; followed by medium (30.39%) and low (12.10%) levels, farmers who undergone training with (59.80%) had high level; followed by medium (25.83%) and low (14.37%) levels, innovativeness of the farmers with (50.33%) had high level; followed by medium (37.25%) and low (12.42%) levels, farmers with contact with extension agency (45.09%) had high level; followed by medium (43.46%) and low (11.45%) levels. Moreover, with respect to economic motivation level of farmers (41.50%) had medium level; followed by high (34.64%) and low (23.85per cent) levels, in risk taking ability of farmers category (51.63%) had medium level; followed by high (30.07%) and low (18.30%) levels, Scientific orientation of the farmers in their farming activities (48.03%) had medium level; followed by high (28.43%) and low (23.54%) levels, the farmers perception on climate resilience (45.10%) had medium level; followed by high (36.27%) and low (18.63%) levels and the farmers' leadership abilities (49.34%) had medium level; followed by high (37.90%) and low (12.76%) levels.

Adoption of On-farm location specific climate smart agricultural practices: The study documented 45 climate smart agricultural practices from the ICAR-IARI climate smart innovative farmers; the documented climate smart technologies presented in various tables with its' adoption percentages. Most of the farmers 'were small and marginal in nature. Hence, they were adopted a need based location specific CSA practices for their betterment.

The climate smart agricultural innovative farmers adopted various agronomic CSA practices based on their farming system and agro-ecology. Among the all adopted on-farm appropriate agronomic CSA practices in Table 2 found that, 83.17 per cent of CSA farmers adopted location specific integrated farming systems practices; followed by intercrop cultivation practices (58.65%), crop rotation (46.15%), organic farming practices (42.30%), crop diversification practices (41.82%), practicing weather based agro advisories for agricultural operations (40.38%), micro irrigation practices (34.61%), mulching practices (33.18%), green and Green leaf manuring (28.37%), farm pond based rainwater storage for effective watershed management practices (27.40%), ridges and furrows based cultivation for soil and water conservation (17.30%), adoption of agri-horti forestry practices (16.34%), fallowing of land for some season (13.46%) and multistage cropping for climate effectiveness and space utilization (5.76%) respectively. The farmers also acted as an opinion leader to spread the CSA technologies to other farmers of the respective social system.

The climate smart agricultural innovative farmers adopted various crop specific on-farm appropriate climate smart agricultural practices; the Table 3 reported in crop specific multiple response; (46.42%) of wheat farmers adopted raised- bed preparation for wheat

Table 2: Adoption of on-farm location specific Agronomic climate smart agricultural practices

Agronomic climate smart agricultural practices	No. of respondents (208)	Percentage
Location specific integrated farming systems practices	173	83.17
Intercrop cultivation practices	122	58.65
Crop rotation	96	46.15
Natural / Organic farming practices	88	42.30
Crop diversification practices	87	41.82
Practicing weather based agro advisories for agricultural operations	84	40.38
Micro irrigation practices	72	34.61
Mulching practices	69	33.18
Green and green leaf manuring	59	28.37
Farm pond based rainwater storage for effective watershed management practices	57	27.40
Adoption of early maturing varieties for climate resilience	47	22.59
Ridges and furrows based cultivation for soil and water conservation	36	17.30
Adoption of Agro, Agro- horti forestry practices	34	16.34
Fallowing of land for some season	28	13.46
Multistage cropping for climate effectiveness and space utilization	12	5.76

Table 3: Adoption of Crop specific on-farm climate smart agricultural practices

Crop specific Climate smart agricultural practices	Possible Number of respondents (Multiple response)	Number of adopted respondents	Percentage
Raised bed preparation for wheat cultivation practices	112	52	46.42
Systems of Rice Intensification (SRI) Practices	152	45	29.62
Zero tillage wheat	112	29	25.89
Direct sown rice	157	32	20.38
Mulching in sugarcane	83	15	18.07
Systems of Wheat Intensification (SWI) Practices	112	12	10.71
Systems of sugarcane Intensification (SSI) Practices	83	8	9.63
Alternate wetting and drying practices in rice	152	13	8.55
Indigenous rice cultivation for climate resilience	157	9	5.73
SRI with Drip irrigation	152	5	3.28

cultivation practices; followed by (29.62%) adopted systems of rice Intensification (SRI) practices; zero tillage wheat (25.89%), direct sown rice (20.38%), mulching in sugarcane (18.07%), systems of wheat intensification (SWI) Practices (10.71%), alternate wetting and drying practices in rice (8.55%), systems of sugarcane Intensification (SSI) practices (9.63%), indigenous rice cultivation for climate resilience (5.73%) and systems of rice intensification with drip irrigation (3.28%) respectively.

Table 4 reported that, among the various on-farm appropriate biodiversity conservation based climate smart agricultural practices adopted by the innovative climate smart agricultural farmers, (40.38%) of farmers not practicing crop residue burning in their farm fields; followed by (19.23%) of farmers adopted conservation agriculture, residue conservation technologies (17.30%), practicing biological control measures (16.82%), cultivation of location specific varieties (13.46%), adoption of bio fertilizer application

Table 4: Adoption of on-farm location specific biodiversity conservation based climate smart agricultural practices

Biodiversity conservation based Climate smart agricultural practices	Number of respondents (208)	Percentage
No crop residue burning	84	40.38
Conservation Agriculture	40	19.23
Residue conservation technologies	36	17.30
Practicing biological control measures	35	16.82
Cultivation of location specific varieties	28	13.46
Adoption of bio fertilizer application practices, bio control agents and conserving microorganisms	20	9.61
Agro-biodiversity based eco-friendly agricultural cultivation practices	17	8.17
Mixed cropping practices	14	6.73
Maintenance of indigenous animal breeds and crops for biodiversity conservation, germplasm maintenance	6	2.88
Separate practices for Carbon sequestration	5	2.40

Table 5: Adoption of Eco- friendly based on-farm location specific climate smart agricultural practices

Eco- friendly Climate smart agricultural practices	Number of respondents (208)	Percentage
Integrated Pest Management	162	77.88
Integrated Diseases Management	150	72.11
Integrated Nutrient Management	136	65.38
Irrigation scheduling for precise water management	97	46.63
Adoption of crop insurance practices	93	44.71
Jeevamitrha and *Panchakavya* application	83	39.90
LEISA and eco-friendly farming practices	76	36.53
Application of compost and vermi composts	37	17.78
Adoption of soil health card based fertilizer recommendation	29	13.46
Accessing solar power for agriculture purpose	12	5.76

practices, bio control agents and conserving microorganisms (9.61%), agro-biodiversity based eco-friendly agricultural cultivation practices (8.17%), mixed cropping practices (6.71%), maintenance of indigenous animal breeds and crops for biodiversity conservation (2.88%) and Separate practices for Carbon sequestration (2.40%) respectively.

Table 5 reported that, among the various eco-friendly based on-farm appropriate climate smart agricultural practices adopted by the innovative climate smart agricultural farmers, (77.88%) of farmers adopted integrated pest management practices; followed integrated diseases management (72.11%), integrated nutrient management (65.38%), irrigation scheduling for precise water management (46.63%), crop insurance practices (44.71%), *Jeevamitra* and *Panchagavya* application (39.90%), low external input for sustainable agriculture and eco-friendly farming practices (36.53%), compost and vermi compost application (17.78%), soil health card based fertilizer recommendation (13.46%) and accessing solar power for agriculture purpose (5.76%) respectively.

The regression results revealed from Table 6, among the all respondents of both adopters and non-adopters of climate smart agricultural practices; the association and contribution of socio-economic profile characteristics of the innovative farmers with adoption of climate smart agricultural practices shows that, economic motivation, training undergone had positive and significant relationship at the five per cent level of

Table 6: Association and contribution of profile of farmers with adoption of climate smart agricultural practices (N = 306)

Profile characteristics	Respondents			
	Correlation r	Regression ('b' value) coefficient	SE of b	't' value
Social participation	0.020	0.038	0.084	-0.540
Economic motivation	0.153*	0.083	0.065	1.158*
Risk orientation	-0.043	0.026	0.064	0.364
Scientific orientation	0.121	-0.081	0.068	1.094*
Information seeking behaviour	0.019	-0.006	0.065	-0.090
Training undergone	0.153*	0.044	0.090	0.613
Perception on climate resilience	-0.043	0.056	0.067	0.772
Innovativeness	0.048	0.063	0.073	0.858
Contact with extension agency	0.183*	0.160	0.087	2.231**
Leadership abilities	-0.088	-0.041	0.065	-0.570

Table 7: Impact ofadoption of climate smart agricultural practices (n=208)

Impact	Increased		No change		Decreased	
	Number	Percentage	Number	Percentage	Number	Percentage
Direct impact						
Yield	69	33.17	113	54.33	26	12.5
Income	77	37.02	98	47.11	33	15.87
Cost of cultivation	20	9.61	72	34.62	116	55.77
Indirect impact						
Confidence in eco-friendly cultivation	144	69.23	53	25.48	11	5.29
Participation in social organization	127	61.05	62	29.81	19	9.14
Investment in savings	102	49.04	79	37.98	27	12.98
Livestock and poultry ownership	126	60.58	30	14.42	52	25.00
Soil fertility	167	80.28	25	12.02	16	7.70
Improvement in water level	78	37.50	117	56.25	13	6.25
Biodiversity conservation	80	38.46	124	59.63	4	1.91

probability and contact with extension agency of farmers exhibited positive and significance relationship at one per cent level of probability. Hence, it indicated that all the selected ten profile characteristics acted as cause to bring 56.80 per cent variation in adoption of climate smart agricultural practices. The prediction equation fitted for adoption of climate smart agricultural practices: the adoption of climate smart agricultural practices (Y) = 0.562 + 0.038 (Social participation) + 0.083 (Economic motivation) +0.026 (Risk orientation) - 0.081 (Scientific orientation) – 0.006 (Information seeking behaviour) + 044 (Training undergone) + 0.056 (Perception on climate resilience) + 0. 063 (Innovativeness) + 0.160 (Contact with extension agency) – 0.041(Leadership abilities).

Adoption of climate smart agricultural practices' s impact in the Table 7 with respect to direct impact, nearly one- third (33.17%) of respondents reported that increase in yield. also, (37.02%) of the respondents reported that increase in income and (55.77%) of the farmers indicated that the cost of cultivation decreased in their farming conditions. The climate smart agricultural practices were more profitable though in the low yield condition for the less cost of cultivation. Further, it also indirect impacted on 69.23 per cent of farmers suggested that their confidence level had increased; followed by 61.05 per cent of farmers' participation in social organization, 49.04 per cent of farmers' investment in savings increased, 60.58 per cent of farmers' purchase of livestock and poultry ownership increased, 80.28 per cent of farmers' fertility status of the soil improved, 37.50 per cent of farmers suggested that the ground water level was increased and 38.46 per cent of farmers reported that the biodiversity of the farm had improved with the increased impact of floral diversity, soil organic matter improvement and soil biological activities.

CONCLUSION

The study concluded that, among the CSA practices adopted farmers, location specific integrated farming systems practices, intercrop cultivation practices, crop rotation, organic farming practices, crop diversification practices, practicing weather based agro advisories for agricultural operations, micro irrigation practices, raised- bed preparation for wheat cultivation, Systems of Rice Intensification, zero tillage wheat, direct sown rice cultivation, effective crop residue management practices, conservation Agriculture, Integrated Pest Management practices, Integrated Diseases Management, Integrated Nutrient Management, Irrigation scheduling for precise water management, crop insurance practices, *Jeevamitra* and *Panchagavya* application, Low External Input for Sustainable Agriculture and eco-friendly farming practices were majorly adopted by the climate smart innovative farmers for better resilience, increased productivity and for reduced emissions. Further, the CSA farmers' economic motivation level, training undergone status and extension agency contact had played a positive and significant relationship for the adoption of CSA practices. Moreover, nearly one- third of respondents reported the increased yield and income conditions, around half of the farmers reported the reduced cost of cultivation under climate smart agriculture. The climate smart agriculture practices indirectly impacted the enhanced self confidence level for their investment in savings and diversified livestock and poultry based livelihoods. It also enhanced the soil fertility status, ground water level and biodiversity of the local farming systems.

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Changes in Agricultural Land Use Pattern Over Time in Kathua District of Jammu and Kashmir

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ABSTRACT

A research study was undertaken to analyse the changes in agricultural land use patterns over time in the Kathua district of Union Territory (UT) of Jammu and Kashmir (J&K). Four blocks were selected purposely because they were more vulnerable to changes in agricultural land use pattern. From each selected block, three villages were selected randomly without replacement. A sample of 120 respondents was chosen for the aim of the study. Primary data were collected for the years 2008-09 to 2016-17, secondary data were also collected for the years 2015-16 to 2017-18. The results of the study indicate that, the proportion of area under current fallow, miscellaneous trees crops and fallow land other than current fallow increased from 6000 ha to 11556 ha, 13000 ha to 18037 ha and 4000 ha to 6722 ha, respectively with a positive compound annual growth rate and high instability index (>30). The proportion of area under barren and uncultivable land, permanent pastures and other grazing and net sown area decreased from 33862 ha to 32298 ha, 10881 ha to 9387 ha and 65240 ha to 58797 ha, respectively all with a negative compound annual growth rate and a low instability index in the range of 0-15 in Kathua district between 2008 to 2017. From 2015 to 2017, the area under food crops in the selected villages declined from 383.31 ha to 367.95 ha, with a negative compound annual growth rate, while the area under non-food crops climbed from 34.47 ha to 45.1 ha, with a positive compound annual growth rate and a low instability index (0-15).

Keywords: Land use pattern, Compound growth rate, Instability index

INTRODUCTION

Agriculture is the backbone of the Indian economy, and it continues to have a prominent position despite the country's rapid industrialisation over the last five decades. Nation progress is directly linked with advancement in agriculture. In a country where over fifty five per cent population lives in villages, where agriculture and allied sectors (including agriculture, livestock, forestry and fisheries) are estimates to contribute nearly 13.9 per cent of national Gross Domestic Product (GDP) and 17 per cent of Gross Value added (GVA) in 2017 and provide employment to over half of the country workforce (Chowdappa *et al.*, 2018). Agriculture contributes significantly to our country's overall economic and social well-being. Land is the most basic input for agriculture, and it ranks first among all the resources required for the sector's development. The amount, distribution, and utilisation of land have long been recognised as critical elements in agricultural development and poverty alleviation (Malthus, 1798). Due to increased pressure on land for food production on the one hand, and housing, industrial expansion, and the creation of infrastructural facilities on the other, the struggle for land between agriculture and non-agriculture sectors is intensifying. Changes in land use patterns are a complicated phenomenon influenced by a variety of socioeconomic, climatic, and institutional factors. Land use patterns have also changed as a result of technological advancements. Notably, the agriculture sector in India has undergone significant changes in terms of area under cultivation, cropping patterns,

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productivity, technology, land holding patterns and reforms, fertilizer and pesticide use, irrigation pattern and area under irrigation, and the use of high yielding varieties of seeds, among other things (FAO, 2017).

India has seen dramatic changes in land use and land cover over time period, including deforestation, agriculture shifts, and urban expansion (Roy *et al.*, 2015 and Tian *et al.*, 2014) and any shift in agricultural land use patterns will have a huge impact on the country's growth, diversity, and long-term viability. The movement in land use is in line with the transition in land use from agricultural to non-agricultural (Singh and Swain, 2016). India has a geographical area of 328.7 million hectares, of which roughly 286 million hectares are now utilised for cultivation of various food and non-food crops. From 1950-51 to 2010-11, the amount of land used for non-agricultural purposes increased from 9.36 mha to 26.31 mha. From 1950-51 to 2010-11, the share of land used for non-agricultural purposes climbed from 3.5 to 8.3 per cent of total reported area. The annual growth rate of land used for non-agricultural purposes is 1.72 per cent (www.indiastat.com). In 2010-11, woods covered roughly 21 per cent of the geographical area, 8 per cent was used for non-agricultural purposes, 5 per cent was barren and uncultivable, and 7.5 per cent was fallow land (GOI, 2015). The average land holding is only 1.1 ha, and it has been steadily diminishing, posing a threat to millions of smallholder farmers' food and livelihood security.

Jammu and Kashmir is a union territory in the north-western mountainous region with a total geographical area of 2417 thousand ha, with net sown area of 757 thousand ha (39.32%), forest land of 659 thousand ha (27.26%), area not available for cultivation of 562 thousand ha (23.25 percent), other uncultivable land of 315 thousand ha (13.03%), and fallow land of 121 thousand ha (5.01%). Kathua district has a total geographical area of around 264 thousand ha. The net sown area is 58 thousand ha (29.96%), forest land is 72 thousand ha (27.3%), non-cultivable land is 78 thousand ha (29.5%), other uncultivable land is 36 thousand ha (13.6%), and fallow land is 18 thousand ha (6.8%) (DES, 2016-17).

Furthermore, shifts in land use classes in the district may occur as a result of urbanisation and infrastructure development. In the study area, the area classified as fallow land, food crops, and net area sown was steadily decreasing. Understanding land use change trends in connection to the driving causes will provide critical information for land use planning and resource management. As a result, the current study was conducted to investigate changes in land use patterns between 2008 and 2017.

MATERIALS AND METHODS

The research was carried out in Kathua district of UT of J&K. Kathua district is divided into 19 blocks. Four blocks namely Marheen, Nagri, Barnoti, and Hiranagar near the roadside were purposefully chosen because they were more vulnerable to changes in agricultural land use patterns. The Directorate of Economics and Statistics in Jammu provided a list of the blocks. are the four blocks chosen. In the second step, three villages were chosen at random from each designated block without replacement. The villages' names were gathered from the Jammu and Kashmir Directorate of Economics and Statistics, as well as the Panchayat. As a result, 12 villages were chosen at random for the study. A list of respondents from selected villages was procured from the Sarpanches and Agriculture Extension Office. From each village, ten respondents were chosen at random and without replacement. In total, 120 respondents were selected to participate in the study. The research was conducted between 2008-09 and 2017-18. Time series data from 2008-09 to 2016-17 was utilised in secondary data to examine changes in agricultural land use patterns over time. The year 2008-09 was chosen as the base year. Secondary data was gathered from published sources, as well as annual reports from the UT of J&K and the Indian government. Time series data from 2015-16 to 2017-18 is utilised in primary data to investigate changes in agricultural land use patterns over time. The base year was chosen to be 2015-16.

RESULTS AND DISCUSSION

Due to rising urbanisation and infrastructure development, UT of J&K is confronted with a bunch of issues relating to land use and distribution/allocation. It has a significant impact on the use of agricultural land.

Land use pattern in Kathua district from 2008 to 2017: The land use pattern of Kathua district revealed

Table 1: Land use pattern in Kathua district from 2008 to 2017 (ha)

S.No.	Parameter	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1.	Total geographical area	265729 (100)	265729 (100)	265729 (100)	265729 (100)	265729 (100)	265729 (100)	265729 (100)	265729 (100)	265729 (100)
2.	Forest land	72732 (27.30)	72732 (27.30)	72732 (27.30)	72732 (27.30)	72732 (27.30)	72732 (27.30)	72732 (27.30)	72732 (27.30)	72732 (27.30)
3.	Land put to non-agriculture use	46145 (17.30)	46145 (17.30)	46145 (17.30)	46145 (17.30)	46145 (17.30)	46145 (17.30)	46145 (17.30)	46145 (17.30)	46145 (17.30)
4.	Barren and uncultivable land	33862 (12.70)	33862 (12.70)	33862 (12.70)	33862 (12.70)	33862 (12.70)	33862 (12.70)	33862 (12.70)	33862 (12.70)	32298 (12.10)
5.	Permanent pastures and other grazing land	10881 (4.09)	10881 (4.09)	10881 (4.09)	10881 (4.09)	10881 (4.09)	10881 (4.09)	10881 (4.09)	10881 (4.09)	9387 (3.50)
6.	Land under miscellaneous tree crops	13000 (4.89)	14270 (5.30)	14270 (5.30)	14270 (5.30)	10274 (3.80)	11255 (4.23)	10253 (3.80)	10275 (3.85)	18037 (6.70)
7.	Cultivable waste land	11000 (4.10)	7936 (2.98)	7936 (2.98)	7936 (2.98)	7936 (2.98)	7936 (2.98)	7936 (2.98)	8951 (3.30)	8950 (3.30)
8.	Current fallow	6000 (2.25)	10000 (3.70)	14867 (5.50)	14867 (5.50)	22125 (8.30)	21788 (8.10)	20750 (7.80)	19881 (7.40)	11556 (4.30)
9.	Fallow land other than current fallow	4000 (1.50)	4000 (1.50)	255 (0.09)	255 (0.09)	275 (0.11)	260 (0.09)	250 (0.09)	270 (0.10)	6722 (2.50)
10.	Land under food crops	121160 (45.50)	118730 (44.60)	120745 (45.40)	116160 (43.70)	111903 (42.10)	110542 (41.50)	110645 (41.60)	105484 (39.60)	107704 (40.50)
11.	Land under non-food crops	11783 (4.40)	10538 (3.90)	7028 (2.60)	9865 (3.70)	10770 (4.05)	8925 (3.30)	8550 (3.20)	13670 (5.10)	9302 (3.50)
12.	Net area sown	65240 (24.50)	65023 (24.40)	63781 (24.00)	63911 (24.05)	60543 (22.70)	59551 (22.40)	56655 (21.30)	53480 (20.10)	58797 (22.13)
13.	Area sown more than once	62000 (23.30)	64258 (24.10)	61230 (23.04)	62114 (23.30)	62032 (23.30)	61561 (23.10)	63689 (23.90)	60456 (22.70)	58221 (21.90)
14.	Total cropped area	127240 (47.88)	129281 (48.65)	125011 (47.04)	126025 (47.42)	122575 (46.10)	121067 (45.50)	120344 (45.28)	100654 (37.87)	117008 (44.03)

**Figures in parentheses are percentages to total geographical area*, Source- DES, 2008-09 to 2016-17 that the geographical area was 265729 ha and the area under forest and land used for non-agricultural purposes did not change during the study period (Table 1). The maximum area was under total cropped area which had decreased from 127240 ha to 117008 ha, followed by land under food crops which also decreased from 121160 ha to 107704 ha. The forest land was found to be 72732 ha. The net area sown had decreased from 65240 ha to 58797 ha, findings are supported by Krishnan (2017) and Sujatha *et al,* (2011). The area sown more than once followed by barren and uncultivable land and permanent pastures and other grazing land had decreased from 62000 ha to 58221 ha, 33682 ha to 32298 ha and 10881 ha to 9387 ha, respectively. The land put to non-agricultural use was found to be 46145 ha during the study period. Cultivable waste land had also decreased from 11000 ha to 8950 ha. Land under non-food crops had decreased from 11783 ha to 9302 ha. The findings are in accordance with Hajare *et al.* (2014) who found decline in area under non-food crops in Kolhapur district. There was a great variations in the land under miscellaneous tree crops which had increased from 13000 ha to 18037 ha. Land under current fallow and fallow land other than current fallow had increased from 6000 ha to 11556 ha and 4000 ha to 6722 ha during the study period. The results are in confirmation with the findings of Sreeja (2004) who reported that there was substantial growth in the current fallow in Kollam district of Kerala.

Land use pattern of selected study area from 2015 to 2017: Land use pattern of the selected study area from 2015-16 to 2017-18 revealed that, the geographical area of the selected villages was 225.55 ha during the study period (Table 2). The maximum area was under total cropped area which had decreased from 428.65 ha to 423.4 ha, followed by land under food crops from 383.31 ha to 367.94 ha. Rejula and Singh (2015) also found decrease in area under food crops in Kerala. Area sown more than once had decreased from 214.59 ha to 209.42 ha. Net area sown had decreased from 214.05 ha to 213.98 ha, the findings are supported with Meenakshi and Indumathy (2009). Fallow land other than current fallow had decreased from 0.20 ha to 0.18 ha during the said period. There was a great variations in land under non-food crops which had increased from 34.47 ha to 45.10 ha. Land put to non-agriculture use, land under miscellaneous tree crops and cultivable waste land was found to be 7.07 ha, 3.50 ha and 0.73 ha, respectively. Land under current fallow was 0.10 ha in 2017-18.

Compound annual growth rate (CAGR) for land use pattern: Compound annual growth rate (CAGR) for land use pattern of Kathua district during 2008 to 2017 is presented in Table 3 shows that, area under fallow land other than current fallow had shown highest positive growth rate of 25.90 per cent followed by area under current fallow which shown 23.10 per cent positive growth rate and land under miscellaneous tree crops had shown 2.23 per cent positive growth

Table 2: Land use pattern of selected study area from 2015 to 2017 (ha)

Parameter	2015-16	2016-17	2017-18
Total geographical area of the respondents	225.55 (100)	225.05 (100)	225.05 (100)
Land put non-agriculture use	7.07 (3.14)	7.07 (3.14)	7.07 (3.14)
Land under miscellaneous tree crops	3.50 (1.50)	3.50 (1.50)	3.50 (1.50)
Cultivable waste land	0.725 (0.32)	0.725 (0.32)	0.725 (0.32)
Current fallow	0	0	0.1 (0.04)
Fallow land other than current fallow	0.2 (0.08)	0.175 (0.07)	0.175 (0.07)
Land under food crops	383.31	377.21	367.945
Land under non-food crops	34.47 (15.28)	40.25 (17.8)	45.1 (19.9)
Net area sown	214.055 (94.9)	214.08 (94.9)	213.98 (94.8)
Area sown more than once	214.595 (95.2)	210.22 (93.2)	209.42 (92.8)
Total cropped area	428.65	424.3	423.4

**Figures in parentheses are percentages to total geographical area,*

Table 3: Compound annual growth rate (CAGR) for land use pattern

Parameter	CAGR (2008-2017)	CAGR (2015-2018)
Barren and uncultivalble land	-0.68	0
Permanent pastures and other grazing land	-2.05	0
Land under miscellaneous tree crops	2.23	0
Cultivable waste land	-1.59	0
Current fallow	23.02	0
Fallow land other than current fallow	25.89	-12.90
Land under food crops	-3.83	-4.5
Land under non-food crops	-0.45	34.89*
Net area sown	-4.72*	-0.02
Area sown more than once	-1.37	-2.2
Total cropped area	-4.5*	-1.3

**Figures depict percentages, *Significant at $p \leq 0.05$,* CAGR of 2008 to 2017 as per digest of 2008-09 to 2016-17

Table 4: Instability index for land use pattern

Parameter	Instability index (2008-2017)	Instability index (2015-2018)
Barren and uncultivable land	1.38	0
Permanent pastures and other grazing land	4.15	0
Land under miscellaneous tree crops	21.81	0
Cultivable waste land	12.68	0
Current fallow	32.54	0
Fallow land other than current fallow	144.70	5.56
Land under food crops	1.67	0.35
Land under non-food crops	20.61	1.33
Net area sown	3.3	0.02
Area sown more than once	2.50	0.69
Total cropped area	4.98	0.37

* Instability index of 2008 to 2017 as per digest of 2008-09 to 2016-17

rate. Whereas, net area sown and total cropped area had significantly negative growth rate of -4.72 per cent and - 4.50 per cent, respectively. Pandey and Ranganathan (2018), Mangalagowari and Nagaraj (2017) also revealed increase in non-agriculture land, current fallow land in the Mysore district.

In the selected study area, land under food crops, permanent pastures and other grazing land, land under miscellaneous tree crops, cultivable waste land, area sown more than once, barren and uncultivable land and land under non-food crops had negative growth rate of -3.83 per cent, -2.05 per cent, -1.59 per cent, -1.37 per cent, -0.68 per cent, -0.45 per cent, respectively. Malik (2012) in his study conducted in Haryana also found decline in net area sown over a period of time.

Instability index for land use pattern: Instability is a measure of extent of variability or the absence of stability in time series data and thus instability index for various land use categories of the Kathua district are presented in Table 4 which reveals that, between 2008 to 2017, for fallow land other than current fallow and area under current fallow was the 55 highest range of 144.70 and 32.54. Land under miscellaneous tree crops and land under non-food crops shows the medium range of instability index with 21.81 and 20.61, respectively. Whereas, the cultivable waste land, total cropped area, permanent pastures and other grazing land, net area sown, area sown more than once, land under food crops and barren and uncultivable land shows the low range of instability index of 12.68, 4.98, 4.15, 3.30, 2.50, 1.67 and 1.38, respectively.

Instability index of the selected study area revealed that, between 2015 to 2017, for fallow land other than current fallow, land under non-food crops, area sown more than once, total cropped area, land under food crops and net area sown was in the low range of instability index of 5.56, 1.33, 0.69, 0.37, 0.35 and 0.02, rrespectively.

CONCLUSION

The present study shows the trends of land use pattern of Kathua district of Jammu and Kashmir. It was found that land under current fallow and fallow land other than current fallow expanded with a positive compound annual growth rate and had a wide range of instability index (>30) from 2008 to 2017. Barren and uncultivable land, permanent pastures and other grazing land, cultivable waste land, land under food crops, non-food crops, net sown area, area sown more than once, and total cropped area, had a negative compound annual growth rate and a low range of instability index (0-15). Land under current fallow and land under non-food crops expanded with a positive compound annual growth rate and had a low range of instability index (0-15) in a selected study area from 2015 to 2018. Other than present fallow land, land under food crops, net area sown, area sown more than once, and total cropped area, on the other hand, had dropped with a negative compound annual growth rate and had a low range of instability index (0-15). Conservation of agriculture can be ensured by incentivizing sustainable farm operations through power connectivity, additional input subsidy, low premium on crop insurance etc. Appropriate extension programmes along with the government support services in terms of minimum sale prices of the newly cultivated crops, storage facilities, technological support, marketing facilities and crop insurance are of utmost importance to take the advantage of globalisation and to attain a higher growth 105 path in agriculture in the face of the emerging threats of declining trend of food grain productivity in Indian agriculture. Land use planning should be integrated with all other developmental programmes for holistic rural development, natural resource management and eco-restoration. Considering the small size of land holding, it is not possible to reap the benefits of economies of scale. Hence, there is need for aggregation of land through contract farming, cooperative farming and collective farming.

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Traditional Storage Structures for Crops: Exploring Indigenous Technical Knowledge from the Cold Desert of Ladakh, India

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ABSTRACT

Due to the adverse climatic conditions in the cold desert of Ladakh, agricultural practices are generally limited to few months only. It is due to this short agricultural season that people of Ladakh have invested in innovations and technologies for better storage systems to survive the harsh and unfriendly winters of Ladakh. Accordingly, very well-thought-out indigenous technologies of storing fruits, vegetables, grains and fodder have been developed overtime. The present study was conducted in order to get acquainted with, and report the Indigenous Technical Knowledge (ITK) of storage structures and techniques, in and around Leh district of Ladakh region. Extensive surveys in the villages of Stakmo, Ranbirpur, Thiksey, Saboo, Naang, Phey, Umla of Leh district were conducted. The data was collected by interviewing experienced farmers of the villages who were proficient in constructing these structures. The storage structures reported were *Chulta*, *Sadong* and *Tsothbang* for vegetable storage, *Paana* for grain storage and *Phugrak* and *Chunpo* for fodder. The study pressed upon the fact that the ITK of farmers has to be integrated with scientific knowledge and technological advancements of today in order for farmers to improve their traditional ways of doing things.

Keywords: Indigenous technical knowledge, Ladakh, Traditional, Storage structures

INTRODUCTION

Local or indigenous technical knowledge refers to the cumulative and complex bodies of knowledge, know-how, practices and representations that are maintained and developed by local communities, who have long histories of interaction with the natural environment (UNESCO, 2012). It is a type of knowledge which is of the people, for the people and by the people. Indigenous technical knowledge develops within a particular community and maintains a non-formal means of dissemination. Such knowledge is collectively owned, developed over several generations and subject to adaptation, and imbedded in a community's way of life as a means of survival (Borthakur and Singh, 2012).

Just like any other part of the world, people in the cold desert of Ladakh have also developed many practices which form a part of the indigenous technical knowledge of this region. Situated between 32° N to 36° S latitude and 75° E to 80° E longitude in the trans-Himalaya and surrounded spectacularly by arid mountains, the cold desert of Ladakh is unique in its own ways. One of the most sparsely populated region of the erstwhile Jammu and Kashmir (J&K) state (now a Union Territory) with a population of 274289 (according to 2011 census), the people of Ladakh are close to their roots. The locals have developed indigenous techniques to store vegetables, fodder and grains during the harsh winter months. Due to sub-zero temperatures, the cultivation of vegetables is not possible in winters. So, when there is no availability of fresh vegetables in the market for consumption and fodder for animals, these storage structures help in continuous supply of vegetables to farmers.

In the present study extensive surveys were done in order to get acquainted with the indigenous technical knowledge (ITK) of storing vegetables, grains and fodder by the locals in the Union Territory of Ladakh.

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MATERIALS AND METHODS

The research design employed for the present study was explorative research design. Explorative research design is employed to investigate a problem which is not clearly defined and is conducted to have a better understanding of the problem at hand. In the present study, explorative research design was employed to investigate about the different storage structures used by locals in Ladakh to store vegetables, grains and fodder in winter.

The study was conducted in seven villages of Leh district i.e., Stakmo, Ranbirpur, Thiksey, Saboo, Naang, Phey and Umla. Simple random sampling method was employed to select a sample of 70 experienced farmers from the study area. Data was collected from the sampled farmers by means of personal interview method. A research schedule was constructed to collect data from the farmers and it covered different aspects of the study.

RESULTS

Farmers in the villages of Leh reported many traditional methods of storing vegetables. The ITK recorded during the survey included the following:

1. Storage structures for vegetables: The storage structures meant to store vegetables included the following structures:

a. Chulta**: *A traditional onion seed production practice:*** *Chulta* is a traditional method of storing onion and is also an onion seed production technique. In this technique onion bulbs harvested in mid-October are first left to harden in the field for two days. The onions are tied together in bunches and interlaced with the help of green leaves (Figure 1). Long sticks strong enough to bear the load of the onion bunches are hanged horizontally on the ceiling of an unheated storehouse using rope hooks and the interlaced onions are hanged on to these sticks. This structure is called *Charches* and the method of hanging interlaced onion on *Charches* is called *Chulta* (Figure 1). The onion can be used for consumption throughout the winter and healthy onions can be kept hanging for seed production purposes when the temperature is conducive for the onion to sprout again and develop seeds. By first week of April, the interlaced onions start sprouting and around first week of May, these green sprouts can be transferred in the soil for seed production. Farmers report that plot size of 2x2 square metre produces about 100 to 200 g onion seed.

b. Sadong: Sadong is a structure which is meant to store root vegetables like potato, carrot, radish and turnip in winter. It is a cone shaped pit which is dug in a well-drained location on the field. The size of the pit varies from 5-6 feet deep, 3-4 feet surface diameter and 5-6 feet basal diameter (Figure 2). The pit is dug in the month of October soon after crops are harvested

Figure 1: a) Interlaced onion bulbs in field **b) Onion hanging on *Chulta***

Figure 2: a) A woman preparing *Sadong* **b) Potato transferred in the pit**

from the field and root vegetables are transferred in the pit. Vegetables are stored in such a way that potatoes (which have more moisture) are put first, followed by radish and carrots. This helps to maintain the quality of the vegetables. The top of the pit is covered with gunny bags and finally the pit is covered with soil. It is ensured that the pit is filled with root vegetables which are free from cuts, cracks, bruises, and mechanical injury. During winter months, the pit is dug to take the required quantity of vegetables for consumption. The gunny bag and soil are placed back to avoid freezing of the root vegetables. Repeated opening of the pit is generally avoided as it increases the chances of mechanical injury and deep freezing. It has been reported by the farmers that in a *Sadong* vegetables can be stored in good conditions for up to 5 months. With the arrival of spring, the leftover vegetables are removed from the pit and pit is filled with soil to carry routine agricultural activities.

c. Tsothbang (vegetable cellar): *Tsothbang* (vegetable cellar) is a rectangular structure with a small entrance and dimension of 12 × 10 × 6 m^3 (L × W × H) prepared to store vegetables during winter. The cellar has a small outdoor entrance and a ventilator and is used to store cabbage and root crops like potato, radish, carrot, turnip etc. (Figure 3). The *tsotbang* helps to keep vegetables fresh for 5 to 6 months. The cellar is made either in the basement of the house or as a separate outdoor underground or semi-underground structure. If the structure is made in the basement of the house, opening is usually made from the kitchen using staircase. Inside the cellar humidity is maintained by sprinkling water at regular intervals (usually 15 to 20 days interval). Temperature of the cellar is maintained by opening and closing the ventilator depending on the temperature outside the cellar. The ventilator is closed tightly from November to February when the temperature outside the cellar is below zero and the ventilator is opened during day time in the month of October and March. For storage in *tsothbang* cabbage is harvested along with roots and spread on the floor of the cellar side by side with their roots dug in 15 cm soil. Root crops are piled in a corner of the cellar and covered with 7.5-10 cm thick soil layer. It

Figure 3: a) Door and ventilator of *Tsothbang* **b) Cabbage stored in *Tsothbang***

has been reported that vegetables can be kept fresh for at least 5 to 6 months inside a *tsothbang*.

2. Storage structures for grains

a. Paana: Paana is the traditional room for storing food grains particularly wheat and barley in winter. The room is a closed structure built underground with only a single window on the roof. The window usually opens as a structure on the floor of the kitchen or store room of the house. Paana is built usually to prevent the infestation of rats and insect-pests of stored grains. The room also keeps the grains fresh and prevent their germination.

b. Storage structures for fodder: The storage structures for fodder includes:

a. Phugrak: Phugrak is a room, usually built underground, attached to the main house and is a traditional storage structure meant for storing dry straw as fodder for animals in winter. The straw is collected after threshing of the crop (wheat and barley) in the field and is transferred in the phugrak. Phugrak is an important storage structure for almost all the village households and provides continuous supply of fodder for animals during winter. Benefits of storing straw under this traditional technique as it maintains the quality of the produce and prevents its rotting.

b. Chunpo: Chunpo are stacks of green fodder (like Alpha alpha) harvested fresh from the field, tied in bunches and stored on the roof of the houses for feeding the cattle during winter. The stacks sundry on the rooftop and remain available to cattle for the winter months.

DISCUSSION

Due to the adverse climatic conditions in the cold desert of Ladakh, agricultural practices are generally limited to few months only. In the Leh district of Ladakh, the agricultural season is confined to the months of May to September in the areas with higher elevation. Whereas, in the areas of lower elevation, like Sham and Nubra regions, double cropping is practiced with the first crop cultivated from March till July and the second crop from July till October. Accordingly, keeping in consideration the harsh climatic conditions of the Himalayan region of Ladakh, very well-thought-out indigenous technologies of storing fruits, vegetables, grains and fodder have been developed overtime. These storage structures are making the life of the people of Ladakh easier by providing continuous supply of vegetables, and grains for consumption, as well as fodder for their animals. Ali *et al.* (2012) reported that the shelf life of different vegetables like potato, carrot, turnip, radish and cabbage under *Sadong, Tsotbang and Charches* varied from 5-8 months.

CONCLUSION

The findings of this study reinforce widely held views that indigenous and local knowledge and practices help local communities adapt to harsh environmental conditions. In Ladakh, people have been dealing with the harsh winter months by innovating indigenous methods of storing vegetables, grains and fodder which in the long run helps them to manage local natural resources and infrastructure development accordingly. This study further argues that the ITK of farmers has to be integrated with scientific knowledge and technological advancements of today in order for farmers to improve their traditional ways of doing things.

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Changes in the Distribution of Operational Land Holdings Over Time in Kathua District of Jammu and Kashmir

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ABSTRACT

A research study was undertaken to analyse the changes in the distribution of operational land holdings over time in the Kathua district of Union Territory (UT) of Jammu and Kashmir (J&K). Differences in land ownership pattern have consequences for the composition and organization of agricultural production, for the overall utilization of land associated assets and for the distribution of income in rural areas. Therefore, to find out the changes in the distribution of operational holdings, a study was conducted in the Kathua district of Jammu and Kashmir. Four blocks were selected purposively, which were on the road side. From each selected block, 3 villages were selected randomly without replacement. Further, 10 respondents were selected randomly without replacement from each selected village which raised the sample size of 120 respondents. Secondary data were also collected for the the years 2000-01 to 2010-11. Whereas, primary data were collected for the year 2015-16 to 2017-18. The results of the study indicate that, in both primary as well as secondary data of Kathua district revealed that there is unequal distribution of operational land holdings among different categories of farm size.

Keywords: Operational land holdings, Unequal distribution, Categories of farm size

INTRODUCTION

In India, over 70 per cent of the population resides in rural areas with majority depending on land based activities for their livelihood. Agriculture provides food to the increasing population, supplies raw material to the industrial sector and furnished goods for exports and helps to earn foreign exchange. Weather conditions, soil, topography are important factors influencing the cropping patter and crop production. The other inputs like irrigation, fertilizers, seeds, pesticides are influencing the crop growth. The control of land continues to be at the centre of social activity for the rural people. Differences in land ownership pattern have consequences for the composition and organization of agricultural production, for the overall utilization of land associated assets and for the distribution of income in rural areas (Kaushik, 2000). Studies have shown that widespread inequalities of income in the rural areas have their genesis in an unequal distribution of land and other productive assets (Julka and Soni, 1988). The structure of land holdings shows an indisputable trend towards progressive disaggregation. As the operated area in the country has decreased from 159.59 mha in 2010-11 to 157.82 mha in 2015-16 showing a decrease of 1.11 per cent. The total number of operational holdings in the country has increased from 138.35 m in 2010-11 to 146.45 m in 2015-16 showing a decrease of 1.11 per cent. The average size of operational holding has declined to 1.08 ha in 2015-16 as compared to 1.15 ha in 2010-11. In the Union Territory (UT) of Jammu and Kashmir (J&K), from 2010-11 to 2015-16, the number of operational land holdings was decreased from 1449 to 1417 and there was -2.27 per cent variation in number of operational land holdings. However, area of operational land holdings was also decreased from 895 to 842 and there was -5.93 per cent variation in number of operational land holdings (Agriculture Census, 2015-16). The

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structure of land holdings shows an indisputable trend towards progressive disaggregation. As a result, the current study was conducted to investigate in the distribution of operational land holdings over time.

MATERIALS AND METHODS

The research was carried out in Kathua district of UT of J&K. Kathua district is divided into 19 blocks. Four blocks namely Marheen, Nagri, Barnoti, and Hiranagar near the roadside were purposefully chosen. The Directorate of Economics and Statistics in Jammu provided a list of the blocks. In the second step, three villages were chosen at random from each designated block without replacement. The villages' names were gathered from the Jammu and Kashmir Directorate of Economics and Statistics, as well as the Panchayat. As a result, 12 villages were chosen at random for the study. A list of respondents from selected villages was procured from the Sarpanches and Agriculture Extension Office. From each village, ten respondents were chosen at random and without replacement. In total, 120 respondents were selected to participate in the study. Time series data from 2000-01 to 2010-11 was utilised in secondary data to examine change in the distribution of operational land holdings over time. Secondary data was gathered from published sources, as well as annual reports from the UT of J&K and the Indian government. Time series data from 2015-16 to 2017-18 is utilised in primary data to investigate changes in the distribution of operational land holdings over time.

RESULTS AND DISCUSSION

Extent of changes in the distribution of operational land holdings: The distribution of operational land holding by farm size in Kathua district from year 2000 to 2011 reveals that, except for marginal and medium land holding farmers, wherein the number of operational land holdings had increased from 67.50 per cent to 70.31 per cent and 3.07 per cent to 3.12 per cent from 2000-01 to 2010-11, the rest of farmers with small, semi-medium and large land holding farmers had decreased from 18.35 per cent to 17.19 per cent, 10.98 per cent to 9.26 per cent and 0.15 per cent to 0.14 per cent, respectively (Table 1). However, area of operational land holdings with semi-medium and large land holding farmers had decreased from 30.25 per cent to 27.14 per cent and 2.08 per cent to 1.98 per cent 2000-01 to 2010-11, respectively.

Whereas, area of operational land holdings of the farmers with marginal, small and medium land holding farmers had increased from 25.12 per cent to 26.12 per cent, 25.71 per cent to 26.51 per cent and 16.87 per cent to 18.27 per cent from 2000-01 to 2010-11. These findings are supported by Prasad (2011), who also experienced that at the national level, 90 per cent of the respondents belonged to marginal and small land holding categories.

The distribution of operational land holdings by farm size in the selected study area from 2015-16 to 2017-18 which reveals that, the number of operational holdings of marginal land holding farmers had increased from 27 per cent to 29 per cent, as well as area of operational land holdings had also increased from 9.9 per cent to 11.3 per cent from 2015 to 2018 (Table 2). Whereas, in case of small land holding farmers, number of operational holdings had decreased from 56 per cent to 54 per cent and area of operational

Table 1: Distribution of land holdings by farm size and area operated for year 2000-01, 2005-06 and 2010-11

Categorization of farm size (ha)	No. of holdings (000)			Area of holdings (000 ha)		
	2000-01	2005-06	2010-11	2000-01	2005-06	2010-11
Marginal (upto 1 ha)	60484 (67.5)	56353 (67.89)	56874 (70.31)	232145 (25.12)	23214 (26.40)	20.037 (26.12)
Small (1 to 2 ha)	16446 (18.35)	14827 (17.87)	13903 (17.19)	23795 (25.71)	21971 (24.99)	20.338 (26.51)
Semi-medium (2 to 4 ha)	9844 (10.98)	8869 (10.69)	7490 (9.26)	27996 (30.25)	24908 (28.33)	20821 (27.14)
Medium (4 to 10 ha)	2748 (3.07)	2830 (3.40)	2516 (3.12)	15610 (16.87)	16039 (18.24)	14018 (18.27)
Large (10 & above ha)	133 (0.15)	132 (0.16)	108 (0.14)	1919 (2.08)	1812 (2.07)	1515 (1.9)
All classes	89655 (100)	83011 (100)	80891 (100)	92562 (100)	87945 (100)	76731 (100)

**Figures depict percentages*

Table 2: Distribution of land holdings by farm size and area operated for the year 2015 to 2018

Categorization of farm size (ha)	No. of holdings (n=120)			Area of holdings (ha)		
	2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
Marginal (upto 1 ha)	33 (27)	34 (28)	35 (29)	20.7 (9.9)	21.7 (10.4)	23.5 (11.3)
Small (1 to 2 ha)	67 (56)	66 (55)	65 (54)	103.32 (49.6)	102.32 (49.2)	101.25 (48.7)
Semi-medium (2 to 4 ha)	11 (9)	11 (9)	11 (9)	32.25 (15.5)	32.25 (15.5)	32.25 (15.5)
Medium (4 to 10 ha)	9 (8)	9 (8)	9 (8)	51.5 (25)	51.5 (25)	51.5 (25)

**Figures depict percentages*

land holdings had also decreased from 49.6 per cent to 48.7 per cent from 2015 to 2018. There were no variations in the number of operational land holdings. However, area of operational land holdings for semi-medium and medium land holding farmers. For semi-medium land holding farmers, the number of operational land holdings was 9 per cent and area of operational land holdings was 15.5 per cent from 2015 to 2018. For medium land holding farmers, the number of operational land holdings was 8 per cent and area of operational land holdings was 25 per cent from 2015 to 2018. These findings are in accordance with the findings of Sirohi *et al.* (1976) and Sood (2016) who also found the largest increase in the number of holdings as well as operated area in case of marginal holdings followed by small land holding farmers.

Gini's coefficient for the distribution of operational land holdings: The Gini's coefficient for the distribution of operational land holdings revealed that for the year 2000-01, it was 0.63, which represents severe equality gap among the distribution of operational land holdings (Table 3). In year 2005-06, Gini's coefficient was 0.47, which represents big equality gap among the distribution of operational land holdings. In year 2010-11, Gini's coefficient was 0.16, which represents the perfect equality gap among the distribution of operational land holdings. Gini's coefficient had declined from 0.63 in 2001-01 to 0.16 in 2010-11. The results are in confirmation with Singh (1976) who found the structure of land holdings in an equal distribution. The findings are also in accordance with the findings of Pawar and More (2018) who also found the distribution of operational land holdings are iniquitous.

Table 3: Distribution of operational land holdings

Year	2000-01	2005-06	2010-11
Gini's coefficient	0.63	0.47	0.16
Farm size of land holdings (ha)	**Gini's coefficient**		
	2015-16	**2016-17**	**2017-18**
Marginal (upto 1 ha)	0.94	0.94	0.90
Small (1 to 2 ha)	0.82	0.97	0.96
Semi-medium (2 to 4 ha)	0.37	0.37	0.37
Medium (4 to 10 ha)	0.29	0.29	0.29
All classes	0.33	0.32	0.33

Gini's coefficient from 2015-16 to 2017-18 in the selected study area had declined in case of marginal land holding farmers from 0.94 into 0.90, which represents severe equality gap among the distribution of operational holdings (Table 3). Whereas, Gini's coefficient had increased in case of small land holding farmers from 0.82 in 2015-16 to 0.96 in 2017-18, which also represents severe equality gap among the distribution of operational land holdings. These results are similar to the findings of Patil (2012). There was no variations in the Gini's coefficient of semi-medium and medium land holding farmers from 2015 to 2018. Gini's coefficient for medium land holding farmers was 0.29, which represents relative equality gap among the distribution of operational land holdings. Gini' coefficient of semi-medium land holding farmers was 0.37, which represents adequate equality gap among the distribution of operational land holdings. Overall Gini's coefficient of all classes from 2015-16 to 2017-18 were 0.33, 0.32 and 0.33 respectively which represents adequate equality gap among the distribution of operational land holdings. The findings are in confirmation with the findings of Kaushik (2000) and Naseer *et al.* (2016) who also quoted that the distribution of operational land holdings are inequal distribution.

CONCLUSION

The present study shows the changes in the distribution of operational land holdings over time in Kathua district of Jammu and Kashmir. It was found that the distribution of operational land holding by farm size in Kathua district from year 2000 to 2011, except for marginal and medium land holding farmers, wherein the number of operational land holdings had increased and the farmers with small, semi-medium and large land holding farmers had decreased. However, area of operational land holdings of the farmers with marginal, small and medium land holding farmers had increased and area of operational land holdings semi-medium and large land holding farmers had decreased. Gini's coefficient had declined from severe equality gap to perfect equality gap among the distribution of operational land holdings. The operational land holdings in the selected study area from 2015-16 to 2017-18 had shown that the number of operational holdings and area of operational land holdings for marginal land holding farmers had increased but Gini's coefficient had declined. Whereas, the number of operational holdings and area of operational land holdings farmers for small land holding farmers had decreased and Gini's coefficient had increased. Equitable distribution of land holdings can be achieved through governmental legislation and intervention through implementing effective land reforms system. Such efforts may not only empower small farmers but will also enhance their living standard and overall agricultural productivity. Further, equitable land allocation may lead towards accelerated economic growth and to achieve the targets of eradicating poverty and sustaining food security at local and regional level.

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Micro-entrepreneurship Development Through Innovative Products from Broken Walnut Kernels in Kashmir Valley

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ABSTRACT

There is a lot of interest in nuts globally and demand for walnut kernels is increasing and a lot more potential for value added products Walnut is much prized as dessert and dry fruit and has proved to be nutritionally valuable food. On an average walnut contains 60-70 per cent lipids comprising of mono polyunsaturated fats, 15.2 per cent proteins, 13.7 per cent carbohydrates, 6.5 per cent dietary fibre and 1.5 per cent ash. Walnuts contain a number of neuroprotective compounds including vitamin E, folate, omega3 fats and antioxidants that support brain health, protect heart and improves digestive system. There is a lot of interest in nuts globally and demand for walnut kernels is increasing and a lot more potential for value added products. Walnuts are most often eaten on their own as a snack. It can be healthful addition to the diet Presently in Jammu and Kashmir walnuts are mostly consumed as fresh in the form of walnut kernels and some broken kernels are being used by baking industry for development of walnut pastry, a novel product of Kashmir for its good organoleptic, nutritional and healthy characteristics. A possible application of broken walnut kernels could be the production of extruded breakfast food. Walnuts add texture and crunch to dishes. Walnut kernels can be added from nourishing salads to delicious desserts**.** Good quality dark chocolate packed with lots of chopped nuts, seeds and dries fruit make these a nutritious energizing snack bar. Globalization has changed the economic, political, social and cultural system of nations across the globe. Phenomenon like urbanization, growing middle class, westernization, working parents etc. has contributed to the fast growth of walnut processing industry and prospects for employment generation. An attempt has been made in this investigation for utilization of broken walnut kernels for development of value added products viz. roasted walnut kernels, jaggary coated candid walnuts and honey glazed walnut walnuts. The sensory evaluation judged best was at T8 (160C for 7 min) for roasted walnut kernels. The sensory evaluation was judged best at sugar and walnut kernels (30:70) for jaggary coated candid walnut. Honey glazed walnut (2:1) was found to be best on organoleptic scale.

Keywords: Broken, Innovative, Micro-entrepreneurship, Walnut

INTRODUCTION

Walnut trade occupies an important place in rural economy of Jammu and Kashmir state. The nuts are rich in unsaturated fatty acids, proteins, carbohydrates, dietary fibre, vitamins and minerals. Consumption of nuts help to reduce blood cholesterol levels and in preventing coronary heart diseases, due to which nuts are regarded as functional/health food (Khir *et al.,* 2019). Walnuts from J&K state are exported as whole in shell or in kernel form to various Indian and foreign markets which generates revenue of more than 700-800 crores annually. Walnut processing provides employment opportunities to a large section of population. The J&K state has been designated as walnut export zone by APEDA as the state has the monopoly of growing quality walnuts. As per WTO agreements global competition in walnut trade has to meet quality standards of the buyer countries. In shell walnut quality depends on shell colour, shell thickness,

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suture seal, kernel size, kernel colour, taste, flavour fungal infection, rancidity etc.

After harvesting of nuts, adoption of non-scientific traditional practices of dehulling, washing, sun drying, nut cracking, kernel drying, packaging and storage are responsible for poor quality of whole nuts or walnut kernels. The poor quality nuts with stain marks on surface are not appealing. Similarly kernel colour, texture, and rancidity problems lower the quality grade of the produce which fetches poor price in the market and as such the income level of producers is declined. Thus for sustainable rural income, production and sale of good quality walnuts is of paramount importance. Qammer and Baba (2018) reported that modernized supply chain involves huge investment and emphasized upon linking walnut production growers with marketing through value addition.

MATERIALS AND METHODS

The present study was carried out in the Division of food science and technology at Sher-e-Kashmir University of science and technology Kashmir. Broken walnut kernels were procured locally. Roasted walnut kernel were developed using different temperature and time variation viz. T1, T2 and T3(120C for 5, 7, 10 min) T4, T5 and T6(140C for 5, 7, 10 min) T7, T8 and T9 (160C for 5, 7, 10 min). Jaggary coated candid walnuts products developed by using walnut and Jaggery in different combination from T1, T2 and T3(30:70,30:110,30:150) T4, T5 and T6(50:70, 50:110, 50:150) T7, T8 and T9(70:70,70:110,70:150). Honey glazed walnut products were developed T1, T2 and T3(30:30, 30:50, 30:70) T4, T5 and T6(50:30, 50:50 and 50:70) T7, T8 and T9(60:30, 60:50, 60:70). Proximate analysis was studied using AOAC 2000 methods and carbohydrate estimation was done by difference method. Sensory evaluation was judged by the panel of semi trained experts using 5 point scale.

RESULT AND DISCUSSION

The results of sensory evaluation of the products developed of broken walnut kernels presented Table 1, 2 and 3 respectively. Zameer *et al.* (2015) studied that walnut kernel incorporated rice based extruded snacks were developed and stored for LDPE bags for three months and found organoleptic acceptable.

Table 1: Effect of temperature and time on the roasting characteristics of walnut kernels

Sample code	Appear-ance	Colour	Texture	Flavor	Overall accepta-bility
T1	3.02	3.20	3.50	2.82	3.05
T2	3.73	3.05	3.18	3.08	3.26
T3	3.60	3.47	2.80	3.20	3.22
T4	3.03	3.50	3.50	3.50	3.38
T5	3.18	3.23	3.70	3.28	3.35
T6	3.08	3.23	3.23	3.30	3.21
T7	3.38	3.30	3.33	3.80	3.46
T8	4.03	3.28	4.60	4.00	**3.98**
T9	3.43	3.20	2.50	3.15	3.13

Table 2: Organoleptic evaluation of Jaggary coated walnut kernels

Sample code	Appear-ance	Colour	Texture	Flavor	Overall accepta-bility
T1	3.80	3.60	3.60	3.20	**3.55**
T2	3.20	3.00	2.80	2.60	2.90
T3	3.00	2.80	2.80	2.40	2.75
T4	2.50	2.60	2.70	2.50	2.57
T5	3.80	3.60	3.40	3.00	3.45
T6	2.80	2.70	2.40	2.00	2.48
T7	2.50	2.50	2.50	2.30	2.45
T8	3.00	3.20	3.20	3.00	3.10
T9	3.60	3.60	3.40	3.20	3.45

Table 3: Organoleptic evaluation of Honey glazed walnut kernels

Sample code	Appear-ance	Colour	Texture	Flavor	Overall accepta-bility
T1	3.80	3.60	3.70	3.00	3.52
T2	3.20	2.70	2.80	2.70	2.85
T3	2.70	2.20	2.40	2.20	2.37
T4	2.70	2.60	2.70	2.70	2.67
T5	2.80	2.60	2.80	2.40	2.65
T6	3.00	3.60	3.40	3.20	3.30
T7	4.20	4.00	4.20	4.00	**4.10**
T8	2.60	2.40	2.40	2.40	2.45
T9	3.40	2.40	3.20	3.00	3.25

Table 4: Physio-chemical evaluation of developed final products of walnut kernels

Parameters	Raw walnut kernels	Roasted walnut kernels	Jaggary coated walnut kernels	Honey glazed walnut kernels
Moisture (%)	3.20	1.45	3.15	3.90
Water activity	0.37	0.33	0.35	0.41
Protein (g)	15.5	15.9	15.8	15.5
Fat (%)	64.1	65.9	64.6	64.3
Ash (%)	1.75	1.82	1.81	1.79
Dietary fibre (%)	6.20	2.30	2.26	2.35
Carbohydrate (g)	9.08	14.93	14.64	14.51

Walnut is much prized as dessert and dry fruit and has proved to be nutritionally valuable food (Tapsell, 2010).

The data given in the Table 4 depicts the chemical composition of the raw broken walnut kernels and the final products judged best for roasted, jaggary coated walnut kernels and honey glazed after sensory evaluation by a panel of trained judges.

Broken walnut kernels contains 3.20 per cent moisture, 15.5 gm protein, 64.1 per cent fat, 1.75 per cent ash and 6.20 per cent dietary fiber and 9.08 per cent carbohydrate whereas the moisture content reduced in roasted walnut kernels as compared to raw walnut kernels. Walnuts are definitely on trend nowadays and incorporation as an indulgent, nutritious, plant based alternative and functional ingredient for food industry.

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Socio-economic Impact of Agri-entrepreneurial Innovations on Livelihood Security

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ABSTRACT

Growing agrarian concerns and govt's initiatives for doubling framers' income necessitate to explore viable, innovative solutions to meet the needs, aspirations and prosperity of rural India. Further, this challenging scenario establishes the fact that agri-entrepreneurial innovations are needed on a large scale. Entrepreneurship and agri-business based start-ups hold immense potential for enhancing livelihood security. Innovations related to agriculture and allied sectors have been available both from formal set up (research organizations) as well as informal set up (grassroot innovations) which have been critical in the growth of agri-entrepreneurship. Though the relations of entrepreneurship and innovation has been analyzed and established, there is a need to examine the entrepreneurial innovations, which make significant impact on livelihood security. The present study aims at analyzing the impact upon livelihood security of the farmers of upper and middle Indo-Gangetic plains of India. The study was conducted in Upper and Mid-regions of Indo-Gangetic plains. Stratified random samples of agripreneurs as well as non-agripreneurs were drawn from the states of Punjab, Haryana, Uttar Pradesh and Bihar, which represents Upper and mid Indo-Gangetic plains, respectively. According to livelihood index value, 58.46 per cent of agripreneurs fall in medium category while 41.53 per cent agripreneurs fall in high category. For non- agripreneurs 50.76 per cent fall in the medium category followed by 49.23 per cent in the low category which clearly indicated that agripreneurs have better livelihood status than non-agripreneurs. The kernel density distribution showed more skewed distribution of income before adoption of agripreneurial innovation compared to after adoption. It indicated more stability of income in after adoption. Results showed that there was significant difference in livelihood indicators, it includes income, employment days created for family, Man days created for others, Education expenditure, Expenditure on food, vehicle, Machinery and gadgets. Two sample t-test was carried out to analyse the difference of different indicators of livelihood between agripreneurs and non-agripreneurs adoption of innovation. There was significant difference in livelihood indicators, it includes income, employment days created for family, health expenditure, Education expenditure, Expenditure on food, vehicle and Machinery.

Keywords: Agripreneurship, Innovation, Livelihood index, Kernel density, Principal component analysis

INTRODUCTION

India is agriculture based economy with more than 60 per cent population of country is dependent on agriculture. Amongst rural population more than 70 per cent of rural household depend on agriculture as their primary means of livelihood. On the other hand, agriculture along with fisheries and forestry sector accounts only for nearly 17 per cent of Gross Domestic Products (GDP) of the country (UNDP report, 2018) where more than 50 per cent of the total workforce of the country is employed in agriculture sector (India Economic Survey 2018). In an agricultural country like India, the contribution of innovative farmers to economic development and sustainability is considerably high. Despite this, the agriculture sector holds a feeble attraction by the majority of the population due to its less reward ability than services and business sectors. The reliance of agriculture on factors like capital, weather parameters, skilled human

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resources, etc., poses a formidable challenge towards the interventions and policies planned to make it a reliable and economic venture (Chand, 2016). Mahapatra (2020) reported that nearly 2000 farmers give up agriculture as a livelihood option every day. Almost 40 percent of farmers in India dislike farming as a profession (Khan, 2015). Often this is attributed to low income, distress, and various other reasons. Entrepreneurship has been identified as a strategic tool for any nation's economic development. Policymakers all over the world, particularly agricultural policymakers, have recognised agribusiness as the engine of economic development and prosperity in the sector (Ayat, 2020). In India, where more than 60 per cent of the population is still finding livelihood from agriculture which is relatively termed as sluggish in the technological adaptation, creates a perplexing situation while talking about economic development in this sector. Though the country has achieved a substantial leap in food sufficiency and affordability in the recent past, the agriculture sector is still hampered by low productivity and economic insecurity in many areas. In rural India, farmers are forced to migrate to cities for a living due to lower remuneration or unfathomable crop losses due to volatile market dynamics and production constraints. However, the government of India has initiated many programmes to inculcate the entrepreneurial culture and climate among the farmers for better economic realisation (Sharma *et al.,* 2021); the trickledown effect of the government schemes are in an enigmatic manner (Bornali *et al.,* 2020). The Indo-Gangetic Plains (IGP), which include the Indian states of Punjab, Haryana, Uttar Pradesh, Bihar, and West Bengal, are one of the country's primary food-producing regions. Even though the region mirrored the green revolution in the 1960s, with a series of dramatic transformations in conventional agricultural practices, it is now constrained by diminishing resource bases. Various studies have concluded that agripreneurs play an imperative and decisive role in the agricultural value chain. Agri-entrepreneurial innovations may serve as viable, sustainable solution to meet the pressing needs and aspirations of rural population and enable them to earn more and live a decent life. Entrepreneurship and agri-business based start-ups hold immense potential for enhancing livelihood security. Innovations related to agriculture and allied sectors have been available both from formal set up (research organizations) as well as informal set up (grassroot innovations) which have been critical in the growth of agri-entrepreneurship.

MATERIALS AND METHODS

The study was conducted in Upper and Mid- regions of Indo-Gangetic plains. Random samples of agripreneurs as well as non-agripreneurs will be drawn from the states of Punjab and Haryana as well as eastern Uttar Pradesh and Bihar, which represent Upper and mid Indo-Gangetic plains, respectively**.** Having enlisted the agripreneurs of the all the 4 states i.e. Punjab, Haryana, eastern Uttar Pradesh and Bihar is six hundred fifty agripreneurs. A sample of sixty-five agripreneurs that is ten percent of total agripreneurs randomly drawn from above four states. Similarly, a sample of sixty-five non-agripreneurs or conventional farmers will be drawn through random sampling technique from the above mentioned four states. Data collection was done by preparing interview schedule and these schedules were pre-tested for validation. Collection of data was done from both agripreneurs and non agripreneurs about different livelihood indicators for the present study.

Construction of livelihood index

Selection of the appropriate indicators: To analyse livelihood status of agripreneurs and non agripreneurs five indicators were taken after review of literature. These indicators were human capital, physical capital, social capital, natural capital and financial capital. These five indicators were measured with the help of twenty seven variables, further to assess the livelihood status, livelihood index was developed using principal component analysis.

Assignment of weights to the indicators: To get the weightage of indicators eigen value was multiplied with absolute rotated matrix value. After selection of suitable indicators in item analysis, again PCA was run separately for each data set to obtain factor loading and eigen values. Kaiser normalization was used to identify the initial eigen values greater than 1. According to the number of eigen values greater than 1, the same number of components were extracted by using varimax rotational method for each indicator as shown in rotational component matrix. Then, method followed by Feroze *et al.* (2010) adopted for this study to assign the weights to the indicators. The normalized indicators are then multiplied with the assigned weights to construct the indices for both agripreneurs and non-agripreneurs.

RESULTS AND DISCUSSION

After calculating the livelihood index value, agripreneurs and non agripreneurs were classified into low, medium and high range according to the mean and standard deviation value. According to livelihood index value, 58.46 per cent of agripreneurs fall in medium category while 41.53 per cent agripreneurs fall in high category. For non- agripreneurs 50.76 per cent fall in the medium category followed by 49.23 per cent in the low category as presented in Table 1. This result clearly indicates that agripreneurs have better livelihood status than non-agripreneurs with agripreneurs fall in the medium and high range of livelihood status and non agripreneurs in low and medium range of livelihood status.

According to the mean and Standard deviation classification, 84.61 per cent agripreneurs fall in medium category of income level (Rs. 1,76,831-645725) followed by 15.38 per cent in high category (more than Rs. 6,45,725). Further box plot analysis of income level of agripreneurs before and after adoption of innovation indicated that, income level of agripreneurs before adoption of innovation was skewed and lied towards lower level as showed in Figure 1. After adoption of innovation, income level of agripreneurs showed a more normal distribution. Further using kernel density distribution resulted more skewed distribution of income before adoption of agripreneurial innovation compared to after adoption as showed in Figure 2. It indicated more stability of income in after adoption of innovation.

In order to ascertain any significant differences between the livelihood indicators before and after the adoption of innovation, a paired sample t-test was performed at significance level of 0.05 on the hypothesis that

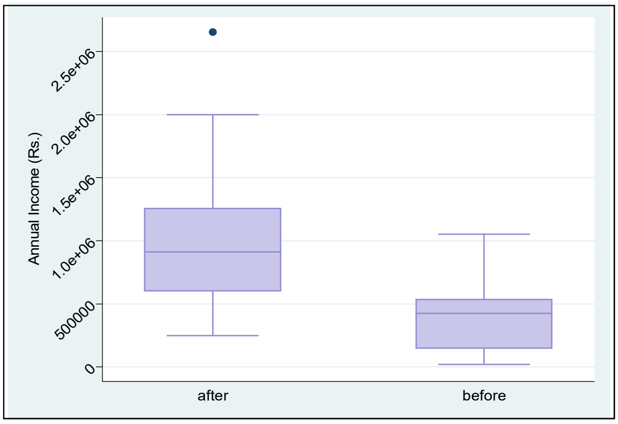

Figure 1: Box plot showing Income Distribution of Agripreneurs After and before adoption of innovation

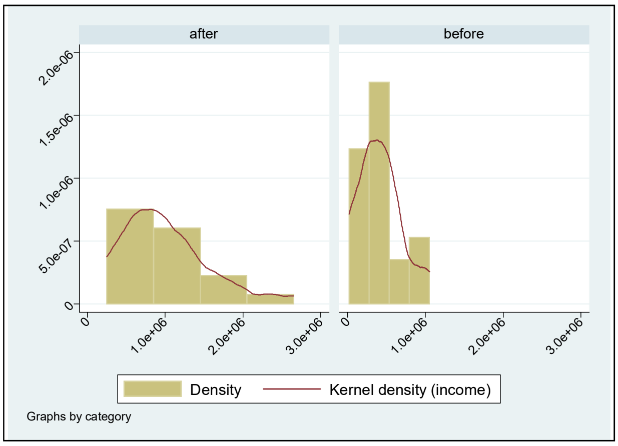

Figure 2: Kernel Density Income Distribution of Agripreneurs After and before adoption of innovation

"Agripreneurial innovation did not significantly improve the livelihood status of the agripreneurs". Paired t-test was carried out to analyse the difference of different indicators of livelihood with before and after data of adoption of innovation. In Table 2 the result indicated that there is signification difference in income level ($p=0.000$), Employment days created for family ($p=0.000$), Man days created for others ($p=0.006$), Education expenditure ($p=0.005$), Expenditure on food ($p=0.000$), Asset building vehicle ($p=0.0015$),

Table 1: Distribution of stakeholders according to their livelihood index value

Categories	Range	Livelihood Index Value	Agri-preneurs	Percen-tage	Non-agripreneurs	Percen-tage
Low	<Mean-S.D.	<0.293	0	0	32	49.23
Medium	Mean- S.D. to Mean +S.D	0.293-0.698	38	58.46	33	50.76
High	> Mean +S.D	>0.698	27	41.53	0	0

gadgets (p=0.000) at 1 percent level of significance. Adoption of innovation as resulted in improving the livelihood status of agripreneuers indicating by the increase in level of income and creation of employment man days for family as well as others. Further as there is significant difference in expenditure on education and food after adoption of innovation, this clearly indicates that there is improvement in livelihood status agripreneurs. In creation of asset, agripreneurs has also improved by expenditure more on vehicle and assets. Uddin *et al.* (2016) found that livelihood status of innovate farmers' asset possession observed that 43.5 percent farmers' savings and cash at hand were increased, income for purchasing assets and equipments was increased for 39.0 percent farmers, and land use efficiency and optimized uses of open water resources were increased for 27.2 percent farmers.

In order to ascertain any significant differences between the livelihood indicators between agripreneurs and non-agripreneurs, t-test was performed at significance level of 0.05. t-test was carried out to analyse the difference of different indicators of livelihood between agripreneurs and non-agripreneurs. In Table 3 the result indicated that there is signification difference in income level (p=0.000), Employment days created for family (p=0.000), health expenditure (p=0.000), Education expenditure(p=0.0032), expenditure on food((p=0.000), Asset building vehicle (p=0.0013) between agripreneurs and non-agripreneurs at one percent level of significance and Asset building machinery (p=0.0469) at five percent level of significance. The result indicated that because of adoption of innovation income level of agripreneurs has increased as well as more employment man days

Table 2: Paired t-test result on livelihood indicators of the agripreneurs due to agriprenurial innovations (before and after innovation)

Variable	Mean difference	t value	p value
Income	-596076.7	-10.8463	0.0000
Employment days created for family	-163.0615	-11.0681	0.0000
Man days created for others	-27.92308	-3.6300	0.0006
Health expenditure	6615.385	0.7193	0.4745
Education expenditure	-41769.23	-3.6735	0.0005
Expenditure on food	-8123.077	-6.3372	0.0000
Asset building (house)	-396000	-1.8936	0.0628
Vehicle	-25892.31	-3.3161	0.0015
Machinery	-94846.15	-1.8039	0.0759
Gadgets	-8953.846	-6.3524	0.0000

Table 3: Result of t-test on livelihood indicators due to agriprenurial innovations (between agripreneurs and non-agripreneurs)

Variable	Mean difference	t value	p value
Income	-940876.9	-13.0932	0.0000
Employment days created for family	-150.2	-18.3298	0.0000
Man days created for others	-9.692308	-1.1972	0.2334
Health expenditure	20523.08	6.7787	0.0000
Education expenditure	-36853.85	-3.0022	0.0032
Expenditure on food	-13178.46	-6.2024	0.0000
Asset building (house)	-485738.5	-1.8587	0.0654
Vehicle	-26303.08	-10426.2	0.0013
Machinery	-130546.2	-2.0064	0.0469
Gadgets	3715.385	-1.5585	0.1216

also created for the family. Among other livelihood indicators expenditure on health, education and food has also significantly different between agripreneurs and non- agripreneurs which indicates better livelihood status of agripreneurs. Apart from expenditures on regular needs, expenditures in asset creation has significant difference between agripreneurs and non agripreneurs where the expenditure on vehicle and machinery agripreneurs are at better position than non agripreneurs. Livelihood diversification for additional and alternate sources of income has been reported as an important precursor to household wellbeing and sustainability in a number of studies across the globe (Pandey *et al.,* 2017).

CONCLUSION

Agricultural entrepreneur progressively has adapted to the vagaries of the market, varying consumer lifestyle, enhanced ecological regulations, new necessities for product quality, chain management, food security, sustainability, and so on. These alterations have cleared the way for new participator, innovation, and portfolio entrepreneurship. Agripreneurship are the sustainable, community-oriented, directly-marketed agriculture. Agriculture entrepreneurship shares many aspects with "generic" entrepreneurship, but it also has its own peculiarities due to the agricultural sector's unique setting. Entrepreneurs will naturally take advantage of the large human resource available if industrial and entrepreneurial education is improved. It is apparent that agriculture has a lot of room for entrepreneurship, and this potential can only be realised with excellent management of agro components. An individual with risk tolerance and a desire to learn about the latest developments in the industry can be a good agripreneur. Agriculture has a significant potential to contribute to national income while also giving direct employment and income to a numerically greater and more vulnerable segment of society. Agripreneurship is not only a possibility, but also a must for increasing agricultural production and profitability.

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Problem Faced by the Potato Growers in Adopting Paddy Straw Management Technologies in Jalandhar District of Punjab

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ABSTRACT

This study was conducted in Jalandhar district of Punjab. A total of 200 potato growers were selected from the five blocks with probability proportional to size sampling method. 73, 50, 31, 31, 15 potato growers were selected from Nakodar, Adampur, Bhogpur, Jalandhar East and Jalandhar West respectively. Interview schedule was prepared and data was collected personally by interviewing potato growers. Majority of the potato growers faced the problem of high rent and complexity of PAU super straw management system and baler. 15.89 per cent of the potato growers faced the problem of timely subsidy available on rotavator and also 61.32 per cent of potato growers faced the problem regarding mulcher that it required high horse power tractor and diesel consumption. One-third of potato growers faced problem of high cost of production with paddy straw chopper.

Keywords: Problems, Paddy straw, Management technologies, Potato

INTRODUCTION

Potato (*Solanum tuberosum*) is a major vegetable crop grown on an area of over 98521 ha with an annual production of 25.7 lakhs tones in the state of Punjab (Department of Horticulture, Punjab 2017-18) most of which is intended planting. Jalandhar, Hoshiarpur, Kapurthala, Ludhiana, Amritsar, Bathinda and Fatehgarh Sahib are the main potato growing districts. It ranks among the four most important food crops in the world including wheat, rice and corn (Government of India, 2019).

China and India are the world's leading potato producers, producing roughly one-third of the world's potatoes. According to Indexes, approximately 370 million metric tonne of potatoes were produced annually worldwide in 2019, a significant rise from the 333.6 million tonne produced in 2010. Potatoes are an important crop that the United Nations recommends as a food security crop. Potatoes thrive in a variety of climates and situations. They grow faster and require less energy than other crops, and they may be sown as seed potatoes. Potatoes give a lot of nutritional calories and complex carbs for a tiny amount of space compared to other options. Potatoes were harvested on more than 17 million hectares around the world in 2019 (Statistical, 2021). Potato follows only rice and wheat in world importance as a food crop for human consumption. Cultivated potatoes have spread to 160 countries worldwide from the Andes of South America where they originated. When potato has become a staple in a rising number of people's diet, minor variations in potato nutritional composition can have significant impacts on human health. It is a strong source of vitamin C, other vitamins and potassium. Many potato compounds contribute to antioxidant function, and growing interest in pigmented flesh cultivars (Ellen *et al.,* 2009).

According to reports, 51 per cent of farmers burn paddy straw to save money, 48 per cent for time savings and 48 per cent for lack of machine availability, while 11 per cent of farmers burn paddy straw for other reasons (Sidhu *et al.,* 2009). For the long-term sustainability of agriculture and natural resources, paddy straw burning must be phased out in favor of other

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options for paddy straw management. Composting is one of several productive paddy straw management techniques that can be applied (Supaporn *et al.,* 2013), input for biofuel production (Wu *et al.,* 2012), and soil recycling (Verma and Acharya, 2004). Alternatives to conventional energy and input intensive agriculture include resource conservation technologies (RCTs) incorporating no- or minimal-tillage, such as direct seeding, bed planting, and crop diversity, as well as advancements in residue management. Researchers had estimated the discharging of various gases from crop residue burning using Intergovernmental Panel on climatic change factors, but they had veiled only a few gaseous pollutants (Venkataraman *et al.,* 2006).

By the end of the year, many organizations in Punjab had tried a variety of alternative strategies to reduce straw burning. The straw can be used as an input for businesses such as paper, energy, and packaging if the paddy is not burned. In-situ inclusion of paddy straw as a management strategy is the most efficient method that farmers may simply implement. This improves soil fertility for the next crop and is also financially beneficial to the farmers (Chaudary, 2020).

Agricultural machinery inputs are the largest capital investment, accounting for up to 25 per cent of overall crop production costs (Adamchuk *et al.,* 2011). In order to lower the cost of operations, efficient utilization of agricultural machinery in field activities becomes critical. For improved operation management and planning, information of the functioning of the machinery in field operations is required.

The Punjab state and Supreme Court established recommendations to offer farmers with incentives to cease burning paddy straw. Punjab and Haryana have offered a rupee 2500 per acre benefit for small and marginal farmers. In 2017, the government made it essential to install a super straw management technology on combine harvesters (India Today, 2020).

To prevent residual burning, the federal government, state governments, and regulartory actions to prohibit burning have been implemented under the Air Act of 1981. Subsidies are available for a variety of machines that are used to handle paddy straw rather than burning it (Kaur, 2020).

MATERIALS AND METHODS

The present study was conducted in Jalandhar district of Punjab. Jalandhar district was selected purposively for the study as it has highest area under potato cultivation. List of potato growers was obtained from the District Horticulture Department, Jalandhar. From that list five blocks Nakodar, Adampur, Bhogpur, Jalandhar East and Jalandhar West having maximum area under potato cultivation were selected. 200 potato growers were selected from the five blocks with probability proportional to size sampling method. 73, 50, 31, 31, 15 potato growers were selected from Nakodar, Adampur, Bhogpur, Jalandhar East and Jalandhar West respectively. Problems are the difficulties faced by the potato growers for adopting the paddy straw management technologies in potato. The response of the potato growers was recorded through open-ended questions.

RESULTS AND DISCUSSION

Problems faced by them in the adoption of different paddy straw management technologies in potato cultivation. Data in Table 1 showed that different problem which were faced by the potato growers in adoption of paddy straw management technologies for managing the straw in potato.

PAU Super straw management system: Majority of the potato growers such as 44.10 per cent which were adopted PAU Super straw management system were facing problem of high rent on combines with attachment of PAU super straw management system as compared to combines without straw management system. In adoption of PAU super straw management system, the potato growers faced problem of non availability or difficult to avail were 3.04 per cent while 14.87 per cent observed the technology were complex to used. Delay potato crop sowing problem faced by 2.53 per cent potato growers which were adopted the super straw management system and 9.23 per cent of them faced problem of uneven spreading of straw in the field.

Baler: Majority of the potato growers which were adopted baler in paddy straw management technologies were faced problem of its complexity of the machine were 73.52. They revealed that skilled persons were required for operating the baler. 47.05

Table 1: Distribution of the adopters according to the problems faced by them in the adoption of different paddy straw management technologies

Problems	F*	%
PAU super straw management system (n =195)		
High rent	86	44.10
Non availability	6	3.07
Complexity	29	14.87
Uneven spreading of straw	18	9.23
Delay potato crop sowing	5	2.53
Baler (n=34)		
Non availability	4	11.76
High rent	16	47.05
Complexity	25	73.52
Delay of shifting of bales from the field	2	5.88
Mulcher (n=137)		
High hp tractor and diesel requirement	84	61.32
Difficult to used in moist soil	4	2.92
Costly	33	24.08
Non availability	14	10.22
Rotavator (n=195)		
Low life span	20	10.25
Lack of subsidy	31	15.89
Diesel consumption is high	17	8.71
Irrigation requirement is high	4	2.05
Paddy straw chopper (n=24)		
High cost of production	8	33.34
Non availability	2	8.34
Mould board Plough (n=163)		
High hp tractor require	93	57.05
High diesel consumption	75	46.01
Requirement of leveler	22	13.5

*(*Multiple Response)*

per cent of them were faced problem of high rent paid by them and 11.76 per cent faced the problem of non availability of baler as it was not available at village level society. 5.88 per cent of adopted baler potato growers faced the problem of shifting of bales from the field.

Mulcher: Majority of the potato growers which were adopted mulcher in potato faced problem that it required high horse power tractor and high diesel consumption which were 61.32 per cent whereas only 2.92 per cent potato growers which were adopted mulcher faced problem that mulcher can't be used in moist soil as the blades slip and it can't cut the straw effectively. 24.08 per cent of them reveals that it was costly and 10.22 per cent of them faced the problem of availability.

Rotavator: After adoption of Rotavator, the majority of potato growers faced problem of lack or delay of subsidy in rotavator such as 15.89 per cent while only 2.05 per cent of them observed that irrigation requirement is high after using rotavator in the field. 10.25 per cent of them faced problem of low life span of rotavator and 8.71 per cent faced problem of high diesel consumption.

Paddy straw chopper: Table showed that the problem faced by the respondent after adopting the paddy straw chopper 33.34 per cent of the potato growers faced problem of high cost of production as it deals with diesel consumption and only 8.34 per cent of them faced the problem of availability of paddy straw chopper

Mould board plough: Majority of the potato growers such as 57.05 per cent after adopting the mould board plough faced the problem that it required high horse power tractor and 46.01 per cent faced problem of diesel consumption in mould board plough. 13.5 per cent revealed the problem that requirement of leveler after the use of mould board plough. The results were in line with Kaur (2020) that majority of the potato growers faced the problem of high rent, non availability in baler and contradicted with that problem faced by the potato growers with mulcher was their non-availability.

CONCLUSION

Potato (*Solanum tuberosum)* is a major vegetable crop give a lot of nutritional calories and complex carbs for a tiny amount of space compared to other options. By the end of the year, many organizations in Punjab had tried a variety of alternative strategies to reduce straw burning. The straw can be used as an input for businesses such as paper, energy, and packaging if the paddy is not burned. In-situ inclusion of paddy straw as a management strategy is the most efficient method that farmers may simply implement. This improves soil fertility for the next crop and is also financially beneficial to the farmers. Most of the potato growers faced the problem of high rent and complexity of PAU super straw management system and baler. Majority of the potato growers faced the problem of timely subsidy available on rotavator and also faced the problem regarding mulcher that it required high horse power tractor and diesel consumption. One-third of potato growers faced problem of high cost of production with paddy straw chopper.

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Attitude of the Farmers Towards Mass Media in Nimar Agro Climatic Region of Madhya Pradesh

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ABSTRACT

Newspapers are an important platform of mass communication as they reach every nooks and corners of the world where electronic media fails to reach. It plays a pivotal role in providing authentic firsthand information, building opinions, updating the knowledge of the reader and serves as a good platform for advertisers to promote their products. Keeping importance of these mass media channels in view, a research study was conducted in Nimar Agro Climatic Region of Madhya Pradesh on Attitude of the farmers towards mass media. The study was carried out on a sample of 240 farmers in 12 villages in the study area of mass media. Data were collected through personal interviews of respondents with the help of a structured interview schedule. The findings of the study revealed that, maximum 48.75 per cent of the newspapers reading farmers had strongly favourable attitude, followed by 38.33 per cent farmers who had favourable attitude, 7.92 per cent farmers who had neutral attitude, 3.34 per cent farmers who had unfavourable attitude and only 1.66 per cent of the farmers had strongly unfavourable attitude towards newspaper. The study also indicated that majority of the newspapers reading farmers strongly agreed with the statements like "Reading of newspapers are helpful in future planning for improved farming" whereas, majority of them were strongly disagreed with the statements like "Uncertain coverage of farm news in newspapers made them inappropriate for farmers". Also, it is found that there is an increase in the attitude toward reading along with the raise in the reading and following rate of magazine, newspapers which can be called traditional tools. Nevertheless, it is detected that having an account in social networks such as Facebook and Twitter has a negative effect on attitude toward reading.

Keywords: Reading, Reading attitude, Mass media, Newspaper

INTRODUCTION

Newspapers enjoyed the position of the most preferred medium to reach a wider audience. A newspaper carries all kinds of communication related to a variety of topics like agriculture, politics, socialism, current affairs, entertainment and finance stocks etc., (Baran, 2004). This captivates the imagination and interests of readers, from all age groups. Newspapers are an important platform of mass communication as they reach every nooks and corners of the world where electronic media fails to reach. It plays a pivotal role in providing authentic firsthand information, building opinions, updating the knowledge of the reader and serves as a good platform for advertisers to promote their products. However, with the emergence of Internet, which updates information every second and just a click away, the popularity of newspapers has reduced. Among the several mass media, newspapers and farm magazines are some of the commonly used print media. They have a vital role to play in the communication of agricultural information among the literate farmers. Increasing rate of literacy in the country offers new promises and prospects for utilizing print medium as a means of mass communication. The print media widened the scope of communication. It is cheap and people can afford to buy and read them at their

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convenience. It is a permanent medium in that the messages are imprinted permanently with high storage value which makes them suitable for reference and research (Ogunbameru, 2001). The coverage of different subject matter by newspapers is almost similar with regard to agriculture, horticulture, animal husbandry, agricultural marketing, agricultural engineering and cooperatives. Farm publications have proved to be effective means for dissemination of information, especially to introduce new technologies. Khushk and Memon (2004) stated that production and distribution of printed material helps farmers in the transfer of new information and technologies. Printing helps in preserving the technologies in the form of books/booklets, magazines, newspapers and brochures.

MATERIALS AND METHODS

Locale of the study: The study was conducted in district Barwani (Tribal dominated district) and Khargone of Nimar Agro Climatic Region of Madhya Pradesh.

Sampling procedure: The sample of the present study was selected by multistage sampling method. The Nimar Agro Climatic Region consist four districts viz., Barwani, Khagone, Khandwa and Bhurhanpur. Out of the four districts, two districts (Barwani and Khagone) 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 help of a structured interview schedule.

Table 1: Distribution of the respondents according to their attitude towards newspapers (n=240)

Category	Frequency	Percentage
Strongly unfavourable (12-22 Score)	04	01.66
Unfavourable (23-31 Score)	08	03.34
Neutral (32-41 Score)	19	07.92
Favourable (42-50 Score)	92	38.33
Strongly favourable (51-60 Score)	117	48.75

RESULTS AND DISCUSSION

Attitude towards newspapers among the farmers: The data presented in Table 1 indicate that, the maximum (48.75%) of the farmers had strongly favourable attitude, followed by 38.33 per cent farmers who had favourable attitude, 7.92 per cent farmers who had neutral attitude, 3.34 per cent farmers who had unfavourable attitude and only 1.66 per cent of the farmers had strongly unfavourable attitude towards newspaper.

To epitomize the results, it can be stated that overwhelming (87.08%) of the farmers had strongly favourable to favourable attitude towards farm newspapers. It might be due to the fact that farmers get the relevant information in printed form which can be saved for future reference too.

Statement–wise attitude of the farmers towards newspapers: The data presented in Table 2 indicated that in positive statements about newspaper, the statements to which the farmers had favourable attitude were “Reading of newspapers are helpful in future planning for improved farming” (Total score 1084) as 60 per cent farmers were “strongly agree” and 35 per cent were “agree” to this statements and it was ranked first. The second rank was awarded to “Newspapers are powerful means of communication to the farmers” (Total score 1081) and “Newspapers offer consistent agricultural information” (Total score 1078).

However, in negative attitude statements about newspaper the statements to which the farmers had unfavourable attitude were “For farmers purchasing of newspapers are waste of money” (Total score 1074), followed by “Farmers who do not have any work only read the newspaper” (Total score 1073), “Intention of readers in villages is to read-only and not to do practical the innovations recommended in farm newspaper” (Total score 1067), “Confusing style of writing and unsuitable title of the message given by author create problems at the encoding level” (Total score 1065), “Message selected in newspapers are not

Table 2: Statement–wise attitude of the farmers towards newspapers (n=240)

Statement	SA	A	N	DA	SDA	TS	MS	Rank
The intention of readers in villages is to read-only and not to do practical the innovations recommended in farm newspaper	03 (01.26)	00 (00.00)	16 (06.66)	89 (37.08)	132 (55.00)	1067	4.44	VI
Newspapers are powerful means of communication to the farmers	128 (53.34)	106 (44.16)	05 (02.08)	01 (00.42)	00 (00.00)	1081	4.50	II
Message selected in newspapers are not important to exist farming situations	00 (00.00)	01 (00.42)	19 (07.91)	97 (40.42)	123 (51.25)	1062	4.42	VIII
For farmers purchasing of newspapers is wastage of money	00 (00.00)	01 (00.42)	22 (09.16)	79 (32.92)	138 (57.50)	1074	4.47	IV
Reading of newspapers is helpful in future planning for improved farming	144 (60.00)	84 (35.00)	05 (02.08)	06 (02.50)	01 (00.42)	1084	4.51	I
Message in newspapers are not selected based on the need of the farmers	01 (00.42)	02 (00.84)	29 (12.08)	76 (31.66)	132 (55.00)	1056	4.40	IX
Confusing style of writing and unsuitable title of the message given by author create problems at the encoding level	01 (00.42)	07 (02.92)	11 (04.58)	88 (36.66)	133 (55.42)	1065	4.43	VII
Insufficient clarity in printing and inadequate use of illustrations in the message creates problems at the decoding level	16 (06.66)	29 (12.08)	41 (17.08)	116 (48.34)	38 (15.84)	851	3.54	XI
Farmers who do not have any work only read the newspapers	00 (00.00)	00 (00.00)	18 (07.50)	91 (37.92)	131 (54.58)	1073	4.47	V
Newspapers offer consistent agricultural information	136 (56.66)	92 (38.34)	08 (03.34)	02 (00.83)	02 (00.83)	1078	4.49	III
Uncertain coverage of farm news in newspapers made them inappropriate for farmers	24 (10.00)	35 (14.58)	36 (15.00)	102 (42.50)	43 (17.92)	825	3.43	XII
Untimely message and coverage of general problems rather than specific make the newspapers inappropriate for farmers	02 (00.83)	05 (02.08)	18 (07.50)	86 (35.84)	129 (53.75)	1055	4.39	X
X= 51.54; σ = 3.78								

Strongly agree, A- agree, N-undecided, DA-disagree, SDA- Strongly disagree, TS-total score, MS-mean score, σ = Standard deviation

important to existing farming situations" (Total score 1062), "Message in newspapers are not selected based on the need of the farmers" (Total score 1056), "Untimely message and coverage of general problems rather than specific make the newspapers inappropriate for farmers" (Total score 1055), "Insufficient clarity in printing and inadequate use of illustrations in the message creates problems at the decoding level" (Total score 851) and "Uncertain coverage of farm news in newspapers made them inappropriate for farmers" (Total score 825). The overall mean score of all statements was 51.54 which show a strongly favourable & favourable attitude of the farmers towards newspapers.

CONCLUSION

It can be concluded that maximum number of the newspapers reading farmers were having strongly favourable to favourable attitude towards farm newspapers programmes. The study also indicated that majority of the newspapers reading farmers strongly agreed with the statements like "Reading of newspapers are helpful in future planning for improved farming" whereas, majority of them were strongly disagreed with the statements like "Uncertain coverage of farm news in newspapers made them inappropriate for farmers". These characteristics of the newspapers should be kept in mind while producing the farm newspapers.

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Utilization of Walnuts for Value Added Product Development

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ABSTRACT

Jammu and Kashmir produces some 3.5 lacs quintals of walnut every year thus contributing around 98 per cent of the total walnut output in India. Jammu and Kashmir valley alone produces 95 percent and rest is grown in Doda and Kistwar districts of the Jammu region. Globalization has changed the economic, political, social and cultural system of the nations across the globe. Phenomenon like urbanization, growing middle class, westernization, working parents has contributed to the fast growth of the food processing industry. There is a lot of interest in nuts globally and demand for walnut kernels is increasing and a lot more potential for value added products. Walnut contains a number of neuroprotective compounds including vitamin E, folate, omega3 fats and antioxidants that support brain health, protects heat and improves digestive system. The nuts are rich in unsaturated fatty acids, proteins, carbohydrates, dietary fibre, vitamins and minerals. Consumption of nuts help to reduce blood cholesterol levels and in preventing coronary heart diseases, due to which nuts are regarded as functional/health foods.

Keywords: Blood cholesterol, Dietary fibre, Value added, Walnut

INTRODUCTION

Walnuts are exported as whole in shell or in kernel form to various Indian and foreign markets which generates revenue of more than 700-800 crores annually. Walnut trade occupies an important place in rural economy of Jammu and Kashmir union territory. After harvesting of nuts, adoption of non-scientific traditional practices of dehulling, washing, sun drying, nut cracking, kernel drying, packaging and storage are responsible for poor quality of whole nuts or walnut kernels. The poor quality nuts with stain marks on surface are not appealing. Similarly kernel colour, texture, and rancidity problems lower the quality grade of the produce which fetches poor price in the market and as such the income level of producers is declined. As per WTO agreements global competition in walnut trade has to meet quality standards of the buyer countries. In shell walnut quality depends on shell colour, shell thickness, suture seal, kernel size, kernel colour, taste, flavour fungal infection, rancidity etc. Walnut processing provides employment opportunities to a large section of population. It has been designated as walnut export zone by APEDA as the state has the monopoly of growing quality walnuts. Thus for sustainable rural income, production and sale of good quality walnuts is of paramount importance. Qammer and Baba (2018) reported that modernized supply chain involves huge investment and emphasized upon linking walnut production growers with marketing through value addition. Presently in Jammu and Kashmir walnuts are mostly consumed as fresh in the form of walnut kernels and some broken kernels are being used by one of the baking industry for development of walnut fudge, a novel product of Kashmir. Apart from that no processing or value addition of kernels is reported in Kashmir on commercial scale except extraction of oil. Conversion of walnut kernels into value added products viz. roasted walnut, walnut oil, jaggery coated, honey dipped, chikkis, chutney, smoothie, walnut butter and walnut flour will extend the shelf life and stability of walnut kernels and thereby farming community shall benefit as well as food processors.

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Flowcharts for making various value added products

Roasted walnut

Broken walnut kernel
↓
Roasting (130°C for 25 minutes)
↓
Cool
↓
Pack
↓
Store

Walnut oil

Walnut kernel
↓
Grind in stainless steel roller crusher
↓
Sprinkle water
↓
Pack in airtight container
↓
Store for 48 hours for equilibration
↓
Extract oil using a Screw press (40°C, 20 rpm)
↓
Filter
↓
Pack
↓
store

Jaggary coated broken walnut kernels

Mix Jaggary, broken walnut kernels in the ratio 1:2 and add water
↓
Set on medium heat on Stir
↓
Lift the pan when sugar has coated the kernels
↓
Bake at 325 degree Fahrenheit for 10 min.
↓
Cool
↓
Break the chunks
↓
Pack
↓
Store

Honey dipped broken walnut kernels

Add walnuts to honey
↓
Stir until kernels are coated
↓
Bake for 20 min. (stir after 5 min. to avoid burning of sample)
↓
Cool at room temperature
↓
Break clumps
↓
Pack
↓
Store

Walnut butter

Roast broken walnuts
↓
Grind
↓
Add emulsifiers
↓
Ensure proper mixing
↓
Pack
↓
Store

Walnut chikki

Jaggery
↓
Crush
↓
Make its syrup by adding warm water
↓
Filter
↓
Heat syrup to a temperature of 145°C
↓
Add roasted broken walnut kernel
↓
Mix thoroughly
↓
Transfer the hot mass to a wooden board/clean platform
↓
Spread the product uniformly
↓
Mark vertical and horizontal lines with a cutter
↓
Cool at room temperature
↓
Pack
↓
Store

Walnut Chutney

Walnut
↓
Shallow fry in oil
↓
Grind (add fried green chilli, salt, tamarind)
↓
Add some water
↓
Dilute to required consistency

Walnut smoothie

Roast broken walnuts
↓
Grind
↓
Add milk, sweetener of choice (preferably honey)
↓
Ensure proper mixing
↓
Add preservative, emulsifier
↓
Pack
↓
Store

Walnut flour

Dry press cake obtained from walnut oil extraction
↓
Grind in a hammer mill
↓
Walnut flour
↓
Pack
↓
Store

Walnut is a fruit that keeps the essential foods largely that people need to have healthy nourishment. Optimum health is the prime concern in every human life. Nuts are a good source of nutrients which play an important role in the maintenance of overall health. The edible kernel known as the walnut is one of the best nutritious food one can take regularly for better health due to its highly rich nutritious content and because of its amazing health benefits essential for a disease free healthy life. Thus consuming a handful of raw walnut a day largely provides the proteins fat, antioxidant, some vitamins and minerals (Seyit Mehmet Sen *et al.,* 2015). Walnut can be consumed raw, unprocessed, directly but also it can be consumed as roasted, salted, and flavoured. It can be used as a flavour enhancer in yogurt, pizza, cake and it can be stewed on salad, dessert especially walnut ice-cream and other ice-creams. One of the walnut wide applications is utilization in candy industry by adding in biscuits, cakes and desserts.

Walnut is much prized as dessert and dry fruit and has proved to be nutritionally valuable food (Tapsell, 2010). Walnut can be used as paste especially it is widely used by the people who have peanut allergy in Middle East countries walnut is added to almond, date, and grape and used to prepare a cake called Mamoul in Ramadan. The most important and outstanding nutritive characteristics of walnut are feeding and supporting the brain and the nervous system.

When we consume enough walnut daily we can see that walnut is a perfect disease preventer. Due to its walnut taste and medical benefits walnut desserts have been appreciated for thousands of years for protecting heart health, some certain type of cancers, diabetes Type 2 and other health problems. In addition walnut has antibacterial, antifungal, antidiabetic, antidepressant, hepatoprotective, hypotriglyceridemic and anticancer property (Taha and Alwadaan, 2011). For the long health life the walnuts should be included in regular human nutrition and health nutrition programs.

Walnut and walnut oils are essential in reducing or managing stress in a wonderful way. Some other health benefits of walnuts include its ability in reducing obesity or prevention of excess weight, better mental health benefits like benefits in reducing depression. Worldwide walnuts are recommended as a constituent of balanced human nutrition. Valentine Yanchou Nike *et al.* (2015) studied walnut ingestion in adults at risk for diabetes reported that despite their energy density walnuts can be included in the diet without adverse effects on weight or weight or body composition. Zameer *et al.* (2015) studied that walnut kernel incorporated rice based extruded snacks were developed and stored for LDPE bags for three months and found organoleptic acceptable.

There is a need to develop the walnut products that appeal to consumers and create new marketing opportunities for growers and popularity of plant based milks and nut butters. Walnut is being integrated into traditional cuisine in Kashmir as well as to develop new items for address local needs and global trends.

An analytical study on the fatty acids, physicochemical characteristics, phenolic compounds, tocopherol content and antioxidant activities of walnut oils extracted by different extraction methods (maceration, Mac; modified Bligh–Dyer, MBD; and cold-press, CP) was conducted (Gharibzahedi *et al.,* 2013). Antioxidant activity of oil was measured by 1,1-diphenyl-2-picrylhydrazyl (DPPH) and ABTS radical scavenging capacity and beta-carotene bleaching assays. Results showed that fatty acid content was not influenced by extraction method. MBD method was found to be the best process for extracting oil with a favorable quality characteristics when compared to Mac and CP. Higher total phenolics content (TPC), ortho-diphenol content (ODC) and total tocopherol content (TTC) and DPPH and ABTS scavenging capacities were also obtained with MBD. According to both principal component and correlation analyses, TPC and ODC were correlated with the beta-carotene bleaching activity and TTC was correlated with the ABTS of the oils extracted by the different methods in the current study.

A similar study was conducted in which walnut oils were obtained using five different extraction solvents (*n*-hexane, ethyl acetate, petroleum ether, Folch solution (chloroform/methanol, v: v=2: 1) and acetone), and their lipid yield, lipid composition, minor components (tocopherols, squalene, phytosterols, and polyphenols), oxidative-stability indices, and antioxidant capacity (via DPPH, ABTS, FRAP, and ORAC assays) were analyzed and compared (Gao *et al.,* 2019). It was found that ethyl acetate was the best solvent for extracting walnut lipids (68.32%), while *n*-hexane extraction gave comparatively lower linoleic acid (62.95%) and trilinolein contents (32.06%) and Folch extraction was suitable for extracting tocopherols (578.0 mg/kg). Although the walnut oil obtained by acetone extraction had relatively low phytosterols content (891.8 mg/kg), it had significantly higher polyphenol content (98.1 mg GAE/kg) and better antioxidant capacity than the other samples. In addition, it was found that polyphenols contributed significantly to the antioxidant capacity of the walnut oil, and thus can be considered as health-promoting.

Walnut flour, a by-product from the production of cold-pressed walnut oil, can contain up to 20 per cent oil, which contains high levels of polyunsaturated fatty acids and is, therefore, potentially unstable. Ground walnut flour was stored in three types of container, polypropylene plastic containers, multi-walled plastic-lined paper bags and manila (brown) paper bags (Vanhanen *et al.,* 2006). These containers were stored at mean temperatures of -24.6, 3.3, 10.4, 14.3 and 23.0 ^{o}C for 26 weeks. The moisture content and the peroxide value of the oil extracted from the flour were determined every four weeks for 26 weeks. The initial peroxide value of the freshly ground flour was 0.01 ± 0.008 meq O_2/kg oil. After 26 weeks of storage, all samples had an increased peroxide values when compared to the values for oil extracted from the freshly extracted walnut flour. After 26 weeks storage the mean peroxide levels of all treatments were below 1.0 meq O_2/kg oil, i.e., lower than that found in commercial samples of walnut oil. Overall, it is recommended that walnut flour should be stored below 23^{o}C with careful consideration given to the moisture content of the storage atmosphere and the type of package used to store the walnut flour.

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Knowledge of Rice and Wheat Farmers About Various Aspects of Agrochemical Use and Plant Protection Practices in the Sub-tropics of Jammu

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ABSTRACT

The present study was undertaken to analyse the knowledge of various aspects of agrochemical use and plant protection practices in the sub-tropics of Jammu (UT of J&K). The study was conducted by employing non-experimental descriptive research design. For the present study, a sample of 270 rice and wheat cultivating farmers from Jammu, Samba and Kathua districts were selected purposively. Interview schedule was developed and Knowledge Test was constructed in order to analyse the knowledge of the respondent farmers about various aspects of agro-chemical use and plant protection practices. The overall knowledge of the rice and wheat farmers was categorised into three categories namely; low (11-20), medium (21-27) and high (28-39) by "cube root method" proposed by Singh (1975). Majority (50%) of the respondent rice/wheat farmers had 'medium' level of knowledge regarding agro-chemical use in rice/wheat. Interestingly, less than one per cent farmers had 'high' level of knowledge which was distributed in Samba district only (1% farmers). The mean knowledge score of the farmers was 23.5 (±4.9) with mean score of 24.5(±3.7) of Jammu district, 22.3 (±5.2) of Samba district and 23.7(±5.4) of Kathua district. The mean difference in the knowledge score between Jammu-Samba and Samba Kathua was statistically significant with p values of 0.00 and 0.04 respectively. The F value of the ANOVA model was 4.808 which was statistically significant at p value of 0.00.

Keywords: Agrochemicals, Knowledge, Plant protection practices, Pesticides, Sub-tropics

INTRODUCTION

Insect pests, diseases and weeds cause considerable damage to potential agricultural production. Evidences indicate that the total global loss due to pests varied from about 50 per cent in wheat to about 37 per cent in rice production and more than 80 per cent in cotton production (Oerke, 2005). According to Dhaliwal and Arora (1996) pests cause 25 per cent loss in rice and the damage caused by major and minor pests of rice is largely controlled by the different natural enemies. Also, it has been reported that overall, weeds produced the highest potential loss (34%) in agriculture, and animal pests and pathogens caused loss up to 18 and 16 per cent respectively (Oerke, 2005). Keeping this in consideration, it is essential that farmers should have knowledge about insect pests, diseases and weeds of the crops they are cultivating and the natural enemies of the insect pests so that they are able to identify them and effectively use their knowledge in plant protection practices. Knowledge is defined as, "behaviour and test situations which emphasize the remembering, either by recognition or recall, of ideas, material or phenomena" (Bloom, 1979). It is a body of understood information possessed by an individual or by a culture (English and English, 1961). It is one of the important components of behaviour and as such plays an important role in the covert and overt behaviour of an individual (Ray and Mondal, 1999).

It is often observed that farmers, the major pesticide users, are not fully aware of the risks related

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to pesticide use (Rola and Pingali, 1993). Misuse and overuse of pesticides are often observed in the developing countries (Warburton *et al.,* 1995; Heong *et al.,* 1995; Yudelman, 1998). A clear understanding of farmers' knowledge, attitudes, and practices regarding pesticide use is the first step toward understanding the reasons for overuse of pesticides by farmers (Huang *et al.,* 2003). In many cases, rural farmers do not know proper usage and disposal techniques of chemical containers with few using protective clothing or equipment when handling highly toxic chemicals. Many farmers assume that applying more pesticides and herbicides is better, without understanding the consequences of its effect on environment (Pepper, 2008). Knowledge is the first step and a pre-requisite in the adoption of a technology. Knowledge of a particular technology is the basic requirement as it gives impetus to adopt a particular technology (Jadav and Manjunath, 2011). It is generally observed that farmers do not adopt a technology because of the lack of knowledge and information about the technology and its merits. On the other hand, in the experience of extension workers many practices including plant protection measures in spite of their merits are not accepted widely by the farmers (Panigrahi, 2014). Thus, it is essential that farmers are made aware of technologies, their knowledge about a particular technology and its merit is enhanced and focus should be not just on 'awareness-knowledge' but also 'how-to-knowledge' and 'principles- knowledge'.

MATERIALS AND METHODS

The union territory of Jammu and Kashmir is situated in North West Himalayan region extending over 32° 17' and 36° 58'North latitude and 73° 26' and 80° 30' East longitudes. Jammu region has 10 districts falling in temperate and sub-tropics. The sub-tropical region of the Jammu province constitutes the entire Jammu district, part of Samba, Kathua, Udhampur, and Rajouri districts. The sample for the study consisted of irrigated as well as rain-fed areas of Jammu, Samba and Kathua districts. The irrigated belt comprised of rice and wheat cultivating areas of Jammu district (Marh, R.S. Pura, and Bishnah), Samba district (Vijaypur, Samba, and Gaghwal) and Kathua district (Hiranagar and Kathua). On the other hand, the rain-fed belt comprised of Basholi block of Kathua district.

The study was conducted by employing non-experimental descriptive research design. Multi stage sampling technique was applied for selecting a total sample of 270 rice and wheat cultivating farmers from Jammu, Samba and Kathua districts. The data were collected from the respondents by using the pre-tested interview schedule by means of face-to-face/personal interview method.

A knowledge test was constructed in order to analyse the knowledge of the respondent farmers about various aspects of agro-chemical use and plant protection practices. The method developed by Bhatia (1990) with the following steps was followed for the present study:

1. Definition of knowledge
2. Statement of process objectives
3. Content area
4. Preparation of test blueprint
5. Writing test items
6. Standardization of test

Standardization of the knowledge test is one of the important steps in developing a final set of statements which reflects the content area and objectives of the study. Standardization has to be done by item analysis in the first phase and then checking the whole test for reliability, validity, stability, objectivity, usability, discriminativeness and comprehensiveness. The reliability of the test was measured through *split-half method* and *correlation coefficient* was calculated by using various formulas like *Spearman correlation coefficient* (r_{tt} = 0.982), *Rulon's formula* (r_{tt} = 0.980), *Flanagan's formula* (r_{tt} = 0.982) and *Kuder-Richardson's formula* (r_{tt} = 0.986) (Table 1). Interestingly, the formulas gave the same result leaving it in the discretion of the researcher to decide which formula or method of reliability suits better to the test situation at hand.

RESULTS AND DISCUSSION

The respondent farmers were asked to identify the insect pests, diseases and weeds of rice and wheat crops through pictures, and the observations were recorded (Table 2). It was observed that farmers had comparatively higher knowledge of insect pests and weeds than diseases of rice and wheat crops.

Table 1: Comparison of coefficient of reliability through various formulas

Formula of reliability	Spearman's correlation coefficient	Rulon's formula	Flanagan's formula	Kuder-Richardson's formula	Cronbach's coefficient alpha
Coefficient of reliability	0.982	0.980	0.982	0.986	0.749

Note: A correlation coefficient greater than or equal to 0.9 is considered to provide "excellent" reliability of the test.

Table 2: Knowledge of farmers about pests of rice and wheat crops (% farmers)

Pest	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Rice				
Insect pests				
Stem borer (*Sciropophaga incertulas*)	72	56	54	61
Leaf folder (*Cnaphalocrocis mainsails*)	37	57	38	44
Green leaf hopper (*Nephotettix virescens*)	36	41	33	37
Rice hispa (*Dicladispa armigera*)	6	14	28	16
Brown plant hopper (*Nilaparvata lugens*)	6	24	19	16
Grasshopper (*Hieroglyphus banian*)	100	100	100	100
Diseases				
False smut (*Ustilaginoidea virens*)	1	3	4	3
Blast (*Pyricularia orisa*)	30	32	27	30
Bacterial leaf blight (*Xanthomonas oryzae*)	0	1	6	7
Bacterial leaf streak (*Xanthomonas oryzae*)	0	0	4	1
Sheath blight (*Ryzoctonia solani*)	0	2	2	1
Weeds				
Dhila (*Cyperus iria*)	87	41	70	66
Kharsu (*Echinochloa colonum*)	88	24	51	54
Swank (*Echinochloa crusgalli)*	88	24	46	53
Nadi (*Euphorbia hirta*)	88	24	36	49
Motha (*Cyperus rotundus*)	80	19	26	41
Wheat				
Insect pests				
Army worm (*Spodoptera frugiperda*)	24	19	32	25
White grub (*Phyllophaga* sp.)	72	85	62	73
Aphid (*Sitobian avenae*)	100	100	100	100
Diseases				
Loose smut (*Ustilago tritici*)	58	49	42	50
Yellow Rust (*Puccinia striiformis*)	87	82	79	83
Leaf spot (*Alternaria triticina*)	14	18	12	15
Karnal bunt (*Tilletia indica*)	13	12	7	11
Weeds				
Sittee booti (*Phalaris minor*)	82	81	87	83
Wild oats (*Avena fatua*)	76	73	82	77
Bathua (*Chenopodium album*)	80	73	35	63

Table 3: Knowledge of farmers about recommended dosage of fertilizers in rice and wheat crops (% farmers)

Recommended dosages of fertilizers	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Rice				
Urea (50-140 kg/ha)	20	33	42	32
DAP (44-90 kg/ha)	32	31	24	29
MOP (16-33 kg/ha)	31	24	13	23
$ZnSO_4$ (20 kg/ha)	13	11	11	12
Wheat				
Urea (100 kg/ha)	70	55	37	54
DAP (80 kg/ha)	32	47	24	34
MOP (60 kg/ha)	49	44	52	48
$ZnSO_4$ (20 kg/ha)	12	9	15	12

The recommended dosage of fertilizers as per the package of practices of SKUAST-Jammu was considered for the present study. Accordingly, it was observed that very small percentage of farmers had correct knowledge about the recommended dosages of fertilizers (Table 3). In case of rice crop, overall, only 32, 29, 23 and 12 per cent farmers respectively, had correct knowledge about the recommended dose of urea (50-80 kg/ha), DAP (44-90 kg/ha), MOP (16-33 kg/ha) and $ZnSO_4$ (20 kg/ha).

Table 4: Knowledge of farmers about pesticides in rice and wheat crops (% farmers)

Pesticide	Jammu	Samba	Kathua	Overall
Herbicide				
Bispyribac sodium	72	68	59	66
Butachlor	16	15	22	18
2-4-D ethyl ester	42	39	19	33
Sulphosulpheron	15	22	47	28
Insecticide				
Phorate	33	38	18	30
Chlorpyriphos	7	4	6	6
Fungicide				
Propiconazole	2	1	0	1

In case of wheat, 54, 34, 48 and 12 per cent farmers had knowledge about recommended dosage of urea (100 kg/ha), DAP (80 kg/ha), MOP (60 kg/ha) and $ZnSO_4$ (20 kg/ha) respectively (Table 3).

It was observed that the knowledge of herbicides was higher than insecticides and fungicides in the study area. The knowledge of *bispyribac sodium* was the highest among the herbicides (66%) with about 72 per cent of the respondents from Jammu district. This can be attributed to the fact that *Bispyribac sodium* with the trade name *Nominee Gold* was the most common herbicide used by farmers in the study area. The knowledge of other herbicides was comparatively lower in the study area. The knowledge of insecticides and fungicides was low to negligible (Table 4).

Beneficial insects were the easiest to identify for farmers, but variation in knowledge was observed when farmers were asked regarding the insects being beneficial or not. The results reveal that overall, 90 per cent farmers could identify dragonfly, out of which 87 per cent farmers had knowledge of it being a beneficial insect. In case of ladybird beetle, 91 per cent farmers could identify the insect but, only 54 per cent farmers had knowledge of it being a beneficial insect. Similarly, 74 per cent farmers identified spider but only 59 per cent had knowledge of it being beneficial (Table 5).

The rice-wheat farmers were asked questions regarding the right time of spraying pesticides. Variation in knowledge was observed among the respondent farmers regarding the right time of spraying pesticides. According to recommended practices, early morning

Table 5: Knowledge of the farmers about beneficial insects in agriculture (% farmers)

Natural enemy	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Dragonfly	93	94	82	90
Knowledge of dragonfly being a beneficial insect	87	94	79	87
Ladybird beetle	96	94	82	91
Knowledge of ladybird beetle being a beneficial insect	38	52	73	54
Spider	81	60	81	74
Knowledge of spider being a beneficial insect	70	60	47	59

or evening time are considered the best times for spraying operations. Yet, the results reveal that majority of the farmers (61%) considered afternoon to be the best time for spraying pesticides. Only 32 and 7 per cent respondents had the correct knowledge of morning or evening as the right time of spraying pesticides respectively. In case of pesticide application, only 5 per cent respondent farmers had correct knowledge regarding spot specific application of pesticides (Table 6).

Seed treatment is the most important step for protecting the crop from diseases, that farmers need to follow before planting the seeds. Yet, in the study area, the knowledge of farmers about seed treatment practices was on the lower side (Table 7). Overall, only 16 per cent respondents could name the right chemical for seed treatment, only 5 per cent had knowledge about correct dose of the seed treatment chemical and only 34 per cent respondents had knowledge about the benefits of seed treatment in rice and wheat.

Table 6: Knowledge about time of pesticide application and weather conditions (% farmers)

	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Time of pesticide application				
Morning	23	40	32	32
Afternoon	73	52	59	61
Evening	3	8	9	7
Pesticide application				
Spot specific	9	1	4	5
Whole area under crop	91	99	96	95
Weather condition				
Sunny	100	100	100	100

Table 7: Knowledge of farmers regarding seed treatment practices (% farmers)

Knowledge about	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Name of chemical	11	22	16	16
Dose of chemical (2-2.5g/kg seed)	3	7	4	5
Benefits of seed treatment	27	33	41	34

A close look at Figure 1 reveals the knowledge of rice and wheat farmers regarding colour identification bands on pesticide labels. It is clear that farmers had very less knowledge about the toxicity level the different colours represent. Among the colours, overall, 37 per cent farmers had knowledge about toxicity of 'bright red' colour (extremely toxic) with highest percentage of farmers (51%) with the correct knowledge from Jammu district. The knowledge of the toxicity level of others colours was very low to negligible (Figure 1).

Knowledge of proper use of protective measures while handling pesticides is a very important aspect of agro-chemical use in agriculture. The rice and wheat farmers were asked questions regarding the use of personal protective equipment. The overall result reveal very low knowledge about basic protective practices like: wearing gloves (9%), wearing mask while mixing (7%), wearing mask while spraying (6%) and wearing

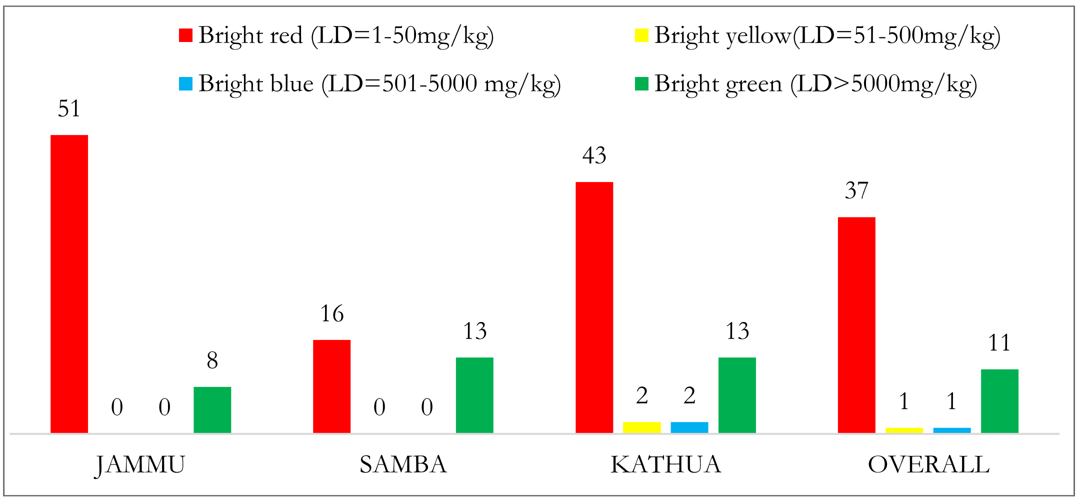

Figure 1: Knowledge of the farmers about colour identification bands on pesticide label (% farmers)

Table 8: Knowledge of the rice and wheat farmers regarding, handling, storage and disposal of pesticides (% farmers)

Knowledge about	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Wearing gloves while mixing	13	8	7	9
Wearing mask while mixing	10	2	8	7
Wearing face mask while spraying	10	2	4	6
Wearing glasses while spraying	20	4	13	13
Inspection of containers for leaks	100	100	100	100
Changing of clothes after spraying	100	100	100	100
Washing of sprayer after application of herbicide	99	100	100	99
Not washing used pesticide bottles in pond/canal/river	79	66	90	78
Disposal of pesticide containers				
Throw in the field	23	21	20	21
Crush and bury in soil	77	79	80	79

Table 9: Knowledge of farmers regarding different aspects of agro-chemical use (% farmers)

Knowledge of farmers	Jammu (n=90)	Samba (n=90)	Kathua (n=90)	Overall (n=270)
Harmful effects of pesticides	72	61	63	65
Symptoms of pesticides poisoning	28	34	53	38
First aid in case of pesticide poisoning	27	22	20	23
Banned pesticides	8	7	3	6
Residual effects of pesticides	9	10	6	24
Alternative pest management practices	7	0	4	4

Table 10: Knowledge level and mean knowledge score

Parameters	Jammu (n=90) (I)	Samba (n=90) (J)	Kathua (n=90) (K)	Overall (n=270)	Mean difference (p value)		
					(I-J)	(I-K)	(J-K)
Knowledge level (% farmers)							
Low (11-20)	10	43	24	26	-	-	-
Medium (21-27)	69	37	46	50	-	-	-
High (28-39)	21	20	30	24	-	-	-
Mean knowledge score	24.5±3.7	22.3±5.2	23.7±5.4	23.5±4.9	2.211*(0.00)	0.733(0.31)	-1.477*(0.04)

ANOVA model summary

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	228.319	2	114.159	4.808	0.00
Within Groups	6338.944	267	23.741		
Total	6567.263	269			

glasses while spraying (13%). (Table 8). On the other hand, 100 per cent farmers had the correct knowledge about practices like inspecting pesticide containers, changing clothes after spraying and washing sprayer after application of herbicides. Also overall, 79 per cent farmers had the knowledge of correct way of disposal of pesticide containers i.e., crush and bury in soil.

It is evident from Table 9 that, out of 270 rice and wheat farmers, 65 per cent farmers had knowledge about harmful effects of pesticides but, at the same time, the knowledge of other aspects was very low. Overall, only 38 per cent farmers had knowledge about symptoms of pesticide poisoning, 23 per cent had knowledge about the first aid measures in case of pesticide poisoning and 24 per cent farmers had knowledge about residual effects of pesticides. Interestingly, the knowledge about banned pesticides and alternative pest management practices was negligible (6% and 4% respectively). The overall knowledge of the rice and wheat farmers was categorised into three categories namely; low (11-20), medium (21-27) and high (28-39) by "cube root method" proposed by Singh in 1975. Majority (50%) of the respondent rice and wheat farmers had 'medium' level of knowledge regarding agro-chemical use in rice and wheat. Interestingly, less than one per cent farmers had 'high' level of knowledge which was distributed in Samba district only (1% farmers). The mean knowledge score of the farmers was 23.5 (±4.9) with mean score of 24.5(±3.7) of Jammu district, 22.3 (±5.2) of Samba district and 23.7(±5.4) of Kathua district (Table 10). Further, mean differences in the knowledge level of rice-wheat farmers were analysed between different districts by applying one-way ANOVA (Table 10). The mean difference in the knowledge score between Jammu-Samba and Samba-Kathua was statistically significant with p values of 0.00 and 0.04 respectively. The F value of the ANOVA model was 4.808 which was statistically significant at p value of 0.00.

CONCLUSION

In the present study majority of the respondent rice and wheat farmers had medium level of knowledge of agro-chemicals and plant protection measures. The absence of desired knowledge level about diseases, natural enemies, seed treatment, pesticides and toxicity of pesticides (resultantly farmers lacking hands on experience about them) could be for the reason for negligible use of insecticide and fungicide in the sub-tropics of Jammu. The extension agencies should focus on educating farmers about major pests of the crops they cultivate, suitable choices of pesticides and their proper application. Farmers should also be trained to differentiate between diseased and nutrient deficient plants. There was no significant difference between the districts of Jammu, Samba and Kathua regarding knowledge about insect pest, diseases and weeds of rice and wheat. Similar results were reported by Panigrahi (2014) in rice and Yangsdon (2016) in vegetables.

Knowledge of recommended technologies (in this case agro-chemicals, plant protection practices and personal protective equipment) is a pre-requisite in adoption of the technology itself. Knowledge of a particular technology is basic requirement as it gives impetus to adopt the technology. The farmers in the present study did not possess the desired knowledge level about diseases, natural enemies and toxicity of pesticides which is true for both rice and wheat. This could be due to the reason that insecticide and fungicide use in rice in Jammu region is negligible and farmers do not have hands on experience about these. However, the training programmes or modules of the department of agriculture, KVKs and SKUAST-Jammu should focus on seed treatment, pest and natural enemy complex, alternative pest management techniques, in the rice and wheat eco-system so that pesticide load could be maintained at low level. The knowledge of personal protective equipment was also low in the study area, but interestingly, knowledge of harmful effects of pesticides was comparatively high in the study area. Thus, it will be easier for extension agencies to convince farmers to use personal protective equipment as they have knowledge about the harmful effects of pesticides. The need is also to train farmers to identify symptoms of pesticide poisoning and first aid in case of pesticide poisoning as the knowledge of both was very low in the study area.

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Identifying the Difficulties Faced by Apple Growers Regarding Trainings Imparted by KVK's in Kashmir Valley

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ABSTRACT

The present study was undertaken to identify the difficulties faced by apple growers regarding trainings imparted by KVK's in Kashmir Valley**.** The study was carried in five districts of KVK Baramulla, Kupwara, Pulwama, Shopian and Kulgam. A proportionate random sample of 410 apple growers who had received trainings were taken from five selected KVK's. The main difficulties faced by apple growers during the time of trainings were: time of imparting trainings on different areas of apple production didn't coincide with field operations of apple production, duration of training imparted by KVK's for apple production is less hence difficult to practice, trainees do not get a chance to practice the skill taught during training-sessions, trainees face the difficulties in understanding the lectures delivered by scientists & also face difficulties in arranging grading machines for grading of apples.

Keywords: Field operations, Apple Growers, Grading machines, Trainings, KVK's

INTRODUCTION

Agriculture is the backbone of Indian economy and the progress of the nation is linked with advancement in agriculture. In India, more than 70 per cent of the population is engaged in Agriculture as it is the source of their livelihood, so speedy development of Agriculture and the farm enterprise are vital to the progress of our country Agricultural as well as horticultural sector is considered as one of the effective factor in economic development of India. Achieving food and nutritional security is possible only by making use of new technologies in farm land. Today in most parts of the world, due to limited land and water resources, increase in production and quality food is hardly possible unless need based effective techniques in production system are adopted by the farmers. People have shifted towards non-conventional dietary pattern, using more of fruits, vegetables and other food items, which are rich in proteins etc. Thus, the demand for these food items has increased tremendously; as such crop pattern too is shifting rapidly, the shifting of cropping pattern in favour of horticultural crops is too demanding for specialised practices that must be known to the farmers, from the very inception of establishment of an orchard till it comes into bearing and thereafter for its management. These practices need specialised trainings such as propagation, training, pruning, fertilization, disease and pest management and other management practices that can make the crop more remunerative, owing to a direct relationship with its productivity and quality (Katiyan, 2019).

During the last 5 years KVK's in the valley of Kashmir have conducted 415 on-farm testing on various crop-based enterprises benefitting 2162 farmers from the year 2016-2020. Also, they have conducted frontline demonstrations on crops like Paddy, Maize, Wheat, Oilseeds, Pulses, Vegetables over an area of 2884.3 ha and benefitting 2360 farmers. During the last five years KVK's have organized 2738 farmers-trainings on Cereals, Pulses, Vegetables etc. thus benefitting 2022 farmers (Source: Directorate of Extension SKUAST-K Shalimar). A Training Needs Assessment is a systematic process for determining and addressing "needs" or "gaps" between the current

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conditions and desired conditions or "wants". The discrepancy between the current condition and desired condition must be measured appropriately to identify the need. The purpose of the training needs assessment is to identify performance requirements and the knowledge, skills, and abilities needed by an individual to achieve the requirements. An effective training needs assessment may help direct resources to the areas of greatest demand. Training of the farmers is essential to induce motivation, create confidence and inculcate efficiency in an individual. Training of the farmers is also inevitable for imparting new knowledge and updating the skills of farmers. Training of farmers has assumed further importance and urgency in the context of the high yielding varieties and improved practices in agriculture and allied fields. In order to make any training meaningful and effective, it is imperative on the part of the training organizers to identify the training needs of the farmers based on which suitable training modules can be developed so that the appropriate training is given to the right people, in the right form, at the right time so that higher degree of productivity and profitability can be achieved (Prajapati and Patel, 2013).

Therefore, training of the farmers is an intensive learning activity, assisted by competent trainers to understand and practice the skills required in a deficit situation in the knowledge, skills and attitude level of the practicing farmers as well as the availability of appropriate applicable information, the utilization of which will correct the problems. The initial idea to provide vocational education in agriculture and allied sectors for the pre and post matriculate levels rural youth was made possible through KVKs. Subsequently objectives and mandate has been changed according to need of the agriculture. Thus KVKs are acting as innovative institutions for imparting vocational training to the practicing farmers, school dropouts and field level extension functionaries.

MATERIALS AND METHODS

Research design: For carrying out the research ex-post-facto design was used. It is systematic inquiry in which the researcher does not have direct control of independent variables because their manifestations have already occurred and they cannot be manipulated. Inferences about relations among variables are made without intervention, from concomitant variation of independent and dependent variables (Kerlinger, 1964).

Pre test-post test control group research also known as before after design in which two equivalent groups of the same size are randomly selected from a population one group randomly given the treatment is called the experimental group and the other group for which no treatment is given, is called the control group. After the treatment is over, post Test is administered to both the groups and the difference is measured. This test also makes a provision for pre-test of both experimental and control groups before the treatment is administered (Mondal and Ray, 1999).

Selection of KVK's

KVK's	Year	Respondents	Total
Baramulla	2017-18	72	355
	2018-19	103	
	2019-20	180	
Shopian	2017-18	425	1395
	2018-19	480	
	2019-20	490	
Kupwara	2017-18	151	638
	2018-19	183	
	2019-20	304	
Kulgam	2017-18	360	1427
	2018-19	600	
	2019-20	467	
Pulwama	2017-18	414	2085
	2018-19	663	
	2019-20	1008	
Total			**5900**

Source: Krishi Vigyan Kendra's

Sampling Procedure

Locale of the study: The present study was carried in five KVK's of the Kashmir Valley located in districts Baramulla, Kupwara, Pulwama, Kulgam and Shopian.

Selection of KVK's: Out of 14 KVK s present in Kashmir & Ladakh province, ten KVK's are located in Valley of Kashmir and four in UT of Ladakh. Out of these ten KVK's, five KVK's having more area under apple were selected for the present study.

Selection of apple growers from concerned KVKs Proportional Allocation method (N=410)

District	Total no. of registered apple growers undergone trainings by KVKs (N_i)	Sample size drawn from each KVK (n_i)
Baramulla	N_3= 355	n_3= 24
Shopian	N_4= 1395	n_4= 97
Kupwara	N_5= 638	n_5= 44
Kulgam	N_1= 1427	n_1= 100
Pulwama	N_2= 2085	n_2= 145

Source: Krishi Vigyan Kendra's)

Selection of the apple growers: The total number of Apple growers who were trained through five selected KVK's from 2017 to 2019 was 5900. A random sample of 410 respondents (7%) proportional to size was taken from each KVK for the present study. Then, accordingly a sample of 410 apple growers was taken for the present study. From each KVK apple growers were randomly selected from the list of trainees who had undergone training on apple production.

Tools for data collection and analysis

Interview schedule: An interview schedule was constructed based upon the objectives, variables and available literature on the topic. The schedule was prepared in English language. While preparing the schedule, due care was taken to avoid questions with double meaning and contradictory statements. The language used was simple for easy understanding. The interview schedule was constructed to collect the necessary information. Interview schedule was divided into two parts- Part A and Part B. Part A was further divided into two parts-Part I and Part II. Part I of the schedule is related with the socio-economic profile and the subject matter areas of trainings imparted by KVKs. In part II of the interview schedule, questions related to Level of adoption of trainings imparted by KVKs regarding apple production were included. Part B included questions related to impact of farmers towards trainings imparted by KVKs and also included the items related to feedback from the farmers regarding trainings imparted by KVKs. Most of the items included in the interview schedule were structured questions which were simple and easy to reply.

Pre-testing of interview schedule: Before finalization of the interview schedule, it was pre-tested on 20 apple growers. Four apple growers were randomly chosen from the five districts of the group of apple growers selected for pretesting which were not taken in the sample.

Collection of data: Data were collected by personal interview method. The apple growers were assured that all the information furnished by them shall be kept confidential and shall be used for the research study only. The apple growers were contacted at their homes during their leisure time or at their respective fields. The interview was conducted in a friendly and informal manner.

Compilation of data: The qualitative data were quantified by using various statistical tools and working out different scores in order to find out the nature of relationship between dependent and independent variables.

Measurement of variables: The present study has two dependent and nine independent variables, the variables were selected based on the review of literature and opinion of the experts. Only those variables were selected which were found to have relevance to the present investigation. The instruments used and the procedure followed to measure the variables have been described in detail in the following pages.

Statistical analysis: The following statistical tests and measures were used for the analysis of the data.

Arithmetic mean: This was used to compare the respondents in respect of their dependent variables. The arithmetic mean is the sum of scores divided by the number of respondents.

$$X = \frac{\Sigma x}{n}$$

Where, x = Mean

Σx = sum of scores

n = Number of respondents

Frequencies (f) and Percentages (%): The frequency of an event "i" in statistics is defined as the number "n_i" of times the event happened in the experiment or analysis. It is the frequency at which a particular value

Table 1: Difficulties faced by trainees in trainings imparted by KVKs (N=410)

Statement	Number	Frequency	Rank
Time of imparting trainings on different areas of apple production do not coincide with field operations of apple production	265	64.63	IV
Duration of training imparted by KVK for apple production is less hence difficult to practice	320	78.04	II
Trainees do not get a chance to practice the skill taught during training	360	87.80	I
We face difficulties in reaching to KVK's for trainings	211	51.46	V
We face difficulties in understanding the lectures delivered by scientists	37	9.02	VI
We face difficulties in arranging grading machines for grading of apples	313	76.34	III

or set of values appears. A percentage is representing a number as a fraction of 100 in arithmetic (percentage means "per hundred"). The present symbol, "percent", is often used to represent it. 45 per cent (read as "forty five percent"), for example, is equivalent to 45/100, or 0.45.

Regression: Statistical measure that attends to determine the strength of relationship between one dependent variable (usually denoted by *y*) and a series of other changing variables (known as independent variable).

$$y = a + bx$$

Where, "y" is dependent variable, "x" is independent variable and "b" is slope.

Paired t-stat: A statistical measure that was used to determine the strength of impact of trainings.

Factor analysis: According to Kothari (1984), factor analysis seeks to resolve a large set of measured variables in terms of relatively few categories, known as factors. This technique allows the researcher to group variables into factors (based on correlation between variables), and the factors so derived may be treated as new variables (often termed as latent variables) and their value derived by summing the values of the original variables which have been grouped into the factor. The meaning and name of such new variable is subjectively determined by the researcher.

RESULTS AND DISCUSSION

An appraisal of data of Table 1 reflected various difficulties faced by the respondents in the trainings imparted by KVK's, among the various difficulties the major difficulty faced by the trainees was that they do not get a chance to practice the skill they are being taught during training programme as ranked I. Another major difficulty they reported was that duration of trainings is one day which is very short time for trainings on apple production and have been ranked at the number II. 76.34 per cent of the respondents reported that they faced difficulties in arranging the grading machines for mechanical grading of apple and this difficulty has been ranked at number III. Majority of the trainees also faced a problem regarding timing of trainings as the subject matter taught doesn't coincide with the immediate field operation & have been ranked at number IV. More than a half of respondents 51.46 per cent have reported that it was difficult for them to reach KVK and the item has been ranked V. Also, 9.02 per cent of trainees had faced a problem of understanding of the lectures & this difficulty has been assigned a rank of VI.

CONCLUSION

The data reflected various difficulties faced by the respondents in the trainings imparted by KVK's, among the various difficulties the major difficulty faced by the trainees was that they do not get a chance to practice the skill they are being taught during training programme as ranked I. Another major difficulty they reported was that duration of trainings is one day which is very short time for trainings on apple production and have been ranked at the number II. Also, 76.34 per cent of the respondents reported that they faced difficulties in arranging the grading machines for mechanical grading of apple and this difficulty has been ranked at number III. Majority of the trainees also faced a problem regarding timing of trainings as the subject matter taught doesn't coincide with the immediate field operation & have been ranked at number IV. More than a half of respondents 51.46 per cent have reported that it was difficult for them to reach KVK and the item has been ranked V. Also, 9.02 per cent of trainees had faced a problem of understanding of the lectures and this difficulty has been assigned a rank of VI.

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Constraints in Adoption of Scientific Beekeeping Management Practices by Beekeepers of Morena District of M.P.

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ABSTRACT

The present study was conducted in adjoining area Morena city of Madhya Pradesh during 2018-19 at the school of Agriculture sciences BRAUSS Mhow. A list of farmers who are involved in bee keeping farming was prepared. From this list 200 bee keeping farmers were selected by random sampling method. It was found that major constraints in adoption of bee keeping management practice were lack of disease management practice, Lack of specific government schemes for beekeeping/beekeepers, Lack Minimum Support Price for honey and honey based products etc.

Keywords: Beekeeping, Beekeepers, Beekeeping management practices, Adoption and constraints

INTRODUCTION

Honey bees (members of the family Apidae; order hymenoptera) are the best known and most useful insects, known not only for the production of honey and other valued hive products (wax, royal jelly, propolis, pollen, venom and the like) but also for their more important ecological role as the most dependable and efficient pollinators of flowering plants / trees; which leads to enhanced crop productivity (quantitatively as well as qualitatively), besides contributing to maintenance of plant diversity. Beekeeping is an excellent source of employment for the rural unemployed – currently approximately 250,000 farmers in India are employed through beekeeping. Two major roles of honeybees are: i) Production of honey and ii) Pollination of field crops/ orchard trees. Commercial beekeeping in India is usually regarded as a subsidiary industry with the primary objective of honey production for supplementary income. Honey was first bee product used by human beings since ancient times. It is good food with high nutritive value. It is therefore, used by both healthy and sick. Its role improved growth of non-breast fed infants, improved calcium fixation in bones and curing anemia and anorexia are well documented in literature. Morena is the leading district in apiculture in Madhya Pradesh. In the Morena district more than 80000 honey bee colonies and more than 5000 beekeepers. They produce about 32000 qt. of honey per annum. All round development of agriculture is possible with the effective exploitation of human as well as material resources. In our country, where human resources are found to be plenty, we can identify individuals in all segments of population who have the requisite entrepreneurial skills. At this juncture, it is logical to analyze to what extent our farmers are progressive, forward looking and willing to diversify their occupations.

Keeping the above facts in view the present study has been designed to analyze the constraints in adoption of scientific beekeeping management practices by beekeepers.

METERIALS AND METHODS

This study was conducted in Morena district of Madhya Pradesh purposively due to the research centre namely Integrated Beekeeping Development Centre was established at ZARS Morena by National Bee Board

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New Delhi. A list of villages where maximum numbers of farmers were engaged in bee keeping was prepared with the help of extension official; out of these 5 villages of Kailarash and Joura blocks were purposively selected due more number of farmers were engaged in bee keeping, a total 10 villages were randomly selected for study. A village wise list of bee keeping farmers was prepared and 20 farmers from each village were randomly selected. Thus, the total sample consisted of 200 farmers spread over ten selected villages. The primary data were collected from the respondents by using a semi-structured interview schedule, which was pre-tested before actual application. The respondents were interviewed individually by the investigator. Secondary data were collected from records& statistical office. Statistical tools like- mean, SD, percentage and Karl Pearson's coefficient of correlation and multiple regression analysis were used for analysis of data.

RESULTS AND DISCUSSION

It is detected from the data presented in Table 1 that the major constraints expressed and reported by the 93.00 per cent of beekeepers, was lack of disease management practice. Most of the loss in beekeeping venture in the study area was due to nosema disease which is a viral disease and had destroyed the colonies. Nosema disease is treated by increasing the ventilation through the hive. Some beekeepers treat hives with antibiotics such as fumagillin.

The second important constraint experienced by the beekeepers was lack of specific government schemes for beekeeping. Beekeeping is not considered as a priority sector and is listed under cottage industries and there is no specific scheme for beekeeping under agriculture schemes. As a result, commercial banks are also reluctant to provide credit to beekeeper citing high risk as a reason. As most of the beekeepers are marginal, small and landless farmers; they are not able to produce property documents required as a collateral security necessary for obtaining loans and financial institutions are reluctant to give credit to beekeepers. The third constraint experienced by the beekeepers was No MSP for honey and honey based products. Most of the beekeepers only produce honey and were not aware of any of the honey based value added products. The fourth constraint experienced by beekeepers is lack of market for honey and honey based products. There

Table 1: Distribution of respondents according to their constraints faced during beekeeping management (n=200)

S.N.	Constraints	Respondents		
		Frequency	Percentage	Ranks
1.	Lack of disease management practice	186	93.00	I
2.	Lack of specific government schemes for beekeeping/beekeepers	169	84.50	II
3.	Lack Minimum Support Price for honey and honey based products	155	77.50	IV
4.	Lack of marketing network for the honey and honey products	160	80.00	III
5.	Lack of storage Facilities	130	65.00	VI
6.	Lack of awareness about Insurance	145	72.50	V
7	Lack of family support/society support	114	57.00	VII
8	Lack of awareness about loan/subsidy	105	52.50	VIII
9	Lack of knowledge about identifying pests and diseases	96	48.00	X
10	High cost of transportation.	91	45.50	XII
11	Lack of honey processing facilities	99	49.50	IX
12	Lack of technical training about beekeeping technology	85	42.50	XIV
13	Lack of appropriate crop for quality/quantity honey production	86	43.00	XIII
14	High cost of equipments	76	38.50	XVII
15	Non-availability of quality bee box	78	39.00	XVIII
16	Government has charging more tax on honey/honey based production	83	41.50	XV
17	Lack of technical expatriation/training about preparation of honey based product	94	47.00	XI

is no government intervention in marketing of honey and other honey based products and the beekeepers are forced to sell at the rate fixed by Chambal and Morena Khadi Gramodyog Beekeeping Society (Rs. 150-200 per kg). Despite this, farmers prefer to sell it to the Society rather than private agencies as they are paid ready cash.

The fifth constraint experienced by the beekeepers is no lack facilities for storage at reasonable price. The government offers warehouse facility only for major agricultural commodities like food grains, cotton, oilseeds, pulses, etc but not honey. Consequently, the beekeepers are forced to sell at prevailing market rate. If they have access to storage facilities at reasonable price, they could be able to explore distant markets or hold the stock for sale during peak demand season (February-June).

Other constraints include lack of insurance coverage to bee colonies which is available for other agro-enterprises and spoil the colonies due to pest infestation. The high cost of sugar is also a bottleneck for beekeepers. During the lean season, honey bees have to be fed with sugar syrup or sugar solution which requires large quantities of sugar. High cost of sugar increases the cost of production. It was found that the government does not provide sugar at subsidized rates to beekeepers.

The seventh constraints faced by bee keepers was lack of family support/society because a regulatory framework for the preparation of financial statements is necessary for ensuring that the needs of the users of financial statements are met with at least a basic minimum of information as well as to increase users' confidence in the financial reporting process and to regulate the behaviour of companies and directors towards their investors. Lack of awareness about loan/subsidy was the eighth constraints experienced by the bee keepers. Small businesses face an uphill battle to keep budgets under control. But there is no proper help available for loan/subsidy assistance, in the form of government and community grants, goes a long way to keeping small businesses afloat.

The ninth constraint was lack of knowledge about identifying pests and diseases is another problem reported by the beekeepers. Since, honey bees live in colonies of thousands; it is very difficult to identify the incidence of pest and disease. Many beekeepers lack the technical know-how and expertise in this field. Another important constraint is the high cost of transportation of honey bee colonies. Most of the beekeepers follow migratory beekeeping during the lean seasons which requires transfer bee colonies. This process is quite cumbersome and high transportation cost increase the cost of production.

Beekeepers practising migratory beekeeping expressed lack of safety to honey bee boxes as another constraint. Honeybee colonies have to be transferred from one place to another depending on the availability of nectar and pollen. Sometimes, the colonies are transferred to areas were rubber is grown. During this time, theft of honey bee boxes is common. Sometimes, when food is scarce, the bees may also leave the beehive boxes in search of food if artificial feeding is delayed.

Lack of honey processing facilities was eleventh constraint experienced by the beekeepers. Raw honey extracted from the bee hives needs processing and refining so as to fetch a good price in the market. Most of the farmers do the processing themselves or sell the honey in raw form which fetches them low price. Since, beekeepers are not a well-organized group and it is not in the priority sector, processing facilities are almost non-existent. Lack of technical training about beekeeping technology is also experienced as 12th constraint by bee keeper during identification of pest and disease and processing of the honey. Most of the things are not learned overnight but it takes time, and over a period of trial and error the required skill set are appropriately developed amongst individuals. Lack of appropriate crop for quality/quantity honey production was also reported as constraints by the bee keepers but. The *apiary* must be located in well-drained open area, preferably near orchards, with profuse source of nectar, pollen and water. Protection from sunlight is important in order to maintain an optimum temperature in the hive.

High cost of equipment (boxes, accessories, etc) and non-availability of quality bee boxes were another major constraint faced by the beekeepers. Secondly, the Chambal and Morena Khadi Gramodyog Beekeeping Society provide necessary equipment to beekeepers at subsidized rates. However, the wooden honey bee-boxes and frame, provided by the society

Table 2: Distribution of respondents according to their suggestion to overcome on constraints (n=200)

S.N.	Constraints	Respondents		
		Frequency	Percentage	Ranks
1.	Need of technical guidance about pests/disease management practice	180	90.00	I
2.	Government should make specific schemes for beekeepers	160	80.00	III
3.	Government should direct purchase of honey based & honey based product	120	60.00	VI
4.	Storage facilities should available to beekeeping	170	85.00	II
5.	Government should provide training about beekeeping technology & preparation of honey based product	100	50.00	VIII
6.	Bank/institution should create awareness about loan/subsidy/scheme	154	77.00	IV
7	Transportation facilities should available for remote area should ovarlable at time	90	45.00	IX
8	Honey processing facilities should available a village panchayat level	80	40.00	X
9	Quality equipment should available at very cheap cast	136	68.00	V
10	Newspaper should publish news on honey marketing	118	59.00	VII
11	Regular visit by scientist/bee export or expected	72	36.00	IIX
12	The honey & honey based product should free from G.S.T/any tax	64	32.00	IIIV

are made from low quality wood. As a result, during rainy season, the wooden frame is attacked by fungus and has to be discarded. Due to this, the quality as well as market value of honey decreases fetching a low price. Non-availability of disease resistant bees and inadequate extension support were some of the other constraints faced by beekeepers.

A close look at Table 2 reveals that the 90.00 per cent of beekeepers reported need of technical guidance about pests/disease management practices. Most of the loss in beekeeping venture in the study area is due to nosema disease which is a viral disease and had destroyed the colonies. The second important measures suggested that Government should make specific schemes for beekeepers, reported by 80.00 per cent of the respondents. As a result, commercial banks are also reluctant to provide credit to beekeeper citing high risk as a reason. The third measure was given, Government should direct purchase of honey and honey based product. The fourth suggestion "storage facilities should available to beekeeper" was given by 60.00 per cent of the respondents. The fifth measure was suggested by the beekeepers "Government should provide training about beekeeping technology & preparation of honey based product". Majority 50.00 per cent of the respondents suggested that Bank/institution should be created awareness about loan/subsidy/scheme. Transportation facilities for remote area should be available at time reported by 45.00 per cent of the respondents. Most of the 40.00 per cent of the bee keepers accounted that honey processing facilities available at village panchayat level and Quality equipment should available at very cheap cast and got the ranked 8^{th} and 9^{th} respectively. Regular visit should be conducted by scientist/bee expert reported by 36.00 per cent of the beekeeping farmers and 32.00 per cent of the respondents suggested that the honey & honey based product should free from G.S.T/any tax and got ranked eleven.

CONCLUSION

It was concluded that lack of disease management practice, lack of specific government schemes for beekeeping, Lack of awareness about loan/subsidy and high cost of transportation of honey bee colonies etc. were the major constraints faced by bee keepers in adoption of scientific beekeeping management practices and suggestion were need of technical guidance about pests/disease management practice, Government should make specific schemes for beekeepers, government should direct purchase of honey based and honey based product and storage facilities should available to beekeeping respectively.

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Economics of Cotton Cultivation in North India - A Comparative State-wise Analysis

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ABSTRACT

Cotton is an important commercial fibre crop. The cotton area in the country is mainly divided into three zones i.e., Northern, Central and Southern zone. North zone of cotton (Punjab, Haryana and Rajasthan) produces about 18 per cent of total cotton production of the country. The present study was purposively conducted in the North Zone of cotton to analyse the comparative economics of cotton along with constraints faced by farmers. The study relies on primary data for the year 2020-21 collected from a sample of 120 farmers by selecting two districts having the highest area under cotton from each state. In the states of north cotton zone, only 36 per cent of farmers use recommended dose of nitrogen and only 7.50 per cent of sampled farmers use recommended dose of phosphorous. In Rajasthan, farmers over utilize potash which results in increase in cost of cultivation and decrease in farm income. Similarly, the farmers of Haryana were found to be the over utilization of nitrogen nutrient in cotton. The human labour cost was the highest in Rajasthan among three sampled states. It was observed that farmers underutilized the labour. Farmers apply more irrigations to crop which results to increase in incidence of crop lodging and reduce farm income. The total variable costs were turned out to be Rs. 60756 per hectare in Haryana, Rs. 65837 per hectare in Rajasthan and Rs. 56269 per hectare in Punjab. Returns over variable costs were the highest in Punjab (Rs. 45175/hectare) as compared to Haryana (Rs. 44893/hectare) and Rajasthan (Rs. 37766/hectare). The average cost for operations at the farm level was found the highest in Rajasthan (Rs. 8802/hectare) followed by Punjab (Rs. 7670/ hectare) and Haryana (Rs. 7532/hectare). In Punjab, it was observed that constraints of price fluctuations, variability in production, long distance marketing access, high transportation cost and contamination in cotton were more severe marketing constraints faced by sampled respondents. In the case of Haryana and Rajasthan, constraints of price fluctuations, variability in production, and inaccurate price according to variety were more severe constraints faced by sampled respondents. Government should ensure the farmers of stable cotton prices with affordable transportation costs and quality check of the cotton produce should also be the factor to be taken care.

Keywords: Analysis, Comparative, Cotton, Cultivation, Economics

INTRODUCTION

Cotton, popularly known as 'White Gold' is a perennial shrub that has been cultivated by man for several thousand years. For many centuries, the cotton plant was known outside India through 'travellers' tales. The famous Greek historian Herodotus wrote about Indian cotton "There are trees which grow wild there, the fruit of which is a wool exceeding in beauty and goodness that of sheep. The Indians make their clothes of this tree wool". India and Africa are the places of origin for the cultivation of cotton crop. The domestication of the cotton crop to obtain fibre for clothing is considered as an initial stride toward its

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commercial use. The cotton is grown across length and breadth of country. The cotton area in the country is mainly divided into three zones i.e., Northern (Punjab, Haryana and Rajasthan), Central (Gujarat, Maharashtra and Madhya Pradesh) and Southern zone (Andhra Pradesh, Tamil Nadu and Karnataka). The cotton belt in the North Zone comprises of Punjab, Haryana and Rajasthan states of India. In irrigated areas of northern zone, cotton is planted from mid-April till last week of May. In the Central and Southern zones, cotton planting is taken up in the months of June and July depending up on the onset of monsoon and continues till August. In Tamil Nadu (Southern zone) planting for summer crop of cotton is taken up in January/ February and for winter in June/July. Harvesting period is mainly confined to the period from October to February throughout the country.

North zone of cotton (Punjab, Haryana and Rajasthan) produces about 18 per cent of total cotton production in the country from about 13 per cent area of country (Govt. of India 2020). During 2019-20, the area under cotton crop in Punjab was 248 thousand ha, production was 1206 thousand bales and the average yield was 827 kg/ha. The major cotton growing districts are Bathinda, Fazilka, Mansa and Sri Muktsar Sahib. These districts cover the 97.4 per cent of area and 98 per cent of production of cotton in the state (Govt. of Punjab 2020). During the same period, area under cotton in Rajasthan was 760 thousand ha, production was 2787 thousand bales with an average yield of 623 kg/ha. Sri Ganganagar, Hanumangarh, Alwar and Nagaur are the major cotton growing districts which account for about 71 per cent of total area 70 per cent of total production of cotton in the state (Govt. of Rajasthan 2020). In Haryana, the area under cotton was 723 thousand ha, production was 2484 thousand bales and the average yield was 584 kg/ha during this period. Hissar, Sirsa, Bhiwani, Fatehabad and Jind are the major cotton producing districts of the state. These districts cover the 80 per cent area and 82 per cent of production of cotton in the state (Govt. of Haryana 2020). Various operations of cotton cultivation are done both manually and mechanically. Cotton production is affected by a variety of factors. Its productivity is influenced by climate conditions, rainfall patterns, insect-pest attack, weed infestation and disease occurrence. Cotton production in the north Indian states had been seriously harmed by pests such as the American ball worm, pink ball worm, white fly, cotton aphids, and others. Cotton crops have been damaged by bollworm and sucking pests for years. Despite the fact that cotton production accounts for only 5 per cent of India's total cultivable land, it consumes over 50 per cent of the insecticides used in the country (Singh *et al.,* 2013*)*. Weeds are also a potential problem in cotton cultivation. Weeds also enhance production costs posing an income risk to the farmers (Frisvold *et al.,* 2009). Weed management did in cotton by three methods i.e. manual weed control, weed control by machine use and by chemical use. There are several production constraints faced by cotton growers. The production constraints are like loss due to insect/pest, loss due to more rainfall, lack of quality seed, lack of good quality inputs, lack of technical knowledge, etc.

MATERIALS AND METHODS

The study pertains to the north cotton zone (Punjab, Haryana and Rajasthan) of India selected purposively. Firstly, two districts having highest area under cotton were selected from each state under study. Then one block was selected randomly from each of the selected district. From each of the selected block, two villages were selected randomly and from each village 10 cotton growers were surveyed. Hence, total 120 respondents was the total sample size. For analysis of sampled data, different statistical tools were used. Simple statistical techniques such as averages, percentages, etc. were carried out.

Ranking of production constraints perceived by respondents: The constraints perceived by the farmers related to cotton production and its marketing were assessed by the 'Agreement Scale'. Several statements were asked regarding these constraints and agreement towards them was marked by the respondents. The agreement scale used was as under: Strongly disagree = 1; Disagree = 2; Neutral = 3; Agree = 4; Strongly agree = 5. Constraint wise analysis was done and mean, standard deviation, 't' value (H_0=3) and 'p' values have been worked out.

RESULTS AND DISCUSSION

Operational land holding: The land on which farmers performs agricultural activities regarding production is known as operational holding, which is defined as, owned land plus leased-in minus leased-

Table 1: Operational land holding of sampled farmers in Punjab, Haryana and Rajasthan, 2020-21 (ha/farm)

Particulars	Irrigated		Unirrigated	Total	Land rent
	Canal	Electric motor and Canal			(Rs./acre)
Punjab					
Owned land	-	4.23	-	4.23	
Leased in	-	0.07	-	0.07	134669
Leased out	-	0.16	-	0.16	128079
Total operational holding	-	4.14	-	4.14	
Haryana					
Owned land	0.47	4.67	0.05	4.19	
Leased in	-	0.04	-	0.04	86485
Leased out	-	0.36	-	0.36	92662
Total operational holding	0.47	4.36	0.05	4.88	
Rajasthan					
Owned land	-	4.83	0.07	4.90	
Leased in	-	0.14	-	0.14	66717
Leased out	-	0.26	-	0.26	76601
Total operational holding	-	4.72	0.07	4.77	
Overall					
Owned land	0.15	4.57	0.04	4.78	
Leased in	-	0.08	-	0.08	95956
Leased out	-	0.26	-	0.26	99114
Total operational holding	0.15	4.40	0.04	4.59	

out land. The results presented in Table 1 showed that average per farm operational holding was highest in Haryana (4.88 ha), followed by Rajasthan (4.77 ha) and Punjab (4.14 ha). The land rent was highest in Punjab and lowest in Rajasthan among all three sampled states. In Punjab, average land rent of leased in and leased out was Rs. 134669 and Rs. 128079 per ha, respectively, whereas in Rajasthan it turns out to be Rs. 66717 and Rs. 76601 per ha, respectively. The average 0.47 ha from sampled farms in Haryana were irrigated with canal water only but in Punjab and Rajasthan there was no land which was irrigated with canal water only. Rajasthan & Haryana had 0.07 ha & 0.05 ha unirrigated land, in Punjab 100% land was under irrigation.

Irrigation: Cotton is a long duration crop and needs 5 to 6 irrigations throughout its life cycle. At overall level 30.83 per cent of famers apply 6 irrigations to cotton crop, followed by 23.33 per cent of farmers apply 4 irrigations to cotton crop (Table 2). Only 1.67 per cent of farmers apply 3 irrigations. At state level in Punjab and Rajasthan highest numbers of farmers apply 6 irrigations, which comprises of 32.50 per cent each. Whereas in Haryana lower number of irrigations applied as compared to Punjab and Rajasthan, as 37.50 per cent of farmers in Haryana apply 5 irrigations to cotton crop. Only in Haryana 5.00 per cent of farmers irrigate cotton only 3 times because brackish water is an issue in some areas of Haryana, so farmers use canal water or combination of canal and tubewell water to irrigate cotton.

Fertilizer application in cotton in North India

Nitrogen: Nitrogen is an important component applied to cotton crop. It is important in fueling growth and providing high yields. It encourages vegetative growth of plant and can increase the number of bolls set by increasing nodes and fruiting positions. In Punjab and Haryana recommended dose of nitrogen was 103.8 kg per ha, whereas in Rajasthan it was 148.3 kg per ha because there was nitrogen loss due to leach down. At

Table 2: Number of irrigations in cotton cultivation by sampled farmers in Punjab, Haryana and Rajasthan, 2020-21 (No. of farmers)

No. of irrigations	Punjab	Haryana	Rajasthan	Overall
3	-	2(5.00)	-	2(1.67)
4	6(15.00)	10(25.00)	12(30.00)	28(23.33)
5	8(20.00)	15(37.50)	4(10.00)	27(22.50)
6	13(32.50)	11(27.50)	13(32.50)	37(30.83)
7	7(17.50)	2(5.00)	8(20.00)	17(14.17)
8	8(20.00)	-	6(15.00)	14(11.67)
Total	40(100.00)	40(100.00)	40(100.00)	120(100.00)

Figures in parentheses indicate percentages to the respective totals

Table 3: Nitrogen application in cotton by sampled farmers in Punjab, Haryana and Rajasthan, 2020-21 (Number of farmers)

Fertilizer application	Punjab	Haryana	Rajasthan	Overall
Nitrogen application				
Less than recommended	2(5.00)	6(15.00)	14(35.00)	22(18.33)
Recommended	10(25.00)	14(35.00)	20(50.00)	44(36.67)
More than recommended	28(70.00)	20(50.00)	6(15.00)	54(45.00)
Total	40(100.00)	40(100.00)	40(100.00)	120(100.00)
Recommended dose (kg/ha)	103.8	103.8	148.3	-
Phosphorous application				
Less than recommended	6(15.00)	1(2.50)	3(7.50)	10(8.33)
Recommended	3(7.50)	3(7.50)	3(7.50)	9(7.50)
More than recommended	31(77.50)	36(90.00)	34(85.00)	101(84.17)
Total	40(100.00)	40(100.00)	40(100.00)	120(100.00)
Recommended dose (kg/ha)	30	30	40	-
Potash application (kg/acre)				
Nil	19(47.50)	20(50.00)	9(22.50)	48(40.00)
12.5-25	-	-	1(2.50)	1(0.83)
25-50	10(25.00)	11(27.50)	14(35.00)	35(29.17)
50-75	2(5.00)	-	13(32.5)	15(12.50)
75-100	9(22.50)	9(22.50)	3(7.50)	21(17.50)
Total	40(100.00)	40(100.00)	40(100.00)	120(100.00)
Zinc application (kg/acre)				
Nil	37(92.50)	40(100.00)	30(75.00)	107(89.16)
<12.5	3(7.50)	-	5(12.50)	8(6.67)
12.5-25	-	-	5(12.50)	5(4.17)
Total	40(100.00)	40(100.00)	40(100.00)	120(100.00)

Figures in parentheses indicate percentages to the respective totals.

overall level 45.00 per cent of sampled farmers applied more than recommended quantity of nitrogen (Table 2). While 39.67 per cent farmers applied recommended dose of nitrogen, whereas 18.33 per cent of farmers applied less than recommended dose of nitrogen. In state wise observations, 50.00 per cent of famers in Rajasthan applied recommended dose of nitrogen, followed by Haryana where 35.00 per cent farmers applied recommended dose, whereas in Punjab only 25.00 per cent of farmers were in same category. Highest number of farmers which use more than recommended dose where in Punjab (70.00%) followed by Haryana and Rajasthan (50.00%) and (15.00%) respectively.

Phosphorous: Application of phosphorous enhances reproductive growth of plant which helpful to increase yield of plant. If phosphorous was applied in *rabi* season, there was no need to apply phosphorous in *kharif* season. But it was observed that at overall level 84.17 per cent sampled farmers apply P_2O_5 more than recommended dose, which causes additional input cost (Table 3). Similar trend was observed in the three states about (90.00), (85.00) and (77.50) per cent of farmers applied phosphate fertilizers in Haryana, Rajasthan and Punjab respectively. Only 8.33 per cent farmers use phosphorous less than recommended dose to crop. In Punjab (15.00), Haryana (2.50) and Rajasthan (7.50%) of sampled farmers use less than recommended dose of phosphorous. If phosphorus didn't apply in *rabi* season than recommended dose of phosphorus in Punjab, Haryana and Rajasthan is 30, 30 and 40 kg/ha respectively, otherwise there is no need to apply phosphorous in *kharif* season. But sampled farmers applied double dose than recommended which increases cultivation cost of farmers.

Potash: At overall level 40.00 per cent farmers don't apply potash to cotton. Similarly in Punjab and Haryana farmers who did not use potash were 47.50 and 50.00 per cent, respectively (Table 3). Rajasthan had highest number of famers (35.0%) who used 25 to 50 kg potash per ha. The recommended dose of potash was based on soil testing.

Zinc: At overall level 89.16 per cent of sampled farmers avoid application of zinc to cotton (Table 3). In Punjab and Rajasthan farmers who did not use zinc were 92.50 and 75.00 per cent respectively, whereas in Haryana 100 per cent of farmers did not use zinc fertilizer. Rajasthan had highest number of farmers (12.5%) using zinc in cotton.

Use of pesticides in cotton: Cotton is prone to several insect pests with potential damage to the crop

Table 4: Pesticide sprays in cotton at sampled farms in Punjab, Haryana and Rajasthan, 2020-21 (Number of farmers)

No. of sprays	Punjab	Haryana	Rajasthan	North zone
1	-	1(2.50)	-	1(0.83)
2	2(5.00)	5(10.00)	3(7.50)	10(8.33)
3	17(42.50)	11(27.50)	24(60.00)	52(43.33)
4	18(45.00)	16(40.00)	13(32.50)	47(39.17)
5	3(7.50)	7(17.50)	-	10(8.34)
Total	40(100.00)	40(100.00)	40(100.00)	120(100.00)

Figures in parentheses indicate percentages to the respective totals

Table 5: Different pesticides applied by sample farmers in Punjab, Haryana and Rajasthan, 2020-21 (No. of farmers)

Name of pesticide	Punjab	Haryana	Rajasthan	Overall
Ulala (Flonicamid 50%)	24(60.00)	22(55.00)	21(52.50)	67.00(55.83)
Actara (Thiamethoxam 25%)	30(75.00)	40(100.00)	24(60.00)	94.00(78.83)
SLR (Diafenthiuron 25% + Pyriproxyfen 5% SE)	17(42.50)	16(40.00)	21(52.50)	54.00(45.00)
Polo (Diafenthiuron 50%)	25(62.50)	22(55.00)	16(40.00)	63.00(52.50)
Rogor (Dimethoate 30% EC)	5(12.50)	-	-	5.00(4.17)
Panama ((Flonicamid 50%)	12(30.00)	11(27.50)	16(40.00)	39.00(32.50)
Monocrotophos	-	5(12.50)	-	5.00(4.17)
Confidor (Imidacloprid)	-	-	6(15.00)	6.00(5.00)
Total sample size	40(100.00)	40(100.00)	40(100.00)	120(100.00)

Figures in parentheses indicate percentages to the respective totals

Table 6: Operation wise human labour use in cotton cultivation in Punjab, Haryana and Rajasthan, 2020-21 (Per ha)

Operations	Punjab		Haryana		Rajasthan		Overall	
	Hours	Cost (Rs)	Hours	Cost (Rs)	Hours	Cost (Rs)	Hours	Cost (Rs)
Rauni (Pre sowing irrigation)	6.65	289	9.98	442	11.69	511	9.44	413
Preparatory tillage	7.96	351	9.41	425	13.79	593	10.38	457
Sowing	3.95	175	3.41	153	9.83	408	5.73	245
Fertilizer application	15.17	680	13.99	638	27.38	1164	18.85	828
Chemical use	21.45	934	22.21	1003	32.32	1386	25.33	1107
Irrigation	71.12	3094	57.62	2681	77.76	3267	68.84	3015
Manual hoeing	177.32	7724	168.97	7551	64.49	7151	136.92	7475
Digging	63.33	2780	62.99	2795	83.59	3482	69.98	3020
Total	367.0	16027	348.58	15688	428.82	17962	381.45	16558

so farmers use several chemicals to control these insect pests. Insecticides and pesticides are widely used in cotton among all three sampled states. From Table 4 it was observed that in Punjab and Haryana highest number of sampled farmers sprayed 4 times which comprises 45.00 and 40.00 per cent, whereas in Rajasthan less application of chemicals, 60.00 per cent sampled farmers sprayed 3 times. In Haryana 2.50 per cent farmers sprayed 1 time, whereas at overall level 43.33 per cent of sampled farmers sprayed 3 times and 39.17 per cent farmers sprayed 4 times. The Table 5 highlighted that Thiamethoxam was highly used protectant in all three sampled state, 78.83 per cent of sampled famers used Thiamethoxam at overall level. In Haryana 100 per cent of sampled farmers used Thiamethoxam followed by Punjab (75.00) and Rajasthan (60.00) respectively. After Thiamethoxam 58.83 per cent farmers used Flonicamid in cotton. Dimethoate used only in Punjab by 12.50 per cent of sampled farmers. Monocrotophos used by 12.50 per cent of sampled farmers in Haryana despite of ban on this chemical.

Operation-wise use of human labour in cotton cultivation: The operation-wise use of human labour for the cotton cultivation in north India is given in Table 6. It excludes the labour used for picking, as the picking rate of cotton is according to the quantity picked. The human labour use was highest in Rajasthan (428.82 hours/ha), followed by Punjab (367 hours/ha) and Haryana (348.58 hours/ha), respectively. At overall level, the maximum human labour was utilized for manual hoeings (136.92 hours/ha) followed by irrigations (68.84 hours/ha), digging (69.98 hours/ha), chemical use (25.33 hours/ha) and fertilizers application (18.85 hours/ha). As a result, the most expensive farm operation was observed to be manual hoeing which costs about Rs. 7475 per ha. The labour cost for fertilizer application was highest in Rajasthan (Rs. 1164/ha) as compared to Punjab (Rs. 680/ha) and Haryana (Rs. 638/ha) because of overuse of fertilizers in state. The labour use for *rauni* (pre sowing irrigation) was highest in Rajasthan (11.69 hours/ha) because of more saturation of water into soil, followed by Haryana (9.98 hours/ha) and Punjab (6.65 hours/ha) respectively.

Tractor usage: Farmers use tractors for different cultural operations such as for field preparation, sowing, hoeing and field cleaning. The cost for different farm operations was highest in Rajasthan due to higher fuel prices. At overall level average cost of operation wise tractor use per ha was Rs. 8046 (Table 7). The average cost for operation wise tractor use (Rs. 8802/ha) were found highest in Rajasthan, followed by Punjab Rs. 7806 per ha whereas in Haryana average cost was Rs. 7532 per ha.

Cost-return structure of cotton cultivation*:* In order to estimate the returns from cotton it is necessary to look into the various costs incurred in cotton cultivation. The expenses on various inputs used in cotton cultivation on sample farms have been given in Table 8. Cotton productivity during the study period was observed lower than preceding year. It has been revealed that at overall level 6.88 per cent of total variable costs constituted expenses on seed which was Rs. 4191 per ha. Seed cost was higher in Punjab (Rs. 4599/ha) as compared to Haryana (Rs. 4272/ha) and

Table 7: Use of tractor in cotton cultivation in Punjab, Haryana and Rajasthan, 2020-21 (Per ha)

Operation	Punjab		Haryana		Rajasthan		Overall	
	Number	Cost (Rs.)	Number	Cost (Rs.)	Number	Cost (Rs.)	Number	Cost (Rs.)
Rauni	0.62	136	-	-	-	-	0.20	44
Disc harrow	4.08	1297	4.57	1455	4.20	1525	4.27	1426
Cultivators	3.68	1179	3.16	1085	3.83	1394	3.56	1218
Planking	3.66	885	4.15	1028	4.08	1134	3.95	1016
Sowing	2.47	677	2.47	689	2.47	778	2.47	717
Hoeing	7.29	2518	7.78	2515	7.22	2856	7.44	2629
Field clearance	2.47	1114	2.47	761	2.47	1114	2.47	996
Total	-	7806	-	7532	-	8802	-	8046

Table 8: Cost-return structure of cotton crop in Punjab, Haryana and Rajasthan, 2020-21 (Rs./ha)

S.No.	Variable costs	Punjab	Haryana	Rajasthan	Overall
1.	Seed	4599(8.15)	4272(6.99)	3704(5.63)	4191(6.88)
2.	Fertilizers	5308(9.41)	5159(8.45)	5743(8.72)	5404(8.87)
3.	Plant protection	5861(10.39)	5313(8.70)	5802(8.81)	5659(9.29)
4.	Irrigations	1334(2.37)	6494(10.63)	8006(12.16)	5278(8.67)
5.	Machine use	7806(13.84)	7779(12.73)	8802(13.37)	8046(13.21)
6.	Human labour (except cotton pickings)	16027(28.41)	15691(25.69)	17962(27.28)	16511(27.11)
7.	Picking cost	13146(23.30)	13961(22.86)	13534(20.56)	13546(22.24)
8.	Transportation and marketing cost	1087(1.93)	1053(1.71)	838(1.27)	993(1.63)
9.	Interest on variable costs @ 9% for half the crop period	1240(2.20)	1344(2.20)	1448(2.20)	1339(2.20)
A.	Total variable costs (1 to 9)	56408(100.00)	61086(100.00)	65837(100.00)	60905(100.00)
	Main product (q)	17.3	18.3	17.8	17.8
	Average price (Rs/q)	5538	5506	5533	5526
	Value of main product (a)	96063	100814	98712	98529
	Value of by product (b)	5382	5164	4893	5147
B.	Gross returns (a+b)	101444	105979	103604	103676
	Returns over variable costs(B-A)	45036	44893	37767	42771

Figures in parentheses indicate percentages to the respective totals

Rajasthan (Rs. 3704/ha). The share of fertilizers at overall was 8.87 per cent of total variable cost while that of plant protection measures was 9.29 per cent. Fertilizer cost was higher in Rajasthan (Rs. 5743/ha) due to overuse of fertilizers. At overall level average machine use cost was Rs. 8046/ha. Rajasthan had highest machine use cost Rs. 8802 per ha, followed by Haryana Rs. 7779 and Punjab Rs. 7806 per ha. The irrigation cost of Punjab was lowest because of free electricity. Irrigation cost of Rajasthan was Rs. 8006 per ha.

Human labour use was major constituent of total variable cost with relative share of 27.11 per cent, human labour cost was higher in Rajasthan (Rs. 17962/ha) as compared to Punjab (Rs. 16027/ha) and Haryana (Rs. 15691/ha). The picking cost was 22.24 per cent of total variable cost, which was Rs. 13546/ha. Picking cost was higher in Haryana (Rs. 13961/ha) as compared to Rajasthan (Rs. 13535/ha) and Punjab (Rs. 13146/ha).

The total variable cost was highest in Rajasthan (Rs. 65837/ha) followed by Haryana (Rs. 61086/ha)

Table 9: Production constraints perceived by cotton growers in Punjab, Haryana and Rajasthan, 2020-21

Production constraints	Mean	S.D.	t value	P value
Punjab				
Unavailability of quality seed	4.30***	0.69	11.97	0.000
Lack of good quality inputs (pesticide/fertilizer etc.)	4.25***	0.63	12.54	0.000
Loss due to insect/pest	4.18***	0.59	12.50	0.000
Variability in productivity	4.08***	0.76	8.89	0.000
Loss due to more rainfall	3.50***	0.68	4.66	0.000
Higher labour cost	3.05^{NS}	0.75	0.42	0.680
Unavailability of labour during lean period	2.90^{NS}	0.78	-0.81	0.421
Lack of skilled labour	2.60***	0.71	-3.57	0.001
Lack of technical knowledge	2.40***	0.78	-4.88	0.000
Haryana				
Lack of good quality inputs (pesticide/fertilizer etc.)	4.20***	0.65	11.70	0.000
Unavailability of quality seed	4.15***	0.98	7.46	0.000
Loss due to insect/pest	4.08***	0.53	12.94	0.000
Variability in productivity	3.90***	0.74	7.65	0.000
Loss due to more rainfall	3.78***	0.68	7.43	0.000
Unavailability of labour during lean period	2.88^{NS}	0.61	-1.30	0.200
Higher labour cost	2.85^{NS}	0.80	-1.18	0.244
Lack of skilled labour	2.65***	0.70	-3.16	0.003
Lack of technical knowledge	2.53***	0.72	-4.20	0.000
Rajasthan				
Lack of good quality inputs (pesticide/fertilizer etc.)	4.28***	0.72	11.27	0.000
Loss due to insect/pest	4.05***	0.78	8.48	0.000
Unavailability of quality seed	3.93***	0.99	5.87	0.000
Variability in productivity	3.83***	0.84	6.18	0.000
Higher labour cost	3.30**	0.82	2.31	0.027
Unavailability of labour during lean period	3.13^{NS}	0.85	0.93	0.36
Lack of technical knowledge	2.85^{NS}	1.00	-0.95	0.349
Lack of skilled labour	2.85^{NS}	0.80	-1.18	0.244
Loss due to more rainfall	2.83^{NS}	1.26	-0.88	0.385

****, ** and *: Statistically significant at 1, 5 and 10 per cent probability level, respectively; S.D. means Standard Deviation*

whereas in Rajasthan (Rs.26644/acre) and Punjab (Rs. 56408/ha). Returns over variable costs were highest in Punjab (Rs. 45036/ha) as compared to Haryana (Rs. 44893/ha) and Rajasthan (Rs. 37767/ha).

Production constraints in cotton cultivation: Constraints are the most significant issues that farmers/producers face on their farms when growing crops in their fields. While conducting the field survey, the type of issues that farmers face in crop production, are highlighted in Table 9. The respondents expressed neutral agreement toward the constraints of higher labour costs and labour unavailability during a lean period in cotton cultivation in Punjab, and the sum was found to be statistically insignificant. The respondents gave a more frequent response to the loss due to insect/pest, loss due to higher rainfall, lack of quality seed, and lack of good quality inputs, variability in productivity and the sum was statistically significant. It was discovered that a lack of technical knowledge was a less common constraint, and the sum was statistically significant. The respondents expressed neutral agreement towards the constraint of a lack of skilled labour, and the sum was statistically significant.

In Haryana, the respondents had a neutral attitude regarding the constraints of increasing labour costs and labour scarcity during a lean phase in cotton farming and the total was statistically insignificant. The respondents gave a more frequent response to the variability in productivity and the sum was statistically significant. The aggregate of the responses to the constraints of loss due to insect/pest, loss owing to additional rainfall, lack of quality seed, and lack of good quality inputs was statistically significant, according to the respondents. The respondents expressed neutral agreement when it came to the constraints of a lack of skilled labour and a lack of technical knowledge, and the aggregate was statistically significant.

In Rajasthan, the respondents expressed neutral agreement toward the constraints of higher labour charges, variability in productivity, lack of technical expertise, loss due to heavier rainfall, lack of skilled labour, and unavailability of labour during a lean period in cotton farming, and the sum was statistically significant. The respondents gave a more frequent response to the constraint of loss due to insect/pest, lack of good quality seed, and lack of good quality inputs and Variability in Productivity and the aggregate was to be statistically significant.

CONCLUSION AND POLICY IMPLICATIONS

During the study it was observed that farmers use less seed in Rajasthan if they increase seed input it will help to increase farm income. It was observed that farmers underutilized labour, it means increase in labour will increase farm income. Farmers apply more irrigations to crop which results to increase in incidence of crop lodging and reduce farm income. According to the agricultural department recommendation potash should apply according to soil testing but in Rajasthan farmers over utilize potash which resulted in increase in cost of cultivation and decrease in farm income. Similarly, the farmers of Haryana were found to be the over utilization of nitrogen nutrient in cotton. Constraints played a major role in analysing the real reason behind lack in efficiency of production and marketing. There are many problems that faced by farmers during marketing of crops. Some of the problems were less severe and others were more severe. In Punjab it was observed during the study that constraints of price fluctuations, variability in production, long distance marketing access, high transportation cost, and contamination in cotton were more severe marketing constraints faced by sampled respondents. In the case of Haryana constraints of price fluctuations, variability in production, and inaccurate price according to variety were more severe constraints faced by sampled respondents. In the case of Rajasthan, constraints of price fluctuations, variability in production, inaccurate price according to variety were more severe constraints faced by sampled respondents. Unavailability of quality inputs, attack of insects/pests, etc. were severe production constraints faced by farmers. These results are in conformity with results of Menasinahal *et al.* (2012) and Gamanagatti *et al.* (2013). To overcome all these constraints, few policies can be implicated for improvement in production of cotton like:

- The supply of quality seed of cotton may be ensured at affordable prices so that the cost of cultivation as well as yield risk could be minimized.
- Extension agencies may create awareness among the cotton growers about the optimum use of plant protection chemicals, fertilizers, etc. which may further help to enhance the cotton productivity.
- Farmers should be made aware to sow refuse plant seeds of cotton.
- The biotic constraints were also prevalent in the study area, so resistant varieties may be developed to increase the area under cotton.
- Problem of lack of quality insecticides/pesticides was observed, so government should interfere in these kinds of frauds so as to make cultivation of crops economical for the farmers.
- The extension staff of the State Departments of Agriculture and State Agricultural Universities of these states may follow an integrated approach in insect/pest management in cotton crop cultivation in northern cotton belt of India.

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Study on Nutrition Sources to Effect on Cropping Behaviour and Quality Attributes of Apricot (*Prunus armanica* L.) Under Rainfed Agro-climatic Conditions

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ABSTRACT

An experiment of On Farm Trial (OFT) was conducted to assess the responses of different combinations of organic sources (FYM and vermicompost) and inorganic fertilizers, during 2019 and 2020 on 12 years apricot trees of "Bebco" cultivar, planted at a distance of 6 × 6 m in Randomized Block Design (RBD) having three treatments with three replications. It has been found that different treatments had a significant effect on growth parameters. Maximum annual shoot growth, trunk girth and tree height (57.20 cm), (82.15 cm) and (5.46 m), respectively was recorded in treatment T_3: $N_{40\%}$ $+VC_{50\%}$ + $FYM_{10\%}$, $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$ + VC $_{40\%}$ + $FYM_{10\%}$). In case of fruit quality and yield parameters, maximum fruit set (65.10%), fruit length (37.87 mm), fruit breadth (39.71 mm), fruit weight (32.75 g), TSS (12.50 ºBrix), TSS/acid ratio (17.60 %), total sugars (11.68%), reducing sugars (5.15%) and minimum titratable acidity (0.71%). and fruit yield (66.27 kg/tree) was observed in treatment T_3: $N_{40\%}$ $+VC_{50\%}$ + $FYM_{10\%}$, $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$ + VC $_{40\%}$ + $FYM_{10\%}$).

Keywords: Apricot, INM, Yield, Quality

INTRODUCTION

Apricot (*Prunus armeniaca* L.) is an important fruit crop of mid-hills and dry temperate regions of India. Cultivated apricot has its origin in North-eastern China, whereas, wild apricot, popularly known as zardalu, appears to be indigenous to India. In India, apricot is mainly grown in the hills of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and to a limited extent in North Eastern hills. In Jammu and Kashmir, it is one of the most important fruit crop in low as well as mid-hills. Among stone fruits, apricot ranks next only to plum and peach in area and production of 5866 ha and 20456 MT, respectively (Anonymous, 2020). Bebco is the commercially accepted cultivar of apricot for the mid-hills of Jammu division of J&K, UT, owing to excellent quality attributes, ripens towards the end of May month, when no other fruit is available in the market and is a source of good income to the orchardists of mid-hill regions. The continuous unbalanced use of chemical fertilizers particularly N, P and K has impaired the soil fertility and decreased the factor productivity. The increasing cost of fertilizers with poor purchasing capacity and their negative effect on soil health has led to intensified attempts to the use of bio-fertilizers and organic matter along with inorganic fertilizers. Integrated nutrient management (INM) is the most efficient and practical way to mobilize all the available, accessible and affordable plant nutrient sources in order to optimize the productivity of the crops and economic return to the farmer. The conjoint application of organic sources along with chemical fertilizers can also play significant role in qualitative and quantitative production of fruits. The judicious combination of inorganic and organic fertilizers may be helpful in increasing the fruit production in apricot. Fertilizers are one of the major inputs accounting for nearly one third of the cost of cultivation and its production consumes a lot of energy used in horticulture. Therefore, keeping in view these

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facts, the present study was conducted in order to study the effect of integrated nutrient sources on growth and yield of apricot.

MATERIALS AND METHODS

The study was carried out by conducted on farm trial (OFT) at different location on apricot in district Poonch for two consecutive years 2019 and 2020. Twelve bearing apricot plants of 12 years of age planted at spacing of 6.0 x 6.0 m were selected in each trial at five different locations and total numbers of plants selected were sixty. The experiment was laid out in Randomized Block Design (RBD) comprised of three treatments having three replications each. The treatments were T_1: Farmers Practice (Urea (500 g) + 10 kg FYM), T_2: Recommended dose (N (735g/tree), DAP (280g/tree), MOP (1080g/ tree) and intervention T_3: $N_{40\%}$ +$VC_{50\%}$ + $FYM_{10\%}$, $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$+VC $_{40\%}$ + $FYM_{10\%}$). Under intervention treatment, to meet out the 100 per cent dose of nutrients through the application of different organic and inorganic resources were (20 kg of Vermicompost and 20 kg of FYM) and remaining was applied by inorganic sources which was calculated on the basis of nutrient content percentage of manures and fertilizers. The recommended dose of fertilizers was given to apricot plants as per the package of practices of SKUAST-Jammu. The chemical fertilizers (SSP and MOP) along with FYM were applied at the mid of December except N (urea) which was applied in two split dozes i.e. first during before flowering and remaining half one month after first application. Vermicompost was used one month after chemical fertilizers application. Observations on growth parameters i.e., annual shoot growth, trunk girth, tree height, fruit set, fruit yield and bio-chemical parameters i.e., TSS, titratable acidity, TSS/acid ratio, total sugars, reducing sugars and non-reducing sugars were recorded. For determination of fruit set (%), four branches from different directions of each tree were tagged, the number of flowers at full bloom were recorded on and the number of fruits at harvest period were recorded, the final fruit set % were calculated by the following equation according to (Westwood, 1993). After harvesting of fruits, both physical and bio-chemical traits of fruit quality were evaluated. For fruit size ten randomly selected fruits from each experimental tree were recorded in terms of length and breadth with the help of digital vernier Calliper. For fruit weight, selected fruits taken for recording the fruit size data were weighed on digital electronic weighing balance and the average fruit weight was expressed in gram per fruit (g/fruit) and TSS was recorded by Erma Hand Refractometer (Tokyo, Japan). Biochemical analysis of fruits for evaluation of quality was done as per standard procedure described by AOAC (1980). The experimental data were analysed as per standard procedures prescribed by Cochran and Cox (1992).

RESULTS AND DISCUSSION

Growth parameters: The integrated nutrient management treatments had a significant on growth parameters viz., annual shoot growth, trunk girth, tree height. Maximum annual shoot growth, trunk girth and tree height (57.20 cm), (82.15 cm) and (5.46 m), respectively was recorded in treatment T_3: $N_{40\%}$ +$VC_{50\%}$ + $FYM_{10\%}$, $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$+VC $_{40\%}$+ $FYM_{10\%}$). Whereas, minimum annual shoot growth, trunk girth and tree height were recorded in treatment T_1: Farmers Practice (Urea (500 g) + 10 kg FYM. These results are in line with the findings of Kumar *et al.* (2019) in their studies on effect of integrated nutrient sources on growth and yield of apricot cv. New Castle.

Table 1: Effect of integrated nutrient management on growth parameters and fruit set in apricot

Treatments	Annual shoot growth (cm)	Trunk girth (cm)	Tree height (m)	Fruit set (%)
T1	45.85	77.83	3.83	48.22
T2	48.45	81.32	4.64	58.28
T3	57.20	82.15	5.46	65.10
CD (P=0.05)	2.58	1.75	0.11	2.24

Table 2: Effect of integrated nutrient management on physical parameters of fruit quality and yield in apricot

Treatments	Fruit length (mm)	Fruit breadth (mm)	Fruit weight (g)	Fruit yield (kg/tree)
T1	25.55	27.07	20.23	35.81
T2	29.56	32.04	25.39	54.75
T3	37.87	39.71	32.75	66.27
CD (P=0.05)	2.55	2.1	3.47	3.30

Table 3: Effect of integrated nutrient management on bio-chemical parameters of fruit quality in apricot

Treatments	TSS (°B)	Titratable acidity (%)	TSS/acid ratio	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
T1	10.17	0.92	11.02	8.22	3.21	5.06
T2	11.30	0.87	12.99	9.55	3.75	5.80
T3	12.50	0.71	17.60	11.68	5.15	6.54
CD (P=0.05)	0.02	0.08	0.09	0.24	0.51	0.31

Fruit quality: The conjoint application of organic and inorganic sources of nutrients on fruit set, fruit size (length, breadth), fruit weight and fruit yield during the present course of study. Maximum fruit set (65.10%), fruit length (37.87 mm), fruit breadth (39.71 mm), fruit weight (32.75 g) and fruit yield (66.27 kg/ tree) was observed in treatment T_3: $N_{40\%}$ +$VC_{50\%}$ + $FYM_{10\%,}$ $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$ + VC $_{40\%}$ + $FYM_{10\%}$). Results of the present experiment are in line with the findings of Sharma *et al.* (2011) in their studies on potential use of bioorganic nutrient source dynamics on cropping behaviour, soil properties and quality attributes of apricot. The similar results are corroborated by Gawandae *et al.* (1988), who recorded significantly higher weight and size of sapota fruits with combined application of inorganic fertilizers + FYM + vermicompost. Similarly, Korwar *et al.* (2005) who recorded higher yield of aonla with 50% inorganic fertilizers + 50% vermicompost and Goswami *et al.* (2015) in guava, also reported significant increase in yield with integrated nutrient management

Bio-chemical parameters: The integrated nutrient management treatments had a significant on fruit TSS, fruit titratable acidity, TSS/acid ratio, total sugars and reducing sugars. The fruits from the trees under the treatment T_3: $N_{40\%}$ +$VC_{50\%}$ + $FYM_{10\%,}$ $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$ + VC $_{40\%}$ + $FYM_{10\%}$). Had maximum TSS (12.50 °Brix), TSS/acid ratio (17.60%), total sugars (11.68%), reducing sugars (5.15%) and minimum titratable acidity (0.71%). These results are in line with the findings of Kumar *et al.* (2019) in their studies on effect of integrated nutrient sources on growth and yield of apricot cv. New Castle and Solanki *et al.* (2020) in their studies on effect of Integrated Nutrient Management on Fruit Yield and Quality of Peach. The improvement in different physico-chemical fruit characteristics of apricot by the application of above nutrient sources in different combinations may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acids, and latter combines with proteins and result in the formation of nucleo proteins which are important constituents of the nuclei of the cells. Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity and also improves the quality of fruits. Nitrogen enhances the uptake of phosphorus and potassium and the nutrient combinations accelerate the metabolic activities of the plant. Nitrogen positively influence the vegetative growth of the plant, manufacturing greater amount of food materials and the same when translocated into the fruit bearing areas leading to enhancement in weight and size of the fruits. The chain reactions in these components might have possibly been reason of the improvement in quality of the fruit.

CONCLUSION

It can be concluded that the application of different integrated nutrient management combination to apricot under rainfed agro-climatic conditions showed that the treatment T_3: $N_{40\%}$ +$VC_{50\%}$ + $FYM_{10\%}$, $P_{50\%}$ + $VC_{45\%}$ + $FYM_{5\%}$ and $K_{50\%}$ + VC $_{40\%}$ + $FYM_{10\%}$) improved fruit quality (both physical and bio-chemical) along with fruit yield in apricot under.

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Use of Plant Extracts in Aquaculture as an Alternative to Chemotherapy: A Review

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ABSTRACT

The fisheries and aquaculture sector significantly expanded in the past few decades, with the total production, trade & consumption reaching an all-time high in 2018 (FAO, 2020). The wide and indiscriminate use of antibiotics in aquaculture has led to the development and spread of antibiotic resistance and residual accumulation in fish tissues. The use of chemotherapy is also regarded unsatisfactory due to limited efficacy with side effects like drug residue. In view of the health risks associated with the rampant use of antibiotics in fish production, there is a growing awareness about the use of safer alternatives to replace them. The increase in aquaculture production by using natural substances in fish feed has been identified as an important area for future developments. Herbal extracts have potential uses in fish culture; as they provide biologically active metabolites that have a variety of beneficial effects such as immune modulation, growth promotion, antioxidant enhancement, antidepressant, digestion enhancement, appetite stimulation, and liver protection. The plant based additives show immunostimulatory effect by up-regulating the expressions of the pro-inûammatory cytokines IL-1β, TNF-β, IL-6, and IFNγ and downgrading the expressions of anti-inûammatory cytokines including IL-1, IL-4, IL-10, IL-11, and IL-13. Many plants as well as their extracts contain phenolic glycosides, polyphenols, flavonoids, alkaloids, quinones, terpenoids, polysaccharides, and tannins or polypeptide compounds. These compounds present in plant extracts have been shown to act at different levels; ranging from their direct effect on aquatic pathogens and intestinal flora, to their impact on nutrient utilization, metabolism, oxidative status, as well as immunology. As such, these compounds are effective alternatives to synthetic compounds and antibiotics. This article aims to review the studies carried out on the use of plant products in aquaculture and their beneficial effect on the fish growth and immunity.

Keywords: Herbs, Medicinal plants, Antibiotics, Immune modulation

INTRODUCTION

The provision of food to human population is one of the major challenges facing humanity, and this has attracted the attention of various nations to increase the aquaculture production. Additionally, high-quality protein derived from aquaculture products has made the aquaculture industry the leading one in the food industry (FAO, 2020). Fish are considered as nutritionally essential part of human diet in various developing countries. They are a vital source of protein, micronutrients and polyunsaturated fatty acids especially EPA & DHA. Aquaculture is regarded as one of the fastest growing food production sectors in the world, which could play a pivotal role in eradicating malnutrition and nutrient deprivation globally. There is an essential need to increase aquaculture production and also to research more on the use of novel feed additives to improve fish growth and survival.

Antibiotics play an important role in the management of infectious diseases in humans, domestic animals, as well as farm-raised fish around the world (Brandt *et al.,* 2015). Due to the overuse, misuse, and poor absorption of antibiotics during treatment, huge amounts of antibiotic residues are being released into the environment, raising serious concerns about impacts on ecological sustainability and health. The un-restricted

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and indiscriminate use of antibiotics in aquaculture led to the development and spread of antibiotic resistance. In view of the health risks associated with the wide use of antibiotics in aquaculture systems, there is a growing awareness about the use of safer alternatives to replace them. The immediate control of fish diseases using only vaccines is impossible (Sakai, 1999). The most effective method is the development of natural disease resistance in fish by the administration of immunostimulants which increase the immuno-competency and disease resistance in fish. Alternative approaches may be developed by focusing on identification of antimicrobial compounds derived from various natural resources. These include active compounds from medicinal plants, marine invertebrates, micro and macro algae, bacteria and fungi.

The increase in aquaculture production by using natural substances in fish feed is considered as an important area for future developments. The natural growth promoters, such as prebiotics, probiotics, enzymes, and plant extracts, can be added in fish feed without causing any adverse impact on their growth. In order to ameliorate the health of fish, at least 60 herbal plants have been studied and implied in aquatic animals (Bulfon *et al.,* 2015). Banerji and Johnson (2006) observed that the use of herbal extract as an additive stimulates haematological and biochemical performance, enhances fish growth, and protects from the diseases. The beneficial properties of plant constituents in fish nutrition may include the stimulation of appetite and feed intake, stimulation of digestion, stimulation of immune response, antibacterial, antiviral, and antioxidant action (Dorman, 2000). Medicinal herbs and their extracts have diverse impact on the growth and performance of fish fauna. They can ameliorate growth and stimulate the immune system when administered in the diet of the fish. In addition, the use of medicinal herbs and their extracts may decrease oxidative stress induced by several stressors during culture and handling. It has been observed that herbs may stimulate the secretion of pancreatic enzymes which are considered important factors in nutrient digestion and assimilation (Frankic *et al.,* 2009).

It has been observed that plant-based additives and herbs may increase the growth and consumption of feed in fish, and reduce the incidence of diseases by regulating the growth of pathogens in the gastrointestinal tract. The use of plants and plant extracts in fish diets has become useful as compared to the classic chemicals, which may have an accumulative effect on fish as well as human health. They can also be used as an attractant to improve feed intake, increase feed utilization, and enhance weight gain (Xiang and Zhou, 2000). The plant-based additives have been widely used in aquaculture and research is being carried out to investigate their suitability in the diets of individual fish species. Platel, *et al.* (2002) observed that medicinal herbs are desirable in stimulating digestion, and have high stimulatory influence on secretion of bile and activity of pancreatic enzymes. Gabor *et al.* (2010) evaluated the effects of various plant based additives like garlic, onion, oregano etc. on growth, health and meat quality of different fish species. It was observed that the phyto-additives represent a better alternative to substitute use of antibiotics in aquaculture.

The World Health Organization has recommended the use of herbs and plants in order to substitute or minimize the use of chemicals through the global trend to *'go back to the nature'*. The attempts to use natural materials including medicinal plants could be widely accepted as feed additives in order to enhance efficiency of feed utilization and animal productive performance.

ANTIBIOTIC USE IN AQUACULTURE

The occurrence of diseases in fish culture caused by various etiological agents has become a limiting factor in aquaculture production. The outbreak of infectious diseases causes significant economic losses in freshwater as well as marine aquaculture systems. Therefore, various farmers and hatchery operators resorted to the use of antibiotics and drugs as a prophylactic measure. Antibiotics are classified as antibacterials, antivirals, antifungals, antiprotozoans, antimetazoans, anaesthetics etc. Most of the fish farms use chloramphenicol, followed by oxytetracycline and erythromycin. These chemicals are used to eliminate the pathogenic microbes as, e.g. chloramphenicol, oxytetracycline and erythromycin for treating the bacterial diseases and, to some extent, parasitical diseases. The amount of antibiotics used in aquaculture worldwide is very difficult to estimate as the various countries involved vary widely with respect to their registration systems; therefore, information is unavailable or impossible to compare due to gaps in the data (Romero *et al.,* 2012). Fish are given antibiotics as a component of their food, and occasionally in baths or injections. Once in the environment, the antibiotics can be ingested by wild fish and other organisms including shellfish.

Antibiotics are designed to inhibit the growth and kill disease causing bacteria. They may act by disrupting the cell membrane, disrupting DNA or protein synthesis or by hampering the enzyme activity. The ability of an antibiotic to arrest the growth of or kill bacteria is dependent upon its mechanism of action and the concentration that the drug attains at the infection site. Many environmental concerns have been associated with the widespread use of antibiotics in aquaculture. Various environmental risks include residue accumulation, aquatic biodiversity toxicity and the emergence of multi-anti-bacterial resistant strains. The continuous use of antibiotics in aquaculture also lead to hazards concerning the health of aquatic organisms as well as the humans consuming the fish or shrimp. The presence of antibiotics in the fish flesh may lead to allergies, toxic effects and change in the microbial fauna (Vignesh *et al.,* 2011). Besides, residual antibiotics may remain in the sediment, exerting selective pressure, thereby altering the composition of the micro-flora of the sediment. There is sufficient evidence to prove that the use of antibiotics may lead to resistance in intestinal bacteria. This resistance may further be transmitted to general population leading to treatment resistance illness.

The unrestricted use of antibiotics in aquaculture in any country has the potential to affect human as well as fish health on a global scale, hence, this problem should be dealt through unified local and global preventive approach. The sustainable development of aquaculture can be achieved by adopting novel strategies to control bacterial and other infections.

IMMUNONUTRITION

The fish health is dependent on what they eat or what they are fed with. An appropriate feed and feeding regime ensures optimum health. Though fish nutrition and fish immunology have existed as separate areas since 1960s, the scientific community developed a binary thinking only during the late 1980s. Apart from the genetic and environmental factors, the nutritional status of the fish is considered as a major aspect that influences the immune responses, modulating the resistance to infection. Appropriate nutrition is critical not only to achieve optimal growth rates but also to maintain the health of cultured fish (Sealey and Gatlin, 2001). The nutrition of fish is a complex and multidimensional factor that interrelates with the immune system, hence fish health, through a broad array of direct or indirect mechanisms (Oliva-Teles, 2012). Nutrients, essential or non-essential, either singly or in combination, directly or indirectly can influence immune functions and fish health.

The teleost immune system is well-developed to operate an efficient defence procedure against unfavourable situations in farms that could be either a stress factor or a pathogen invasion. The endogenous sources of nutrients supply the basic requirements for the immune system to realize its functions as well as to protect tissues from collateral damage. Immunonutrition is aimed to provide the fish with additional resources/molecules that would support one or more of the defence processes, to finally obtain a higher degree of protection. Immunomodulation of the immune system in fish can be achieved using functional feed additives.

PLANT EXTRACTS AND THEIR USE IN AQUACULTURE

The plant extracts have been used for the treatment of fever and aches since ancient Egyptian and Roman times. Plant extracts serve as an important source of bioactive compounds and several important drugs have been isolated and identified from plants. The medicinal herbs are as old as civilization and throughout history, they have been used as popular folk medicine because of their broad-spectrum medicinal properties. There has been a considerable interest in the use of medicinal plants in aquaculture with a view to providing safe and eco-friendly compounds for replacing antibiotics and chemical compounds as well as to enhance immune status and control various fish diseases. The attempt to use them in fish culture is a novel development that got huge attention virtually in every part of the globe, with Asia having the most researched herbs (Bulfon *et al.,* 2013). The herbal medicines have being examined in the field of aquaculture research as an alternative method for disease management and prophylaxis. More than 250 plant species from 75 families and 32 orders, which can be applied orally, through immersion or intraperitoneal injection (Bulfon *et al.,* 2015) have been studied to evaluate their use as growth promoters, for prophylactic and therapeutic control methods, and as immunomodulators (Awad and Awaad, 2017).

Plants and their extracts have been reported to stimulate appetite and promote weight gain, to act as immunostimulant and to have antibacterial and anti-parasitic (virus, protozoans, monogeneans) properties in fish and shellfish aquaculture. This may be attributed to the presence of active molecules such as alkaloids, terpenoids, saponins, polyphenols, glycosides and flavonoids (Reverter, 2014). These secondary metabolites have been selected by plants during evolution to fulfil a chemical defence mechanism or to act as signalling compounds in plant–animal, plant–microbe and plant–plant interactions (Trasvina *et al.,* 2019). The structure of secondary metabolites is believed to interfere in three main areas: in proteins, where they can act as agonists (stimulating receptors) or antagonists (receptor blockers); in DNA and RNA, including related enzymes and regulatory proteins; and in bio-membranes (Wink, 2008).

The garlic supplemented feeds have been shown to prevent *Gyrodactylus* sp. infection in *Oreochromis niloticus* fry (Abd El-Galil and Aboelhadid, 2012). The dietary supplementation of garlic also significantly impedes hatching success, oncomiracidia longevity and infection success of *Neobenedenia* sp. infecting *L. calcarifer* (Militz *et al.,* 2013). Use of garlic and ginger extract also reduced infection with *Gyrodactylus turnbulli* in the guppy *Poecilia reticulata* (Fridman *et al.,* 2014). Similar results have been elucidated by Trasvina *et al.* (2017) who observed that water–ethanol extracts of ginger, basil and bitter chaparro are toxic against the various life stages of the fish ectoparasite *Neobenedenia* species.

Park and Choi (2012) showed that dietary supplemented mistletoe (*Viscum album*) extract elicit non-specific immune response in terms of the respiratory burst activity, lysozyme activity, phagocytic activity in Tilapia. Rao *et al.* (2006) reported that *Achyranthes aspera* in the diet of *L. rohita* increased the non-specific immunity and significantly decreased mortality when the fish were infected with *Aeromonas hydrophilla*. It was observed that *Achyranthes* improves phagocytosis and killing activity by neutrophils and macrophages. Christybapita *et al.* (2007) observed the immunostimulatory effect of aqueous extract of *Eclipta alba* leaf in tilapia *Oreochromis mossambicus*. It was observed that the *E. alba* extract enhances non-specific immune responses and disease resistance of *O. mossambicus* against *Aeromonas hydrophila* infection.

Sharma *et al.* (2010) observed the immunostimulatory effect of dietary doses of *Withania somnifera* (Ashwagandha) root on immunity and disease resistance against *A. hydrophila* infection in *L. rohita* fingerlings. The growth promoting effect and disease resistant properties of *Aloe vera* were observed in gold fish *Carassius auratus* when experimentally challenged with *A. hydrophila* (Ahilan *et al.,* 2010). The oral administration of *Aloe vera* in common carp also enhances specific and nonspecific immune responses. This appears to be achieved primarily by increasing lysozyme activity, serum bactericidal power and the total protein and IgM levels (Alishahi, 2010).

The antiviral activity of plant extract of *Cynodon dactylon* was examined on white spot syndrome virus (WSSV) in black tiger shrimp *Penaeus monodon* by in vivo testing. The results of the study depict that the extract of *C. dactylon* was found to be highly effective in preventing WSSV infection in *P. monodon* with no mortality and no signs of WSD (White spot disease) at 2% inclusion level (Balasubramanian, 2008).

Dietary administration of *Achyranthes aspera* enhanced both specific and non-specific immune response in *Catla catla* (Sahoo and Mukherjee, 1999). This was revealed in terms of higher serum antibody levels, serum anti-proteases as well as high globulin levels in the treated group as compared to the control group.

Logambal and Michael (2000) observed that feeding tilapia with selected doses of chloroform extract of *Nyctanthes arbortristis* seeds significantly enhanced serum lysozyme, alternate complement activities and cellular ROS (reactive oxygen species), RNI (reactive nitrogen intermediate) and MPO production. The supplemented feed significantly reduced mortality in the treated groups as compared to the control.

CONCLUSION

Various natural products including medicinal plants have been known from thousands of years for treating human diseases. A wide range of medicinal plants in the form of herbs, seeds, and spices have been used as immuno-stimulants in aquaculture. They show a marked enhancement in the immune system of fish to prevent and control various diseases (Awad and Awad, 2017). The herbal compounds have the ability to inhibit the generation of oxygen anions and scavenge free radicals, thereby reducing stress effects. The mode of action of medicinal plants includes stimulation of the cellular and humoral immune response. The dietary medicinal plants are also reported to attenuate the harmful effects caused during different aquaculture operations on the fish due to their active bioactive compounds (Samavat *et al.,* 2019). These plants act as growth promoters and immunomodulators at the same time. The herbal supplements are potential immune regulators that are involved in activating the innate immune responses of fish (Reverter *et al.,* 2014). The biological activities of medicinal plants include enhancement of growth and feed utilization, stimulation of the cellular and humoral immune response, gene expression, and increased disease resistance in fish and shellfish. It may be concluded that the plants and their extracts represent a viable alternative to antibiotics and other banned drugs in aquaculture; being safer for the cultured organism as well as for the environment.

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Decision Making Pattern of Farm Women About Input Management in Horticultural Crops Production in Raisen District of Madhya Pradesh

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ABSTRACT

The present study was conducted in Raisen district of Madhya Pradesh during 2020-21 at the school of Agriculture sciences BRAUSS Mhow, M.P. The main objective of the present research was to study the role of decision making pattern of farm women about input management in horticultural crops production. For this study 180 randomly selected farm women were taken as a sample from study area. The study revealed that majority of the farmwomen belonged to medium decision making pattern followed by low and high decision making pattern about horticultural crops production respectively.

Keywords: Farm women, Decision making pattern, Input management and horticultural crops production

INTRODUCTION

Across India, women contribute in land preparation; seed selection and seedling production; sowing; applying manure, fertilizer and pesticides; weeding; transplanting and threshing, winnowing and harvesting. Apart from this, they also engage in important on-farm activities that are not solely cultivation-oriented. Thus women are critical in augmenting family incomes through tasks such as collection of fuel, fodder, drinking water and water for use by household members and domestic animals. Despite the importance of women in agriculture and especially in horticulture crops, they are scarcely recognized as farmers. In social terms, there are all sorts of restrictions that persist to different degrees in different parts of rural India, such as cultural restrictions on women's ability to plough, which in turn affects their ability to use mechanical instruments like tractors. In the field of horticultural crops, women perform a variety of tasks both in cultivation as well as marketing. With the advent of science and technology, the rural society is witnessing unprecedented changes in all spheres of life; Consequently, the members of families involved in horticultural crops cultivation are called upon to make certain adjustment which involve series of decision. In Horticultural crop production, decision making always remained associated with the female. Women utilization relating to various aspects in the study area, yet their involvement in this process has not been recognized. It was evident from vegetable cultivation, the joint decisions by male and female partners of the household are important.

Keeping this in view the present study was undertaken with objective, Role of farm women in decision making pattern about input management of horticultural crops production in Raisen District of Madhya Pradesh.

MATERIALS AND METHODS

The state of Madhya Pradesh is having 52 districts. Out of which one district i.e. Raisen was selected randomly, for the present study. The district beside the area under field crops, significant area comes under the horticultural crops. The Raisen district comprises

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Table 1: Distribution of farm women according to their Role in decision making pattern about Input management of horticultural crops production

S.No.	Practices	Decision making pattern about Input management				Total score	Mean score	Rank
		Self decision	Decision taken with spouse	Decision taken with consultation of family members	Follow the decisions of others			
1	Quantity of seed per hac.	75	62	31	12	380	2.11	II
2.	Farm machinery according to crop	36	82	42	20	314	1.74	VI
3.	Manure and fertilizer combination	61	79	23	17	364	2.02	III
4.	Plant protection measure	29	94	22	35	297	1.65	VII
5.	Weed control	86	52	32	10	394	2.18	I
6.	Irrigation requirement	45	99	21	15	354	1.96	IV
7.	About soil treatment	48	87	31	14	349	1.93	V

of 5 blocks namely Raisen, Sanchi, Bareli badi, Begamganj, Obedullaganj, Udaipura and Silwani. Out of these blocks Sanchi block was selected randomly. The selected Sanchi block comprised with 77 Village Panchayats. Out of the total 77 village panchayats ten (10) were selected randomly for the study. The village panchayat wise list of horticultural crop growers farm women was prepared with the help of Rural Horticulture Extension Officers and farmers friends. Eighteen (18) horticultural crop growers farm women were selected randomly from each selected village panchayats to get a sample of 180 farm women.

RESULTS AND DISCUSSION

It is obvious that any decision taken in strongly influenced by the attitude and opinion of concerned person. In the present study role of farm women in decision making regarding horticultural crops production has been ascertained. Distribution of farm women in respect to their decision making pattern about Input management of horticulture crops production was presented in Table 1.

The result presented in Table 1 reveals mean score regarding different aspects of the decision making about input management of horticultural crops production it was observed as maximum for weed control (2.18) followed by quantity of seed per hac (2.11), manure and fertilizer combination (2.02), Irrigation requirement (1.96), about soil treatment (1.93), farm machinery according to crop (1.74). The decision making pattern about Input management of horticultural crops production mean score was minimum in case of Plant protection measure (1.65).

Table 2: Over all Distribution of farm women according to their Role in decision making pattern about Input management of horticultural crops production

Categories	Frequency	Percentage
Low	54	30.00
Medium	78	43.33
High	48	26.67
Total	180	100

The result presented in Table 2 shows the percentage distribution of respondents according to their decision making about Input management of horticultural crops production. Majority of farm women belonged to medium decision making about Input management of horticultural crops production (43.33%) followed by low (30.00%) and high Input management of horticultural crops production (26.67%). The reason behind medium decision making pattern of farm women related to input management of horticultural crops may be due to lack of technical knowledge and low risk preference. social norms are also can act as barrier in participation in decision making.

CONCLUSION

It was concluded that the role of farm women in decision making pattern about input management of horticultural crops production in study area, majority of farm women belonged to medium decision making about input management of horticultural crops production respectively. It might be due to they had taken joint decision with their spouse either with family members or follow the decisions of others, younger age and less confident to take decisions independently.

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Factors Affecting Post-Harvest Losses in Tomato Crop in Amritsar District of Punjab

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ABSTRACT

Post-harvest losses of vegetables are much more painful and expensive then pre-harvest losses both in terms of money and man hours. The purpose of this study was to examine post-harvest losses of tomato crops at the farmer, wholesaler, and retailer levels in Punjab's Amritsar area over the 2020-21 period. In order to conduct the research, we gathered primary data from 90 farmers, 10 wholesalers and 10 retailers using a variety of sampling methods at each stage of selection of sample. The study found that the majority of large study farmers used the 575 hybrid varieties of tomato rather than Rani. The main cause of damage to the tomato was harvesting loss, followed by grading loss and bruises loss at the farm level, whereas, in the case of wholesaler crush fruit, physical damage, and transportation loss were the damages. Overripe and rotten fruits, as well as damage to the fruits themselves, were the most common problems retailers encountered when selling at the retail level. According to the findings of the cost structure, post-harvest losses were more prevalent among large-scale farmers than among marginal-scale and small-scale farmers, both in absolute terms and monetary terms. Regression analysis showed that area under tomato, annual farm income, and farming experience all have a significant impact on post-harvest loss per acre of tomato crop in the field after harvest. High infestation by fruit borer and occurrence of blight, low prices of potato, and lack of processing facilities are the major problem configurated by the farmers in the study area. The study suggested that to cut down on post-harvest losses, farmers should have access to subsidized deep freezer vans for handling perishable goods, plastic crates for long-distance transportation, FPOs formed to reduce the time between harvest and sale of produce, and resources mobilized by the federal and state governments.

Keywords: Post-harvest, Losses, Tomato, Farmer's level, Loss per acre

INTRODUCTION

In the post-harvest period, both qualitative and quantitative food loss are involved, from harvesting to consumption or other end uses. Every year, an estimated 1.3 billion ton roughly one third of the food produced for the human consumption worldwide is lost or wasted. In developing countries, food losses takes place during the early and middle stage of the supply chain (Hegazy, 2013)

Post-harvest losses in India were estimated to be Rs. 926.51 (USD 15-19 billion) in financial year 2014 representing a significant loss of national wealth (Jha *et al.,* 2015). According to Central Institute of post-harvest engineering and technology, Ludhiana (CIPHET), losses ranged were 4.64 per cent for maize crop, 5.99 per cent for sorghum crop, 4.93 for wheat crop and 5.53 for paddy crop. Post-harvest losses in tomato were 12.44 per cent which was contributed by 9.41 per cent at the level of farm operations and 3.03 per cent in the storage at wholesale, retail and processing levels. In 2012-13 the production of horticulture was Rs. 2,84,000 crore while the losses came about to be 31,500 crores which came about to be 11 per cent (Central Statistical Organization, 2016).

Post-harvest losses of vegetables are much more painful and expensive than pre-harvest losses in terms of money and man hours. The main reasons for post-

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harvest losses are absence of proper storage and marketing facilities, losses caused by mechanical injuries, inadequate storage, inappropriate handling, poor system of the transport and delayed transportation in retail market (Khatum, 2014).

Tomato rank second in global production of all horticultural produce (Arah, 2016). A large amount of tomato is not reaching the consumer particularly due to post harvest losses. Post-harvest losses in tomato can be due to many variables, but in most developing countries, improper handling, packaging, low level of technology, lack of basic equipment's and facilities at collection centers and lack of qualified workers are prevalent (Bhattarai and Gautum, 2012). Tomato has high post-harvest losses due to its high moisture content and high degree of perishability. For increasing 10 per cent yield is not easy as it will need additional land for production but to reduce 10 per cent loss in tomato is easy (Gautam and Bhattarai, 2006). The State like Punjab where Tomato is one of the important vegetables of Punjab after potato, peas and chillies. The problem of post-harvest losses will not reduce the net availability of food but also effect on producer's returns and consumer's prices. On the other hand, few study has been done in Punjab, particularly post-harvest losses in tomato crop in Amritsar district of Punjab on So, the present study is an attempt which tries to fill this literature gap. The present study attempted to analyze the post-harvest losses of tomato crop at farmer's level, wholesaler, retailer level, cost and returns structure of tomato growers, losses in the monetary term, and physical terms. It also find out the various factors affecting losses per acre of tomato crop in Amritsar district of Punjab

MATERIALS AND METHODS

The primary data at farmer's field were collected from Amritsar district of Punjab state through multistage random sampling technique during the crop year 2020-21. At the first stage, one district was purposively selected on the basis of having maximum area under tomato crop. At the second stage, two blocks namely Jandiala Guru and Tarsika was taken on the basis of maximum growing area under tomato crop. At the third stage, two cluster (2-3 villages) from each block were selected randomly It was Chappa Ram Singh and Wadala Johal from Jandiala Guru block and Dheriwala, Khadowal village from Tarsika block, respectively. At the final stage, total of 90 farmers were selected for ultimate study on the basis of probability proportional to the total number of farmers in each farm category. For the selection of farmers, cumulative cube root frequency method was used. In order to study assess the post-harvest losses at wholesale and retail level, 10 wholesalers and 10 retailers were selected from nearby wholesale and retail market. Simple descriptive statistics such as percentages, and averages were used. Regression analysis (Multiple Linear Regression Analysis were used to assess the post-harvest losses at farm level to retail level in study area.

Estimation Procedures

Cost–return estimation procedure: In order to estimate the cost of cultivation of crop, the various inputs purchased from the market were valued at the actual price paid by the farmers and the home-produced inputs like seed and FYM etc. were estimated at the prevailing market prices. The family labour and owned machine used at the farm were assessed the prevailing custom hiring charges during survey period. The interest on the total variable cost was taken @ 7 per cent per annum for half of the crop period. The variable cost included human labour (family + hired) for all the farm operations, machine expenses (owned + hired) for all the farm operations, seed, insecticides & pesticides, fertilizers, irrigation charges, interest on working capital. The gross income of a crop has been estimated by multiplying the production of main product with their respective post-harvest period prices. The return over variable cost has been calculated by deducting total variable cost from the gross income and net income by deducting total cost from the gross income. The loss at farms level in monetary term is calculated by price per qtl with Postharvest losses at farmers level (qtl/acre). The Net Returns without post-harvest losses is the summation of Net returns with post-harvest losses with losses at farm level in monetary terms

Multiple linear regression analysis: Linear regression analysis is a statistical method used to estimate the relationship between one or more independent variables and a single dependent variable. A Multiple Linear Regression method was applied to determine significant factors from potential explanatory variables.

The general form of a multiple linear regression model is given by:

$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon i$

Where Y = Loss per acre of Tomato (LSPA);

X_1= Area under Tomato (in Acres)

X_2= Education level

X_3= Annual Income (in Rs Lakhs)

X_4= Sale Price of Tomato (in Rs/ kg)

X_5= Farming Experience (in Years)

X_6= Covid Restrictions

X_7= Storage Facilities Available

X_8= Labour's Availability

X_9= Distance from the Market (in Km)

β_o is the intercept and $\beta_1, \beta_2 \ldots, \beta_k$ are coefficients of the variable and εi error term

Step-wise multiple linear regression analysis: Stepwise regression is the step-by-step iterative construction of a regression model that involves the selection of independent variables to be used in a final model. It involves adding or removing potential explanatory variables in succession and testing for statistical significance after each iteration.

$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon i$

Where Y = Loss per acre of Tomato (LSPA);

X_1= Area under Tomato (in Acres)

X_2= Annual Income (in Rs Lakhs)

X_3= Farming Experience (in Years)

X_4= Storage Facilities Available

β_o is the intercept and $\beta_1, \beta_2 \ldots, \beta_k$ are coefficients of the variable and εi error term

RESULTS AND DISCUSSION

Varieties-wise description of tomato crop: In Amritsar, there were two hybrid varieties of tomato crop, namely Rani and 575 variety, grown in the study area compared to traditional varieties. In which 58.89 per cent of preferred 575 variety to cultivate on their land and nearly 41 per cent farmers cultivate Rani variety of tomato crop shown in Table 1. The study results also depicted that most of large category farmers i.e., 83.33 per cent preferred to grow 575 variety of tomato crop, followed by medium farmers (63.33%) and small farmers (30.00%) respectively. On the other hand, Rani variety was highly preferred by small category farmers i.e., 70 per cent followed by medium farmers (36.67%) and large farmers with (16.67%). It also conducted that selected study farmers preferred to hybrid varieties instead of organic or traditional varieties. It might due to tomato is the one of highly perishable horticultural crops. It has faced problems, i.e., attack of various pests, insects, and diseases, which damage the fruits and ultimately affect the yield. The producer has also to bear the losses at the time of grading and enroute transportation (Victor, 2014).

Post-harvest Losses at the farm level were mainly caused during harvesting (insect damage and rotten loss), grading and transportation (bruises, damage, loading/unloading loss). Post-harvest losses due to harvesting might due to insects and the rotting of the tomato crop. Transportation loss was incurred due to bruises, crop damage, problem in the handling of crop and loading and unloading of the tomato crop, and problem in marketing. They do not sort out ripe and unripe, ethylene producers from ethylene sensitive products, or odor producers from odor sensitive products. Absence of warehouses for horticultural crops and use of human residence or working room as store were also factors for deterioration of products (Kasso and Bekele, 2016). The estimation of Table 2 depicted that small farmer faced maximum post-harvest losses were due to harvesting loss i.e.,7%) followed by grading loss (4%) and transportation loss (0.6%) shown in Table 2. Among medium and large farmers post-harvest losses were observed more due

Table 1: Variety wise tomato cultivated by the selected farmers, Amritsar district of Punjab

Variety	Small (N_1=30)	Medium (N_2=30)	Large (N_3=30)	Overall ($N_1+N_2+N_3$=90)
575 (Hybrid)	9(30.00)	19(63.33)	25(83.33)	53(58.89)
Rani (Hybrid)	21(70.00)	11(36.67)	5(16.67)	37(41.11)

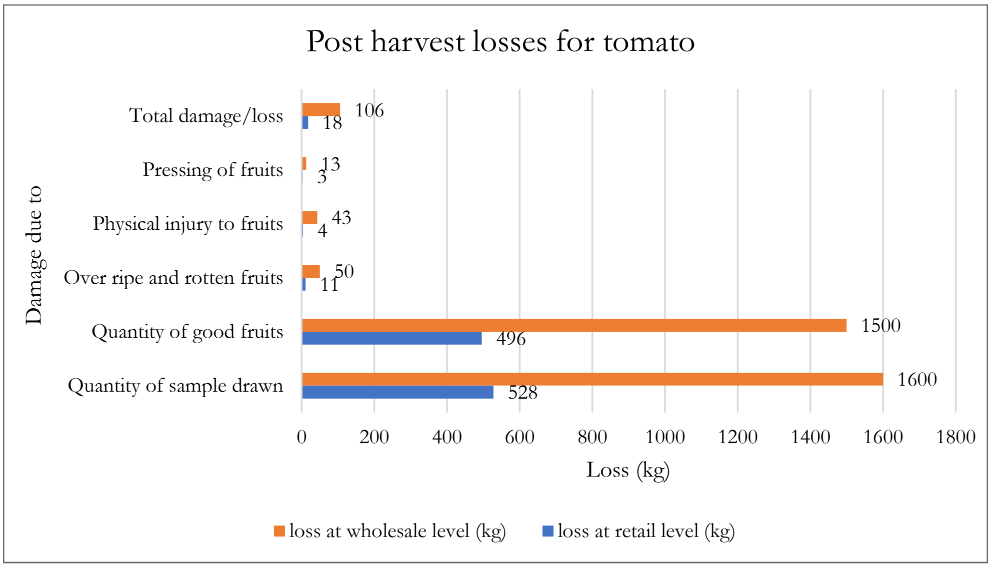
Source: Field survey; Figure in bracket the percentage from total sample size

Table 2: Post-harvest losses of tomato crop at field level, Amritsar district of Punjab (qtl/acre)

S.No.	Particulars	Small (N_1=30)	Medium (N_2=30)	Large (N_3=30)	Overall (N_1+ N_2+ N_3=90)
1	Total production	4943(100)	10770(100)	46615(100)	62328(100)
2	Quantity of good fruits	4372(88.4)	9438(87.6)	40648(87.2)	54458(87.4)
3	Damage due to				
a)	Harvesting loss	346(7)	754(7.2)	3403(7.3)	4503(7.2)
(i)	Insect damaged	193(3.9)	431(4.1)	1911(4.1)	2533(4)
(ii)	Rotten loss	153(3.1)	323(3.1)	1493(3.2)	1969(3.1)
b)	Grading loss	198(2.3)	323(2.6)	1678(2.6)	2199(3.5)
c)	Transportation	30(0.6)	183(1.7)	886(1.9)	1099(1.8)
(i)	Bruises loss	15(0.3)	108(1)	466(1)	589(0.9)
(ii)	Damage loss	5(0.1)	21(0.2)	140(0.3)	166(0.2)
(iii)	Loading/ Unloading loss	10(0.2)	54(0.5)	280(0.6)	344(0.5)
4	Total damage/loss	571(11.6)	1332(12.4)	5967(12.8)	7870(12.6)

Source: Field survey; Figure in bracket the percentage from total production

Figure 1: Post-harvest losses for tomato at wholesale level and retailer in Amritsar district of Punjab



to harvesting loss followed by grading loss and transportation loss.

Overall scenario of Amritsar district revealed that post-harvest losses was found more in case of harvesting loss i.e.,7.2 per cent, followed by grading loss (3.5%) and transportation loss (1.8%). Total post-harvest losses of tomato crop were 11.6 per cent for small farmers, 12.4 per cent for medium farmers and 12.8 per cent for large farmers. Overall post-harvest losses in tomato crop was 12.6 per cent at farmer's level in Amritsar district of Punjab. But these losses were 9.41 at farmers level according to study conducted by ICAR CIPHET. The reason for high post-harvest losses in tomato crop was covid related to restrictions in various operations.

Figure 1 shows that the losses at the time of harvesting, grading, cleaning and due to delay in harvesting ranged between about 8 to 10 per cent across the retail and wholesale markets of Amritsar district of Punjab State. Of the total the post-harvest losses of tomato at wholesale level was 106 kg which was 6.6 per cent of the total quantity of sample drawn. Maximum losses at wholesale level was due to crushing of tomatoes (3.11%), followed by damage due to physical handling of tomatoes (2.67%) and losses due to transportation of tomato (0.89%), respectively. The calculation of the above figure shows that losses at the wholesale level were observed less than the losses at the farmers level. It might be due to the pandemic situation, a lot of problems faced by farm and market level, i.e., unavailability of labour, demand and supply of products, and cash transaction. Similarly, in the case of retailer who is considered the last intermediary of tomato crop marketing in the survey shown in figure 1. On the other hand, at the retailer level faced the over ripe horticulture crop, rotten fruits, physical injury and pressing of the fruits and vegetables. Out of total sample 96.38 per cent were of good quality and 3.41 were wasted. The reason of maximum loss of tomato was due over ripe and rotten tomato i.e., 2.08 per cent, followed by physical injury 0.75 per cent and pressing of the fruits each by 0.56 per cent. These losses were caused due to multiple handling and heaping of tomato for longer period. Tomato production is highly input intensive in nature. It requires higher level of expenditure on labour, fertilizer, plant protection etc. as compared to food grains. The analysis regarding cost and returns would be beneficial for the farmers and policy planners to know about the comparative benefit in tomato cultivation. The returns gap between harvesting and post-harvesting level were studied in Table 3.

The total cost on per acre basis was found to vary between Rs 35703 for small farms to Rs 39409 for the large farms. It may be due to the fact that large farmers are mostly contract farmers and had to incur higher expenses on labour, seedlings and plant protection measures. Amongst variable cost components, the share of human labour was more than 55 per cent. It shows that tomato cultivation is highly labour intensive. The large farmers had to incur higher expenses on human labour as compared to the

Table 3: Monetary loss due to post-harvest losses in tomato crop in Amritsar district of Punjab (Rs. /acre)

Components	Small (N_1=30)	Medium (N_2=30)	Large (N_3=30)	Overall (N_1+ N_2+ N_3=90)
Variable cost components				
Seed/seedlings	2785(6.89)	2625(6.41)	2510(6.10)	2640(6.47)
Manure and Fertilizers	4965(12.29)	4977(12.51)	5003(12.16)	4981(12.20)
Irrigation	1050(2.60)	975(2.38)	937(2.28)	987(2.42)
Plant Protection	2691(6.66)	3107(7.59)	3162(7.69)	3091(7.57)
Labour charges	23000(56.92)	23120(56.45)	23220(56.44)	23113(56.53)
Tractor	4550(11.26)	4767(11.64)	4919(11.96)	4625(11.33)
Interest on working capital*	1366(3.38)	1384(3.38)	1391(3.38)	1380(3.38)
Total Variable cost	40407	40955	41141	40817
Returns components				
Yield (qtl/acre)	177	178	179	178
Price/qtl	430	450	450	443
Gross Returns	76110	80100	80550	78854
Net Returns	35703	39145	39409	38037
Post-harvest losses at farmers level (qtl/acre)				
Post-harvest losses (qtl/acre) (%)	11.6	12.4	12.8	12.1
Yield (qtl/acre)	21	22	23	22
Yield Loss (qtl/acre)	156	156	156	156
Losses in Monetary terms	8875	9932	10310	9538
Gross Returns	67235	70169	70241	69316
Net Returns	26828	29214	29100	28499

Source: Field survey; Figure in bracket the percentage from total variable cost other farm categories. Moreover, the cost of labour employed for tomato cultivation was comparatively higher overall and for all the study categories, as shown in Table 3. It might due to at time covid-19, the supply of labour was less than demand of labour. It would lead to hike their cost of employing labour on farm.Expenses on fertilizer, insecticides and machinery were the other important components of the variable cost. The tomato crop being perishable in nature the insects, post attack is very high and lead to more use of plant protection chemicals thus adding to variable cost of production. The net returns for small farmers was Rs. 35703/acre, Rs. 39145/acre for medium and Rs. 39409/acre for large farmers. The post-harvest losses were calculated as 11.6 per cent for small farmers, 12.4 per cent for medium and 12.8 per cent for large farmers in the study area. The losses in yield of tomato among small farmers was 21 qtl/acre which came out to be Rs. 8875/acre, among medium farmers it was 22 qtl/acre which came out to be Rs. 9932/acre and among large farmers it was 23 qtl/acre which came out to be Rs.10310/acre. Overall in Amritsar district, the losses in yield of tomato came out to be Rs. 9538/ acre.

In order to further identify the chief determinants of the study variable, *i.e.,* Loss per acre of Tomato (LSPA), multiple linear regression analysis was used. The analysis was carried out in two stages: In the first stage, the study variable was regressed upon all the nine explanatory variables. In the second stage, Step-wise regression analysis was carried out, wherein a search was made to identify, in an iterative manner, the group of the explanatory variables which resulted in the highest value of the adjusted coefficient of multiple determination ($\bar{R}^2$), and the least value of the Akaike's Information Criterion (AIC). The analytical results obtained through the two stages are given in Table 4 and Table 5 respectively.

Computed value of the coefficient of multiple determination (R^2) for the multiple linear regression equation was 0.393, which implied that of the total variation in the dependent variable i.e, loss per unit of operational area, nearly 39.3 per cent of the variation was attributable jointly to the nine explanatory variables. (Table 6) Rest of the variation (nearly 60.7 per cent) in loss per unit of operational area was found to be occurring due to other factors, not explicitly known to us. Value of the adjusted (for number of degrees of freedom) coefficient of multiple determination ($\bar{R}^2$) was 0.325; and the value of Akaike's information criterion (AIC) was computed to be 74.831. This could be taken to imply that the nine explanatory variables taken together were capable of explaining the study variable quite precisely. However, in the estimated equation, only three variables (viz., area under tomato, annual income and farming experience) were statistically significant (at varying probability levels), while the other six were non-significant. The intercept term (which absorbs the joint effect of the other unknown factors) was also observed to be highly significant at 1 percent level of significance. The area under tomato was positively significant with post-harvest losses of tomato crop whereas, annual income and farming experience was negatively significant with post-harvest losses in tomato crop.

A number of the superfluous variables (*viz.,* level of education, sale price of tomato, covid restrictions, labour's availability, distance from the market) got filtered out from the regression equation. Thus, the most appropriate combination of the explanatory variables for the purpose of explaining the study variable (loss per unit of operational area) were area under tomato, annual income, farmer's experience and availability of storage facility (Table 4). Out of these four determinants, the first three were tested to be statistically significant, whereas the last one (*i.e.,* storage facilities available) was non-significant. In the simplified equation, the value of R^2 has marginally come down (from 0.393 to 0.377). However, the value of $\bar{R}^2$ has improved from 0.325 to 0.347. The value for was observed to be statistically highly significant (at 0.1% level). Thus, the major determinants of the Loss per Acre of tomato were identified to be: area under tomato, annual income, farmer's experience and availability of storage facility. Nature of the effect of the determinants on the Loss can be interpreted appropriately on the basis of the signs of the corresponding regression coefficients.

From the field, it was found that the farmers faced many problems while cultivating the tomato crop in the field. The overall scenario showed that high infestation by fruit borer and occurrence of blight was the main problem faced by tomato growers (76%)

followed by low price of tomato (70%), lack of processing facilities (68%), poor storage and transportation facilities (58%), poor extension services (52%), high cost of inputs (47%), covid related restrictions (43%), less technical knowledge (37%), shortage of labour (34%) and least was due to spurious quality of pesticides/inputs (26%).

In case small category farmers, high infestation by fruit borer and occurrence of blight (77%), followed by low price of tomato (74%), poor storage and transportation facilities (70%) were responded by most of farmers. While lack of processing facilities, poor extension services, high cost of input, covid related restrictions had comparatively less than other problems. In case of medium farmers, main problem faced by the selected farmers are high infestation by fruit borer and occurrence of blight (74%), followed by low price of tomato (70%), lack of processing facilities (67%), poor storage and transportation facilities (57%), respectively. In the case of large category farmers, high infestation by fruit borer and occurrence of blight

Table 4: Multiple Linear Regression Analysis of Post-harvest losses for tomato in Amritsar district of Punjab

Variables	Loss per acre of tomato (LSPA) in monetary term		
	$\hat{\beta}$	SE ($\hat{\beta}$)	t-value
Intercept	10.7176***	2.3935	4.478
Area under Tomato (in Acres)	0.5437***	0.0912	5.964
Level of Education	-0.0612	0.1046	0.585
Annual Income (in Rs Lakhs)	-0.2753***	0.0451	6.101
Sale Price of Tomato (in Rs/ kg)	-0.4001	0.4507	0.888
Farming Experience (in Years)	-0.3550*	0.1499	2.368
Covid Restrictions	0.0006	0.3346	0.002
Storage Facilities Available	-0.4315	0.3297	1.309
Labour's Availability	-0.2201	0.3337	0.660
Distance from the Market (km)	-0.1247	0.2306	0.541
R^2		0.393***	
$\bar{R}^2$		0.325	
AIC		74.831	

*Note: ***, **, * indicates 1,5 and 10 percent level of significance, respectively.*

Table 5: Step-Wise Multiple Linear Regression Analysis of Post-harvest losses for tomato in Amritsar district of Punjab

Variables	Loss per acre of tomato (LSPA) in monetary term		
	$\hat{\beta}$	SE ($\hat{\beta}$)	t-value
Intercept	8.225***	0.807	10.196
Area under Tomato (in Acres)	0.544***	0.086	6.325
Annual Income (in Rs Lakhs)	-0.282***	0.042	6.678
Farming Experience (in Years)	-0.354***	0.135	2.617
Storage Facilities Available	-0.395	0.315	1.253
R^2		0.377***	
$\bar{R}^2$		0.347	
AIC		67.230	

*Note: ***, **, * indicates 1,5 and 10 percent level of significance, respectively*

Table 6: Problems faced by farmers during production of tomato in Amritsar district (Multiple response)

Problems	Small (N_1=30)	Medium (N_2=30)	Large (N_3=30)	Overall (N_1+ N_2+ N_3=90)
High infestation by fruit borer and occurrence of blight	23(77)	22(74)	23(77)	68(76)
High costs of inputs	15(50)	14(46)	13(43)	42(47)
Shortage of labour	10(33)	11(37)	10(33)	31(34)
Spurious quality of pesticides/inputs	11(37)	9(30)	4(13)	24(26)
Less technical knowledge	12(40)	10(33)	11(37)	33(37)
Covid related restrictions	12(40)	11(37)	16(53)	39(43)
Low price of tomato	22(74)	21(70)	20(67)	63(70)
Poor extension services	18(60)	15(50)	14(46)	47(52)
Poor storage and transportation facilities	21(70)	17(57)	14(47)	52(58)
Lack of processing facilities	18(63)	20(67)	23(76)	61(68)

Source: Field survey; Figure in bracket the percentage from total sample size

(77%) and lack of processing facilities (76%) were the main constraints compared to other constraints. Hence, it concluded that most farmers irrespective of their category faced the problem of high infestation by fruit borer and the occurrence of blight and low prices of potato and lack of processing facilities.

CONCLUSION

Estimation of post-harvest losses and identification of problem faced by farmers are important as it helps in identifying the casual factors and provide ways and means to reduce the losses. These losses occur at all stages, i.e., farmers level, wholesaler level, and retailer level. The present study attempted to analyze the post-harvest losses of tomato crop in Amritsar district of Punjab. The results of study depicted that most of large category farmers preferred the 575 hybrid varieties of tomato as compared to Rani variety by small farmers. The main cause of damage the tomato was harvesting loss followed by grading loss and bruises loss at farm level whereas in case of wholesaler crush fruit followed by physical damaged and transportation loss were the damages. Further in case of retail level over ripe and rotten fruits followed by physical injury to fruits and pressing of fruits were the damaged faced by retailers. The results of cost structure revealed the portion of human labour in total variable cost was more than 55 per cent in all the categories of farmers and overall study farmers. It also showed that post-harvest loss was comparatively higher in large category farmers, followed by marginal category farmers and small category farmers both in real and monetary terms. The step-wise multiple linear regression model results depicted that area under tomato crop, annual income of farmers, and experience in farming are the major factor that significantly impact the post-harvested loss per acre of tomato crop in the field. High infestation by fruit borer and occurrence of blight, low prices of potato, and lack of processing facilities are the major problem configurated by the farmers in the study area. In order to reduce post-harvest losses, the study recommends that farmers be given scientific methods of grading, specialised deep freezer vans for handling perishable commodities on subsidised rates should be provided to them, plastic crates should be used for long-distance transportation to reduce packing losses, FPOs should be formed to reduce the time lag between harvesting and selling produce, and the centre and state should mobilise resources for investment in the supply chain.

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Artificial Intelligence (AI): A New Paradigm for Sustainable Environment and Agriculture

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ABSTRACT

The advent of information and communications technology (ICT) and Internet-of-Things (IoT) has culminated in the fourth industrial revolution (4IR) and ushered in the big data era of artificial intelligence (AI)-enabled precision and personalization via the convergence of physical, biological, and digital technology. The basic concept of AI is to develop a technology which functions like a human brain. This technology is perpetrated by studying how human brain thinks, how humans learn, make decisions, and work while solving a problem, and on this ground intelligent software and systems are developed. These softwares are fed with training data and further these intelligent devices provide us with desired output for every valid input, just like the human brain. AI is game-changing by maximizing objective functions for the optimal outcome. It is constantly evolving as part of the technological evolution of the agricultural industry. It has become one of the most important technologies in every field, including education, banking, robotics, agriculture, etc.

Keywords: Agriculture, Artificial intelligence, Environment, Paradigm, Sustainable

INTRODUCTION

Artificial intelligence, digitization and automation seem to be gaining traction in sectors of fundamental importance for sustainability. The driving forces behind the diffusion of these technologies are the result of both technological advancements, and societal and environmental pressures. On the technological side, leaps forward in predictive analysis through various forms of AI-methods, IoT-systems, satellite technologies, increasing computational capacity, and new developments in robotics industries, have paved the way for new approaches to efficiency, productivity, and decision making under uncertainty. Secondly, demands from society to better manage scarce natural resources and understand the scope and impacts of rapid climate and environmental change have also spurred research and development in this promising field.

According to the Food and Agriculture Organization of the United Nations, the world population will reach over 9 billion by 2050. Rapid population growth, shrinking farmland, dwindling natural resources, erratic climate changes, and shifting market demands are posing challenges towards sustainable food production, thereby pushing the agricultural production system into a new paradigm. Agriculture involves a number of processes and stages, the lion's share of which are manual. By complementing the adopted technologies, AI facilitates the automation of the most complex and routine tasks, while aiding the optimal usage of resources. It can gather and process big data on a digital platform, come up with

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the best course of action, and even initiate that action when combined with other technology. It can help make the whole food production process more efficient and improve the sustainability of agricultural techniques.

AI is an emerging technology in the field of agriculture. AI-based equipment and machines, has taken today's agriculture system to a different level. However, farmers see AI as something that only applies to the digital world. They can't see how it can help them work on the physical earth. This is not because they are conservative or wary of the unknown. Their resistance is due to a lack of understanding of the practical use of AI tools. AI may be useful, there is still much work to be done by technology providers to help farmers implement it properly. We need to devise policy of implementing AI technology such that the new agricultural system must become more productive in output, efficient in operation, resilient to climate change, and sustainable for future generations.

Smart systems can be deployed for farm monitoring, management, husbandry, operation, and surveillance as well as implementing smart contracts with blockchain for automated transactions. They have the advantages of transparency, reliability, efficiency, and cost-saving. Agricultural production is a highly complex supply chain. AI is shifting the way our food is produced, distributed, and consumed. Researchers use AI-powered technologies to provide knowledge and guidance about crop rotation planning, planting times, water and nutrient management, pest management, disease control, optimal harvesting, food marketing, product distribution, food safety, and other agriculture-related tasks in the entire food supply chain.

Farms produce a large number of data points on the ground daily. With the help of AI, farmers can now analyze a variety of drivers in real-time such as weather conditions, temperature, water usage or soil conditions collected from their farm to better inform their decisions. AI technologies enable farmers to take advantage of the data at their fingertips to grow healthy crops while using fewer natural resources.AI-enabled precision farming integrates climate sensors with automated irrigation and fertilizing systems can function efficiently with minimal labor. Utilizing AI is an efficient way to monitor and identify possible crop health issues or nutrient deficiencies in the soil, whereas conventional crop health monitoring methods are labor-intensive and time-consuming. With the help of deep learning, applications are being developed to analyze plant health patterns in agriculture. Such AI-enabled applications are instrumental in understanding better, soil health, plant pests, and plant diseases.AI-based tools leverage site-based science and big data to help farmers and land managers make site-specific decisions. These tools provide early-warning of pest and disease outbreaks and facilitate the selection of sustainable cropland management practices.AI-based image recognition systems have been developed for recognizing specific plant diseases with a high degree of accuracy, potentially paving the way for field-based crop-disease identification using mobile devices, such as smartphones. Various hi-tech computer based systems are designed to determine various important parameters like weed detection, yield detection and crop quality and many other techniques. Satellite and drone imaging also allows field assessment to inform and agrichemical applications and crop productivity measurement for yield prediction.

The latest technologies of automated systems using agricultural robots and drones have made a tremendous contribution in the agro-based sector. Smart sweepers or harvesters are made possible with continuous machine learning based on virtual training with augmented reality for the robots to recognize fruits of different ripening stages from hard-to-reach areas. For large-scale farming, IoT-enabled monitoring of soil and weather conditions permits the automation of farm husbandry. Diverse robotic and drone technologies are available for weeding, fertilizing, seeding, pruning, and harvest in the field.

The digital twin of greenhouses permits real-time monitoring and controls. Speed breeding of crops is made possible with smart greenhouses regulating the photoperiods via LED lightings to shorten the time to flowering and fruiting. Automated vertical farms integrated with aquaculture have been adapted for urban farming to reduce the carbon footprint of transporting fresh produce.

While developing technology to increase food production with efficient farming, the green citizenry should also be cultivated through awareness campaigns to reduce consumptions and food wastes.AI can help reducing wastes with a more efficient supply chain. Automated food delivery to predict daily orders based on consumer big data for ingredient logistics and food waste minimization promotes a more sustainable food system. The impacts will be tremendous when applied to large fast-food chains around the world to optimize resources. Another transformative change is to shift from animal-based to plant-based proteins that will greatly cut the emissions of greenhouse gases (GHG). To change dietary preference, a Chilean company, Not Co, uses an AI algorithm "Giuseppe" to reproduce animal taste and texture based on molecular flavor profiles from hundreds of thousands of plant ingredients to look, cook, blend, and taste just like the animal produce. Such a food-tech disruptor not only can save the environment but also ensure food security for the future.

Artificial Intelligence based technologies have already started to shape agricultural practices in India. Some of the Indian farmers having a large volume of cultivable lands are now getting inclined to adopt smart farming strategies powered by AI enabled sophisticated technologies, autonomous tractors fitted with GPS and various other sensors including digital cameras to plant crops, apply fertilizers, spray pesticides, manage the weeds, determine the need for irrigation, predict the yield etc. in more efficient ways than ever before. ICRISAT headquartered in Hyderabad, India, is collaborating with the software giant Microsoft to enable Indian farmers to harness the power of AI to increase agricultural yields while maintaining environmental sustainability. Tech giant IBM is now providing Indian farmers and its agritechstartups the opportunity to use its weather monitoring tools developed by its subsidiary, The Weather Company, free-of-cost to support smallholders and supply chain-focused startups with decision-making. In the near future, there may not be enough people to put their labour towards harvesting the required enormous volume of food and a robotic solution may hold the key to a sustainable food future that will benefit both the producers and its consumers. Harvest CROO Robotics established a few years back has developed a robot that helps farmers to pick and pack their crops. On the other hand, PEAT, a Berlin-based agricultural tech farm has developed a deep learning based application, called Plantix which is capable of detecting potential defects and nutrient deficiencies in the soil in some efficient way.

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Attitude of the Farmers Towards Greenhouse Technology in Jaipur District of Rajasthan

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ABSTRACT

Agricultural technology is among the most revolutionary and impactful areas of modern technology, driven by the fundamental need for food and for feeding an ever-growing population. The present study was conducted in Jaipur district of Rajasthan. There are total thirteen blocks in Jaipur district of Rajasthan, out of which, four blocks were selected on the basis of maximum number of greenhouse farmers. One hundred four (104) respondents were selected from four blocks with the help of the probability proportionate sampling techniques. The study clearly showed that majority (77.88%) of the respondents had favorable attitude towards greenhouse technology, followed by (17.31%) less favorable and (4.81%) had more favorable attitude towards greenhouse technology, respectively.

Keywords: Attitude, Greenhouse, Technology

INTRODUCTION

Agricultural technology is among the most revolutionary and impactful areas of modern technology, driven by the fundamental need for food and for feeding an ever-growing population. It has opened an era in which powered machinery does the work formerly performed by people and animals (such as oxen and horses). These machines have massively increased farm output and dramatically changed the way people are employed and produce food worldwide. A well-known example of agricultural machinery is the tractor.

Greenhouse (also called a glasshouse, or, if with sufficient heating, a hothouse) is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheds to industrial-sized buildings. A miniature greenhouse is known as a cold frame. The interior of a greenhouse exposed to sunlight becomes significantly warmer than the external ambient temperature, protecting its contents in cold weather. The different types of greenhouses are there based on shape, utility, covering material, construction and cost involved. Higher the capability of the greenhouse to modify the temperature higher will be the cost of construction.

MATERIALS AND METHODS

The present study was conducted in Jaipur district of Rajasthan. Jaipur district is divided in to thirteen blocks *viz.* Amber, Bassi, Chaksu, Dudu, Govindgarh, Jamwaramgarh, Jhotwara, Kotputli, Phagi, Sambhar, Sanganer, Shahpura and Viratnagar. Out of these thirteen blocks four blocks were selected on the basis of maximum number of greenhouse farmers. Selected blocks were visited by investigator and list of the farmers who are adopting greenhouse technology was collected from the horticulture supervisor. Near about eighty per cent respondents were selected from four blocks with the help of the probability proportionate sampling techniques. Thus, 104 respondents were selected for study purpose. To measure the attitude of farmers towards greenhouse technology, scale adopted

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by Smitha (2013) was used with some modifications as per the suggestions of the experts. All the major aspects were included in attitude scale. The scoring procedure for individual positive items in the attitude scale was strongly agree (5), Agree (4), Undecided (3), Disagree (2), strongly disagree (1). The scoring procedure was just reversed for the negative items i.e. 1,2,3,4 and 5. The responses thus obtained from the respondents were counted and converted into Mean and Mean Percent Score.

RESULTS AND DISCUSSION

Attitude of the farmers is very important for the use of any new agricultural technology. If the farmer has positive attitude or positive behaviour about new technology, they can easily adopt greenhouse technology. Here, an attempt has been made to study the attitude of farmers towards greenhouse technology and data in this regard are presented in Table 1. The Table 1, it can be concluded that a majority (77.88%) of the respondents had favorable attitude towards greenhouse technology, followed by (17.31%) less favorable and (4.81%) had highly favorable attitude towards greenhouse technology.

Data presented in the Table 2 reveal that most of the greenhouse farmer were strongly agreed with fact

Table 1: Distribution of respondents according to attitude towards greenhouse technology (n=104)

Attitude categories	F	%
Less favourable (up to 49.16 score)	18	17.31
Favourable (between 49.16 to 56.04 score)	81	77.88
More favourable (above 56.04 score)	5	4.81
Total	104	100

Mean = 52.60, SD = 3.43

that greenhouse technology provides round the year income with MPS 88.46 and ranked first by the respondents. This was followed by greenhouse technology is possible to adopt even for average farmers, it helps in generating high agricultural return, and greenhouse technology is a profitable venture with MPS 87.88, 86.34 and 86.15 assigned rank second, third and fourth respectively.

Table further reveals that greenhouse technology helps to get maximum benefits from a small piece of land, that Greenhouse technology helps to produces quality crop production, it reduces labour cost and small farmer can also earn better from greenhouse technology with MPS 85.96, 85.76, 85.57 and 84.80 have rank fifth, sixth, seventh and eighth respectively. The data of this table also indicates that Greenhouse

Table 2: Aspect wise Attitude of the respondents

S.No.	Attitude statement	MPS	Rank
1	Greenhouse technology is a profitable venture	86.15	IV
2	Greenhouse technology is complicated so it is impractical to adopt (-)	34.61	XI
3	Greenhouse technology is worth to adopt though it is laborious	82.30	X
4	Greenhouse technology is unviable for illiterate farmers (-)	31.34	XVI
5	Greenhouse technology is it reduces labour cost	85.57	VII
6	Greenhouse technology is only possible for rich farmers (-)	31.73	XV
7	Greenhouse technology is possible to adopt even for average farmers	87.88	II
8	Greenhouse technology is difficult to adopt because its operations are tedious (-)	33.84	XII
9	Greenhouse technology provides income	88.46	I
10	Greenhouse technology helps in generating high agricultural return	86.34	III
11	Greenhouse technology helps to get maximum benefits from a small piece of land	85.96	V
12	Greenhouse technology helps to produces quality crop production.	85.76	VI
13	Greenhouse technology is the best substitute for supplement the income	82.88	IX
14	Greenhouse technology does not help to improve social status of farmer (-)	32.30	XIII
15	small farmer can also earn better from greenhouse technology	84.80	VIII
16	Greenhouse is a risk involving technology (-)	31.92	XIV

MPS = Mean per cent score

technology is the best substitute for supplement the income, Greenhouse technology is worth to adopt though it is laborious, Greenhouse technology is complicated so it is impractical to adopt, Greenhouse technology is difficult to adopt because its operations are tedious, Greenhouse technology does not help to improve social status of farmer, Greenhouse is a risk involving technology, Greenhouse technology is only possible for rich farmers, and Greenhouse technology is unviable for illiterate farmers with MPS 82.88, 82.30, 34.61, 33.84 , 32.30, 31.92, 31.73 and 31.34 is very less were ranked ninth, tenth, eleventh, twelfth, thirteen, fourteen, fifteen and sixteen respectively.

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Constraints Perceived by Milk Producers in Adoption of Milk Production Technology of Udaipur District of Rajasthan

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ABSTRACT

Dairying provides livelihood to millions of Indian farmers and generates additional income and employment for a large number of families in the country. The present study was conducted in Udaipur district of Rajasthan. There are total eleven tehsils in Udaipur district, out of which two tehsils namely, Girwa and Salumbar were selected for the present study on the basis of maximum livestock population. Five villages from each tehsil were selected on the basis of maximum number of milk producers. For selection of respondents, 120 milk producers were randomly selected from identified villages (12 from each village) for data collection. The study revealed that majority of respondents (54.17%) fell in medium level of constraint. The study clearly showed that the major constraints perceived by milk producers was inadequate knowledge of technology as followed by high price of cross-bred animals, high cost of construction of animal shed and repeat breeding problem in animals.

Keywords: Milk, Constraint, Adoption, Production, Technology

INTRODUCTION

Dairying provides livelihood to millions of Indian farmers and generates additional income and employment for a large number of families in the country. Dairy industry is the single largest contributor to India's GDP with a significant contribution of 4.11 per cent. With its profound social impact, dairy involves over 80 million small farming households. Milk forms an important constituent of human diet, so the importance of milk in human diet cannot be under estimated in India.

The dairy industry in India is going through major changes with liberalization policies of Government. Indian dairy industry is heading towards an accelerated and positive momentum with unprecedented growth in milk production during last 30 years. India has emerged as the largest producer of milk in the world. This has brought greater participation of the private sector. This is also consistent with global trends which could hopefully lead to greater integration of Indian dairying with the world market for milk and milk products. Dairy farming is an integral component of economic and social life of the rural masses in Rajasthan. It plays a crucial role in shaping the rural economy. Besides, it has potential to fetch cash income on regular basis to meet the social and family requirements of farmers.

In this perspective, the dairy sub sector occupies a very important productive activity in agricultural economy in India as milk is the second largest agricultural commodity contributing to GNP, next only to rice. It is said that crop husbandry is a land resource based enterprise and provides almost seasonal income and employment to the farmers, whereas dairy provides not only employment to the farmer's family during off season but also a regular flow of income all the year round. Therefore, dairy development is recognized as an important activity suitable for employment

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generation and value addition in agricultural sector in Indian economy, in general and for rural families especially small and marginal farmers and landless agricultural labours, in particular.

The dairy industry in India is going through major changes with liberalization policies of Government. Indian dairy industry is heading towards an accelerated and positive momentum with unprecedented growth in milk production during last 30 years. India has emerged as the largest producer of milk in the world. This has brought greater participation of the private sector. This is also consistent with global trends which could hopefully lead to greater integration of Indian dairying with the world market for milk and milk products.

Milk forms an important constituent of human diet, so the importance of milk in human diet cannot be under estimated in India. Milk is one of the important sources of animal protein, calcium and riboflavin, as getting an adequate quantity of animal protein, calcium and riboflavin is difficult solely from plant foods. Hence, it is necessary to include milk in any balanced diet particularly in vegetarian diet.

MATERIALS AND METHODS

The present investigation was conducted purposely in Rajasthan state. Rajasthan is India's largest state by area. It is located on the western side of the country. The present study was conducted in Udaipur district of Southern Rajasthan. Girwa and Salumbar were selected for the present study on the basis of maximum livestock population to draw the sample of village for inclusion in the study. A complete list of all the major milk producing villages of the selected tehsils was prepared in consultation with the personnel of revenue department, patwari, officials of dairy union etc. From the prepared list, five villages from each tehsil were selected on the basis of maximum number of milk producers. Thus, ten villages were selected for the present investigation. Out of the prepared list, 12 farmers were selected from each village on the basis of random sampling technique. Thus, total 120 farmers were selected for investigation.

RESULTS AND DISCUSSION

In the present context, the term constraint means all those barriers or obstacles, which were perceived by the milk producers while adopting the milk production technology. It is needless to mention that the pace of adoption can be augmented by overcoming the perceived constraints. The constraints perceived by the milk producers in adoption of milk production technology were identified and same have been presented in subsequent tables:

To get an overview of constraint level, the respondents were divided into three groups viz., low level constraint (<28.14), medium level constraint (28.14 to 48.35) and high level constraint (>48.35). The groups were formulated on the basis of calculated mean and standard deviation of the constraints scores obtained by the respondents. The results are presented in the Table 1.

The data in Table 1 reveals that out of 120 respondents, majority of respondents (54.17%) fell in medium level of constraint group whereas, 23.33 per cent milk producers were observed in the high level of constraint group and remaining 22.50 per cent respondents possessed low level of constraint about milk production practices.

Analysis of table further reveals that 30.00 and 15.00 per cent respondents were observed in low constraint group in Girwa and Salumbar tehsils, respectively. About 50.00 and 58.33 per cent respondents were observed in medium constraint group in Girwa and

Table 1: Distribution of respondents according to their constraint level in adoption of milk production technology (n = 120)

Constraint Level	Girwa tehsil		Salumbar tehsil		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Low (<28.14)	18	30.00	9	15.00	27	22.50
Medium (28.14 to 48.35)	30	50.00	35	58.33	65	54.17
High (>48.35)	12	20.00	16	26.67	28	23.33
Total	60	100	60	100	120	100

Salumbar tehsils, respectively, while 20.00 and 26.67 per cent respondents were observed in high constraint group in Girwa and Salumbar tehsils, respectively.

For working out constraints perceived by the milk producers in production of milk, in all 22 statements related to constraints in production of milk were considered. The mean per cent score (MPS) was calculated for each statement and rank was assigned accordingly. The results of constraints in production of milk have been presented in Table 2.

It is evident from the data incorporated in Table 2 that inadequate knowledge of technologies was the most severe constraint encountered by majority of the milk producer with MPS 80.00 and was ranked first by milk producers. Besides, high price of cross-bred animals was also a severe constraint perceived by the milk producers with MPS 76.66 and was ranked second by milk producers.

The next most important problem faced by milk producers was high cost of construction of animal shed with 72.77 MPS and was ranked third by the milk producers. Repeat breeding problem in animals was another serious constraint with 71.66 MPS and was ranked fourth by the milk producers followed by low productivity of animals with 69.66 MPS and was ranked fifth by the milk producers. Table further shows that low availability of green and dry fodder with 67.22 MPS was ranked sixth by the milk producers, whereas, the other constraint in descending order of its magnitude was related to high cost of animal feed and mineral mixture with 66.38 MPS and was ranked seventh by the milk producers. Another problem which was faced by the milk producers was low price of milk offered with 62.77 MPS and was ranked eighth by the milk producers.

Table 2 shows that constraint like poor production status of livestock was assigned ninth rank with 59.44

Table 2: Aspect-wise constraints perceived by the milk producers in production of milk (n = 120)

S.No.	Constraints	MPS	Rank
1.	Inadequate knowledge of technology use	80.00	I
2.	No technical assistance or extension services	51.66	XVII
3.	High price of cross-bred animals	76.66	II
4.	High cost of construction of animal shed	72.77	III
5.	Lack of knowledge about cross breeding	53.88	XI
6.	Repeat breeding problem in animals	71.66	IV
7.	Low productivity of animals	69.44	V
8.	Low conception rate through AI	52.79	XIV
9.	Low availability of green and dry fodder	67.22	VI
10.	Non-availability of land for fodder production	53.20	XII
11.	High cost of animal feed and mineral mixture	66.38	VII
12.	Water shortage	46.38	XXI
13.	Low price of milk offered	62.77	VIII
14.	Insufficient veterinary extension functionaries	53.05	XIII
15.	Lack of dairy cooperative society in village	49.72	XX
16.	High incidence of diseases among livestock	52.67	XV
17.	Distant location of veterinary health centre	51.94	XVI
18.	Poor production status of livestock	59.44	IX
19.	Management require more family labour	58.05	X
20.	Inadequate supply of drugs and medicines	50.83	XVIII
21.	High cost of animal disease treatment	50.00	XIX
22.	Non-availability of information booklet	41.11	XXII
	Average	58.71	

MPS = Mean per cent score

MPS by the milk producers followed by constraint like management require more family labour with 58.05 MPS and were ranked tenth by the milk producers. The next important problem faced by the milk producers was lack of knowledge about cross breeding with 53.88 MPS and was ranked eleventh by the milk producers.

Table 2 shows that constraint like non-availability of land for fodder production was assigned twelfth rank with 53.20 MPS by the milk producers followed by constraint about insufficient veterinary extension functionaries with 53.05 MPS and ranked thirteenth. Another problem which was faced by the milk producers was low conception rate through AI with 52.79 MPS and was ranked fourteenth by the milk producers. The next problem faced by the milk producers was high incidence of diseases among livestock with 52.67 MPS and was ranked fifteenth by the milk producers. The constraint about distant location of veterinary health centre was accorded sixteenth rank with 51.94 MPS by the milk producers.

The problem like no technical assistance or extension services was assigned seventeenth rank with 51.66 MPS by the milk producers. This was followed by inadequate supply of drugs and medicines with 50.83 MPS and was ranked eighteenth by the milk producers. The constraints like high cost of animal disease treatment, lack of dairy cooperative society in village and water shortage were considered important constraints by the milk producers with 50.00 MPS, 49.72 MPS and 46.38 MPS, respectively and accordingly ranked at nineteenth, twentieth and twenty first position in the list of constraints faced by milk producers. Analysis of data indicates that constraint about non-availability of information booklet with 41.11 MPS was assigned last rank i.e. 22nd by the milk producers.

CONCLUSION

The study revealed that majority of respondents (54.17%) fell in medium level of constraint group whereas, 23.33 per cent milk producers were observed in the high level of constraint group and remaining 22.50 per cent respondents possessed low level of constraint about milk production technology. Major constraints perceived by milk producers was inadequate knowledge of technology as followed by high price of cross-bred animals, high cost of construction of animal shed and repeat breeding problem in animals. Further, the constraints about high cost of animal disease treatment, lack of dairy cooperative society in village, water shortage and non-availability of information booklet were considered less important constraints perceived by milk producers.

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Availability of ICT Tools for Crop Practices by Farmers of Jaipur District of Rajasthan

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ABSTRACT

Information Communication Technology (ICTs) bridges the gap between extension personnel, agriculture researchers, and farmers thus enhancing agricultural production and quality. The study was conducted in Jobner Panchayat Samiti of Jaipur district of Rajasthan. Out of 22 Panchayat Samities in Jaipur district, the Jobner Panchayat Samiti was selected purposively. Total 4 gram panchayats were selected randomly. Two villages were selected randomly from each selected gram panchayats. Thus a total of 8 villages were selected for study purposes and 15 farmers were selected randomly from each selected village constituting a sample of 120 farmers. The study revealed that the majority of the farmers adjacent (95%) as well as distant (93.3%) farmers were using mobile phones as ICTs tools. The second most used ICT tool was the television. While it was also seen that farmers were using the Internet and WhatsApp also for communicating with others. On the basis of the results, it is concluded that now mobile became a very useful device in urban and rural communities. On behalf of the results, we can say that the Government of India and telecom companies worked very hard and efficiently in the field of the digital world and provided the best facilities to every Indian.

Keywords: Information communication technology, Mobile phone, Farmers, Internet

INTRODUCTION

Information Communication Technology (ICT) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as video conferencing and distance learning. Information and communication technology can be simply defined as an electronic medium for creating, storing, manipulating, receiving and sending information through one place to another. It tempers message delivery faster and convenient, easy to access, understand and decode. ICTs bridge the gap between extension personnel, agriculture researchers and farmers thus enhancing agricultural production and quality.

Poor access to markets and marketing information has made rural farmers vulnerable to exploitation by off takers in the chain. Rural farmers most times don't know the prices of their produces at distant markets. Middlemen also known as off takers visit the farmers at their homes and local markets to purchase their goods. In most cases, farmers negotiate based on the prices proposed by the middlemen. Middlemen con the farmers by taking advantage of their lack of knowledge of market prices, poverty and weak bargaining power arising from illiteracy and low social status. Intermediaries often flout market norms and their pricing lacks transparency. Farmers' markets access is limited by costs (in terms of time and resources), lack of information and poor knowledge of marketing. The use of information and communication technologies (ICTs) is one approach to linking smallholder farmers to markets.

The recent developments of ICTs have completely changed the way people communicate, share information and do their businesses. ICTs have emerged as an important instrument in bridging the information

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gap. ICTs (especially mobile phones) link farmers to markets and provide them with current market information. Based on the information, farmers can perform informed decision-making during selling and when farming. NGOs and farmers' organizations may get involved in linking farmers to markets and in helping them to use current technologies in their farming activities.

Availability of agricultural information and effective use in imperfect markets can be considered as a merit good. It will make market segments more contestable and it will make farmers more eager to develop commercial activities if the information is adapted to their needs. The existence and timely use of reliable information on prices, quality, and supply and market demand conditions contribute to ensuring a better market environment and to balance the capacities of the various actors.

MATERIALS AND METHODS

The study was conducted in Jobner Panchayat Samiti of Jaipur district of Rajasthan. Out of 22 Panchayat Samities in Jaipur district, the Jobner Panchayat Samiti was selected purposively. Total 4 gram panchayats were selected randomly. Two villages were selected randomly from each selected gram panchayats. Thus, a total of 8 villages were selected for study purpose and 15 farmers were selected randomly from each selected village constituting a sample of 120 farmers. It is the degree or the extent to which respondents possesses ICTs for its applications for the use of agriculture and rural development. A scoring of 1 and 0 was given to "Available" and "Not available" respectively.

RESULTS AND DISCUSSION

For finding out of the levels of availability of different ICT tools by the farmers, the farmers were categories in three levels namely low availability, medium availability and high availability of ICT tools by using the arbitrary method. The findings related to this section has been presented in Table 1.

The data in Table 1, indicated that majority of farmers (55.83%) had medium level of availability of ICT tools followed by low availability by 40.83% and high availability by 3.33% ICT using farmers.

The data in Table 1 further indicated that majority of adjacent farmers (55.00%) and distant farmers (56.67%) were having medium level of availability of ICT tools, whereas 40.00 per cent of adjacent farmers and 41.67 per cent of distant farmers were having low level of availability of ICT tools and 5.00 per cent of adjacent farmers and 1.67 per cent of distant farmers were having high level of availability of ICT tools. For measuring the availability of different ICT tools to the farmers the frequency of availability of different ICT tools like radio, television, mobile, internet etc. was calculated along with percentage of farmers using different ICT tools and results are presented in Table 2.

The result presented in Table 2 highlights that majority of farmers had availability of mobile phone (95.00 per cent adjacent and 93.33 per cent distant farmers) followed by the availability of television by 93.33 per cent adjacent and 91.67 per cent by distant farmers. The availability of internet was to 80.00 per cent and 76.67 per cent adjacent and distant farmers, respectively. While 73.33 per cent per cent adjacent and 71.67 per cent distant farmers had access to WhatsApp. So, these were ranked as I, II, III and IV respectively according to their user farmers percentage.

The other availability ICT tools to adjacent and distant farmers were facebook (65.00% and 61.67% respectively) followed by you tube (60.00% and 58.33% respectively) which were ranked as V, VI according to their users percentage. The least availability of ICT tools to adjacent and distant farmers were CD/DVD player

Table 1: Levels of availability of ICT tools to the farmer (n=120)

Levels of availability	Adjacent farmers (n_1=60)		Distant farmers (n_2=60)		Total farmers (n=120)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Low (below 5 score)	24	40.00	25	41.67	49	40.83
Medium (from 5.1 to 10 score)	33	55.00	34	56.67	67	55.83
High (above 10 score)	3	5.00	1	1.67	4	3.33
Total	60	100.00	60	100.00	120	100.00

Table 2: Frequency of farmers according to availability of ICT tools (n=120) (multiple responses)

S.No.	Tools	Adjacent farmers (n_1=60)			Distant farmers (n_2=60)		
		Frequency	Percentage	Rank	Frequency	Percentage	Rank
1	Radio	14	23.33	VIII	17	28.33	VIII
2	Television	56	93.33	II	55	91.67	II
3	Mobile phones	57	95.00	I	56	93.33	I
4	Personal computer/ laptop	5	8.33	XIV	2	3.33	XIV
5	Internet	48	80.00	III	46	76.67	III
6	Whatsapp	44	73.33	IV	43	71.67	IV
7	Facebook	39	65.00	V	37	61.67	V
8	You tube	36	60.00	VI	35	58.33	VI
9	Video conferencing	7	11.67	XI	5	8.33	XI
10	E-mail	10	16.67	X	9	14.00	X
11	Kisan help line	25	41.67	VII	23	38.33	VII
12	E-books, E-magazine, E-newspaper	6	41.67	XII	5	8.32	XII
13	Web portals (internet)	5	8.34	XIII	3	5.00	XIII
14	CD/DVD Player	4	6.67	XV	2	3.32	XV
15	Kiosk of KVKs	11	18.33	IX	9	15.00	IX

(6.67% and 3.32% respectively) followed by personal computer or laptop (8.33% and 3.33% respectively) and ranked as XV, XIV respectively according to percentage of user farmers.

It may be because lack of knowledge about these tools as people were unaware about these tools, that through this they can also get information. Majority of farmers were having mobile phone which may be because of the farmers appreciate mobile phone as easy to handle with fast and convenient way to communicate and get relevant information of their problems. Now a days, the mobile phone has generated an opportunity for the farmers especially to get the information about marketing and weather. The television is also widely seen as it may be because farmers cannot visit to different offices randomly so, with the various television programs through channels like DD Kisan, Kisan TV etc. focused on identifying problems and controlling *i.e.* various crop related pests information, precautions and provide various information, same as radio programs like chaupal, do work provide relevant and update news about market commodity, weather etc., to farmers at ones door step.

CONCLUSION

It concluded that major available ICT tools are mobile phone followed by television to adjacent and distant farmers also, which might be due to the fact that, mobile phone have multipurpose uses gadget so mobile phone is more required in day-to-day life.

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Synergies of Conservation Agriculture as an Effective Strategy in the Plethora of Weed Dynamics

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ABSTRACT

Indian agriculture has made significant progress in terms of productivity increase in the last five decades. However, many challenges remain including stagnating net sown area, reduction in per capita land availability, climate change effects and deterioration of land quality. Therefore, a paradigm shift in farming practices is needed to ensure future productivity gains while sustaining the natural resources. Conservation agriculture (CA) has emerged as an effective strategy to enhance sustainable agriculture worldwide and has the potential to address the problems of natural resource degradation and environmental pollution, while enhancing system productivity. Shift from conventional tillage, where the soil is turned prior to planting to conservation agriculture where tillage is reduced can be particularly difficult with respect to weed control. Hence, weeds are a major constraint in adoption of CA-based technologies. To achieve goals proposed with conservation agriculture, innovative weed control strategies including chemical methods have and will continue to be an essential component in the development of sustainable agricultural practices. Changes in patterns of tillage, planting systems, and other management strategies can alter the soil environment and lead to a major change in weed flora. Herbicide use has been an extremely important component of weed management in CA systems but greater effort is needed to integrate non-chemical weed control tactics with herbicides.

Keywords: Conservation agriculture, Conventional tillage, Crop residue, Weed management

INTRODUCTION

Widespread resource degradation problems under conventional system and the need of reducing production costs, increasing profitability and making agriculture more competitive, have made the conservation issues more imperative. Globally innovations of conservation agriculture-based crop management technologies are said to be more efficient, use less inputs, improve production and income, and address the emerging problems and also availability of new farm machinery, availability of new biocide molecules for efficient weed, insect-pest and disease control, ever-decreasing labour force and ever-increasing labour cost, increasing production costs, energy shortages, erosion losses, pollution hazards and escalating fuel cost and residue burning have accelerated change in thinking of researchers, policymakers and farmers to adopt modified methods for cultivation of crops aimed at improving productivity and resource-use efficiency (Gupta and Seth, 2007).

Conservation Agriculture - a new paradigm in crop production

Adequate food production for increasing global population can only be achieved through the implementation of sustainable growing practices that minimize environmental degradation and preserve resources while maintaining high-yielding profitable systems. Conservation agriculture practices are designed to achieve agricultural sustainability by implementation of sustainable management practices that minimize environmental degradation and conserve resources while maintaining high yielding profitable systems and also improve the biological functions of the agro-ecosystem with limited mechanical practices and

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judicious use of external inputs. It is characterized by three principles. (i) continuous minimum mechanical soil disturbance, (ii) permanent organic soil cover, and (iii) diversification of crop species grown in sequences and/or associations (Bhan and Behera, 2014). A host of benefits can be achieved through employing components of conservation agriculture or conservation tillage, including reduced soil erosion and water runoff, increased productivity through improved soil quality, increased water availability, increased biotic diversity, and reduced labour demands. Conservation agriculture systems require a total paradigm shift from conventional agriculture with regard to management of crops, soil, water, nutrients, weeds, and farm machinery (Sharma and Singh, 2014).

Adoption of conservation agriculture systems and the associated problems

Conservation agriculture systems are being advocated since 1970s but it is only in the last 2 decades that the area has been increasing rapidly. This has been accelerated due to development of efficient farm machinery and availability of effective herbicides coupled with trained manpower, which have resulted in reduced production costs and higher profitability, besides several indirect benefits. Farmers of the developing countries have also initiated to practice some of the conservation agriculture technologies. According to available estimates, the resource conservation technologies are practiced in >3 M ha under the rice-wheat based system in the Indo-Gangetic plains (Mishra *et al.*, 2002). The major CA-based technology being adopted in this region is zero-till (ZT) wheat in the rice-wheat system. Adoption and spread of ZT wheat has been a success story in north-western parts of India due to: (i) reduction in cost of production by 2000-3000 per ha, (ii) enhanced soil quality i.e. soil physical, chemical and biological conditions in the long-term, (iii) enhanced soil organic matter(iv) reduced incidence of weeds such as *Phalaris minor* in wheat (v) enhanced water and nutrient use efficiency (vi) enhanced production and productivity (vii) advanced sowing date (viii) reduced greenhouse gas emission and improved environmental sustainability (ix) avoiding crop residue burning, loss of nutrient, environmental pollution, reduced serious health hazard (x) providing opportunities for crop diversification and intensification (xi) enhanced resource-use efficiency through residue decomposition, soil structural improvement, increased recycling and availability of plant nutrients (xii) surface residues as mulch control weeds, moderate soil temperature, reduce evaporation, and improve biological activity (Sharma and Singh, 2014)

Weeds are the major constraints in CA-based systems. Presence of weed seeds on the upper soil surface due to no tillage operations leads to higher weed infestation in conservation agriculture. Shifts in weed populations from annuals to perennials have been observed in CA systems. Most perennial weeds have the ability to reproduce from several structural organs other than seeds. For example, Bermuda grass (*Cynodon dactylon*), nutsedge (*Cyperus rotundus*) and Johnson grass (*Sorghum halepense*) generally reproduce from underground plant storage structures. Conservation tillage may encourage these perennial reproductive structures by not burying them to depths that are unfavourable to emergence or by failing to uproot and kill them. Weed species shifts and losses in crop yield as a result of increased weed density have been cited as major hurdles to the widespread adoption of CA. Crop yield losses in CA due to weeds may vary depending on weed dynamics and weed intensity. However, the recent development of post-emergence broad-spectrum herbicides provides an opportunity to control weeds in CA. Crop yields can be similar for conventional and conservation tillage systems if weeds are controlled and crop stands are uniform (Mahajan *et al.,*2002).

Weed management under conservation agriculture

Management of weeds is a major issue in agricultural production system, particularly under CA where the infestation is likely to be higher than conventional agriculture (Mahajan *et al.,* 2002). The shift from conventional transplanted to dry direct-seeding in rice with reduced or ZT, typically results in changes in tillage, crop establishment method, irrigation practices, and weed management that influence weed diversity (Kumar *et al.*, 2013). Under ZT-DSR, weed flora often shifts towards more difficult to control and competitive grasses and sedges (Singh *et al.*, 2015). Most of the species are well adapted to establish at or close to the soil surface, where weed seeds in ZT systems typically concentrate (Chauhan and Johnson, 2009). The shift from conventional tillage to zero tillage in wheat has resulted in a shift in weed flora. Emergence of *Phalaris minor* is lower under ZT than CT in wheat (Malik *et al.*, 2002) but higher for some of the broad-leaf weeds, such as *Rumex dentatus* (Chhokar *et al.*, 2007). Weeds like *Ipomoea* spp. which germinate well in shade (Bhullar *et al.*, 2012) could also be a problem in residue based CA systems. In CA, the presence of residue on the soil surface may influence soil temperature and moisture, which may affect weed seed germination and emergence patterns over the growing season. Soil surface residues can interfere with the effectiveness of herbicides, so there is a greater likelihood of weed escapes if residue is not managed properly or herbicide application timings or rates are not adjusted. In the absence of tillage, perennial weeds may also become a more serious challenge in this system.

Opportunities for managing weeds in CA

As the density of some annual and perennial weeds can increase under CA, effective weed control techniques are required to manage weeds successfully (Moyer *et al.*, 1994). Various approaches, including use of preventive measures, crop residue as mulches, intercropping, competitive crop cultivars, herbicide tolerant cultivars, and herbicides are needed to manage weeds in a CA system.

Preventive measures

Preventing invasive and alien weeds in fields is usually easier and less costly than controlling them after severe infestation, as it is difficult to control weeds once they are established. Some weed preventive measures include the use of clean crop seeds, the use of clean agricultural implements and managing weeds on bunds and roads. The aim should be to minimize the area of weed infestation and decrease the dissemination of weed seeds from one area to another or from one crop to another. Hand-rouging weeds before seed shed could be an important tactic in India, where farm size tends to be small. Such a practice would be obviously impractical on large farms.

Stale seedbed

Most of the weed seeds remain in the top soil layer in CA, a flush of weed seedlings appears within a week after irrigation or shower. These weed seedlings can be killed by the application of non selective herbicides such as *glyphosate, paraquat* or *glufosinate*. Stale seedbed significantly reduced weed pressure in ZT (Mahajan *et al.*, 2002). In an ongoing study on DSR in Punjab, stale seedbed reduced weed density by 39%. The fallow period (45-60 days) between wheat harvest and the sowing of rice provides an excellent opportunity to implement stale seedbed for weed management before planting DSR. When stale seedbed practice is used, the crop emerges under weed-free conditions and it will have a competitive advantage over late-emerging weed seedlings. With the limited options available to manage weedy rice in ZT-DSR, the stale seedbed technique is recommended as part of an IWM strategy in many weedy rice-infested areas (Rao *et al.*, 2007).

Intercropping

Intercropping involves growing a smother crop between rows of the main crop such that the competition for water or nutrients does not occur. Intercrops help to effectively pre-empt resources used by weeds, suppress weed growth and hence can be used as an effective weed control strategy in CA. Intercropping of short-duration, quick-growing, and early-maturing legume crops with long-duration and wide-spaced crops leads to quickly ground cover, with higher total weed suppressing ability than sole cropping. This technique enhances weed control by increasing shade and crop competition. Like cover crops, intercrops increase the ecological diversity in a field and compete better with weeds for light, water and nutrients. Success of intercropping relies on the best match between the requirements of the component species for light, water and nutrients, which increases resource use. Many short duration pulses like cowpea, green gram and soybean effectively smother weeds without reducing the yield of the main crop (Table 1). Weed density reduced under intercropping combinations of maize + cowpea over the sole maize crop without losing productivity of the main crop Dubey (2008). Similar observations were also recorded

Table 1: Effect of intercrop on weed density (number/m^2)

Intercropping system	Grassy weeds	Broad leaf weeds	Weed dry matter (g/m^2)
Sole maize	5.3	7.6	6.0
Maize + cowpea	3.6	6.1	4.8

Source: Dubey (2008)

by (Rathi *et al.,* 2007) under a maize + cowpea intercropping system.

Cover cropping

Ground cover with dead or live mulch, allowing less time for weeds to establish during fallow or turn around period is an important component of conservation agriculture technology. Inclusion of cover crops in a rotation between two main crops is a good preventive measure when developing a weed management strategy. Cover crops are fundamental and sustainable tools to manage weeds, optimize the use of natural resources, and reduce water runoff, nutrient leaching and soil erosion. Competition from a strong cover crop can virtually shut down the growth of many annual weeds emerging from seeds. Weed suppression is exerted partly through resource competition for light, nutrients and water during the cover crop growing cycle and partly through physical and chemical effects that occur when cover crop residues are left on the soil surface as dead mulch or ploughed down (Moyer *et al.*, 1994) (Table 2). Weed pressure in conservation agriculture can be reduced by including short-duration legume crops e.g. mungbean, cowpea, green gram, *Sesbania,* etc., during the fallow period between harvesting wheat and planting rice. This practice facilitates emergence of weeds during the legume period and reduces the weed population during the rice season (Kumar *et al.,*2013). In India, *Sesbania* grown as a cover crop produced green biomass up to 30 t ha^{-1} in 60 days and controlled most of the weeds (Mahapatra *et al.,* 2004). Growing green manure or cover crops in the summer season or as a relay crop to efficiently suppress weed growth is a cost and labour efficient practice. Therefore, green manures are sometimes also called the herbicides of small farmers. Perennial grasses such as cogon grass (*Imperata cylindrical* (L.) *P. Beauv.*) and *bermuda grass (Cynodon dactylon* (L.) Pers.), and other problem weeds like *Striga* spp. and Siam weed (*Chromolaena odorata* (L.) can be suppressed by one or two seasons of cover crops. In CA, a number of cover crops, including legumes (alfalfa, Sesbania, sunhemp, clover, soybean, lupin and cowpea) and non-legumes (sunflower, rapeseed, rye, buckwheat and sudan grass) could be exploited to suppress and smother various weeds.

Table 2: Effect of mulching on weed growth

Mulch levels	No. of weeds per m^2		Weed dry weight (g/m^2)	
	1985-86	1986-87	1985-86	1986-87
No mulch	31.8	16.9	17.4	12.7
Trash mulch	25.9	14.0	15.2	12.1

Source: Moyer *et al.* (1994)

Crop rotation

Continuous cultivation of a single crop or crops having similar management practices allows certain weed species to become dominant in the system and, over time, these weed species become hard to control. Rotating crops that have dissimilar life cycles or cultivation practices is an effective cultural practice for disrupting life cycles and improving control of problematic weeds such as *P. minor* (Chhokar *et al.*, 2007) (Table 3). On heavy soils, infestations of wild oats that dominated in the maize-wheat system were completely eliminated by growing rice instead of maize (Gill and Brar, 1975). Diversification and intensification system by growing a short duration vegetable crop (pea or potato) followed by late sown wheat can also improve weed control without increasing herbicide use (Chhokar *et al.*, 2007). By replacing wheat with alternate crops such as berseem, potato, sunflower, oilseed rape for 2-3 years in rice-wheat cropping system, seed bank of *P. minor* was significantly reduced in Punjab (Brar, 2002). Diversified crop rotation can be exploited to improve the management of problematic weeds, because the selection pressure is diversified by changing patterns of weed control tactics.

Chemical weed control

Herbicides are an integral part of weed management in CA. In CA, the diverse weed flora present in the

Table 3: Status of *P. minor* seed bank in different crop rotations in two districts of Punjab

Crop rotation	No. of *P. minor* seeds/kg top soil			
	0-7.5 cm		7.5 - 15.0 cm	
	Kapurthala	Patiala	Kapurthala	Patiala
Rice-wheat	40	30	18	10
Rice-potato+ sunflower	7	0	3	0
Rice-toria	0	0	0	0
Rice-berseem	0	0	0	0

Source: Brar (2002)

field before crop sowing must be killed by using non-selective herbicides. Proper selection of herbicide formulations for CA may be necessary to achieve effective weed control because crop residues may intercept 15 to 80% of the applied herbicides (Chauhan *et al.*, 2012). The rotation of herbicides with different modes of action may be important in avoiding or delaying the evolution of resistance. Herbicide-tolerant crops provide growers in many countries with a useful tool for managing weeds in CA systems. Continuous use of the same herbicide such as glyphosate may result in shifts in weed flora or it may accelerate the development of glyphosate resistance in weeds. Indeed, glyphosate was successfully utilized for over 2 decades before a resistant biotype of rigid ryegrass (*Lolium rigidum*) was identified in Australia in 1996 (Powles *et al.*, 1998). However, since the release of herbicide tolerant crops, several resistant weed biotypes have been reported in glyphosate-tolerant systems in as little as 3 years (Duke and Powles, 2008). Therefore, herbicide tolerant crop cultivars should not be considered as a stand-alone component of weed management. An integrated weed management strategy should be used to ensure that this important weed management tool

Table 4: Influence of crop establishment methods and weed management practices on weed density (No./m^2) of major weed species in DSR

Treament	Density of major weeds species (No./m^2)				
	E. crusgalli	***E. colona***	***C. rotundus***	***C. iria***	***E. alba***
Crop establishment methods					
Conventional	7.3	5.6	4.5	4.5	3.8
Bed planting	6.3	5.4	4.3	4.1	3.5
Zero tillage	6.5	5.8	4.5	4.5	3.6
Weed management practices					
Pendimethalin (1 kg/ha)	7.8	6.1	5.1	4.7	4.0
Bispyribac– sodium (0.025 kg/ha)	7.1	6.1	4.7	4.7	3.7
Brown manuring	7.3	6.4	4.4	4.2	3.5
Pendimethalin + BM	4.2	4.5	4.0	3.5	3.2
Pendimethalin + Bispyribac-Na	5.5	4.7	3.9	3.9	3.3
Pendimethalin + Bispyribac- sodium + BM	4.3	3.3	3.2	3.2	2.7

Source: Duke and Powles (2008)

Table 5: Effect of integrated weed management on weed density and weed dry matter production under different tillage systems

Treatments	Weed density (No./m^2)	Weed dry weight (g/m^2)	Grain yield (t/ha)
Cultural Approaches			
CT(TPR)+ S-CT (wheat)-ZT (greengram)	5.0	5.0	2.34
CT(TPR)+ R+S-CT (wheat)+R-ZT (greengram)+R	4.5	5.8	2.96
ZT(DSR)+ S-ZT (wheat)-ZT (greengram)	3.3	3.4	3.08
ZT(DSR)+ R+S-ZT (wheat)+R-ZT (greengram)+R	4.2	5.4	3.14
CT(TPR)-CT (wheat)	3.9	4.0	3.42
Chemical weed management			
Weedy check	7.3	10.2	2.41
Repetitive use of herbicides	2.4	2.4	3.35
Herbicide rotation	3.5	3.5	3.20

Source: Singh *et al.* (2008)

remains effective, profitable and environmentally sound over a long period of time.

Integrated weed management

Considering the diversity of weed problems in CA systems, no single method of weed control, viz. cultural, mechanical or chemical, provides the desired level of weed control. Therefore, a combination of different weed management strategies should be evaluated to widen the weed control spectrum and efficacy for sustainable crop production. The IWM system is not meant to replace selective, safe and efficient herbicides but is a sound strategy to encourage judicious use of herbicides along with other safe, effective, economical and eco-friendly control measures. The integration of herbicides with intercropping in sugarcane (Bhullar *et al*., 2006) and with nitrogen fertilization in wheat (Bhullar and Walia, 2003) improved weed control than sole cropping or herbicides alone.

CONCLUSION

Conservation agriculture is a complex suite of resource-efficient technologies. It is possible to achieve the same or even higher yields with conservation agriculture compared with conventional tillage. Altering tillage practices changes the depth of weed seeds in the soil, which play a role in weed species shifts and affect the efficacy of control practices. Conservation system causes a shift in weed flora and may result in emergence of perennial weeds like Purple nut sedge, Bermuda grass and Johnson grass in most crops. Restricting tillage also reduces weed control options and increases reliance on herbicides; consequently, evolvement of weed resistance to herbicides has become a serious and escalating problem for many CA farmers worldwide. ZT along with residue has beneficial effects on soil moisture, temperature moderation and weed control. CA is a machine, herbicide and management driven agriculture for its successful adoption. Integrated weed management involving chemical and non-chemical methods (residue, cover crops, varieties etc.) is essential for success of CA systems in the long term.

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To Find Out the Constraints Faced by the Vegetable Growers in Information Utilization Behaviour of Integrated Pest Management Practices in Jaipur District of Rajasthan

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ABSTRACT

Vegetables play a very important role in meeting the nutritional requirements of human beings. The present study was undertaken in Jaipur district of Rajasthan. Chomu and Amber tehsil were selected for the research purpose. Villages in the selected Tehsils were prepared, out of which, eight villages have maximum number of vegetable growers from the two identified Tehsils. From the selected village a sample of 15 respondents were selected randomly from each village. Thus, the total 120 respondents were selected for the study. The findings revealed that correlation between the independent & dependent variables showed that the occupation, education, social participation, annual income, and land holding, were positively and significantly correlated at 0.05 per cent level of probability. However, the variables like age, caste and farming experience had shown non-significant relationship with the utilization of IPM practices by the respondents.

Keywords: Constraints, Information, Utilization behaviour, Independent variables

INTRODUCTION

Indian subcontinent is endowed with salubrious climate, which permits growing of vegetables throughout the year. Vegetable plays an important role in balanced nutrition as they are valuable source of carbohydrates, vitamins, protein and minerals. India is the second largest producer of vegetables in the world, next to China. India produces 184.17 mt of vegetables annually from an area of 10.08 million hectares, with an average productivity of 18.18 t/ha (NHB, 2019-20).

The research phenomena of vegetable are moving very fast which is evident from the present status of vegetable technology, which has emerged, from the researches carried out in the country, resulted in raising the vegetable production to remarkable extent. Despite the rapid development of knowledge, much of the research findings could hardly put into practice. The ultimate practitioners are the vegetable growers. Hence, this knowledge must reach to the vegetable growers to make its optimum application. Farmers respond differently to the different information sources and channels. The action of farmer mainly depends on his exposure to the sources and channels of agriculture information. Previous researches revealed that variability of knowledge acquired through different sources and channels by the farmers accounts for the personnel characteristics like age, education, family back ground and farming experience.

MATERIALS AND METHODS

The present study was undertaken in Jaipur district of Rajasthan. Chomu and Amber tehsil were selected for the research purpose as Chomu and Amber have

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maximum number of vegetable growers in the Jaipur district. Villages in the selected Tehsils were prepared, out of which, eight villages have maximum number of vegetable growers from the two identified Tehsils. From the selected village a sample of 15 respondents were selected randomly from each village. Thus, the total 120 respondents were selected for the study.

To measure the intensity of the constraints as perceived by the respondents, they were asked to express their perception about the different anticipated constraints. The perceived intensity of constraints was quantified by assigning the score using the three-point continuum scale *viz.*, most serious, serious and less serious with a score of 3, 2 and 1, respectively.

RESULTS AND DISCUSSION

In this section, it was tried to find out the constraints in utilization of integrated pest management practices as perceived by the respondents in the study area. Constraints in utilization of IPM practices by the vegetable growers was measured by getting responses of the vegetable growers on three-point continuum namely "Most serious", "Serious" and "Less serious" with weightage of 3, 2 and 1, score, respectively. All the possible constraints faced by the respondents were grouped into four major categories *viz.*, technological, economical, marketing and miscellaneous constraints.

It found that majority of vegetable growers (65.83%) were having medium level of perception of

Table 1: Distribution of vegetable growers according to their level of constraints in utilization of IPM practices (n=120)

Constraints	Frequency	Percentage
Low (Below 33.1 score)	22	18.33
Medium (From 33 to 36.5 score)	79	65.83
High (Above 36.5 score)	19	15.84
Total	120	100.00

Table 2: Distribution of respondents according to their type of constraints in utilization of IPM practices (n=120)

S.No.		Mean per cent Score	Rank
1.	**Technological constraints**		
a.	Lack of knowledge about technical guidance in integrated pest management	66.4	III
b.	Lack of knowledge about weedmanagement practices in integrated pest management	73.3	II
c.	Lack of proper guidance regarding preparation of biopesticide/plant Vitalisers	64.4	V
d.	Lack of knowledge about use ofnatural enemies	65.8	IV
e.	Lack of knowledge about the life cycle of pests and their infection on vegetables	75.5	I
	Overall MPS	**58.38**	
2.	**Economical constraints**		
a.	Lack of finance to purchase biopesticideand plant vitalisers	64.2	III
b.	High cost of labour charges	67.5	IIa
c.	High cost of chemical pesticides	67.5	IIb
d.	Non availability of neem cake at the local level	73.6	I
	Overall MPS	**76.00**	
3.	**Marketing constraints**		
a.	Non availability of Bio-control agents	65.8	IIa
b.	High labour charges for weed control during peak season	65.8	IIb
c.	Inadequate availability of Bio- pesticides in the market	63.8	IV
d.	Lack of market facilities in the local areas	77.8	I
4	**Miscellaneous constraints**		
a.	Lack of timely & appropriate transfer of technology measures by Agri. Deptt. /private agencies	65.6	III
b.	Lack of dedicated and competent extension personnel	61.4	IV
c.	Lack of supply of published information regarding various practices of IPM	67.8	II
d.	Lack of co-ordination between various services and supply of marketing agencies	76.1	I
	Overall MPS	**59.02**	

the constraints followed by low problem in utilization of integrated pest management practices (18.33%). Whereas, 15.84 per cent of vegetable growers having high constraints in utilization of integrated pest management practices (Table 1).

As far as the technological constraints are concerned it was found that lack of knowledge about the life cycle of pests and their infection on vegetables in integrated pest management technology (75.5 MPS) and Lack of proper guidance regarding preparation of biopesticides about the use of integrated pest management (64.4 MPS) was the least serious technological constraints perceived by the total tomato growers (Table 2).

In case of economical constraints, it was reported that non availability of neem cake at the local level (73.6 MPS) and. Lack of finance of purchase of biopesticide and plant vitalisers (64.2 MPS) was the least serious economical constraints perceived by the total vegetable growers.

In case of marketing constraints, it was reported that lack of market facilities in the local areas (77.8 MPS) were the marketing constraints which were perceived with high intensity by vegetable growers in study area. and Inadequate availability of bio pesticides (63.8 MPS) was the least serious marketing constraints perceived by the total vegetable growers.

In case of miscellaneous constraints, it was reported that lack of co-ordination between various services, supply of marketing agencies (76.1 MPS) were the miscellaneous constraints which were perceived with high intensity by vegetable growers in study area. and lack of dedicated and competent extension personnel integrated pest management (61.4 MPS) was the least serious miscellaneous constraints perceived by the total vegetable growers.

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Standardization of Methods and Timing of Budding on Pecan Nut (*Carya illinoensis* W.) Under Intermediate Agro-Climatic Conditions

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ABSTRACT

An experiment was conducted to standardize the methods and time of budding on pecan nut (*Carya illinoensis* W.) at research farm of KVK Poonch, SKUAST-Jammu during 2020-21. Two budding methods viz., Patch budding and Ring budding with three different timings, viz., 4th week of June, 2nd week of July and 1st week of August were employed. The experiment was laid out in Randomized block design (RBD) with three replications. The results indicated that among all the budding methods, Patch budding performed during 1st week of August showed highest budding success (66.33) and maximum survival percentage (41.00), maximum shoot length (15.23), number of leaves (9.63), leaflets (17.00) and leaf area (176.67cm^2). Hence the budding performed during 1st week of August showed better performance as compared to other dates of budding.

Keywords: Pecan Nut, Budding methods, Time of propagation

INTRODUCTION

The pecan (*Carya illinoensis* Wangenh) belonging to family Juglandaceae was originated from the south east of USA. It is considered as the "queen of nuts" in USA because of its value both as wild and cultivated nut (Woodroof, 1979). Pecan nuts have high nutritional and calorific value. Pecans are good source of protein and unsaturated fats like walnuts, pecans are rich in omega-6 fatty acids, although pecans contain about half as much omega-6 fatty acids as in walnuts. The antioxidants and plant sterols found in pecans reduce high cholesterol by reducing the "bad" cholesterol (low-density lipoproteins) levels. The seeds of the pecan are edible, with a rich buttery flavor and vary widely in size, shape and shell thickness which are commonly used to add aroma, flavour, crispness, meatiness, tenderness, a rich colour. Pecan nuts vary widely in size, shape, and shell thickness. Pecans grown from seed are not true to type. Seedling pecan trees often produce small, thick-shelled nuts while trees budded to improved cultivars produce large, thin-shelled nuts. This means that a nut produced by a given variety will not, when planted, produce a tree identical to the parent. In fact, each seedling tree is unique and will have extremely variable nut quality. Therefore, in order to propagate a tree of a given variety, buds or shoots from the parent tree must be grafted onto a seedling rootstock. Pecan nut is the one of the most important temperate nuts grown in India. In India, it is mainly grown in Jammu and Kashmir, and Himachal Pradesh. In Jammu and Kashmir UT, pecan nut is being successfully grown in Poonch, Rajouri, Udhampur, Kathua, Reasi, Doda, Kishtwar and Ramban districts of Jammu region. The total area under pecan nut production is increasing due its high economic returns and adaptation to intermediate zone of Jammu and Kashmir, UT of India. Woody tree seed often does not breed true due to uncontrolled pollination and favourable characteristics of the parent tree cannot be reliably transferred via seed. However, by grafting a

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scion of known production quality onto a rootstock with known features, the identical tree can be reproduced with ensured fruit quality (Onay, 2000). A variety of budding methods are used in commercial orchard nurseries. The most common budding techniques in pecan are patch and ring budding which are used when trunk diameter of rootstock arranged between of 4-6 cm. The main constraints in commercialization of this crop in J&K include non-availability of standardized techniques of vegetative propagation, non-availability of quality plant material and late fruit bearing. The sexually reproduced plants come to bearing in 11-12 years in comparison to vegetative propagated plants which come into bearing in 4-6 years. Most plantations of pecan nuts are of seedling origin in scattered form and produce nuts of variable quality. Pecan nut cultivation suffers from lack of suitable methods of propagation, inadequate vegetatively propagated plants, lack of standard rootstocks and cultivars, problems of re-establishment of nursery plants in the orchard, pollination behaviour, and lack of suitable pollinizers, long juvenile period and lack of appropriate harvesting techniques. Therefore, standardization of methods and timing of propagation (budding) is very important to get the highest success and good plant growth. Keeping in view the importance of time and method of budding, this study was initiated to find out the most appropriate method and time of budding for pecan nut.

MATERIALS AND METHODS

The present investigation entitled "Standardization of methods and timing of budding on pecan (Carya illinoensis) under intermediate agro-climatic conditions was carried out at research farm of KVK Poonch, SKUAST-Jammu during 2020-21. Poonch is classified as warm and temperate zone at an altitude of 33.38° North and longitude of 74.3° East. The altitude of the place is 915 m above mean sea level. Summers are short and pleasant. The experiment was carried out with different budding methods, viz. patch budding and ring budding with different timing, viz. 3rd week of June, 2nd week of July and 1st week of August. The experiment was laid in a Randomized Block Design (RBD) with three replications (where in10 budded plants constitute one replication of a treatment). The seedling rootstocks of 1-1.5 cm thickness were utilized for the purpose Generally 4 inch portion of the root stock from the ground surface was kept clean and smooth for performing budding. Healthy bud sticks of uniform growth from previous season shoot were selected for budding purposes. The observations were recorded on bud bursting/leafing out, average shoot length, number of leaves/shoot, leaf area/ shoot, survival (%) and budding success (%) and the data was analyzed using the statistical programme SPSS.

RESULTS AND DISCUSSION

It is evident from the data in Table 1, that the minimum number of days (21.00) to bud burst taken in patch budding when performed during 2nd week of July followed by 25.00 days in 1st week of August. The significant superiority of patch budding over the ring budding performed in other timing might be due to rapid sap flow in stock and scion favourable for the higher bud sprouting.

Different methods and timing of budding had a significant influence on the shoot growth of budded plants. The shoot length of the plants was maximum in patch budded (15.23 cm) plants and minimum in ring budded (9.23 cm) plants. The minimum shoot

Table 1: Effect of methods and timing of budding in days taken to bud burst, grafting success (%), Survival (%) in Pecan Nut

Methods of budding	Time of budding	Days taken to bud burst	Budding success (%)	Survival (%)
Patch budding	3rd week of June	28.00	61.36	35.66
Patch budding	2nd week of July	21.00	62.33	37.63
Patch budding	1st week of August	25.00	66.33	41.00
Ring budding	3rd week of June	26.66	53.34	32.66
Ring budding	2nd week of July	22.00	56.45	34.00
Ring budding	1st week of August	24.00	58.12	35.00
CD at 0.05%		1.06	2.95	1.04

Table 2: Effect of methods and timing of budding on shoot length, number of leaves, number of leaflets and leaf area in Pecan Nut

Methods of budding	Time of budding	Shoot length (cm)	Number of leaves	Number of leaflets	Leaf area (cm^2)
Patch budding	3rd week of June	11.14	7.66	11.66	151.67
Patch budding	2nd week of July	12.47	8.66	14.33	159.67
Patch budding	1st week of August	15.23	9.66	17.00	176.67
Ring budding	3rd week of June	7.80	4.66	7.00	142.00
Ring budding	2nd week of July	8.12	5.35	8.33	146.00
Ring budding	1st week of August	9.83	5.66	8.66	155.67
CD at 0.05%		1.05	1.07	1.09	1.08

growth (7.80 and 8.12 cm) was recorded in ring budding performed during 3rd week of June and 2nd week of July, respectively. These findings are in conformity with the findings of Chandel and Ananda (2002). Maximum growth of patch budded plants might be attributed to better graft union due to better contact of cambial layers of stock and scion, early completion of bud sprouting and initiation of subsequent growth. Maximum number of leaves (9.66), leaflets (17.00) and leaf area (176.67 cm) was recorded in patch budded plants when performed during 1st week of August followed by same method when performed during 2nd week of July. The maximum number of leaves in patch budded plants might be due to higher shoot length attained by such plants (Table 2).

There were significant variation in the success rate of the two budding methods namely patch and ring budding. Significantly higher success was obtained with patch budding (66.33%) followed by (62.33%) when performed during 1st week of August and 2nd week of July than ring budding (58.12%) when performed during 1st week of August. These findings are in conformity with the findings of Chandel and Ananda (2002), who also obtained higher bud take with Patch budding in pecan. The higher percentage of patch budding when performed during growing season in walnut has also been reported by Ebrahim *et al.* (2008) and Hodaj *et al.* (2014). In the present study, comparatively higher percentage of success in patch budding might be because of the formation of better graft union due to more contact of cambial layer of stock and scion, good sap flow and congenial weather and optimum soil moisture.

After the end of growing season highest per cent survival (41.00%) was recorded in patch budding when performed during 1st week of August, followed by the same method percent survival (37.63%) when performed during 2nd week of July. The minimum survival (32.66%) was recorded in case of ring budding when performed during 3rd week of June. Poor survival of plants budded in June might be due to low sap flow and poor cambium contact.

CONCLUSION

On the basis of the different parameters recorded, (shoot length, number of leaves, leaf area), it is concluded that patch budding was better method of propagation for obtaining effective vegetative growth at the end of growing season. The results also revealed that the best time for performing budding in pecan nut is the 1st week of August under open conditions.

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Dual-purpose Basmati Rice: A Solution to Stubble Burning in North Western Plains of India

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ABSTRACT

Green Revolution came into existence for the security of food and to reduce the country's dependence on imports. Due to intensive agriculture in North-Western plains of Himalayan, a number of problems came up such as depletion of groundwater table, reduction of soil fertility, and degradation of land. Out of many, the burning of paddy straw is the main source of pollutant emission, air-quality deterioration and greenhouse gases in the environment. The generation of heat due to burning increases the soil temperature which destroys many organisms that are beneficial to soil, therefore leading to reduced soil fertility. Many subsidized schemes have been launched by governments to reduce the burning in this region, however no significant improvement has been achieved so far. Among the various approaches development of dual-purpose basmati rice varieties is one of the better options to reduce straw burning. Being low-silica and high-carbohydrate contents, these varieties not only give better yield but the straw is also used as animal fodder during the lean period. Being developed through pure line selection of traditional landraces of basmati, these varieties also perform better under natural and organic farming conditions. Cultivation of dual-purpose basmati varieties and diversified farming need to be encouraged in these areas, which will further lead to a reduction in straw burning cases.

Keywords: Dual-purpose basmati varieties, Natural farming, Paddy straw burning, North-Western plains

INTRODUCTION

The Indian aromatic rice, also known as 'Basmati', is a nature's gift to the North-Western region of Himalaya. The term has been derived from two Sanskrit words, *vaas* (fragrance or aroma) and *matup* (possessing) or ingrained or present from the beginning. In North India, 'va' is pronounced as 'ba', and 'matup' becomes Mati making it Vasumati (Gupta, 1995; Ahuja, 1995). Therefore, Vaasmati is changed into Basmati, which people generally pronounce ('Bas' means fragrance and 'mati' means queen). The earliest reference to the existence of aromatic rices in India can be traced to the documents of Susrutha (circa 400 BCE), the great Indian pioneer in medicine and surgery (Ahuja, 1995; Karishnamurthy, 1991; Ahuja *et al.,* 2008). The first usage of the term word 'Basmati' can be found in the Punjabi classic *Heer Ranjah* (1766) by the Punjabi poet Waris Shah (Kovach *et al.,* 2009; Giruad and Pirzada, 2009; Ashfaq *et al.,* 2014; 2015). The name of rice cultivars such as Basmati, Begumi and Satthi (60-day rice) suggests that 'Basmati' rices might have been in the cultivation since long before 1700 AD (Ahuja, 1995). Subsequent reference to 'Basmati' can be found in *A Dictionary of the Economic Products of India* compiled by George Watt in 1891. The varieties of Basmati grown can be understood by their names. They often include the places where they are predominantly grown. For instance, Jammu Basmati is from Jammu, Haryana Basmati from Haryana and Dehradun Basmati (Type 3) from the Dehradun area in Uttaranchal. Long slender grain, soft and fluffy texture of cooked rice, lengthwise excessive elongation on cooking, delicious taste, pleasant aroma and distinct flavour differentiates them from other varieties of rices (Nagaraju *et al.,* 2002; Vemireddy *et al.,* 2007).

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Unlike other aromatic rices, the unique quality traits of basmati rice found their expression only when they are grown in the North-Western foot hills of the Himalayas in the Indian subcontinent. In 2016 due to its geographic-specific manifestation of quality features, Geographical Indications (GI) tag was granted for the cultivation of basmati rice in those specific territories. Basmati rice is cultivated in the North-Western parts of India, including Haryana, Punjab, Uttaranchal, Western Uttar Pradesh, Jammu & Kashmir, Himachal Pradesh and Delhi (Table 1 and Figure 1a), and in some parts of Pakistan. Consumers from all over the world specifically prefer basmati rice due to its flavour and palatability (Siddiq *et al.,* 2012). To date, 35 plus basmati varieties have been notified under the Seeds Act 1966, including six traditional basmati varieties such as Basmati 370, Basmati 217, Dehraduni Basmati (Type 3), Taraori Basmati (HBC 19/Karnal Local), Ranbir Basmati and Basmati 386. India is the prime exporter of basmati rice across the globe. During the year 2020–21, 46,31,531.0 MT of basmati rice worth Rs. 29,849.00 crores have been exported (APEDA 2021).

Basmati rice cultivated in Jammu & Kashmir is one of the major sources of income of the people living in this hilly and sub-mountainous Union Territory. The rice produced in the Ranbir Singh Pura (R.S. Pura) area of the Jammu region holds a prominent position in the market because of their high quality. Moreover, this variety of rice is considered auspicious. Due to the agro-climatic conditions, the basmati rice grown in areas of Jammu region have a much more beautiful aroma and mouth-feel taste in comparison to other basmati rice grown in other different regions of the country (Gupta *et al.,* 2009). Moreover, the lower sub-tropical part of Jammu region falls in GI area of basmati so has got national importance to vide GI No. 145 on 15 February 2016 (Figure 1). Moreover, the cultivation areas in the Jammu region fall between the flood plains of the Tawi, the Basantar river and scores of rivulets which bring mineral-rich soil from the Himalayas and the Shivaliks during rains. In J&K, basmati is grown on 63,000 ha and has the potential to grow up to 1,00,000 ha if supported by problem-solving innovative scientific technologies. Every year Jammu region produces about 1 lakh metric tons, out of which 30,000 metric ton is exported.

The basmati rice of R.S. Pura area is well-known in the national and international markets because of its richness in aroma, soft texture, relish and high palatability. Areas adjoining the Indo-Pak border are the hot spots where farmers cultivate these local cultivars for a long time. Some of the basmati rice landraces have a special cultural value, for example *Kamon basmati* is traditionally served occasions like marriage ceremonies and festivals. During the reign of kings, these were sold as 'food for the royal families because they could only be afforded by the affluent families. In comparison to other normal varieties of rice, it was around four to five times more costly (Amjad and Sofi, 2018). The farmers in this region have been growing this traditional cultivar for centuries but are gradually losing interest in its cultivation and conservation because of low yield and susceptibility to a number of biotic and abiotic stresses. These landraces are known to have specific adaptation and their quality is fully expressed if grown in the specific region. No doubt that a number of long-grain basmati varieties – such as Pusa 1121, Pusa 1509, Pusa 2511, CSK 30, and Punjab Basmati 3 – are available but farmers of this region prefer dual-type basmati because of their unique qualities such as beautiful aroma like traditional basmati and straw with more carbohydrates and low silica and lignin contents for animal consumption. These farmers conserve and use paddy straws as fodder for animals during their lean period.

Genetic erosion has been more intense for these traditional basmati landraces and rate of replacement of landraces is very fast due to their poor inherent yield potential, susceptibility to prevailing diseases and insect pests, and no incentive for growing such landraces (Singh *et al.,* 2000). The information gathered so far are about common varieties, and knowledge on indigenous basmati rice is vague. Moreover, there is an increase in dwarf varieties in the market apart from the traditional basmati strains, and it is very difficult to differentiate them based on their phenological and morphological characteristics. Consequently, this genetic wealth is in immediate danger and disappearing from its native place. Before the traditional basmati landraces and biodiversity become extinct from their native area, the Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (SKUAST-J) has undertaken expeditions to R.S. Pura, particularly the hot spot areas

Table 1: State/UT wise basmati acreage and production

State	Area (000 ha)	Basmati production (000' tons)	Productivity (q/ha)
Haryana	596.00	2,138.00	35.87
Punjab	547.00	1964.00	35.90
Uttar Pradesh	252.00	720.00	28.57
J & K	63.00	135.00	21.42
Uttarakhand	15.00	37.00	24.66
Himachal Pradesh	7.00	20.00	28.57
Delhi	1.00	2.00	20.00
G. Total	1481.00	5027.00	27.85

Source: APEDA 2019

near Indo-Pak border and part of surrounding districts of Jammu region falling under GI. To meet the requirements of farmers and to revive the Jammu Basmati, Agriculture Production Department, Govt. of J&K, has also sanctioned a project under Special Task Force entitled Upgradation of Seed Multiplication Farm Chakroi for Jammu Basmati in 2013. The main objectives of the project are collection of local basmati, characterization (morphologically as well as molecular), conservation and release of promising genotypes as varieties. Under this project, local germplasm of basmati rice from different basmati growing areas, particularly from the adjoining areas of Indo-Pak borders, was collected and characterized. A total of 431 samples were collected, and out of these, 3 promising basmati varieties, namely, Jammu Basmati 118, Jammu Basmati 123 and Jammu Basmati 138, which are having excellent aroma and quality traits, were released and notified.

DEVELOPMENT OF DUAL PURPOSES BASMATI VARIETIES

Jammu and Kashmir has two main geographical regions: the Jammu region and the Kashmir region of the Indian Union comprise the extreme western part of the Himalayas (32.44°N and 74.54°E). The explorations were made in three basmati growing districts which fall under GI of basmati, namely, Jammu (latitude: 32° 432 48.003 N; longitude: 74° 522 12.003 E), Samba (latitude: 32° 332 44.823 N; longitude: 75° 072 11.753 E) and Kathua (latitude: 32° 342 59.993 N; longitude: 75° 292 59.993 E) (Figure 1). In the Jammu region, the basmati rice is cultivated at a height of 300–400 m above sea level where the temperature varies from 6°C (in winter) to 45°C (in summer). The annual precipitation varies from 700 to 1500 mm. The soil is sandy loam and clay loam with a neutral pH is also present in the sub-tropical zone of the Union Territory.

Survey and collection of basmati rice germplasm: Each year a total of 15 rice specific explorations were conducted during the month of September–November (2013, 2014 and 2015). Germplasm samples were collected from the field, threshing yard and occasionally from the farm stores. The techniques for germplasm collection and passport data documentation were followed as per the technical guidelines of Moss and Guarino (1995). During the time of collection, every collected accession was assigned a specific collector number. In this time, farmers' knowledge, germplasm use, common names, unique features and information about past cultivation of crops including rice landraces were also recorded as part of the collected accessions' passport data (IPGRI, 1980). For each accession, a representative sample (10%–15%) of single populations by collecting seeds from several individual plants was prepared. A total of 431 local basmati rice accessions were collected from these regions (Figure 1), which possess different morphological and quality traits.

Morphological and physico-chemical evaluation: In this article, 431 genotypes were collected during the 15 explorations, out of which 130 were screened based on locations and hot spot areas of collections. The collected germplasm was evaluated for morpho-physicochemical and grain quality traits along with four checks (Basmati 370, Ranbir Basmati, Pusa 1121 and Pusa Basmati 1) at Experimental Farm, School of Biotechnology, Faculty of Agriculture, SKUAST-J, Chatha, Jammu (J&K), India. Each genotype along with parents was planted in a plot of size 5.0 m^2 with row-to-row and plant-to-plant spacing of 20 and 15 cm, respectively, with a total plant density of 75 plants/m^2. The experiment was arranged in a randomized block design with three replications during kharif season (warm humid conditions). All the recommended package practices were followed to raise a good crop. The data on morphological and physico-chemical traits were recorded from three randomly

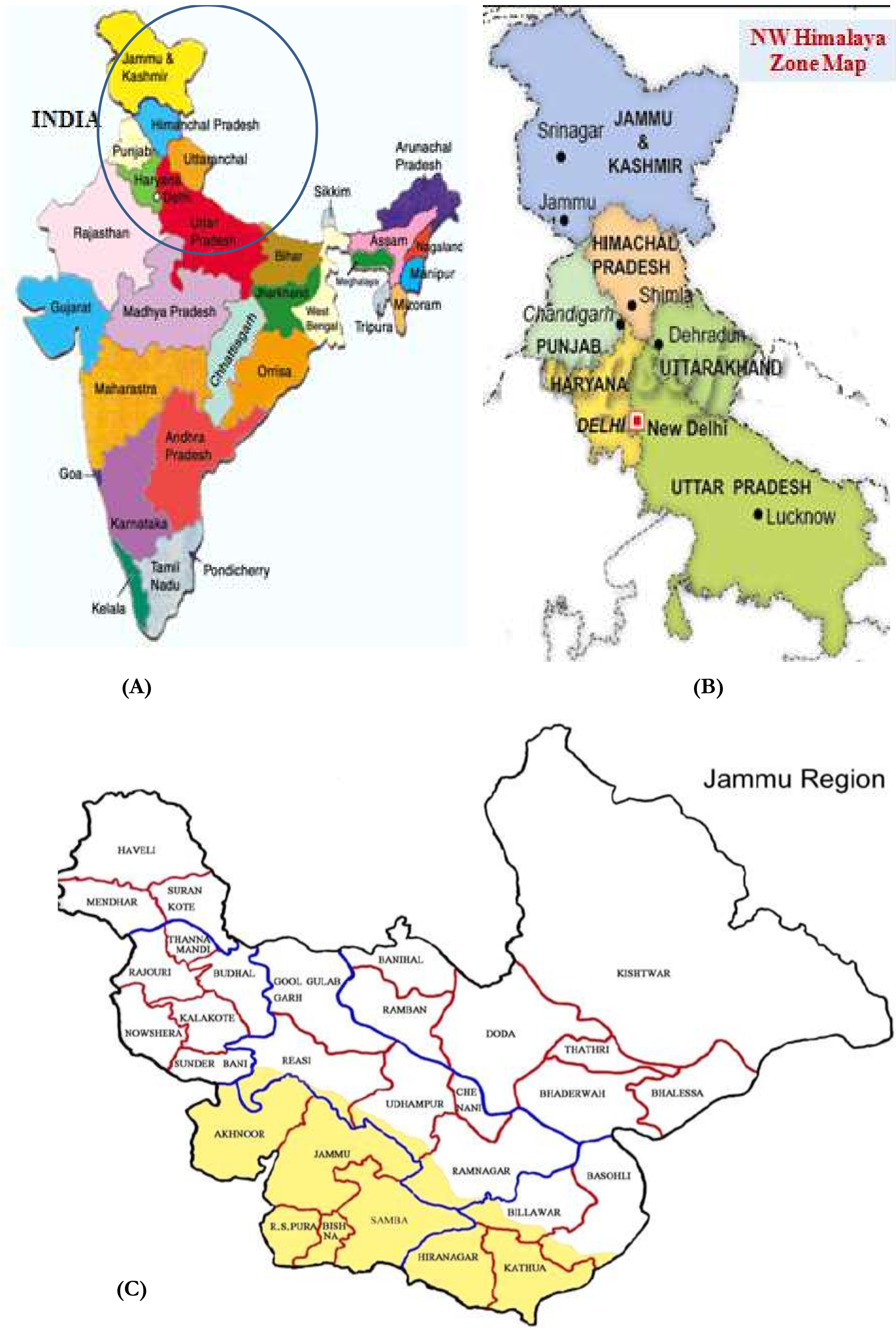

Figure 1: (A) Political map of India showing the states (encircled) for GI. (B) Enlarged view of states of NW Himalaya under GI. (C) Map of Jammu region showing areas from which local basmati rice (*Oryza sativa* L.) is being grown

selected representative plants in all the genotypes from each replication. The simplified method of Juliano (1971) was used for estimating the amylose content. Using Pearson correlation coefficient with SPSS@ software version 16 (SPSS Inc., Chicago, IL, USA), the average values of the measured characters were calculated for the analysis (Norusis, 1998).

The collected germplasm was characterized for various morpho-physiological and grain quality traits followed by molecular markers. The collected basmati rice genotypes showed wide variations in quantitative and qualitative characters (Salgotra *et al.,* 2015). The collected rice germplasm was evaluated for yield and its component traits, and grain quality traits (Tables 2 and 3). The diverse genotypes were further evaluated as multi-location trials, and seeds of best entries were multiplied. The top five entries were further evaluated under the All India Coordinated Rice Improvement Project (AICRIP). Three out of these basmati varieties, that is Jammu Basmati 118, Jammu Basmati 123 and Jammu Basmati 138, have been released and notified. These three basmati varieties have been explained in detail.

Jammu Basmati 118: This variety of basmati has a yield potential of 45q/ha which is 20–25 per cent more than the potential yield of Basmati 370. In the Jammu region, more than 80 per cent area is under traditional basmati rice including Ranbir Basmati. In production, lodging is a major problem in basmati production. Jammu Basmati 118 has a huge demand in all the districts that fall under GI, including Jammu, Samba and Kathua. The farmers in the Jammu region face a major problem in fodder production, and the paddy straw of this variety can be as fodder. This variety is also resistant to lodging due to its short stature with a reduced plant height of 130–135 cm. It is an early maturing variety that matures 25 days earlier to Basmati 370 which could save water and fit best in the rice-wheat cropping system. This variety has an excellent aroma and other grain qualities that meet all the international standards of basmati export. It has high hulling (79.77%), milling (71.70%) and head rice recovery (HRR) (61.00%). This variety has shown a moderate reaction to bacterial blight, leaf blast, sheath rot and brown spot diseases and has also shown moderate resistance to stem borer and leaf folder compared to checks and other entries tested in the trials.

Jammu Basmati 123: Jammu Basmati 123 is a high yielding basmati variety (40q/ha) with a yield advantage of more than 15–20 per cent over Basmati 370. Jammu Basmati 123 is well performing in all the basmati growing districts of the Jammu region such as Jammu, Samba and Kathua. This is a dual-purpose variety, that is it can be used both for fodder and grain purpose. It has high hulling (79.03%), milling (73.49%) and HRR (69.09%). As this variety meets all the international standards, this helps in enhancing the export potential of this region. The cultivars majorly struggle with diseases like Bacterial blight, leaf blast and brown spot but this variety of basmati rice was found moderately resistant to these diseases.

Jammu Basmati 138: Jammu Basmati 138 can be yielded up to 42q/ha, that is more than 20–25 per cent of the potential yield of Basmati 370. Like Jammu

Table 2: Mean values of newly developed basmati rice varieties for different morphological traits

Genotype	Plant height (cm)	Days to 50% flowering	Days to maturity	Panicles per m^2	Panicle length (cm)	1000-grain weight (g)	Grain yield per plant (g)	Grain yield (q/ha)
Jammu Basmati 118	136.4	102.0	137.5	311.0	25.7	20.5	32.5	48.37
Jammu Basmati 123	158.9	121.0	155.0	343.0	22.4	20.5	30.0	43.46
Jammu Basmati 138	155.4	118.0	157.5	317.0	21.7	19.5	34.5	45.36
Basmati 370	154.3	124.5	161.0	274.0	19.9	21.5	22.5	33.50
CD	4.885	6.192	1.504	13.236	0.685	1.116	0.583	5.569
SE(m)	1.048	1.329	0.323	2.839	0.147	0.239	0.125	1.195
SE(d)	1.482	1.879	0.456	4.016	0.208	0.339	0.177	1.689
C.V.	0.976	1.609	0.298	1.290	0.908	1.617	0.586	4.0002

Basmati 123, this variety also has dual purposes, and it is good for milking animals. It has high hulling (78.68%), milling (72.49%) and HRR (66.59%). This will give high returns to the farmers. Due to meeting the international standards, Jammu Basmati 138 also enhances the export potential in this region. This variety is moderately resistant to bacterial blight, leaf blast and brown spot diseases, along with showing moderate resistance to stem borer and leaf folder insect pests.

PERFORMANCE OF DUAL-PURPOSE VARIETIES UNDER ORGANIC CONDITION

The gradual increase in the use of pesticides has hindered the soil quality as well as quality of produce. Strict pesticide norms on basmati rice have been enforced in many regions including Europe and USA. Due to which basmati rice exports to Europe have lowered extremely up to 80%. For the third consecutive year, basmati rice exports decreased due to the use of high doses of agro-chemicals such as fertilizers, weedicides, pesticides, etc (Figure 2). Organic farming and natural farming are not just alternatives but only choice to sustain export of basmati rice in future. The traditional basmati varieties are well performing under organic and natural farming conditions. The experiment was also undertaken to study the performance of newly developed dual purpose basmati rice varieties, namely Jammu Basmati 118,

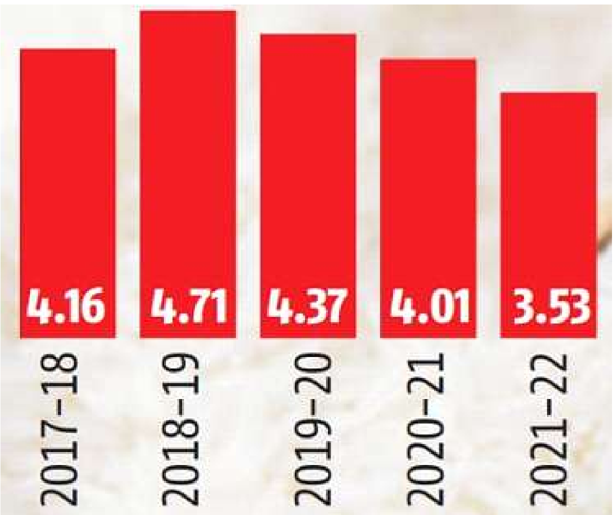

Figure 2. Export of Indian basmati rice during the last 5 years
Source: Department of Commerce, Ministry of Commerce and Industry, Govt. of India

Table 3: Mean values of grain quality characteristics of newly evolved basmati varieties

Genotype	Hulling (%)	Milling (%)	Head rice recovery (%)	Grain length (L) (mm)	Grain breadth (B) (mm)	L/B ratio	Glycemic index (%)	KLAC parameter (mm)	ASV	Volume expan. ratio	Water uptake ratio	Gel consis-tency (cm)	Amylose content (%)	Cooking time (min)	Aroma
Jammu Basmati 118	78.80	71.70	61.00	7.20	1.64	4.34	59.33	12.3	5	3.38	1.07	8.7	24.6	12	Highly aromatic
Jammu Basmati 123	79.03	73.49	69.09	7.08	1.70	4.15	60.76	14.1	4	4.06	1.06	14.7	24.0	14	Highly aromatic
Jammu Basmati 138	77.10	72.49	66.59	6.97	1.65	4.21	62.29	12.8	5	3.63	1.08	8.1	23.8	13	Highly aromatic
Basmati 370	68.00	61.50	47.00	6.89	1.73	3.98	65.98	13.1	4	3.68	1.05	4.2	22.4	15	Highly aromatic
CD	4.301	4.099	5.039	0.173	0.040	0.081	1.658	-	-	-	-	3.971	-	-	-
SE(m)	0.923	0.879	1.081	0.037	0.009	0.017	0.356	0.312	0.500	0.162	0.044	0.852	0.753	1.031	-
SE(d)	1.305	1.243	1.529	0.053	0.012	0.025	0.503	0.441	0.707	0.229	0.062	1.205	1.065	1.458	-
C.V.	1.740	1.808	2.523	0.746	0.727	0.591	0.804	3.187	13.887	6.072	5.528	12.901	4.511	10.699	-

Table 4: Performance of newly developed basmati varieties under organic conditions

Varieties	Plant height (cm)	Days to maturity	Panicle length (cm)	Stem thickness (mm)	Effective tillers/ plant	No. of grains / panicle	1000-grain weight (g)	Panicle weight (g)	Grain yield (q/ha)	Harvest index	Kernel length (mm)
Jammu Basmati 118	140.90	139.5	24.5	3.24	8.22	206.00	22.57	3.23	41.36	33.33	7.33
Jammu Basmati 123	154.21	156.0	23.0	3.15	8.56	122.78	21.27	2.39	38.30	30.74	7.10
Jammu Basmati 138	158.26	158.5	22.6	2.57	8.56	128.67	20.94	3.05	37.86	22.45	7.13
Basmati 370	154.28	160.0	20.5	3.04	6.67	117.67	19.97	1.26	28.16	21.37	6.89
CD@5%	27.911	5.575	3.608	N.S.	N.S.	35.498	3.938	1.171	14.723	10.279	0.64
S.Em(±)	9.585	1.915	1.239	0.296	1.164	12.191	1.35	0.402	5.056	3.53	0.21

Jammu Basmati 123 and Jammu Basmati 138 under organic conditions during Kharif 2018 at Organic Farming Research Centre (OFRC), SKUAST-J, Chatha (Table 4). In this study, different combinations of farmyard manure (FYM) and vermicompost were applied, and all the varieties have performed well under organic conditions. No significant yield loss was observed under organic conditions compared to recommended doses of fertilizers. These results follow traditional method of basmati rice production in the Jammu region where farmers mostly use any FYM in basmati rice cultivation. In the Jammu region, organic type of cultivation of basmati is being practised. Generally, farmers of this region grow the basmati rice on available FYM and vermicompost. The paddy straw is of high carbohydrates and low silica and lignin content and is used as fodder.

PADDY STRAW BURNING IN PLAINS OF NORTH-WEST HIMALAYAN

Green Revolution had a selective impact in the North-Western plains of Himalayan with the introduction of semi-dwarf high-yielding and fertilizer responsive varieties. However, it bypassed the rainfed areas, landless labourers and resource-poor farmers. To counter the adverse environmental effects – such as straw burning, degradation of land and soil fertility, loss of biodiversity, and receding groundwater – of the Green Revolution, a paradigm shift is needed towards the promotion of sustainable agriculture. To increase the income sources of poor farmers with the available limited resources, there is a need to use technologies that lower input costs and build resilience in farming activities. Apart from that, innovations have to be scaled up urgently to improve the efficiencies in agriculture crop production, post-harvest management and agro-processing.

The time window available between the harvesting of paddy crop and the sowing of the next crop is very short. To clear the stubbles from the fields for sowing of rabi crops in a short span, Punjab, Haryana and Uttar Pradesh has been following a routine practice of burning the paddy straw. Moreover, farmers do not use paddy straw due to high silica content. Punjab, until 1965, rice cultivation was restricted only in the North-Western part of the state where only traditional basmati rice varieties were grown. The straw of the traditional basmati varieties was mostly consumed as fodder for animals because of low silica content. However, newly developed semi-dwarf varieties have a high amount of silica content compared to the traditional varieties and are, therefore, less liked by the animals. The farmers of these states burn paddy straw to clear the stubbles for sowing next season crops, which hampers the air quality and damages the soil health. Due to the burning, Delhi and adjoining states face adverse impacts in agricultural productivity in the following ways:

***1. Loss of nutritional values of soil*:** Generally, crop residues of different crops contain 80% of nitrogen (N), 25% phosphorus (P), 50% sulphur (S) and 20% of potassium (K). If the crop residue is incorporated or retained in the soil itself, it gets enriched, particularly with organic C and N. It is estimated that burning 1 tonne of paddy straw accounts for a loss of 5.5 kg, 2.3 kg, 25 kg and 1.2 kg nitrogen, phosphorus, potassium and sulphur, respectively, besides the organic carbon in the soil.

***2. Impact on soil properties due to loss of important microbial population*:** The heat generated from the burning of residues elevates soil temperature causing the death of soil organisms that are beneficial.

Frequent residue burning leads to loss of microbial population and reduces the level of N and C in the top 0–15 cm soil profile, which is important for crop root development.

***3. Emission of greenhouse gases (GHGs)*:** The GHG emission results in an increase in chemically and radioactively important trace gases and aerosols such as CH_4, CO, N_2O, NO_X and other hydrocarbons. Moreover, besides other particulates and carcinogens, burning of rice straw emits about 70% of CO_2, 7% CO, 2.09% N_2O and CH_4 (0.66%).

To avoid burning the respective state governments and Government of India have taken many steps such as purchase of farm machinery on subsidized rates for in situ crop residue management and promoting the use of paddy straw in power plants and other industries. However, the development of dual-purpose basmati varieties, that is variety having high grain yield and good fodder quality, helps in the reduction of paddy straw burning. The traditional basmati varieties have low silica content and are of good fodder quality; however, their low yield and susceptibility to diseases are becoming less popular among the farmers. In Haryana, farmers have started using basmati paddy straw as fodder for animals which results in significantly lower amount of crop residue in the field and hence less burning. No doubt that a number of stubble burning incidents have come down over the years by promoting the use of paddy straw as fodder and other government subsidized schemes for the purchase of machines, but the development of dual-purpose basmati varieties is one of the options for sustainable agriculture development. This will not only provide a higher yield of basmati rice but will also reduce stubble burning and solve the problem of fodder during the lean period.

CONCLUSION

The development of dual-purpose basmati is one of the best options to curve the problem of stubble burning problem in the North-Western plains of Himalayan. Heat generated from stubble burning residues increases the temperature of soil causing the death of beneficial soil microorganisms. This leads to loss of microbial population in the top 0–15cm soil profile – important for field crop root development. To minimize the soil fertility losses and sustainable development, there is a need to promote the cultivation of dual purposes basmati varieties, i.e., basmati varieties with more carbohydrates and low silica and lignin contents. The paddy straw of these varieties can be used as fodder for animals. In the Jammu region, the farmers still prefer traditional basmati varieties such as Basmati 370, Ranbir Basmati, Basmati 564 due to the high demand of paddy straw for animal fodder. To further minimize the stubble burning, there is need to encourage the farmers to cultivate dual-purpose rice varieties and the use of paddy straw in biomass power plants to produce energy and in other industries. Besides, promotion of natural and diversified farming inclusion of more less water loving crops needs to be encouraged.

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Enhancing Productivity of Cumin Through Front Line Demonstration in Nagaur District of Western Rajasthan

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ABSTRACT

Keeping in view of an effective approach of frontline demonstration for transfer of technology in cumin the frontline demonstration on cumin were conducted by Krishi Vigyan Kendra, Nagaur-I during *rabi*-season 2019-20 to 2020-21. After organizing an off campus training and group discussion total 50 farmers were selected from Khajvana and Jhadeli village. The demonstrations were laid out in area of 20 ha by the active participation of farmers with the objective to demonstrate the improved technology of cumin crop. It was also noticed that the farmers adopted new high yielding variety, seed treatment, mechanized sowing, integrated nutrient & weed management, pest and disease management. The improved technology recorded higher yield, net return, and B: C ratio in the value of 10.27 qt/ha, Rs. 118797/ha and 4.35, respectively as compared to farmer's local practices (7.9 q/ha, Rs 84885/ha and 3.47, respectively). The overall knowledge and adoption level of cumin production technology was increased by 29.97 percent due to front line demonstration.

Keywords: Front line demonstration, Package of practices, Cumin, Productivity, Technology gap, Extension gap

INTRODUCTION

Cumin (*Cumin cymene*) belongs to Apiece family. It is the second most popular spices in the world after black pepper. It is very pungent and aromatic and is used whole ground. India produces 70 per cent of the world supply and consumes 90 per cent of the world. Cumin accounts for 5.81 Lakh ha area of the total spice produced in India and Gujrat and Rajasthan alone produce 99 per cent of total cumin production. In Rajasthan cumin is grown in about 5.11 Lakh ha area with production about 2.01 Lakh tons. Cumin occupies 44.70 per cent of total condiments and spices area of the state, but its productivity is very low 339 kg/ha in Rajasthan. There are various technologies recommendation made by the State Agriculture University and ICARs Institute to increase the production and productivity of cumin in the state. In Nagaur district farmers grow cumin in large area due to its low water requirement but obtain very low yield due to use of poor yielding variety and poor knowledge about scientific cultivation of cumin. The FLDs is an important method of transfer of latest package of practices in totality to farmers. KVK Nagaur-I had efforts and conducted many on-campus, off campus training programme and other extension activities for the benefit of the farmers and farm women. The main objective of this programme is demonstrate of newly released varieties of crops and protection technologies and management practices at the farmers field under real farming situation at his own field under different agro-climatic region. Keeping this in view the present study was conducted to discuss the impact of frontline demonstration on yield, knowledge, adoption and spread of cumin in Arid zone.

MATERIALS AND METHODS

The present study was carried out in the Nagaur district which is located on the north-western part of the Rajasthan state and lies at 27^{o}20 N latitude and 73^{o}74 E longitude with altitude of 302 m above the mean

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sea level. The front line demonstrations on 20 ha under cumin crop were conducted during *rabi*-2018-19 and 2019-2020. The soil of the district is generally sand to sandy loam in texture which is low in organic carbon & available phosphorus and medium to high in potash. With the objective to evaluate the performance of GC-4 variety of cumin at the 50 farmers in Mundawa block village Khajvana and Jhadeli. of the district Nagaur the demonstration were conducted. Each demonstration was conducted on an area of 0.4 ha and same area adjacent to the demonstration plot was kept as farmers practices. The package of practices for improved production technologies included improved variety GC-4, fertilizers NPK 30:20:10 and 12 kg $ZnSO_4$ kg/ha, seed treatment with carbendazim @ 2.0g/kg seed and Trichoderma @ 4 g/kg seed and soil treatment by Trichoderma viride @ 2.5 kg/ha (Mixed with 100 kg FYM) and seed sowing was done in November month with a seed rate of 12 kg/ha. The sowing was done by seed drill under front line demonstration and under farmers practices broad casting method was used. The details of present study with respect to front line demonstration and farmers practices are given in (Table 1) in regards to grain yield, gap analysis, cost of cultivation, net return and additional return. Parameters were recorded (Table 2 and 3) after assessment of gap in adoption of recommended technology through discussion with selected farmers. The extension activities i.e. scientist visit and field day were organized at the FLD sites. The benefit cost ration was calculated based on gross return. The basic information were collected from the demonstration and farmers practices and then extension gap, technology gap and the technology index were worked out (Samui *et at*., 2000).

RESULTS AND DISCUSSION

The major difference were observed between demonstration package and farmers practices due to recommended varieties, seed treatment, time of sowing, fertilizers dose, method of fertilizer application and plant protection measures. The results revealed that the average higher plot yield recorded 10.27 q/ha compared to average local check yield of 7.9 q/ha and the per cent increase in the demonstration yield over the local check was 29.97 percent. Similarly yield enhancement in different crops in the front line demonstration was documented by Meena *et al.* (2018).

An extension gap between demonstrated technology and farmers practices ranges from 2.53 to 2.21 q/ha during the study in 2019-20 and 2020-21 (Table 2). This gap might be attributed to adoption of improved technology in demonstration which resulted in higher grain yield than the traditional farmer's practices. The technology gap may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other vagaries of weather in the demonstration area. Hence, location specific recommendations may

Table 1: Comparison between demonstration package and farmers practice of Cumin

Technological intervention	Farmer's practices	Recommended Practices (FLDs)
Use of variety	Local seed	GC-4 improved variety from SDAU, Gujrat
Seed rate (kg ha)	15 kg/ha	12 kg/ha
Seed treatment	Carbendazim 50 WP @ 2g/kg	Carbendazim 50 WP @ 2g/kg seed andMetalaxyl @ 3g/kg seed
Soil treatment	No Application	*Trichoderma viridae* @ 2.5 kg/ha (mixed with 100 kg FYM
Spacing	Un uniform plant	30 x 10 cm
Sowing time	15-30 Nov.	20 Oct.- 10 Dec.
Sowing method	Broadcasting	Line sowing by tractor operated seed drill
Nutrient management	NPK (20:0:0)	NPK (30:20:10) and Zinc sulphate (12.50 kg/ha)
Weed Management	Hand Weeding	Oxadiargyl 6% EC @ 50 gm a.i. per ha at 18-20 DAS followed by one hand weeding at 45 DAS
Plant protection measures (Control of powdery mildew and blight disease)	Spray with Mancozeb 75 WP @ 2 gm/ litre water	Use of Azoxystrobin (11%) + Tebuconazole (18.3%) @ 1 litre/ha for blight management and control of powdery mildew & one spray of wettable sulphur 80% @ 2 kg/ha

Table 2: Yield performance, technology gap, extension gap and technology index of Cumin crop under farmer's practices and front line demonstration

FLD Conducted Year	Crop	Variety	Area (ha)	No. of demons-tration	Yield (q/ha)		% yield increase	Techno-logy gap (q/ha)	Extension gap (q/ha)
					Demons-tration	Local Check			
2019-2020	Cumin	GC-4	5	10	10.52	7.99	31.68	1.48	2.53
2020-2021	Cumin	GC-4	10	20	10.02	7.81	28.26	1.98	2.21
Average					10.27	7.9	29.97	1.73	2.37

Table 3: Economics of Cumin under Front line demonstrations

Conducted year	Cost of cultivation (Rs/ha)		Gross return (Rs/ ha)		Net return (Rs/ha)		B:C Ratio	
	Demo	Local check	Demo.	Local check	Demo.	Local check	Demo.	Local check
2019-20	35,985	34,575	1,63,076	1,23,845	1,27,091	89,270	4.53	3.58
2020-21	34,750	33,580	1,45,253.75	1,13,281	1,10503	79,701.25	4.18	3.37
Average	35,367.50	34,077.5	1,54,164.875	1,18,563	1,18,797	84,485.5	4.35	3.47

become necessary to narrow down the gap 1.73 was recorded (Table 2) during 2019-20 and 2020-21, respectively. Technology index shows the feasibility of technology. The lower the value of technology index (14.41) more is the feasibility of the particular technology (Table 2). The results of the present study are in consonance with finding Meena *et al.* (2018).

Economics analysis: The net return and B:C ratio of demonstration plot was Rs. 118797 ha & 4.35 and for local check Rs. 84485/ha and 3.47, respectively (Table 2). This increased in yield might be due to the use of improved variety, seed treatment, soil treatment, used of biofertilizers, timely sowing, application of recommended dose of fertilizers and timely weed management and integrated pest management practices. The result indicated that the frontline demonstration gave good impact over the farmers practice. The results confirm the finding of frontline demonstration on oilseed and pulse crops reported by Choudhary *et al.* (2012).

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Assessment of Farmer's Attitude and Knowledge Towards the Adoption of Vermicompost in Jind District, Haryana

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ABSTRACT

In this era of globalisation, it is very vital for Indian farmers to produce higher production within minimum cost by emphasizes the need to educate farmers for adopting improved technology. Vermicompost is superior among the most efficient methods for recycling organic waste as with the hefty use of fertilizers, the fertile lands were affected and as a result humans were immensely affected. It is an eco-friendly easy technology for handling biodegradable waste and encourage efficient recycling of biomass even generates income and employment for the rural poor is being promoted as a prudent option. The findings of the study exhibited that the majority of farmers (82% and above) agreed that the use of vermicompost decreases the use of fertilizers, it also reduces the environmental pollution and improve the quality & quantity of output. Further validity & reliability of a questionnaire has been tested using Cronbach's alpha method. The factor analysis with 12 observed variables summarized in terms of three imperative factors with Cronbach alpha values .845, .836 & .674. Cronbach alpha for all the factors is greater than 0.6, hence questionnaire is reliable and strength of factor 1 is more with higher value of Cronbach alpha. The study has specified that majority of farmers (84%) were having moderate level of knowledge and favorable attitude towards vermicompost technology. In addition, major constraints noted were- the non-availability of worms in nearby market, high temperature during summers and lack of knowledge about preparation of vermicompost. As a whole, the findings of the study concluded that food safety, better plant quality, environmental safety, nutrition content & improve soil aeration are effective variables with high factor loading. Vermicomposting technology is highly beneficial and helps in improving the economic status of the manufacturers and farmers. To remove constraints and for hastening the use of vermicompost, it is essential to train farmers, every stakeholder including farmers, governmental functionaries and non-governmental organizations should focus and organized efforts need to be taken to remove the constraints.

Keyword: Vermicompost, Assessment, Reliability, Factor analysis, Farmer's attitude and knowledge, Constraints

INTRODUCTION

The compost prepared by using earthworms is called vermicompost. Vermicompost is today a very important aspect of an organic farming. Vermicastings are the faecal castings released by earthworms, while vermiculture is the culture of earthworms. The term "vermicompost" originated from a latin word "vermes" meaning "worms" and the process of composting of organic material using earthworms is known as vermicomposting. Earthworms that influences soil microbial community, physical and chemical properties are popularly known as the "farmer's friend" or "nature's plowman". Earthworms have the ability to breakdown the large soil particles and leaf litter and thereby increase the availability of organic matter for microbial degradation. Vermicompost is becoming popular day by day as it provided quality products through major component of organic farming system (Yadav *et al.,* 2013). Using those organic inputs that are less expensive as compared

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to chemical fertilizers and pesticides and with a gradual but sustained increase in yields over a period of time, farmers are sure to heap handsome benefits in the long run.

Use of organic manures have several advantages, i.e., they improve soil physical properties, they supply macro, secondary and micro nutrients, these manures increase the availability of nutrients etc. and content high nutrients with growth hormones and 4-5 times powerful growth promoters than all the organic fertilizers and over 30-40% then the chemical fertilizers (Narkhede *et al.,* 2011, Attarde *et al.,* 2012). Technical merits of using these manures are proven not only to improve soil tilt and water holding capacity of the soil. Therefore it will be deemed necessary to apply these manures in crop production. Vermicompost is recognized as the best organic manure today.

Vermicompost has consistently improved seed germination, enhanced seedling growth and development and increased plant productivity much more than would be possible from the mere conversion of mineral nutrients into plant-available forms. Vermicompost has very 'high porosity', 'aeration', 'drainage' and 'water holding capacity'. They have a vast surface area, providing strong absorbability and retention of nutrients. They appear to retain more nutrients for longer period of time.

Vermicompost or vermiculture associated with other biological inputs have been applied to grow vegetables and other crops successfully. These approaches have proved to be economical as well as productive (Kumar and Sivanarayana, 2019). Use of various types of vermiculture for production of vermicompost has been gaining popularity among Indian farmers because of its simplicity, ease, low cost and non-bulkiness as compared to general compost. Vermicompost technology is affordable for farmers because of its low cost and marketing of its available plant nutrient like nitrogen and phosphorus (Pandey and Pandey, 1995). Marketing vermicompost is now a potential and flourishing industry due to the growing awareness among the people about the ill effects of chemical fertilizers and the relative benefits of organic farming. The retail market in urban areas is more promising with the sale price of vermicompost in neatly designed and printed packets, fetching higher rates. This has encouraged many Government and non government agencies to promote vermicompost production. Many entrepreneurs have been showing keen interest in undertaking vermicompost production. Vermicompost could contribute enormously to farm production and economic conditions of rural people, besides being an eco-friendly activity.

With growing concerns about the human health, soil quality and environmental safety need (Atiyeh and Subbulakshmi, 2020) has been felt to rethink over the existing agricultural practices especially the nutrient management. In view of the resurgence of interest in alternative agriculture in recent years, organic farming has been considered to be sound and viable option in most of the countries. In organic farming, the application of organic manure especially vermicompost derived from earthworm is recommended. The money-making potential of vermiculture is so attractive that it is rapidly becoming a growth industry. India has enough potential for production of sufficient quantities of organic inputs.

MATERIALS AND METHODS

The current study was conducted in Jind district of Haryana state by using convenience sampling. A total of 75 respondents were selected for the study. The age group selected was above 20 Years. The relevant data were collected with the help of a well-structured questionnaire. For the objectives regarding constraints, knowledge and attitude of farmer and factors influencing prevailing in vermicompost technology data of 75 respondents were taken on five-point Likert scale. A Likert scale more commonly involved in research that employs questionnaires. It is the foremost widely used approach to scaling responses in survey research. The format of a typical five-point Likert item which is used for the study-1. Most Important, 2. Important, 3. Neither Important nor Unimportant, 4. Unimportant, 5. Most Unimportant. Mean of the constraints faced by the farmers was also calculated within the constraints and among the constraints. On the other hand, Overall mean was calculated as well as rank was also given on the basis of mean score to find out which constraint was most important among all the constraints. Exploratory research design has been used for attaining the objectives. For statistical analysis, SPSS13 software was used by which reliability analysis and factor analysis were found. To measure the level of knowledge and attitude of farmers towards vermicompost technology questions were prepared. The scores were assigned as 5, 4, 3, 2 and 1 for strongly agree, agree, neutral, disagree and strongly disagree response, respectively. In order to attain at the composite score, score obtained by each respondent for all items were added upon the basis of their attitude and knowledge scores, the respondents were classified into three groups namely least favourable, favourable and most favorable & Low, medium and high respectively.

RESULTS AND DISCUSSION

The majority of the respondents were belonging from the age group of 45-60 years (48%), followed by 24 per cent from age group 31-45 years, 20 per cent belong to the age group of 20-30 years and only 8 per cent farmers belong to the age group of above 60 years. Education level of majority of the respondents was up to primary school i.e., 36 per cent followed by 28 per cent respondent with secondary education. However, 24 per cent respondents of the present study were educated upto senior secondary, followed by 8 per cent with graduation and above education level, only 4 per cent respondents were below primary. Data indicated that most of the respondents (58%) were using vermicompost first time. 41 per cent farmers were using vermicompost for horticulture, 37 per cent for cereal crops and only 21 per cent for kitchen gardening. 88% percent of the total respondent's farmers reflects that vermicompost reduce the use of fertilizers during the findings of the present study. Whereas 88 per cent farmers agreed that vermicompost reduces the soil pollution. Majority of the farmers i.e., 82 per cent convinced that it improves the quantity and quality of output (Table 1).

The knowledge and attitude possessed by the farmers (Table 2) revealed that majority of the farmers (84%) were having medium level of knowledge about vermicompost and the associated practices. About one tenth of them (10.6%) were adequately equipped with the knowledge about vermicompost production and appeared in high knowledge category. Meager percentage (5.3%) of farmers were in low knowledge category with poor knowledge. The farmers were therefore, mediocre in knowledge about

Table 1: Effect of different variables

Variables	Frequency	Percentage
Age of Respondent (Years)		
20-30 Years	15	20
31-45 Years	18	24
45-60 Years (Old Age Group)	36	48
Above 60 years	6	8
Qualification		
Below Primary	3	4
Primary	27	36
Secondary	21	28
Senior Secondary	18	24
Graduate and above	6	8
Are you using vermicompost for the first time		
Yes	43	57.3
No	32	42.6
Purpose for which you use vermicompost		
Kitchen Gardening	16	21.3
Cereal Crops	28	37.3
Horticulture	31	41.3
The application of vermicompost could help to reduce the environmental pollution		
Yes	66	88
No	3	4
Maybe	6	8
The application of vermicompost reduce the use of fertilizers		
Yes	66	88
No	3	4
Maybe	6	8
The application of vermicompost could improve the quantity and quality of output		
Yes	62	82.6
No	5	6.6
Maybe	8	10.6

Table 2: Distribution of farmers according to the knowledge and attitude towards vermicompost technology (N=75)

Variable and Category	Number	Percentage
Knowledge level		
Low	04	5.33
Medium	63	84.0
High	08	10.6
Attitude		
Least favourable	9	12.0
Favourable	47	62.6
Most Favourable	19	25.3

vermicompost technology which indicates that there is a scope for improvement. Similar were the observation of Chothe (1999) with regard to knowledge of farmers about bio-fertilizers. Regarding attitude, it was evident (Table 2) that majority of the farmers (62.6%) were found to be favourable in the feeling about vermicompost technology. Nearly one fourth of the farmers (25.3%) were found to be favourably disposed towards vermicompost. Only 12 per cent farmers were observed to be unfavourable in the reaction about vermicompost. The farmers in general were thus favourable in their feelings towards vermicompost production but due to lack of detailed knowledge about this technology they were not undertaking its production. The persuasion through regular guidance trainings, demonstration and required infrastructure seems to be essential.

Therefore, Chi square analysis was carried out to know the association among these variables. It was observed that knowledge and attitude were associated very strongly (Table 3). Further, favourable attitude leads to active participation by the farmers by adopting such practices which improve the living conditions. This was brought out by strong association between attitude and knowledge as shown by the chi-Square value (*)

Table 3: Association between knowledge and attitude of farmers

Variables	χ^2 values	
	Knowledge	Attitude
Knowledge	-	9.12*
Attitude	-	

*Significant at 1 per cent level.

From the Table 4, it can be concluded that 62.6 per cent of the farmers stated problem of non-availability of worms at nearby places hence given rank 1st. Second important constraint reported by 53.3 per cent farmers was lack of knowledge about methods and preparation of vermicompost. Most of the farmers (49.3%) remarked that response of vermicompost is not uniform or immediate. Next constraint expressed by 40 per cent of the respondents was occurrence of high temperature during summer season especially in the months of April to June. The other constraints like lack of reinforcement, lack of interest and lack of finance was reported by 26.6, 22.6 and 20.0 per cent, respectively. Similar findings were observed by Ranganatha *et al.* (2001), Bhople and Borker (2002) and Nirmala *et al.* (2002).

The researcher used the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for evaluating the reliability of the sample. The Kaiser-Meyer-Olkin (KMO) and the Bartlett's Test of Sphericity values were

Table 5: Kaiser-Meyer-Olkin Measure for Sampling Adequacy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.700
Bartlett's Test of Sphericity	χ^2 (Approx.)	289.123
	df	66
	Sig.	.000

Table 6: Cronbach Alpha for Reliability

Cronbach's Alpha	No. of Items
0.845	7
0.836	3
0.674	2

Table 4: Constraints faced by farmers in adoption of vermicompost technology

S.No.	Problems	Number	Per cent	Rank
1	Non-availability of Worms in nearby Market	47	62.6	I
2	Lack of knowledge/guidance about preparation of vermicompost	40	53.3	II
3	Response of vermicompost immediate	37	49.3	III
4	Shooting temperature especially in summer (April - June)	30	40.0	IV
5	Lack of reinforcement	20	26.6	V
6	Lack of interest	17	22.6	VI
7	Lack of finance	15	20.0	VII
8	Delayed land preparation	13	17.3	VIII
9	Venue of training is at far off places	11	14.6	IX

Table 7: Total Variance Explained

	Factor1	Factor2	Factor3
Eigen Value	3.618	2.561	1.676
% Variance	30.146	21.345	13.963
Cumulative %	30.146	51.491	65.456

Table 8: Rotated Component Matrix

	Component		
	1	2	3
f9 Food Safety	**.844**	.136	.160
f6 Better Plant Quality	**.797**	-.013	.222
f7 Environment Friendly	.736	.231	-.078
f8 Easy Handle	.671	.333	.169
f10 Dose	.621	.289	.092
f5 High Yield	.594	-.020	.277
f11 Cost	.521	.455	-.428
f12 Improve Soil Aeration	.206	**.883**	.050
f4 Environmental Safety	.027	**.818**	.126
f3 Organic Content	.282	.743	.325
f1 Content Nutrition	.367	.113	**.785**
f2 Water Holding Capacity	.105	.269	.747

Table 9: Factor Labels and their Eigen values

Factor Name and Statements		Cronbach	%Variance Alpha Value
Factor1			
Food safety	.844	.845	30.143
Better plant quality	.797		
Environment friendly	.736		
Easy to handle	.671		
Dose	.621		
High yield	.594		
Cost	.521		
Factor2			
Improve soil aeration	.883	.836	21.345
Environmental safety	.818		
Organic content	.743		
Factor3			
Nutrition content	.785	.674	13.693
Water holding capacity	.747		

0.700 and 289.123, respectively, depicted from Table 5, found highly significant. Moreover, in Table 6, overall Cronbach alpha for first two factors is highly significant i.e. 0.845 & 0.836 and for third factor it is 0.674.

The data from the survey has been analyzed while employing factor analysis to encapsulate the 12 statements linked to opinion of farmers while using vermicompost. Firstly, data is checked through rotated component matrix, where 12 statements are reduced to three factors through rotated component varimax shown in Table 8. Here, factors having eigen value greater than one was considered. Three factors have been taken, which contributed for 65.45% variation. The variations by factors 1, 2 and 3 were 30.146, 21.345 and 13.963 percent, respectively (Table 7).

Table 9 shows the Cronbach alpha values for both the factors along with the loading of variables.

CONCLUSION

The study revealed that 88% farmers agreed that the use of vermicompost decreases the use of fertilizers & it also reduces the environmental pollution. 82 per cent farmers thinks that application of vermicompost improve the quality & quantity of output. Near about 60 per cent and more farmers accepted that the vermicompost is very beneficial in terms of nutrition content, water holding capacity, organic content, environmental safety, high yield, better plant quality and low cost. This paper also attempts to investigate the factors that influence the opinion of farmers about use of vermicompost. It was found that all variable under study has significant effect on the decision. The KMO test shows that data is suitable to use factor analysis. The bartletts test shows that there is redundancy between variables that can be summarized with some factors. The factor analysis with twelve observed variables (i.e., survey question responses) that can be summarized in terms of three factors with Cronbach alpha values .845, .836 & .674. Cronbach alpha for all factors is greater than 0.6, hence questionnaire is reliable and strength of factor-1 is more with higher value of Cronbach alpha. It is concluded that food safety, better plant quality, environmental safety, nutrition content & improve soil aeration are effective variables with high factor loading. The present study showed that the farmers were medium in knowledge and favourable in attitude about vermicompost technology. Imperative constraints in adoption of vermicompost faced by farmers were non-availability of worms in nearby market, lack of knowledge / guidance about preparation of vermicompost and response of its application not uniform or immediate in the field crops.

The positive and significant relationship between the knowledge and attitude revealed that if farmers had good knowledge with positive attitude towards any technology, it results in its better adoption. To overcome these constraints in order to increase the adoption level by the farmers, efforts by governmental functionaries and non-governmental organizations should be directed.

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Regression Analysis of Independent Variables on Entrepreneurial Behaviour of Grape Growers in District Ganderbal

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ABSTRACT

The present study was carried out in six purposively selected villages of horticulture block Lar of district Ganderbal of J&K state. By using proportionate allocation method, a sample of 120 grape growers was taken for collecting the primary data with the help of a well-structured interview schedule. Data derived from the interviewees of the sampled growers was analysed using suitable statistical methods. Six independent variables were categorized and studied in relation to nine dependent variables i.e. knowledge, innovativeness, decision making ability, information seeking ability, leadership ability, achievement motivation, risk orientation, management orientation and economic motivation of grape growers. Regression analysis revealed that all the independent variables had significant variation of 78% on entrepreneurial behavior. Further, the variables whose regression co-efficient values were found significant (annual income, extension contact and mass media exposure) could be termed as good predictors in determining the extent of entrepreneurial behaviour of grape growers.

Keywords: Entrepreneurial behaviour, Grape growers, Regression analysis

INTRODUCTION

Grapes (*Vitis vinifera* L.), the queen of fruits is botanically a berry and belongs to genus vitis. Grapes can be eaten fresh as table grapes or they can be used for making jams, juices etc. Globally grape production contributes about 16.00 per cent of total fruit production. Grape is the third most widely cultivated fruit after citrus and banana (Bhat *et al.*, 2017). Italy ranks first in production of grapes with an annual production of 83 lakh metric tons followed by France and United States with annual productions of 67 and 62 lakh metric tons respectively (Anonymous, 2018). India is the 13th largest producer of grapes accounting 2.24 per cent of the global production (Anonymous, 2015-16). In India, the area under grape is 1.36 lakh ha with an annual production of 26 lakh Mt (Anonymous, 2016-17). In Jammu and Kashmir, the area under grape is 321 ha with a production of 648 Mt (Anonymous, 2016-17). Kashmir grapes lived up its reputation for being one of the choicest fruits. Kashmir valley is endowed with congenial agro-climatic conditions for a wide range of temperate fruits. In Kashmir valley the productivity is highest in district Ganderbal which ranks first in area (188 ha) and production (358 Mt) under grapes (Anonymous, 2015-16).

MATERIALS AND METHODS

This chapter deals with the detailed description of the research methodology adopted for conducting the study on entrepreneurial behaviour of grape growers. The methods employed for conducting the study are elaborated under the following heads:

1. Sampling procedure: Multistage cum purposive and random sampling techniques were used keeping in view the following objectives of the study.

Locale of study: On the basis of research problem and its objectives, the present study was conducted in the purposively selected district Ganderbal of Jammu and Kashmir having an area of 187.85 hectare under grape with production of 358.43 Mt (Anonymous 2015-16).

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Selection of the horticultural block: District Ganderbal has seven horticultural blocks out of which one block namely Lar was selected purposively on the basis of maximum area and production under grapes.

Selection of villages: Horticultural Block Lar consists of 15 villages, out of which only 6 villages were selected on the basis of maximum number of grape growers. The villages were selected randomly namely Raipora; Chanthan Gulab Bagh; Chount Valiwar; Qasba Lar; Thuru and Watlar for the present study.

Selection of grape growers: A comprehensive list of grape growers from the selected villages was procured from the concerned Chief Horticultural Officer and a sample of number of grape growers was taken by proportionate allocation method of sampling (taking area as auxiliary information) from the selected villages. Out of the six selected villages, a total of 120 grape growers were selected randomly with minimum number of 8 grape trees/vines.

2 Agro-climatic conditions: Ganderbal district with its headquarters located at 34 degree -12'N, longitude of 74 degree -46'E and at an altitude of 5213 ft above sea level at a distance of 21 kilometres from Srinagar city. Ganderbal district possesses all the typical characteristics of the climate of Kashmir valley as a whole. The annual rainfall and precipitation of the area is 676 mm having 67 normal rainy days. The majority of the area has clay loam soils followed by sandy loam and forest and hill soils. The net sown area is 14.109 thousand hectares with cropping intensity of 128 per cent. The net irrigated area is 10.672 thousand hectare, gross irrigated area of 13.877 thousand hectare and rainfed area covers 4.012 thousand hectares. Mostly the source of irrigation is canal or small canals.

3 Cropping pattern: Cropping pattern is dominant by food crops like rice, maize etc but now the trend has changed the bit. Most of the population prefers horticulture as it is economically preferable.

4 Variables and their measurement: Based on the objectives, available literature and opinion of the experts, 9 dependent variables and 6 independent variables were selected. The variables, which were found to have relevance to the present investigation, were included in the study. The instruments used to measure the variables together with the procedure followed, have been described in detail. Considering the dependent and independent variables, the respondents were classified into different categories based on mean and standard deviation.

RESULTS AND DISCUSSION

The data in Table 1 indicated that majority (73.00%) of the respondents had medium entrepreneurial behaviour followed by 15.00% with high entrepreneurial behaviour while as 12.00% had low entrepreneurial behaviour. The findings are in line with the findings of Anitha (2004), Dawar (2008) and Jain (2008).

Table 1: Overall entrepreneurial behaviour of grape growers (N=120)

Categories	F	%tage
Low (Below mean – S.D) (< 69.39)	14	12.00
Medium (Between mean + S.D) (>= 69.39 and <= 88.01)	88	73.00
High (Above mean + S.D) (> 88.01)	18	15.00

The data in Table 2 indicated that majority 78.00 per cent of the growers had medium level of innovativeness followed by high and low level of innovativeness 14.00 per cent and 8.00 per cent respectively. The medium level of innovativeness of grape growers might be due to their less education, smaller size of land holding, less extension contact which leads to restricted information about new technologies. The findings are in line with the findings of Thorat (2007).

Table 2: Innovativeness (N=120)

Categories	F	%tage
Low (below 8.25)	10	8.00
Medium (between 8.25-10.61)	94	78.00
High (above 10.61)	16	14.00

The data in Table 3 indicated that majority 91.00 per cent of the growers had medium level of decision making ability followed by high and low level of decision making ability 8.00 and 1.00% respectively. The possible reason might be that decision making of grape growers especially in Indian conditions is very difficult due to ever changing agro-climatic conditions and lack of stabilized price policy. The findings are in line with the findings of Chaudhari (2006).

Table 3: Decision Making Ability (N=120)

Categories	Frequency	Percentage
Low (below 15.83)	10	8.00
Medium (between15.83-24.01)	109	91.00
High (above 24.01)	1	1.00

The data in Table 4 revealed that majority 41.00 per cent of the growers had low level of information seeking ability followed by medium and high level of information seeking ability 32.00 per cent and 27.00 per cent respectively. The possible reasons for majority of grape growers to fall in low information seeking ability category might be due to their less education and low extension contact. The findings are in line with the findings of Vijaya kumar (2011).

Table 4: Information Seeking Ability (N=120)

Categories	Frequency	Percentage
Low (below 1.2)	49	41.00
Medium (between1.2-3.7)	39	32.00
High (above 3.7)	32	27.00

The data in Table 5 showed that majority 52.00 per cent of the growers had medium level of leadership ability followed by high and low level of leadership ability 27.00 per cent and 21.00 per cent respectively. The reason for medium level of leadership ability might be that the grape growers had low level of education and low extension contact which made them followers to a leader but not as a leader. The findings are in line with the findings of Shreekant (2017).

Table 5: Leadership Ability (N=120)

Categories	Frequency	Percentage
Low (below 2.24)	25	21.00
Medium (between 2.24-6.56)	62	52.00
High (above 6.56)	33	27.00

The data presented in Table 6 indicated that majority 78.00 per cent of the growers had medium level of achievement motivation, 16.00 per cent of the respondents were having high level of achievement motivation and 6.00 per cent of the respondents had low level of achievement motivation. This can be attributed to the social status a respondent feels to keep by achieving greater goals. The findings are in line with the findings of Gupta *et al.* (2013).

Table 6: Achievement Motivation (N=120)

Categories	Frequency	Percentage
Low (below 1.69)	7	6.00
Medium (between 1.69-4.79)	94	78.00
High (above 4.79)	19	16.00

The data in Table 7 revealed that majority 66.00 per cent of the growers had low level of risk orientation followed by high and medium level of risk orientation 22.00 per cent and 12.00 per cent respectively. The low risk orientation of grape growers might be due to their inability to face losses as they were financially not sound. The findings are in line with the findings of Sabi (2012).

Table 7: Risk Orientation (N=120)

Categories	Frequency	Percentage
Low (below 0.08)	79	66.00
Medium (between 0.08-3.92)	14	12.00
High (above 3.92)	27	22.00

The data in Table 8 indicated that majority 59.00 per cent of the growers had medium level of management orientation followed by low and high level of management orientation 21.00 per cent and 20.00 per cent respectively. The findings are not in line with the findings of Nagesh (2006) and Patil (2008).

Table 8: Management Orientation (N=120)

Categories	Frequency	Percentage
Low (below 20.09)	25	21.00
Medium (between 20.09-27.07)	71	59.00
High (above 27.07)	24	20.00

The data in Table 9 revealed that majority 73.00 per cent of the growers had medium level of economic motivation followed by high and low level of economic motivation 19.00 per cent and 8.00 per cent respectively. The findings are in line with the findings of Sharma and Gupta (2013) and Suman (2019).

Table 9: Economic Motivation (N=120)

Categories	Frequency	Percentage
Low (below 13.54)	10	8.00
Medium (between 13.54-17.76)	87	73.00
High (above 17.76)	23	19.00

Table 10: Multiple regression analysis of selected independent variables with entrepreneurial behaviour of grape growers

Independent Variables	Entrepreneurial Behaviour	
	'b' value	'p' value
Age	-0.015	0.062
Education	-0.041	0.615
Annual Income	0.000*	0.042
Land Holding	-0.023	0.065
Extension Contact	0.201*	0.002
Mass Media Exposure	0.141 *	0.001

R^2 value = 0.78

The Table 10 shows that out of six independent variables, 3 variables namely annual income, extension contact and mass media exposure were found to have significant effect on the entrepreneurial behaviour of the grape growers. The R value (0.78) suggests that all independent variables jointly contributed 78 per cent towards the variation in extent of entrepreneurial behaviour. Further, the variables whose regression co-efficient values were found significant (annual income, extension contact and mass media exposure) could be termed as good predictors in determining the extent of entrepreneurial behaviour of grape growers (Jaswal and Patil, 2012).

CONCLUSION

Majority of the respondents had medium innovativeness, decision making ability, leadership ability, achievement motivation, management orientation and economic motivation. The majority of respondents had low information seeking ability and risk orientation. The overall entrepreneurial behaviour and knowledge of grape growers about recommended package of practices was found to be medium. The results in the table showed that out of six independent variables, 3 variables namely annual income, extension contact and mass media exposure were found to have significant effect on the entrepreneurial behaviour of the grape growers. The R value (0.78) suggests that all independent variables jointly contributed 78 per cent towards the variation in extent of entrepreneurial behaviour. Further, the variables whose regression co-efficient values were found significant (annual income, extension contact and mass media exposure) could be termed as good predictors in determining the extent of entrepreneurial behaviour of grape growers.

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Factors Affecting Adoption of Rapeseed Mustard Production Recommendations in Jammu Region of Jammu & Kashmir

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ABSTRACT

Adoption of agricultural technologies is determined by many factors such as socio-personal including knowledge and attitude, economical, communication behaviour, attributes of the innovation and efforts of the change agency and agents. In order to find out the extent and level of adoption of different production technologies of rapeseed mustard crop a study entitled "Factors affecting adoption of rapeseed mustard production recommendations in Jammu region of the Jammu and Kashmir" was conducted. Stratified random sampling technique was employed for selecting the sample of rapeseed mustard growers. The total sample size was 200 comprises 100 respondents from Jammu & Samba districts falling under sub-tropical zone & 100 from Reasi & Doda district falling under temperate zone of Jammu province. Overall adoption of different production recommendations was low in study area. Irrigation facility, knowledge about production recommendations and agro-climatic zone were important variables which affected the adoption decision of recommended sowing time (R^2=.150), recommended seed rate (R^2=0.515), urea (R^2=0.065), DAP (R^2=0.599) and insecticide (R^2=0.207). This study provides an empirical feedback to research and extension agencies in the Jammu region for making farmer specific research and extension endeavors for increasing the adoption of recommended technologies by the mustard growers at farm level which will lead to higher productivity of rapeseed crop in UT of Jammu and Kashmir in general and Jammu region in particular.

Keywords: Rapeseed, Mustard, Adoption, Adoption gap, Production recommendations

INTRODUCTION

Rapeseed-mustard is a group of crops comprising rapeseed (toria, brown sarson and yellow sarson) cultivar of *Brassica campestris;* Indian mustard (*Brassica juncea*); black mustard (*Brassica nigra*) and taramira (*Eruca sativa*). Some exotic species of Brassicas like gobhi sarson (*B. napus*), Ethopian mustard or karanrai (*B. carinata*) and white mustard (*Sinapis alba*) have been brought into cultivation in India. Rapeseed mustard is one of the primary source of oilseed (Anonymous, 2021). Rapeseed mustard is the second most important edible oilseed crop in India after groundnut. The importance and potential of rapeseed-mustard crop is well known as it is the key oilseed crop that can help in addressing the challenge of demand - supply gap of edible oil in India. India is one of the largest rapeseed mustard growing countries in the world, occupying the first position in area and third largest rapeseed-mustard producer in the world, accounting for about 12 per cent of the world's total rapeseed-mustard "seed" and about 8.5 percent of the world's total rapeseed-mustard "oil. India contribution to the world rapeseed mustard acreage and production is 19.8 per cent and 9.8 per cent respectively (Anonymous, 2019). Rapeseed mustard is a major oilseed crop of Rabi season in Jammu and Kashmir. In J&K total area under rapeseed mustard crop is 55236 ha and in Jammu province the total area under rapeseed mustard crop is about 11241 ha comprises of both temperate and sub-tropical area. Total production is about 37000 mt and average Productivity of rapeseed mustard in J&K is 6.99 qts/ha which is 35.30 per cent of global

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productivity and 46.63 per cent of national productivity. (Anonymous, 2018). Rapeseed mustard is cultivated both in temperate and sub-tropical regions. Non-adoption of recommended varieties is the main reason for low productivity of rapeseed mustard in sub-tropical regions of Jammu division as reported by Ajrawat *et al.* (2013) in their study on rapeseed mustard crop. Adoption of technological improvements is crucial to increase agricultural productivity to help reduce poverty by obtaining higher farm incomes due to higher productivity and lower production costs. Adoption is a decision to make full use of an innovation as the best course of action available (Rogers and Shoemaker, 1971). Lionberger (1960) defined adoption as the integration of an innovation into farmer's ongoing operation through repeated and continuous use. The yield of rapeseed mustard crop like other crops primarily depends upon the adoption of recommended practices. Relevant agro-climatic specific production and protection technologies for the cultivation of rapeseed mustard cultivation have been developed by the SKUAST-J. However, the varying adoption of recommendations leads to large difference between the potential yield and the actual yield of the crop. But there is no comprehensive empirical data available to access the status of adoption of these practices by the rapeseed mustard growers of the region. Lack of adoption of major production & protection recommendations is the main reason for low productivity of rapeseed mustard in sub-tropics of J&K as compared to national productivity. (Slathia *et al.*, 2016). In view of this and to enhance the adoption of recommended practices, it becomes necessary to know the present status of adoption of recommended practices and reasons leading to their non-adoption. Therefore the present study entitled "Factors affecting adoption of rapeseed mustard production recommendations in Jammu region of Jammu & Kashmir" was undertaken.

MATERIALS AND METHODS

Non-experimental diagnostic research design and stratified random sampling technique was employed for the present study. In non-experimental research, the independent variables are not manipulated by the researchers. Researchers study the aspects, what naturally occur or have already occurred, and in addition, also study how variables are related. Diagnostic research design is a design in which the major emphasis is on diagnosing the real cause of a particular situation. Stratified random sampling technique was employed for selection of districts for the present study. At first stage all the ten districts of Jammu division were divided into two strata. First strata includes districts having overall maximum area falling under sub-tropical zone and second strata includes districts having maximum area under temperate zone. From sub-tropical zone, Jammu & Samba district, whereas from temperate zone, Reasi and Doda were purposively selected on the basis of maximum area under rapeseed mustard crop in these districts. Based on the maximum area under rapeseed mustard crop, two blocks from each district were selected purposively. R.S. Pura and Bishnah blocks from Jammu district, Purmandal and Vijaypur blocks from Samba district, Mahore and Arnas blocks from Reasi district and Bhaderwah and Marmat blocks from Doda district were selected. A list of rapeseed mustard growers for each of the selected block was prepared with the help of concerned agencies. From a total list of 1177 rapeseed mustard growers in the selected blocks, 25 rapeseed mustard growers from each block were selected by random sampling method making a total sample size of 200 rapeseed mustard growers for assessing the adoption of rapeseed mustard production recommendations.

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of rapeseed mustard farmers interviewed. Overall average age in all the four study districts was 49.02 years (±13.09). Majority of rapeseed mustard growers (51.00 per cent) belong to middle age group (43-60 years) followed by 32.00 per cent (18-42 years) group and 17.00 per cent (61-85 years) group respectively. The average overall formal education was 8.00 years (±4.00). The data in Table 1 indicates that in case of rapeseed mustard growers in Samba district 84 per cent had nuclear families followed by 80.00 per cent in Doda, 76.00 per cent in Reasi and 70.00 per cent in Jammu district. The percentage of joint families of rapeseed mustard growers was 16.00, 30.00, 24.00 and 20.00 in Samba, Jammu, Reasi and Doda districts respectively. With respect to categorization of family size done by 'Singh's Cube root method (1975) overall 71 per cent of the mustard growers had a family size

Table 1: Socio-economic profile of sampled rapeseed mustard growers

Parameter	Samba (n=50)	Jammu (n=50)	Reasi (n=50)	Doda (n=50)	Overall %tage (N=200)
Average age	51.20 ±14.37	51.10 ±11.35	46.64 ±11.24	47.14±13.09	49.02±13.09
Age categories (per cent farmers)					
18-42 yrs	32	18	36	40	32
43-60 yrs	42	64	54	46	51
61-85 yrs	26	18	10	14	17
Education (per cent farmers)					
Illiterate	16	14	38	10	20
Below primary	02	00	02	00	01
Primary	14	02	8	10	08
Middle	24	18	26	26	24
Matric	32	38	16	38	31
10+2	08	18	04	12	10
Graduate and above	04	10	06	04	06
Average education (formal no. of schooling years completed)	7.47±4.04	9.34±4.07	5.66±5.00	8.42±3.55	7.79±4.39
Average family size	6±2.65	7±3.12	7±2.45	7±3.85	7±3.08
Type of farm households (per cent farmers)					
Joint	16	30	24	20	23
Nuclear	84	70	76	80	77
Size of farm households (per cent farmers)					
2-7 members	80	72	64	68	71
8-11 members	18	22	34	20	24
12-22 members	02	06	02	12	05
Land holding (in ha)					
Avg. operational land holding (S.D)	1.81(±2.12)	1.61(±1.31)	2.10(±1.72)	1.08±.96)	1.64(±1.63)
Average irrigated land holding (ha)	1.22 ±2.20	1.57 ±1.32	0.18 ±3.40	0.11 ±0.32	0.77±1.44
Average un irrigated land holding	0.59 ±1.01	0.04 ±0.14	1.91±1.58	0.97 ±.96	0.88±1.25
Categories of farmers (% farmers)					
Marginal (<1 ha)	44	34	30	56	41
Small (1-2 ha)	22	32	24	28	26
Semi-medium (2-4 ha)	22	26	30	12	23
Medium (4-10 ha)	10	08	16	04	09
Large (>10 ha)	02	00	00	00	01
Average farming experience (years)	29.84±12.99	27.00±10.29	25.00±10.29	23.48±12.36	26.33±11.63
Average distance from (in km)					
Agri office	3.68±2.45	3.72±2.93	10.04±9.68	11.39±7.55	7.21± 7.30
Seed store	3.68±2.45	3.42± 2.72	9.32± 9.37	7.29±3.97	5.93± 5.92
Fertilizer store	2.12± 2.10	2.76± 2.30	9.32± 9.37	7.29±3.97	5.37± 6.09
Pesticide store	2.12±2.10	2.76± 2.29	9.49± 9.39	7.29±3.97	5.39± 6.09
Market	3.96 ±3.33	3.80 ±2.78	9.64±9.38	7.69±3.79	6.22±6.06
Social participation (%)					
Membership of an organization	6	4	12	08	10
No membership in any organization	94	86	88	92	90
Extension contacts with different agencies (%)					
Yes	60	52	40	50	51
No	40	48	60	50	49

of 2 to 7 members followed by 24 per cent growers who had family size of 8 to 11 members and only 5 per cent growers had family size between 12 to 22 members per family (Table 1). Overall average operational land holding of mustard growers in the study area was 1.64 hectare which was higher than state average land holding size of 0.67 hectare (DSE, 2007). The present findings got support from the study conducted by Hadiya and Deshmukh (2014) in which they reported that majority of oilseed growers belong to middle age category.

Data presented in Table 2 show that overall cultivated area of mustard growers in all the four sampled districts was 330.42 ha and out of which 40.37 ha was under rapeseed mustard cultivation which constitutes 12 per cent of total cultivated area. Only 25 per cent of total area under rapeseed mustard crop was irrigated in study area. Raya covered maximum 69 per cent (27.99 ha) of total sampled rapeseed mustard area followed by gobhisarson 14 per cent (5.56 ha), toria 10 per cent (4.20 ha), mixed toria and gobhi sarson 4 per cent (1.65 ha) and 2per cent area under

Table 2: Area under rapeseed mustard crops (in hectares)

Area (ha)	Samba (n =50)	Jammu (n =50)	Reasi (n =50)	Doda (n =50)	Overall total	Overall (%)
Cultivable area (ha)	90.50	81.12	105.15	53.65	330.42	-
Total Rapeseed mustardarea	6.91(8%)	7.49(9%)	18.97(18%)	7.0(13%)	40.37	12
Irrigated	3.12(45)	6.84	0	0	9.96	25
Un-irrigated	3.79(55)	.65	18.97(100)	7(100)	30.41	75
Indian Mustard (Raya)	2.02(29)	3.20(43)	15.77(83)	7.0(100)	27.99	70
Irrigated	0	3.20(100)	0	0	3.20	11
Un-irrigated	2.02(100)	0	15.77(100)	7.0(100)	24.79	89
Gobi sarson	2.44(35)	1.57(21)	1.55(8)	-	5.56	14
Irrigated	1.32(55)	1.27(81)	0	-	2.59	47
Un-irrigated	1.12(45)	.30(19)	1.55(100)		2.97	5
Toria	1.75()	0.80(11)	1.65(9)	-	4.20	10
Irrigated	1.25(71)	.70(88)	0		1.95	46
Un-irrigated	.50(29)	.10(12)	1.65(100)		2.25	54
Hybrid	.05(1)	.92512	-	-	.97	2
Irrigated	.05(100)	.67(73)	-	-	.72	74
Un-irrigated	0	.25(27)			.25	26
Mixed cropping area (Toria + gobisarson)	.65(9)	1.00(13)	-	-	1.65	4
Irrigated	.50(77)	1(100)	-	-	1.50	91
Un irrigated	.15(23)	0	-	-	.15	9

Table 3: Source of seed (percent farmers)

Source of seed	Samba (n =50)	Jammu (n =50)	Reasi (n =50)	Doda (n =50)	Overall (%)
Department of Agriculture	42	32	20	16	27
Agri University/KVK	12	18	-	-	8
Private Input dealers	16	28	10	6	15
Fellow farmers	4	10	20	30	16
Own saved seed	30	20	50	50	37

*Multiple responses

hybrid gobhisarson (0.97 ha) respectively. Maximum irrigated area was under mixed sown toria and gobhi sarson crop (91%) followed by hybrid gobhi sarson (74%). Data presented in Table 3 show that overall 37 per cent mustard growers had used last year saved seed for growing their next mustard crop followed by 27 per cent growers who obtained seed from department of agriculture, 16 per cent took seed from fellow farmers,15 per cent purchased from private input dealers and only 8 per cent obtained seed from SKUAST-J/KVKs.

Data presented in Table 4 show that in Samba district total area under rapeseed crop was 6.91 ha and out of which seed was replaced on 42 per cent (2.90 ha) area in the study year. In Jammu district total area under rapeseed crop was 7.49 ha and out of which seed was replaced on 51 per cent (3.85 ha) area. In Reasi district total area under rapeseed crop was 18.97 ha and out of which seed was replaced on 28 per cent (5.22 ha) area. In Doda district total area under rapeseed crop was 7.0 ha and out of which seed was replaced on 26 per cent (1.85 ha) area. Overall seed replacement

Table 4: Seed replacement ratio of rapeseed mustard crop in study area

Particulars	Samba	Jammu	Reasi	Doda	Overall total
Total area under rapeseed mustard crops (ha)	6.91	7.49	18.97	7.0	40.37
Area under replaced seed (ha)	2.90	3.85	5.22	1.85	13.82
Seed replacement ratio	42%	51%	28%	26%	34%

Table 5: Adoption status of different production recommendations of rapeseed mustard crop

Practices	District wise percentage of respondents				Overall
	Samba (n=50)	Jammu (n=50)	Reasi (n=50)	Doda (n=50)	Percentage (n=200)
Varieties grown					
Recommended (RSPR-1, Pusa Vijay, Giriraj KOS-1, KS-101, DGS-1, RSPT-1)	31(62%)	27(54%)	14(28%)	5 (10%)	77(38.50%)
Average seed rate (kg/ha)	5(±2.07)	6(±2.17)	13(±5.59)	22(±5.58)	11.41(±8.10)
Level of adoption					
Equal to recommended (5 kg/ha & 7.5 kg/ha in case of KOS-1, KS-101)	22(44%)	23(46%)	2(4%)	1(2%)	48(24%)
Sowing method	**Extent of adoption (%)**				
Broadcasting	100	95	100	100	99
Line sowing	0	5	-	-	1
Seed treatment	**Extent of adoption**				
Used treated seed (%)	72	68	27	42	44
Fertilizer applied	**Extent and level of adoption**				
Percentage of farmers used urea	37(74%)	36(72%)	18(36%)	17(34%)	108(54%)
Recommended (00-110 kg/ha)	3(6%)	8(16%)	5(10%)	12(24%)	28(14%)
Percentage of farmers used DAP	40(80%)	43(86%)	-	6(12%)	89(44.50%)
Equal to recommended (60-70 kg/ha)	4(10%)	5(12%)	5(100%)	-	14(7%)
Percentage of farmers used MOP	-	2(4%)	-	-	2(1.0%)
Thinning	8(16%)	10(20%)	-	4(8%)	22(11%)
Irrigation	23(46%)	50(100%)	-	-	73(36.50%)
Herbicides	-	3(6%)	-	-	3(1.50%)
Plant protection spray	9(18%)	17(34%)	-	7(14%)	33(16.50%)

ratio was 34 per cent in study area in 2015 with maximum seed replacement ratio in Jammu district.

Data presented in Table 5 show adoption of different production recommendations of rapeseed mustard crop. Overall 38 per cent mustard growers adopted the cultivation of recommended varieties. Average seed rate used by the sampled growers for growing rapeseed mustard in Doda district was 22 kg/ha (±5.58) followed by 13 kg (±5.59), 6kg (±2.17) and 5kg (±2.07) per hectares in Reasi, Jammu and Samba districts respectively. Overall 24 per cent mustard growers adopted the recommended seed rate for sowing rapeseed mustard crop. Overall 1per cent adopted the line sowing and 99 per cent had sown their crop by broadcasting method. Further with regard to seed treatment 44 per cent growers used the treated seed. With regard to extent of adoption of urea and DAP in raya data presented in Table 5 depict that overall 54% and 44.50% sampled farmers had used urea and DAP in cultivation of rapeseed mustard crop respectively. Regarding level of adoption overall only 14% and 7% sampled mustard growers used the recommended quantity of urea fertilizer. Overall only 1% sampled mustard growers applied MOP fertilizer. Overall only 11 percent farmers adopted the practice of thinning and 36.50% applied irrigation in their rapeseed mustard crop. Only 1.50% sampled farmers used the herbicides for control of weeds in mustard crop and 16.50% sampled farmers sprayed their mustard crop with different insecticides and fungicides for protecting their crop from attack of different insects mainly aphid and diseases. The present findings regarding the adoption of different production recommendations such as adoption of recommended varieties, sowing time, recommended doses of fertilizers and adoption of plant protection practices of different crops under rapeseed mustard group mainly raya, gobisarson, and toria got support from the earlier studies conducted on rapeseed mustard crop by Sharma *et al.* (2013); Monayemmiah *et al.* (2015); Meena and Shekhwat (2015), Mauriya *et al.* (2019) and Singh (2003).

The mustard growers were categorized into three levels of adopters namely low (0-3), medium (4-7)

Table 6: Categorization of growers on the basis of adoption of major production recommendations of rapeseed mustard crop

Adoption level	Samba	Jammu	Reasi	Doda	Overall (%)
Low level (0-3)	24	6	86	84	50
Medium level (4-7)	64	68	14	16	41
High level (8-16)	12	26	0	0	9
Average adoption score (S.D)	5.14(±2.04)	6.22(±2.00)	2.44(±1.05)	2.36(±1.38)	4.04(±2.35)

Table 7: District wise one way analysis of variance in mean difference of adoption score (ANOVA)

(I) Districts	(J) Districts	Mean Difference (I-J)	Std. Error	p-value	Model Summary
Samba	Jammu	-1.08000*	.32715	0.001	F=70.665
	Reasi	2.70000*	.32715	0.000	P=.000
	Doda	2.78000*	.32715	0.000	
Jammu	Samba	1.08000*	.32715	0.001	
	Reasi	3.78000*	.32715	0.000	
	Doda	3.86000*	.32715	0.000	
Reasi	Samba	-2.70000*	.32715	0.000	
	Jammu	-3.78000*	.32715	0.000	
	Doda	.08000	.32715	0.807	
Doda	Samba	-2.78000*	.32715	0.000	
	Jammu	-3.86000*	.32715	0.000	
	Reasi	-.08000	.32715	0.807	

Table 8: Factors affecting the adoption of different inputs in rapeseed mustard cultivation (Binary logistic regression)

Monetary Inputs	Independent variables	Coefficient B	S.E.	Wald	df	p-value	Model summary
Recommended	**Constant**	-10.377	3.007	11.906	1	0.001	Nagelkerke
Seed rate	Age	0.083	0.036	5.407	1	0.020	R Square=.515
	Land holding	0.402	0.165	5.938	1	0.015	-2Log
	Knowledge	0.202	0.101	3.996	1	0.046	likelihood=154.550
	Extension contact	1.052	0.417	6.356	1	0.012	X^2=91.521
	Irrigation	1.839	0.482	14.529	1	0.000	
Urea	**Constant**	0.538	0.205	6.888	1	0.009	Nagelkerke
	Distance from agricultural office	-0.066	0.022	8.936	1	0.003	R Square=.065 -2Log likelihood=275.053 X^2=10.213
DAP	**Constant**	-7.692	2.420	10.105	1	0.001	Nagelkerke
	Extension contact	1.076	0.386	7.769	1	0.005	R Square=.599
	Attitude	0.215	0.061	12.370	1	0.000	-2Log
	Irrigation	1.680	0.422	15.834	1	0.000	likelihood=160.449
	Agri. office distance	-0.213	0.054	15.551	1	0.000	X^2=121.837
	Agro climatic zone	-1.967	0.442	19.829	1	0.000	
Insecticides	**Constant**	-2.294	0.398	33.298	1	0.000	Nagelkerke
	Social participation	1.627	0.603	7.272	1	0.007	R Square=.207
	Irrigation	1.631	0.441	13.698	1	0.000	-2Log
	Agro climatic zone	-0.915	0.455	4.046	1	0.044	likelihood=154.737 X^2=26.539
(Non-monetary	**Constant**	-2.686	0.776	11.981	1	0.001	Nagelkerke
input)	Main Occupation	-0.888	0.315	7.965	1	0.005	R Square=.150
Recommended	Knowledge	0.202	0.070	8.336	1	0.004	-2Log
sowing time	Extension contact	0.778	0.292	7.117	1	0.008	likelihood=256.734
	Agro-climatic zone	0.698	0.318	4.828	1	0.028	X^2=24.459

and high (8-16) by employing Singh cube root method (1975) as depicted in Table 6. In Samba district 64.00 per cent growers had medium level of adoption of different production recommendations of rapeseed mustard crop followed by 24.00 per cent low level of adoption and 12 per cent had high level of adoption. In Jammu district 68.00 per cent growers had medium level of adoption followed by 26.00 per cent growers who had high level of adoption and 6.00 per cent growers had low level of adoption. In Reasi district 86.00 per cent growers had low level of adoption followed by 14.00 per cent growers who had medium level of adoption. In Doda district 84.00 per cent growers had low level of adoption followed by 16.00 per cent growers who had medium level of adoption.

Analysis of data given in Table 7 shows that except between Reasi and Doda district there is significant difference between others sampled districts regarding adoption of different production recommendations of rapeseed mustard crop. The model so applied was significant with p-value 0.000 and f-value 70.665.

Data presented in Table 8 show factors affecting the adoption of different monetary and non-monetary inputs by respondent mustard growers in mustard cultivation. Age, land holding, knowledge, extension contact and irrigation significantly affected the use of recommended seed rate with R^2 value of model 0.515

which means 51 per cent variation in use of recommended seed rate is due to these independent variables. Distance from agricultural office was negatively significant which affected the use of urea by mustard growers with R^2 value 0.065 which means more the distance from agricultural office, lesser will be the use of urea. In case of use of DAP extension contact, attitude, and irrigation was positively significant and distance from agricultural office and agro-climatic zone was negatively significant which affected the use of DAP fertilizer by the mustard growers with R^2 value 0.599 which means 60 per cent decision to use DAP is affected by these independent variables. Use of insecticides is significantly affected by independent variables such as social participation, irrigation and agro climatic zone with R^2 value 0.207 which means decision to use insecticide in mustard crop is affected by these variables to the tune of 20 per cent. Adoption of non-monetary input i.e. recommended sowing time was significantly affected by independent variables such as occupation, knowledge, extension contact and agro-climatic zone to which the mustard growers belong with R^2 value 0.150 which means 15 per cent variation in adoption of recommended sowing time was due to these independent variables selected for analysis. The present findings regarding different socio-personal and economic factors affecting adoption of different rapeseed mustard production technologies especially in temperate study area adequately supported by study conducted by Sheikh *et al.* (2013) in north-western temperate Himalayan region of India on mustard crop and reported that level of knowledge with some socio-personal, psychological and communication variables among respondent farmers have indeed helped in contributing to extent of adoption of improved rapeseed mustard production technology amongst farming community. The present findings also got support from study conducted by Rai *et al.* (2012) in which it is reported that attributes knowledge of production technology, annual income, level of education, socio-economic status, social participation, extension participation, size of land holding were positively and significantly correlated with adoption of mustard production technology. The present findings also got support from the study conducted by Lakhera *et al.* (2011).

CONCLUSION

On the basis of above findings it is concluded that adoption of different rapeseed mustard production recommendations is very low in the study area. Wide gap between rapeseed mustard production technologies especially protection technologies produced in research institutions and adoption of these technologies by farming community at their field level is the main reason behind low productivity of rapeseed mustard crop in J&K than its potential level. Field extension functionaries need to lessen this adoption gap by preparing farmers to adopt recommended technology so that farmers may increase their farm income from rapeseed mustard cultivation. Exposure visits of farmers, trainings and demonstrations should be conducted at regular intervals for enhancing the adoption of recommended crop cultivation technologies by the farming community.

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Digital Agriculture: An Emerging Approach Towards Sustainability in Agriculture and Rural Development

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ABSTRACT

Agriculture is the mainstay of the Indian economy and 70 percent of the Indian population lives in rural areas, so rural development is essential for the progress of the economy. Various internet-based inventions have been designed to uplift rural areas like e-agriculture, e-education, e-health services, e-marketing, e-banking, e-finance, e-insurance, etc. Digital agriculture or e-agriculture is the use of digital technology to integrate agricultural production from the paddock to the consumer and these technologies enable farmers and other stakeholders within the agriculture value chain to improve food production. The natural resources are depleting day by day and it is going to be a big challenge to feed the population in the near future. To ensure food security and maintain sustainable agriculture there is a need to strengthen farmers by timely and expert suggestions on recent technologies applicable in agricultural and rural development. Rural areas are predominantly underdeveloped with fewer possibilities of orienting technology to address their specific needs. To achieve a sustainable level of food production it is necessary that they must have seamless access to technologies based on remote sensing, soil sensors, unmanned aerial surveying and market insights, etc., for the information on the weather; production and cultivation techniques; seeds and fertilizers; plant nutrients and water usage; funds and liability coverage through digital agriculture; assistance from universities on new techniques; market infrastructures that will permit farmers to gather, visualize and assess crop and soil health conditions at different stages of production, in a convenient and sustainable manner. In the current scenario, the role of information technology (IT) assumes great importance, and only with proper integration of IT with agriculture and rural sector, the problems can be handled and the country can make progress toward achieving sustainable production.

Keywords: Digital agriculture, Rural development, Information technology, Sustainable agriculture

Introduction- The Digital Agriculture

The agriculture industry in India is one of the most important in the country's economy, with a current worth of US$ 370 billion. Agriculture has gone through a series of revolutions that have increased efficiency, production, and profitability to previously unimaginable heights. The first agricultural revolution enabled humanity to settle, which resulted in the establishment of the world's earliest societies and civilizations. Further revolutions introduced mechanization (between 1900 and1930), the creation of new, more resistant crop types, and the use of agrochemicals (during "The Green Revolution" in the 1960s), which were all followed by the emergence of genetic modification technology (between 1990 and 2005). With established agricultural methods and supporting regulations, the government has taken significant strides to help and strengthen the agriculture industry over time. The current progress of "digital technology" in agriculture will help to accelerate growth by assuring greater agricultural yields and improving sustainability by lowering water consumption and pesticide usage. As part of Industry 4.0, the widespread availability of highly interconnected and data-demanding computational technology opens up new potential for digital agriculture (Schwab, 2016). Digital agriculture is the use of digital technology to

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integrate agricultural production from the paddock to the consumer and these technologies enable farmers and other stakeholders within the agriculture value chain to improve food production. Digital agriculture is also known as smart farming or e-agriculture which digitally collect, store, analyse and share electronic data and/or information in agriculture.

The rise of digital agriculture could be the most transformative and disruptive of all the industries because digital agriculture will not only revolutionize how farmers cultivate their fields but will also fundamentally overhaul every component of the agrifood value chain. Farmer's behavior will be influenced by digital agriculture, as will the marketing and sales strategies used by input providers, processors, and retailers. It can be applied to all aspects of agrifood systems and reflects a change in generalized management of resources towards highly optimized, individualized, intelligent and anticipatory management, in real time, hyperconnected and driven by data. The targeted outcomes of digital agriculture include higher-productivity systems that are safe, anticipatory, and adaptive to the effects of climate change, resulting in increased food security, profitability, and sustainability.

Need of Digitalization in Agricultural and Rural Development

Agriculture is the mainstay of the Indian economy and 70 percent of the Indian population lives in rural areas (Nedumaran and Manida, 2020), so rural development is essential for the progress of the economy. The natural resources are depleting day by day and it is going to be a big challenge to feed the population in the near future. To ensure food security and maintain sustainable agriculture there is a need to strengthen farmers by timely and expert suggestions on recent technologies applicable in agricultural and rural development. Rural areas are predominantly underdeveloped with fewer possibilities of orienting technology to address their specific needs. To achieve a sustainable level of food production it is necessary that they must have seamless access to technologies based on remote sensing, soil sensors, unmanned aerial surveying and market insights, etc., for the information on the weather; production and cultivation techniques; seeds and fertilizers; plant nutrients and water usage; funds and liability coverage through digital agriculture; assistance from universities on new techniques; market infrastructures (Suresha, 2019) that will permit farmers to gather, visualize and assess crop and soil health conditions at different stages of production, in a convenient and sustainable manner.

Application of Digital Technologies in Agriculture and Rural Development

Different digital technologies in agriculture and rural development may be described as follows:

Communication technology in agriculture and rural development: Information is power; the better informed a person is, the more empowered he is. Information is a flowing asset which is continuously generated, disseminated and gets utilized which needs an unhindered information communication system. However, it is a contradiction that rural India has one of the world's least connected populations. Recent advancements in space science and information communication technology have opened up a world of potential for this underprivileged segment of India's population. The rural masses are largely disconnected from the outer world and the internet is the only way to make them global which is an effective medium to introduce the world to those rural masses and their socio-cultural aspects. In the current scenario, the role of information technology (IT) assumes great importance, and only with proper integration of IT with agriculture and rural sector, the problems can be handled and the country can make progress toward achieving sustainable production (Suresha, 2019). The quality and quantity of agricultural output will undoubtedly improve as a result of IT-based agriculture. Various internet-based technologies have been developed to help rural communities. Some of them are (Suresha, 2019):

IT infrastructure and network in rural areas: IT not only provides technology for farming methods but also provides the best source to get farm inputs and the best destination to sell their produce at the best price. Extension agents and field workers can use internet-based interventions to provide communities with up-to-date information. Several technologies have been developed to take into account the region's agro-ecological environment and have been released into the globe, where people may access them by visiting numerous rural portals.

E-education: The rural population is largely illiterate and uneducated. Many educational professionals believe that the only cost-effective option to give high-quality education to the people is through IT. Developing a programme to teach the village's core group (VCG), which includes women and energetic youth, would ensure that information technology reaches the average person even in the most distant corners of the country.

E-health service: Information technology tools are available to improve communication, consultation and two way refer all linkages from primary health care to tertiary health care level. Telemedicine is a combination of information technology and medicine that will assist the rural population in the near future. Telemedicine can assist people in rural regions with distant diagnostic services and the extension of super specialised hospital care.

E-marketing: The Internet has strengthened the marketing information and marketing intelligence services. Without travelling to the customer's door and spending a lot of money on the intermediaries, one may sell and negotiate the price of produce by sending e-mails to the buyer.

E-banking: To provide the banking facility and to develop banking habits among the rural population, e-banking is essential as it facilitates e-finance and e-insurance to the farmers quickly and without much paperwork. ATMs are becoming increasingly popular among e-banking services. Queries about loans and savings may be quickly answered via the internet and e-banking.

E-government: It refers to information communication technology (ICT) enable route of governance. The government may link the rural people with their administrators through e-governance, allowing them to inquire about the status of their problem's solution. Various global bank and centrally supported e-governance initiatives, such as Meghdoot in Madhya Pradesh and Bhoomi in Karnataka, are now operational. Over 700 VSATS, the NICNET (National Informatics Centre Network) is being utilised to offer a countrywide data communication link between the district and state capitals for administrative planning and other purposes.

E-panchayat: For the first time in the country, electronic knowledge-based panchayat is introduced in Andhra Pradesh by the National Information Centre (NIC) of the Department of Information Technology (DIT). As a pilot basis in Ramachandrapuram Gram Panchayat in Medak District of A.P., here all the functions of panchayat are computerized and web-enabled. In the computerised e-panchayat system, services such as birth and death registrations, home tax assessment and collection, trade licencing, old age pension, job monitoring, financial accounting, and so on are all carried out over the internet. E-panchayat also provides additional services to the residents of the village, such as market information and agricultural extension services.

***Mobile applications, social media and networks among agriculture stakeholders*:** The use of mobile applications to help businesses has increased dramatically. Mobile agricultural apps have a lot of potential for modernizing the agricultural sector in both developed and developing countries because they can help small-scale farmers earn more money, reduce the cost of supply and distribution transactions, increase consumer traceability and quality requirements, and provide financial institutions more opportunities (Costopoulou *et al.*, 2016). There is an amazing range of agricultural applications available in developing nations, provided by either public institutions or local businesses. mKisan[1] is a prominent government portal in India that provides mobile apps for agriculture, horticulture, animal husbandry, and other agriculture sectors. Also, Digital Green[2] operates in India, as an information provider with a focus on agricultural extension and increasing its efficacy and cost-efficiency. Esoko[3] and M-Pesa (owned by the vodafone group) operate in various countries, providing information to farmers on different segments in the Agri-value chain through SMS and voice. Plantix[4], developed by PEAT (German startup) is a mobile application, which is a

[1]https://mkisan.gov.in/
[2]www.digitalgreen.org/
[3]https://esoko.com/
[4]https://www.networkedindia.com/2016/10/11/geman-startup-peats-plant-disease-appempowering-indian-farmers/

massive database of pictures of plant diseases that can be used for comparison. This aids in the identification, diagnosis, and treatment of the problem. PEAT's mission is to help farmers all around the world improve their agricultural productivity by providing prompt and accurate disease treatment. The facility is now also available[5] over WhatsApp where just an image of the infected leaf is required to be sent to the Plantix WhatsApp number and the diagnosis is messaged back to the sender in real-time and many farmers in India are using this service.

Social media is an engagement platform, and for agricultural producers, mass influence is the primary reason for adopting it (Varner, 2012). It gives farmers a voice and an opportunity to directly connect with customers, which can help in direct marketing aiming to increase profits alongside the facilitation of mass personal communication (Carr and Hayes, 2015). To agriculture as an industry, the key values of communication provided by social media are peer-to-peer networking, farmer to processing industry to consumer engagement (Stanley, 2013). It has been reported that there is increased use of social media among agricultural researchers, professionals, and other stakeholders in the agricultural sector (Sokoya *et al.*, 2012). Extensionists can utilize social media like YouTube, facebook, blogs, wikis, and podcasts, but the content and outreach must be decided based on the users (Gharis *et al.*, 2014). The Department of Agriculture in the Indian state of Karnataka has made it mandatory for agricultural development officials to have a smartphone in order to convey information, messages, and circulars via WhatsApp. The WhatsApp group "Baliraja," similar to facebook, allows farmers from distant areas to seek and exchange agricultural advice, as well as interact with specialists in other sectors and learn new ideas.[6]

Remote Sensing in Agriculture: Remote sensing is the science and art of acquiring information (special, spatial, and temporal) about material objects, areas, or phenomena under investigation, by a recording device that is not in physical or intimate contact with the object. Agriculture remote sensing is a potential technique in the agricultural information and management system. For a country like India, where agriculture is the basis of the economy, the comprehensive, trustworthy, and timely information on agricultural resources is critical. The agricultural survey is, in reality, the foundation for planning and allocating limited resources to various sectors of the economy. The government must increasingly employ this technology to handle numerous agricultural issues. Following are some techniques of how remote sensing can currently meet the information needs in agriculture (Suresha, 2019):

Agro-climatic mapping: Agro-climatic map based on remote sensing data assists in crop selection and subsequently guides various agricultural activities based on local resources and existing agro-climatic conditions in the region. It reduces the risks of farming and boosts revenue in rural regions. Yuktix Technologies is a Bangalore-based agritech business that specializes in developing digital solutions for agricultural field monitoring and risk management. Growers may use the solution to make better decisions and apply best practices that will boost productivity and reduce losses. The tools are powered by their GreenSense IoT (internet of thing) devices and GreenSense dashboard hardware and software solution. Yuktix GreenSense is an agricultural off-grid remote monitoring and analytics technology. GreenSense nodes with dashboards are a useful tool for monitoring and managing DPI (disease, pest, and irrigation). Their solar-powered weather stations deliver accurate weather information at any time and from any location. In Odisha, for example, they set up a network of Yuktix micro-weather stations to collect data from various locations, combine indigenous knowledge with research, and create a digital tool that allowed them to distribute crop-specific recommendations to a group of tribal farmers to encourage them to use climate-smart agriculture practices.

Soil mapping: The combined use of remote sensing data and ancillary information such as lithology and physiography has allowed for the mapping of soils at various scales, which is useful for land use planning.

Land use/land cover mapping: A good database for agro-climate regional planning for boosting food

[5]https://plantix.net/en/blog/plant-disease-detection-whatsapp
[6]https://agrinfobank.com.pk/whatsapp- inagriculture/

production, reclamation of degraded lands, and so on has been supplied by a map of land use/land cover generated on the basis of space-borne multispectral data.

Watershed development: The use of remote sensing data to map watersheds aids in the optimal design of arable and non-arable land, as well as the placement of natural drains. It not only aids in the prevention of various sorts of erosion, but it also aids in the creation of resources in the region.

Agricultural drought assessment: The vegetation index (VI) is a proxy indicator for the agricultural drought that is generated from space-borne data and is sensitive to moisture stress in crops.

Pest assessment and control: Possible pest investigation warming is the key to the preventive measure of first control which is not only cheap but also eco-friendly. Remote sensing-based locust control may become increasingly important in the future. Drones have been used for anti-locust spraying by the Agriculture Ministries at both the federal and state levels. They are proving to be effective[7] solutions in an otherwise challenging scenario where India stares at large amounts of crop loss[8] in the states of Rajasthan, Gujarat, Madhya Pradesh, and Uttar Pradesh.

***Precision farming technology (PFT)*:** A technology that combines a whole-farm management approach using ICT (Information and Communication Technology), satellite positioning (GNSS) data, remote sensing, and proximal data gathering for purpose of farming is precision agriculture (PA), which aims to reduce operating costs by preventing farmers from over-applying inputs. Even if input costs and operational costs rise as a result of PA, yields can rise sufficiently to boost profitability. The capital expenditures needed to implement PA technologies can raise overhead costs, but can also enable farmers to substitute capital and labor for operating inputs (Schimmelpfennig, 2017). Yield monitors, maps, and GPS guidance systems were the next most common practices with high adoption rates of more than 80 percent.

***Artificial Intelligence/Machine Learning (AI/ ML)*:** AI/ML algorithms can create real-time actionable insights to help boost crop output, control pests, assist in soil screening, give actionable data to farmers, and minimize their labor. AgroPad is an AI-powered technology helping farmers to check soil and water health. AgroPad[9], developed by IBM, is a paper device about the size of a business card. The card's microfluidics chip analyses the sample chemically on the spot and displays the results in less than 10 seconds. A drop of water or soil sample is placed on the AgroPad, and colorimetric test results are provided by the set of circles on the reverse of the card; the color of each circle signifies the quantity of a certain chemical in the sample. Using a smartphone and a dedicated mobile application, the farmer may take a single photo of the AgroPad and obtain an instant chemical test result for a water or soil sample (Mahindru, 2019).

Robotics and autonomous systems in agriculture: Agricultural robots, sometimes known as "agrobots", are seen as an upcoming technology that will deeply influence agriculture in the future. From nursery planting to shepherding and herding, robots are already in agriculture. For farming purposes, such as mechanical weeding, crop monitoring, fertilizer application, or fruit harvesting, automated, robotic vehicles have been developed. Advanced robotic systems will also take care of plants, as well as carry out on-farm data collection, resulting in increasing crop yields. Crop weeding robots are now available that use camera-guided hoes (Tillett *et al.*, 2008), precision sprayers (Binch and Fox, 2017), or lasers (Mathiassen *et al.*, 2006) to eliminate the need for pesticides for weed management.

Another option for automated equipment technology is the conversion of existing equipment into automated equipment. Normal tractors and other motorized equipment have been fitted with guiding

[7]https://economictimes.indiatimes.com/news/economy/agriculture/agriculture-ministryeyes-drones-for-night-duty-in-locust-fight/articleshow/76681161.cms

[8]https://www.financialexpress.com/lifestyle/science/locust-swarms-attack-centre-lists-outvarious-meas ures-taken-curb-the-menace/2020812/

[9]https://www.ibm.com/blogs/research/2018/09/agropad/

and sensor systems, allowing them to operate independently and in swarms. This opens up a big opportunity for farmers to evolve towards more efficient production systems without investing in brand new equipment and being able to operate their machinery, reducing the costs of adaptation and capacity building.

Agrobots also present a significant possibility for emerging countries agritech industries. The versatility of the equipment, which can be designed to do simple farm tasks like weeding or transporting goods, increasing farm productivity, and reducing drudgery, is linked to the creation of new job opportunities for qualified youth who may find a niche working in technological solutions customized to their country's context. This, along with the requirement for professional operators and technicians to maintain agrobots running, opens up a new business and career opportunity for young people in underdeveloped nations.

Quality assessment using technology: AgNext[10] produced a technology platform QuaLIX, to assess trade quality and safety parameters for multiple commodities (grains, pulses, tea, spices, herbs, milk, honey, etc.) in a minute. It's a platform for integrating quick quality assessments in the agriculture and food value chain by combining hardware, software, and data analytics with AI-based spectral and AI-based picture analytics. Thus, they claim that their solution, which uses a small pocket-sized gadget, can detect the chemical and physical composition of grains such as wheat, rice, pulses, maize, and oilseeds in less than a minute. The chemical composition of milk and honey may be determined using the same Bluetooth-enabled, battery-driven handheld equipment that works in tandem with a mobile application to identify the presence of adulterants. The same device also checks fat percentage, protein, lactose, and SNF (Solids-Not-Fat) content in a milk sample.

Block chain technology: Blockchain technology offers tamper-proof and precise data about farms, inventories, quick and secure transactions, and food tracking. As a result, farmers no longer rely on paperwork or files to record and save crucial data.

Government initiatives under Digital Agriculture in India

The government has introduced new strategies and initiatives to assist farmers in the form of e-government services, which entails the use of ICTs to enable citizens to assess the use of online services by governments to citizens ("e-information sharing"), interaction among various stakeholders ("e-consultation"), and participation in decision-making processes.[11] The Government has put in task three entrances viz. agriculturist gateway, Kisan call focus, and the mKisan entryway to enable ranchers to make educated choices for effective cultivating under differing agro-climatic conditions.

In August 1998, Indian banks established the Kisan Credit Card (KCC). This model credit card program was established by the National Bank for Agriculture and Rural Development. Its goal is to provide financial assistance to farmers in order to address the agricultural sector's comprehensive funding requirements. All commercial banks, regional rural banks, and state cooperative banks are among the participants. Farmers can get credit from Kisan Credit Card in two ways: cash credit and term credit for linked operations including pump sets, land expansion, plantation, and drip irrigations (Nedumaran and Manida, 2020).

Under the e-governance program, soil wellbeing card programming has been institutionalized and data is given to ranchers through numerous channels including Common Service Centers Internet Kiosks and SMS. The government's "Advanced India Project" venture propelled on the 1st July 2015 imagines enabling natives with e-access to taxpayer-driven organizations and work-related administrations, among others (Nedumaran and Manida, 2020). It tries to:

- Transform rural India into a learning economy that is well-equipped.
- Provide all-inclusive telephone availability and access to broadband in 250000 towns.
- Extend convenient administration to ranchers through data innovation and its devices.

[10]https://agnext.com/product.html#qualixsection

[11]https://publicadministration.un.org/ egovkb/enus/About/Overview/EParticipation-Index

- Improve rural administration productivity by using computerized education and electronic administration delivery.

In India, the "Aadhaar" biometric-based national identity system was established in 2010. Within a few years, almost 95 percent of India's 1.25 billion people were registered in the system.

Mr. Narendra Singh Tomar, Union Minister of Agriculture and Farmers Welfare, announced the launch of the Digital Agriculture Mission 2021–2025 in September 2021, while also signing five memorandums of understanding (MoUs) with CISCO, Ninjacart, Jio Platforms Limited, ITC Limited, and NCDEX e-markets Limited (NeML) to advance digital agriculture through pilot projects. The Digital Agriculture Mission 2021–2025 intends to encourage and accelerate initiatives based on emerging technologies such as artificial intelligence (AI), blockchain, remote sensing and geographic information systems (GIS), and the use of drones and robotics.

In August 2019, CISCO released an Agricultural Digital Infrastructure (ADI) solution that improves farming and knowledge exchange. This ADI is anticipated to play a key role in the data pool that will be created by the Department of Agriculture under the National Agri Stack. Kaithal (Haryana) and Morena (India) will host this initiative's pilot project (Madhya Pradesh).

The Jio Agri (JioKrishi) platform, which was introduced in February 2020, digitizes the agricultural ecosystem along the value chain to empower farmers. The main function of the platform uses stand-alone application data to provide advisory, the advanced functions use data from numerous sources, feed the data into AI/ML algorithms, and deliver accurate tailored advice. This initiative's pilot project will take place in Jalna and Nashik (Maharashtra).

Using a digital crop monitoring platform housed on ITC's e-Choupal 4.0 digital platform, ITC has suggested creating a personalized 'Site Specific Crop Advise' service to change traditional crop-level generic guidance into a personalized site-specific crop advisory for farmers. This initiative's pilot experiment will take place in Sehore and Vidisha (Madhya Pradesh).

To encourage farmers to utilize technology, the Ministry of Agriculture and Farmers Welfare has developed many important digital applications:

National Agriculture Market (eNAM): The National Agriculture Market (eNAM), which was launched in April 2016, is a pan-India electronic trading system that connects the current Agricultural Produce Market Committee (APMC) mandis to establish a unified national market for agricultural commodities. By earning competitive returns on their investment, eNAM assists farmers in selling their goods without the use of brokers or mediators.

Direct Benefit Transfer (DBT) Central Agri Portal: Launched in January 2013, the DBT Agri Portal is a unified central portal for agricultural schemes across the country. Through government incentives, the portal assists farmers in adopting new farm machinery.

In June 2021, the Ministry of Agriculture and Farmers Welfare and Microsoft signed a Memorandum of Understanding to run a pilot program in 100 villages across six states. Microsoft will use its cloud computing resources to establish a 'Unified Farmer Services Interface' as part of the MoU. This is a key component of the ministry's long-term ambition to develop 'AgriStack,' a single platform that would supply farmers with end-to-end services across the agriculture food value chain. For this, they intend to create unique farmer IDs for farmers across the country, which would be integrated with other government initiatives and used to establish digital agricultural ecosystems.

Benefits of Digital Agriculture

Implementing these technological solutions in place allows for more dependable farm management and monitoring. Farmers may respond appropriately since they have a comprehensive digital analysis of their farms in real-time and they can act accordingly by not applying excess pesticides, and fertilizers which will result in overall reduced water consumption. Other advantages include:

- Increased farm productivity and decreased production costs
- Inhibits soil degradation
- Lessens chemical application in crop production

- Encourages the efficient and effective use of water resources
- Uplifts socio-economic statuses of farmers
- Reduces environmental and ecological impacts
- Augments worker safety

Implementation of Digital Agriculture in India

Limited access to mechanisation equipment, as well as frequent natural disasters like droughts, floods, and heavy monsoon rains, have hampered the adoption of digital innovations in the sector. As a result, a specialized method to implement digital agriculture on a typical Indian small farm would be required, which could then be scaled up and made available to a large number of Indian farms. To make digital agriculture successful in India, the following initiatives could be undertaken:

Low cost technology: The average annual income[12] of an Indian farmer is >US$ 1,000. The difficult financial situation in which a typical Indian farmer operates is explained by this low revenue.

Portable hardware: As most Indian farms are tiny, plug-and-play gear has a better chance in the Indian market. Agricultural land leasing is also popular under various agricultural agreements, allowing a farmer to move from one plot of land to another the next season. Farmers would be better off investing in portable equipment in such scenarios.

Renting and sharing platforms for agriculture equipment and machinery: Owing to both constrained financial resources and small farm plots, the opportunity exists for digital platforms that offer equipment renting and sharing services instead of outright purchases. Farmkart (rent4farm), EM3 AgriServices, and Trringo are among the agritech start-ups that offer equipment rental services.

Academic support: Farmers are routinely interacted with by local agricultural organizations and academic institutes through a variety of locally run programs and government initiatives. Training facilities provided by multiple academic institutes and agricultural organizations will improve digital adoption among farmers. People in rural areas should be encouraged to join organizations in order to obtain access to financial institution initiatives.

Repacking of the internet–accessed information and combining internet technology with traditional or more effective dissemination medium like the radio, T.V., street theater, C.D. ROMs, and even folklore songs (Suresha, 2019). Alongside investment in technology, we need investment in skills and knowledge, to prepare for the future. The demand for new multidisciplinary digital talents is growing at a rapid pace. The skillsets required in the agrifood sector will change and transform how and where people work. The development of digital skill models is required for farmers in which they can learn the skills to quickly analyze, assess and implement the best actions, solutions, and technologies for their farm business.

CONCLUSION

It can be rightly stated that the potential impact of digital agriculture on rural development and sustainable productivity would be enormous. Overall, the scenario for digital agriculture is promising in India where different initiatives have been taken up by the government like the Kisan call center, mKisan portal, etc. to empower farmers to settle on taught decisions for profitable developments under evolving agro-climatic conditions. For making countries, the advances in enrolling power, accessibility, electronic thinking, biotechnology, GIS, and more state-of-the-art, progressively equipped headways hold monstrous assurance. In order for Digital Agriculture to really empower Indian farmers, there is a need for strong research and development that takes into account last-mile delivery and ground difficulties.

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Constraints Faced by Farmers of Samba District in Adoption of Marigold Production Technology

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ABSTRACT

Marigold is an important commercial crop among all flower crops. Its flowers are available year around. Marigold flowers are used for various purposes like: worshipping, as cut flower, for beautification of beds and borders in lawns, in textile industry and for medicinal purpose. Marigold cultivation is highly commercialized now days. But still area and production of marigold under Jammu province is less due to several factors. The present study was undertaken in Samba District of Jammu and Kashmir to investigate the constraints faced by marigold growers during production and marketing of marigold. This district consist of eight blocks from which Block Samba, Ghagwal, and Vijaypur were selected purposively. From each block four villages and from each village thirty farmers were selected, where the farmers were having largest area under marigold cultivation. Random samples of 120 farmers were drawn by randomization. A structured interview schedule was prepared for collection of date with a view to study various aspects regarding marigold cultivation. The data was collected through pre structured interview schedule and statistical procedures were employed to analyse the data. The study highlighted that majority of farmers have medium knowledge as well as medium level of adoption of marigold production techniques. The study further highlighted that majority of farmers were not adopting marigold cultivation due to various constraints like Input constraint, technical constraints, Economic constraints, extension constraints and Marketing constraints. The major constraints expressed by marigold grower in each group of constraints were lack of timely availability of good quality seed material, lack of knowledge about production technology, high cost of hybrid seeds, lack of information through mass media, lack of cooperative institutions for marketing.

Keywords: Constraints, Production technology marigold and adoption

INTRODUCTION

Floriculture is a fast emerging and highly competitive industry. Flowers are the beauty in human life. Flowers may be cheaper as well as costly one. But marigold is a flower of common man. Marigold flower have available year around. In addition to being a poplar garden flower today marigold are approved for use in the European Union as a food additive, acting as a natural food colorant and nutritional supplement. Now a day, marigold becomes popular among most of the farmers because this crop fetch maximum price from per unit area. Recommended package of practice for the marigold are cost effective and moreover, farmers are not aware about its cultivation techniques. Potential of marigold crop in Jammu province is more than their actual production on farmer's field. The gap between the potential yield and actual yield needs to be cover. Marigold has also an important spiritual and religious significance. Its flowers are used for making garlands as well as loose flowers for worshiping God. Flowers with long stalks are used as cut flowers. The vivid orange colour of marigold make them ideal for use décor on wedding cakes and other pastries prepare for celebratory occasions. Marigold flowers are also

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fed to chickens to increase lutein content of eggs and as a way to naturally produce an egg with a rich yellow hued yolk. In field, marigold is grown for keeping the nematode population under control and also as a trap crop against fruit borer in vegetables. Area under marigold in Jammu Division is 245.7 ha. In Samba District production and productivity of marigold is low as compare to other leading districts of state, as there is need to increase the potential of marigold crop.

The present study was undertaken in Samba District of Jammu and Kashmir. This is an investigation related to marigold growers and constraints faced by them during production and marketing. This district consists of eight blocks from which Block Samba, Ghagwal and Vijaypur were selected purposively. From each block four villages and from each village thirty farmers were selected, where the farmers were having largest area under marigold cultivation. The farmers from each village were arranged alphabetically and random sample of 120 farmers were drawn by randomization. A structured interview schedule was prepared for collection of date with a view to study various aspects. During investigation, the respondents expressed many reasons due to which they could not use recommended practices in their farming. The reasons or the causes were termed as constraint in the studies. The respondent was asked to indicate the constraints faced in adoption of recommended practices with its intensity of feeling on "yes or no answer." Obtained problems were expressed in terms of frequency and percentage. Rank order was given from the highest percentage to the lowest percentage.

Knowledge and adoption level of marigold growers: Knowledge and adoption level of the respondents were measured and date have been presented in Table 1. It has been observed from the date that more than half of the respondents were having medium knowledge level about marigold production technology i.e. 53, 20 & 25 per cent respondents were possessing low and high knowledge level, respectively. Further, it is evident from the table that 49 per cent of the respondents were medium adopters respectively. It may be resulted from the above findings that majority of the respondents were possessing medium knowledge level about Marigold production Technology and medium adopters the technology. Similar finding have been reported by Sharma and Sharma (2008).

Table 1: Distribution of marigold farmers according to their knowledge and adoption level

Categories	Knowledge	Extent of adoption
High	31 (25.83)	29 (24.16)
Medium	64 (53.33)	59 (49.16)
Low	25 (20.83)	32 (26.66)
Mean	33.33	33.32

Constraints faced by the respondents in adoption of marigold cultivation: During study, the respondent expressed many constraints which were grouped into following categories: 1. Input constraint 2. Economic constraint 3. Knowledge and information constraints 4. Marketing constraint. The responses of marigold growers with regard to constraints a presented in the table:

The finding on the constraints faced by marigold growers as perceived by the respondents related to input, technical know-how, finical, extension, related and marketing is given in Table 2.

Input constraints faced by the marigold growers: With regard to input supply constraints, the date reveal that, lack of timely availability of good quality seed material was the first major constraint faced by 68.33 per cent of marigold growers, followed by non availability of fertilizers in time (64.16%), less availability of subsidised inputs (51.6%), lack of pesticides and insecticides whenever required (46.6%), lack of organic manures (40%) and lack of live saving irrigation facilities (43.33%).

Technical constraints faced by the marigold growers: with respect to technical constraints, lack of knowledge about production technology (75.83%), lack of knowledge about varieties suitable to their area(66.66%), lack of knowledge about plant protection measures (60.83%), lack of knowledge about fertilizers application (57.50%), lack of knowledge about marketing aspect (53.33%), lack of knowledge about exact harvesting stage and packing of flowers (50.00%),lack of knowledge about important cultural operations (48.33%),lack of knowledge about selection

Table 2: Constraints faced by the marigold growers in adoption of marigold production Technology

S.No	Constraints	Frequency	Percentage	Rank
Input Constraints				
1	Lack of Timely availability of good quality seed material	82	68.33	I
2	Non availability of fertilizers in time	77	64.16	II
3	Lack of insecticides and pesticdies whenever required	56	46.66	IV
4	Lack organic manures	48	40	VI
5	Lack of assured irrigation	52	43.33	V
6	*Less availability of subsidized inputs*	62	51.6	III
Technical constraints				
1	Lack of knowledge about production technology	91	75.83	I
2	Lack of knowledge about varieties suitable to their areas	80	66.66	II
3	Lack of knowledge about plant protection measures	73	60.83	III
4	Lack of knowledge about marketing of flowers	64	53.33	V
5	Lack of knowledge about exact harvesting stage and packing of flowers	60	50.00	VI
6	Lack of knowledge about fertilizer obligation	69	57.50	IV
7	Lack of knowledge about selection and preparation of land	52	43.33	VIII
8	Lack of knowledge about important cultural operations	58	48.33	VII
Economic constraints				
1	High cost of hybrid seeds	94	78.33	I
2	High cost of manures and fertilizers	78	65.00	IV
3	High cost of insecticides and pesticides	76	63.33	V
4	High cost of labour	86	71.66	II
5	Costly in plant protection appliances	69	57.56	VI
6	Costly transportation	80	66.66	III
Extension constraints				
1	Lack of information through mass media	65	54.16	II
2	Lack of communication between extension persons and farmers	72	60.00	I
3	Non availability of literature in local language	58	48.33	III
Marketing constraints				
1	Lack of knowledge about proper place of sale of produce	64	53.33	IV
2	Lack of cooperative institute for marketing	78	65.00	I
3	Unavailability of vehicle for timely dispose of produce	46	38.33	VI
4	Commission agents are not giving proper rates to the farmers	72	60.00	II
5	Commission rates are high	58	48.33	V
6	Lack of storage van for transportation	68	56.00	III

and preparation of land (43.3%) were the major constraints faced by marigold growers.

Economic constraints: with regard to economic constraints high cost of hybrid seeds was major constraint (78.33%), followed by high cost of labour (71.66%), costly transportation (66.33%), high cost of manure and fertilizers (65%), high cost of insecticides and pesticides (63.33%), costly plant protection appliances (57.56%). Due to high cost of cultivation farmers showed less interest regarding marigold cultivation.

Extension constraints faced by marigold growers: Among extension constraints the marigold growers endorsed major constraints about lack of communication between extension personals and farmers (60%), lack of information through mass media (54.16%), non-availability of literature in local language regarding marigold cultivation (48.33%) was the major problem among the growers to understand its cultivation also.

Marketing constraints among marigold growers: In relation to the marketing constraints, lack of cooperative institute for marketing of produce (65%) was the first constraint expressed by the growers followed by the commission agents, they were not giving proper rates to the farmers (60%), another one of the major constraint endorsed by the farmer was lack of knowledge about the proper place of sale of produce (53.33%), lack of storage van for transportation (56%) because marigold flowers deteriorate due to their perishable nature; when they are packed uneven, unavailability of vehicle for timely dispose of produce 38.33 per cent and commission rates are very high (48.33%).

It can be concluded that the major constraints expressed by marigold grower in each group of constraints were lack of timely availability of good quality seed material, lack of knowledge about production technology, high cost of hybrid seeds, lack of information through mass media, lack of cooperative institutions for marketing. Similarly Verma (2012) also conducted an investigation on training need assessment of marigold farmers.

CONCLUSION

While analysing over all constraints as perceived by the farmers it was concluded that there is need to educate the farmer, either through organizing training programmes, proper demonstrations of improved technologies, awareness camps and by the use of mass media to encourage the farmers to go for marigold cultivation. There is also a need to educate the farmer on various marketing services available because the main aim of farmer is to dispose off his sale at proper place with a handsome earning so that the farmers can be profited by cultivation of marigold crop. Therefore, it is suggested that need based training programme should be conducting during crop season to improve the knowledge as well as the skill of the farmers.

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Yield and Economics as Influenced by Climate Resilient Agriculture Technological Interventions in Rabi Crops

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ABSTRACT

A field experiment was conducted during the *kharif*, *rabi* and *summer* seasons of 2019 and 2020 at different adopted villages of climate-resilient agriculture program by Krishi Vigyan Kendra of Bihar to evaluate the yield and economics of rabi crops through climate-resilient agriculture technological interventions. Zero tillage technology, raised bed wheat, green seeker based nutrient Management in wheat, zero tillage lentil, zero tillage chickpea raised bed Maize, and raised bed mustard are climate-resilient agriculture practices adopted on the farmer's field in rabi season. Grain and straw yield of wheat was recorded more in happy seeder (43.97 & 64.68q/ha), raised bed method (42.30 & 61.79q/ha), green seeker based nutrient management (41.88 & 62.20q/ha), zero tillage (40.10 & 61.51q/ha) as compared to traditional practice. Seed and straw yield of chickpea was observed more in zero tillage (14.86 & 12.27 q/ha) as compared to traditional practice. Seed and straw yield of lentil was also recorded more in zero tillage (11.23 & 8.51 q/ha) as compared to traditional practice. Grain and stover yield of maize was also recorded more in raised bed (116.38 & 196.35 q/ha) as compared to traditional practice. Grain and stover yield of mustard was also recorded more in raised bed (11.60 & 36.23 q/ha) as compared to traditional practice. In terms of economics, net return and B: C ratio of wheat was recorded more in happy seeder (57740 & 2.91:1), raised bed method (49300 & 2.40:1), green seeker based nutrient management (44180 & 2.92:1), zero tillage (51600 & 2.80:1) as compared to traditional practice.Net return and B:C ratio of chickpea and lentil was recorded more in zero tillage technology 60330 & 3.82:1 as well as 41196 & 3.39:1, respectively.Net return and B: C ratio of mustard and maize was recorded more in raised bed planting 20820 & 1.75:1 as well as 91356& 2.87:1, respectively.

Keywords: Zero tillage, Happy seeder, Raised bed, Green seeker

INTRODUCTION

Agriculture is strongly influenced by weather and climate. Agriculture is particularly vulnerable to climate change. There is a different type of threats governed by climate change, among them temperature CO_2, rainfall affects directly the plant growth and indirectly by land availability, irrigation, weed growth, pest, disease outbreak, etc. The climatic potential yield, which depends mainly on the climatic condition gets reduced due to the vagaries of the threats. Since 1970 the global average temperature has been rising at a rate of 1.7°C per century (Shaun and Marcott, 2013). While farmers are often flexible in dealing with weather and year-to-year variability, there is nevertheless a high degree of adaptation to the local climate in the form of established infrastructure, local farming practice, and individual experience. Climate change can therefore be expected to impact agriculture, potentially threatening established aspects of farming systems but also providing opportunities for improvements. Climate-resilient agriculture (CRA) is an approach that includes sustainability with existing natural resources through crop production systems to achieve long-term higher productivity and farm incomes under climate variabilities. Climate resilient agriculture is an inbuilt mechanism of the system to recognize the threats that need to be responded to, with effectiveness. Climate-resilient agriculture (CRA) include adverse threats such as erratic rainfall, cyclone, drought, flood, heat or cold wave, long dry spell, frost, insect and pest outbreaks, and other threats caused by climate change. It is also

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known as initial phase of CRA. Resilience is the ability of a system and its component to anticipate, absorb, accommodate or recover from the effect of a hazardous event in a timely and efficient manner (IPCC, 2012).

MATERIALS AND METHODS

A field experiment was conducted during the rabi seasons of 2020 and 2021 at the farmer's field of Uprama village (24030'N latitude and 86030'E latitude at an altitude of 79 m from the mean sea level) in Banka District of Bihar as a frontline demonstration to evaluate the Yield enhancement and Economics of *rabi* crops through Climate Resilient Agriculture technological interventions. The soil of the experimental site was sandy-clay-loam in texture with neutral pH (7.23), low in organic C (0.46%) and available N (193.5 kg/ha), and medium in available P (17.1 kg/ha) and K (213.3 kg/ha). The field experiment consisted of technological interventions for wheat, chickpea, maize, and mustard. The land was prepared by giving two ploughing each followed by planking with the help of a tractor-drawn cultivator in raised bed planting methods of wheat, maize, and mustard. The sowing of wheat, chickpea, and lentil by zero tillage was after the harvesting of paddy by manual and the wheat sowing by happy seeder with the presence of crop residue after the harvesting of paddy by combine harvester at 22.5 cm apart. A uniform fertilizer dose of 120, 60, 40 kg N, P_2O_5, and K_2O/ha in the form of urea, di-ammonium phosphate, and muriate of potash (MOP) was applied to zero tillage and raised bed wheat. Soil test-based nutrients applied in green seeker-based nutrient management wheat. A full dose of phosphorus, potassium, and half dose of nitrogen was applied at sowing, and the remaining half dose of nitrogen was top-dressed in two split doses after the first and third irrigation. A uniform fertilizer dose of 20, 40 kg N and P_2O_5 in the form of di-ammonium phosphate was applied to chickpea and lentil as a full dose at the time of sowing. Application of nitrogen in green seeker-based nutrient management as per the NDVI value of green seeker. A uniform fertilizer dose of 80, 50, 40 kg N, P_2O_5 and K_2O/ha in the form of urea, single super phosphate, and muriate of potash was applied to raised bed mustard. The full dose of phosphorus, potassium, and half of the nitrogen dose was applied basal at the time of sowing, and the remaining half was top-dressed after35 days after sowing.

RESULTS AND DISCUSSION

Grain and straw yield of wheat was recorded more in happy seeder (43.97 & 64.68q/ha), raised bed method (42.30 & 61.79q/ha), green seeker based nutrient management (41.88 & 62.20q/ha), zero tillage (40.10 & 61.51q/ha) as compared to traditional practice. Seed and straw yield of chickpea (14.86 & 12.27 q/ha) and lentil (11.23 & 8.51 q/ha) was observed more in zero tillage as compared to traditional practice. Busari *et al.* (2015) reported that the zero tillage system in chickpeas successfully adopts the weather conditions in the growing season. According to an FAO (2012) report, the climate adaptation benefits of no-tillage can be

Table 1: Yield and percent enhancement of crops under climate resilient agriculture technological interventions in Rabi season (average data of 2 years)

Name ofTechnology	Average Grain Yield (q/ha)		Average Straw Yield (q/ha)		Harvest Index		% increase (yield)
	Demo	Local check	Demo	Local check	Demo	Local check	
Zero Tillage Wheat	40.10	35.49	61.51	51.51	39.46	40.58	11.35
Raised Bed Wheat	42.30	36.96	61.79	53.35	40.64	40.76	12.62
Happy Seeder Wheat	43.97	36.69	64.68	52.41	40.47	41.25	16.55
Green Seeker based Nutrient Management	41.88	36.39	62.20	52.90	40.23	40.75	13.10
Zero Tillage Lentil	11.23	8.51	20.99	16.76	34.85	33.67	24.22
Zero Tillage Chickpea	14.86	12.27	26.87	23.55	35.60	34.25	17.43
Raised Bed Mustard	11.60	8.30	36.23	26.03	24.25	24.18	28.44
Raised Bed Maize	116.38	98.42	196.35	165.36	37.21	37.31	15.43

Table 2: Economics of crops under climate resilient agriculture technological interventions in Rabi season (average data of two years)

Name ofTechnology	Cost of Cultivation (Rs/ha)*		Gross Return (Rs/ha)		Net Return (Rs/ha)		B:C ratio	
	Demo	Local check	Demo	Local check	Demo	Local check	Demo	Local check
Zero Tillage Wheat	28600	34500	80200	68980	51600	34480	2.80:1	2.00:1
Raised Bed Wheat	35300	33900	84600	67920	49300	34020	2.40:1	2.00:1
Happy Seeder Wheat	30200	34400	87940	69380	57740	34980	2.91:1	2.02:1
Green Seeker based Nutrient Management	28600	34500	83760	72780	44180	38280	2.92:1	2.10:1
Zero Tillage Lentil	17200	20100	58396	44252	41196	24152	3.39:1	2.20:1
Zero Tillage Chickpea	21400	23900	81730	67485	60330	43585	3.82:1	2.82:1
Raised Bed Mustard	27900	24700	48720	34860	20820	10160	1.75:1	1.41:1
Raised Bed Maize	48600	45700	139656	118104	91356	73904	2.87:1	2.57:1

significant. The prominent result of nodulation by zero tillage might be conserved moisture; improved fertility associated with minimum disturbance of soil and makes more efficient use of natural resources as well as a nutrient (FAO, 2001; Bell *et al.*, 2019) (Table 1). Hence, the zero tillage contributed to achieving higher root nodules. Grain and stover yield of maize was also recorded more in raised bed (116.38 & 196.35 q/ha) as compared to traditional practice. Grain and stover yield of mustard was also recorded more in raised bed (11.60 & 36.23 q/ha) as compared to traditional practice. Percent enhancement of grain yield of wheat was recorded 11.35 per cent, 12.62 per cent, 13.10 per cent and 16.55 per cent by zero tillage, raised bed method, green seeker, and happy seeder, respectively.

Net return and B:C ratio of wheat was recorded more in happy seeder (57740 & 2.91:1), raised bed method (49300 & 2.40:1), green seeker based nutrient management (44180 & 2.92:1), zero tillage (51600 & 2.80:1) as compared to traditional practice. Several studies have also shown that the ZT method of wheat production provides several benefits such as saving of irrigation water, reduction in production cost, less requirement of labor, and timely establishment of crops, resulting in improved crop yield and higher net income (Laxmi *et al.*, 2007; Farooq *et al.*, 2006; Erenstein *et al.*, 2007) (Table 2). This suggests that by adopting the zero tillage method, farmers can save a substantial quantity of resources which helps to overcome the problems of human and machine (tractor) labor shortages at the time of land preparation and sowing operations. Net return and B:C ratio of chickpea and lentil was recorded more in zero tillage technology 60330 & 3.82:1 as well as 41196 & 3.39:1, respectively.Net return and B:C ratio of mustard and maize was recorded more in raised bed planting 20820 &1.75:1 as well as 91356 & 2.87:1, respectively.

CONCLUSION

The study has revealed that it is possible to save machine labor and irrigation water under zero tillage than under the conventional method. Due to resource-saving, the net return has been significantly higher in zero tillage technology and happy seeder machine. Hence, these technologies are an important alternative to save scarce resources and enhance the net farm income and B:C ratio. The decomposition analysis has shown that per hectare production of wheat was 1.88 percent higher in zero tillage than in the conventional tillage method. In this improved production method, zero tillage technology contributed 0.84 per cent and inputs contributed 1.04 per cent. By adopting this technology, farmers could save scarce resources and reduce the cultivation cost. The availability of zero-till seed drill needs to be accorded more attention to foster the adoption of zero tillage technology in wheat production.

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Adoption of Agricultural Technology with Special Reference to Super Seeder Versus Conventional Practices in Wheat in Haryana-A Sociological Study

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ABSTRACT

Wheat is the most widely grown cereal crop in India and the total area under the crop is about 29.8 million hectares. Paddy residue burning at the time of wheat sowing, decrease the soil fertility and produce harmful gases for human beings, animal and environment. Thus, adoption of Super Seeder farm technology is the most successful implement for sowing wheat in paddy residue without burning straw. The present study was conducted during 2020-21 among 60 super seeder adopter and 60 non-adopter farmers in Kaithal district of Haryana. The study aimed to investigate the adoption level and socio economic factors affecting adoption level of the farmers. Data revealed that 55.00 per cent of the respondents had high level of adoption of Super Seeder. Socio economic factors like Age, Caste, and Education of the respondents, land holding, income, mass media exposure, social organization participation and socio economic status were found significantly associated with adoption of the super seeder farm technology. Regarding comparative advantages between Super Seeder adoption and conventional practices data revealed that Super Seeder takes 5h/ha while by conventional practices 14 h/ha is required means 64 per cent of time saving was reported by adopters. Saving in Fuel consumptions, labour requirement and cost of sowing were reported 42, 64 and 47 per cent respectively. Other advantages with Super Seeder adoption reported were saving in gross return from grain (1.85%), cost of operation (3.32%), net return (11.59%) and total benefit over conventional practices were reported 5225 Rs/ha by the farmers. Regarding constraints in adoption of Super Seeder near about half of the farmers were somewhat agreed about the higher cost of Super Seeder/more custom charges being a constraint which got rank I, other constraints reported by farmers were non-availability of Super Seeder when required and inadequate extension contacts with ADOs and SDOs got rank II and III respectively and sowing of wheat crop is difficult in high moisture straw and soil condition and choking of machinery while working which were given IV rank.

Keywords: Super seeder, Adoption, Socio economic factors, Conventional

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the world's most extensively planted cereal crops. Wheat is the most important food grain and staple food of Indians, especially in the northern portions of the country, and its area under cultivation is growing every year. In 2014-15, India produced a new high of 257.07 million tonnes of food grains, a significant step toward making the country self-sufficient and food security (Roy, 2018). The total area under the crop is about 29.8 million hectares in the country. India accounts for 8.7 per cent of total world production of wheat. Rice-wheat cropping system (RWCS) occupies ~4.1 Mha area in north-western states of India comprising Punjab, Haryana, Uttarakhand and western Uttar Pradesh. (RKMP) The production of wheat in the country has increased significantly from 75.81 million MT in 2006-07 to an all-time record high of 105 million MT in

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2019-20. Technique of sowing is one of important factors which compensate the low tillering in wheat, to give the best plant distribution in the field and to save the labour in controlling weeds within ridges or rows (Kabesh *et al.,* 2009). Increasing grain yield of wheat is an important national goal to face the continuous increasing foodneeds. Rice is grown in 18 districts of Haryana. Chander *et al.* (2020) Out of which seven districts are in high productivity group, that is, yield more than 2,500 kg/ha Rice residue burning contributes towards emission of greenhouse gases (Gujral *et al.,* 2010; Lohan *et al.,* 2013) with serious environmental implications. Nonetheless, residue burning is not a viable option as it leaves high carbon (C) footprints and lowers C sustainability of world's largest cropping system (Singh *et al.,* 2020). Besides GHGs emissions, residue burning causes nutrient loss of 100% C, 90% N, 60% S and 25% each of P and K. (Dobermann and Fairhurst, 2002). Estimates revealed that burning of one Mg of rice straw leads to a loss of ~400 kg of organic C, 5.5 kg of N, 2.3 kg of $P_2 O_5$, 25 kg of K_2O, 1.2 kg of S and 50-70 per cent of micro-nutrients, which costs more than Rs. 200 crores (Sidhu *et al.,* 2007). In the last two decades, significant progress has been made by the government to evolve and disseminate number of technologies for in-situ management of loose rice straw using different technologies like straw management system (SMS) on combine harvesters, zero till drill, (ZTD), happy seeder (HS, a modified ZT), super seeder (SS), reversible mouldboard plough (RMBP), rotavator tillage (RT), rice straw chopper and cutter-cum-shredder etc. The Government of India (GOI) has taken a number of steps to combat residue burning, including subsidizing crop residue management (CRM) machinery for cooperative societies, farmers' groups, and individual farmers. A considerable reduction in agricultural fires has been recorded over the last two years, and farmers are eager to implement these RRM technology. Effect of sowing techniques and variety on wheat yield has been studied by many researchers.

Manan and Sharma (2017) studied the effect of variety and method of sowing on the yield of wheat and the analysis revealed that farmers preferred new technologies and new varieties for sowing of wheat crop. Among these machines the super seeder is a tractor-mounted machine that cuts and lifts rice straw, sows wheat into the soil, then mulches the sown area with the straw. In the field, it also cultivates paddy straw. This method is environmentally friendly and saves water while also improving soil health. Farmers commonly burn paddy residue during wheat sowing, which reduces soil fertility and produces toxic fumes for humans, animals, and the environment. Therefore, to maintain soil nutrition value super seeder is the most successful implement for sowing wheat in paddy residue without burning straw. The super seeder ploughs the standing paddy residue and sow seeds for the next wheat crop, in a single operation. This technology is superior to Happy seeder and also more expensive. It requires a tractor of 65 hp to run the machine (Kirandeep *et al.,* 2020). There is currently no information available about the adoption status, advantages over traditional approaches, or constraints in Super seeder adoption.

MATERIALS AND METHODS

The study was conducted in Kaithal district of Haryana state. From this district, three blocks namely Kaithal, Pundri and Guhla were selected where maximum number of farmers had adopted Super Seeder. From Kaithal block Jaswanti, Balwanti, Pobla, Silakhera, Chandana and Deoban villages and from Pundri block Sanch and Rasina villages and from Guhla block Guhla, Salempur, Cheeka, Gaggarpur and Kharaudi villages were drawn to get information from Super Seeder adopters and non- adopters. On the whole, a total of 60 Super Seeder adopter farmers and 60 non-adopter farmers were selected. Interview schedule was prepared to collect the desired information as per objectives of the study. Data were collected with survey method and telephonically with the help of interview schedule. Statistical techniques like frequency, chi square, weighted mean scores etc. were used as per the nature of data.

RESULTS AND DISCUSSION

Contextual matrix of the farmers: From the Table 1, it was found that out of total, fifty percent of the farmers hailed from 36-50 years of age group. Rest 31.67 per cent and 18.33 per cent farmers were up to 35 years and above 50 years of age respectively. Results revealed that half of the farmers (50.83%) belonged to General castes and 26.67 per cent farmer's belonged

Table 1: Contextual matrix of the farmers (n=120)

Variables	Adopters (n=60)		Conventional (n=60)		Total
	Frequency	Percentage	Frequency	Percentage	
Age					
Up to 35 years	24	40.00	14	23.33	38(31.67)
36-50 years	26	43.34	34	56.67	60(50.00)
Above 50 years	10	16.66	12	20.00	22(18.33)
Total	60	100	60	100	
Caste					
General Caste	39	65.00	22	36.67	61(50.83)
Backward Class	12	20.00	20	33.33	32(26.67)
Schedule Caste	09	15.00	18	30.00	27(22.50)
Level of Education					
Illiterate	07	11.67	21	35.00	28(23.34)
Up to middle	10	16.66	15	25.00	25(20.83)
Secondary & Senior secondary level	18	30.00	14	23.34	32(26.67)
Graduation and above	25	41.67	10	16.66	35(29.16)
Subsidiary occupation of the Family					
Nil	23	38.33	37	61.67	60(50.00)
Business and service	21	35.00	06	10.00	27(22.50)
small scale enterprise	16	26.67	17	28.33	33(27.50)
Size of land holding					
Marginal (up to 1 ha)	21	35.00	27	45.00	48(40.00)
Small (1-2 ha)	16	26.67	24	40.00	40(33.33)
Semi-medium (2-4 ha)	14	23.33	06	10.00	20(16.67)
Medium (4-10 ha)	9	15.00	03	05.00	12(10.00)
Type of Family					
Nuclear	35	58.33	43	71.67	78(65.00)
Joint	25	41.67	17	28.33	42(35.00)
Size of Family					
Up to 4 members	29	48.33	19	31.67	48(40.00)
5-8 members	21	35.00	21	18.33	42(35.00)
Above 8 members	10	16.67	18	15.00	30(25.00)
Annual Income					
Rs.75,000 - 1,50,000/-	11	18.33	13	21.67	24(20.00)
Rs.1,50,000 - 3,00,000/-	28	46.67	30	50.00	58(48.33)
Above Rs. 3,00,000/-	21	35.00	17	28.33	38(31.67)
Social organization Participation					
No participation	12	20.00	35	58.33	47(39.17)
Upto one	24	40.00	21	35.00	45(37.50)
More than one	24	40.00	04	6.67	28(23.33)
Mass media exposure					
Low (up to 6)	15	25.00	13	21.67	28(23.33)
Medium (7-12)	24	40.00	28	46.67	52(43.34)
High (above 12)	21	35.00	19	31.66	40(33.33)
Socio-economic Status					
Low (6-9)	15	25.00	13	21.67	28(23.33)
Medium (10-12)	21	35.00	21	35.00	42(35.00)
High (above 12)	24	40.00	26	43.33	50(41.67)

Figures in Parentheses indicate percentage to backward classes, while 22.50 per cent farmers hailed from scheduled castes. Regarding education of the farmers data revealed that 26.67 per cent of the farmers were educated up to secondary &senior secondary level while rest of the farmers were educated up to middle level (20.83%), graduation level and above (29.16%) and 23.34% were illiterate. It was also found that half of the farmer's families had nil subsidiary occupation, while 27.50 per cent were engaged in small scale enterprise and rest 22.50 per cent were in business and services. Regarding land holding, maximum number of the farmers (40.00%) had marginal size of land holding i.e. up to 1 ha. followed by small size of land holding (33.33%) i.e. between 1-2 ha. Rest 16.67 per cent and 10.00 per cent had semi-medium and medium size of land holding distributive. It was found that more than three-fifth of the farmers (65.00%) belonged to nuclear family. On the other hand, nearly one-third of the farmers (35.00%) were from joint families.

Analysis depicted that almost half of the farmers had family income between Rs. 1,50,000 to Rs. 3,00,000 while more than $1/4^{th}$ of the farmers (31.67%) had annual family income > Rs. 300000 per annum and rest 20 per cent had between Rs. 750000-150000 per annum. Near about one-fourth of the farmers had no social participation while 23.33 per cent had more than one and 37.50 per cent had up to one organization of social participation. Also, maximum number of the farmers (43.34%) had medium level of exposure to mass-media followed by high (33.33%) and low (23.33%) level of exposure to mass media. Last but not the least, more than one-third (41.67%) of the farmers had high level of socio-economic status. Rest 35.00 per cent and 23.33 per cent farmers had medium and low level of socio-economic status, sequentially.

The factors associated with adoption level of the farmers are shown in Table 2. Age was found significantly associated with adoption level. More than

Table 2: Association between socio-economic variables and Adoption level of farmers (n=60)

Socio-economic variables	Adoption level			Total
	Low	Medium	High	
Age				
up to 35 yrs.	2(8.33)	6(25.00)	16(66.67)	24(40.00)
36-50 yrs.	2(7.69)	10(38.47)	14(53.84)	26(43.33)
above 50 yrs.	5(50.00)	2(20.00)	3(30.00)	10(16.67)
Total	9(15)	18(30)	33(55)	60(100.0)
χ^2 *Cal*= 12.69*				
Caste				
General Castes	3(7.69)	9(23.08)	27(69.23)	39(65.00)
Backward Class	1(8.33)	6(50.00)	5(41.67)	12(20.00)
Scheduled Castes	5(55.56)	3(33.33)	1(11.11)	9(15.00)
χ^2 *Cal*= 18.32*				
Level of Education				
Illiterate	4(57.14)	1(14.29)	2(28.57)	7(11.67)
Up to Middle	3(30.00)	6(60.00)	1(10.00)	10(16.67)
Secondary and Senior secondary	1(5.56)	9(50.00)	8(44.44)	18(30.00)
Graduation and above	1(4.00)	2(8.00)	22(88.00)	25(41.66)
χ^2 *Cal*= 32.67*				
Subsidiary occupation of the family				
Nil	3(13.05)	11(47.82)	9(39.13)	23(38.33)
Business and services	3(14.28)	6(28.57)	12(57.15)	21(35.00)
Small scale enterprise	3(18.75))	1(6.25)	12(75.00)	16(26.67)
χ^2 *Cal*= 7.32				

Table 2 contd...

Socio-economic variables	Adoption level			Total
	Low	Medium	High	
Size of land holdings				
Marginal (up to 1 ha)	3(14.29)	8(38.10)	10(47.61)	21(35.00)
Small (1-2 ha)	2(12.50)	5(31.25)	9(56.25)	16(26.67)
Semi-medium (2-4 ha)	3(21.42)	3(21.42)	8 (57.16)	14(23.33)
Medium (4-10 ha)	1(11.11)	2(22.22)	6(66.67)	9(15.00)
χ^2 *Cal*= 26.31*				
Annual family income				
Between Rs.75,000 - 1,50,000/-	5(45.45)	5(45.45)	1(9.10)	11(18.33)
Between Rs.1,50,001 - 3,00,000/-	3(10.70)	10(35.70)	15(53.60)	28(46.67)
Above Rs. 3,00,000/-	1(4.70)	3(14.30)	17(81.00)	21(35.00)
χ^2 *Cal*= 18.31*				
Mass media exposure				
Low (up to 9)	5(33.33)	8(53.33)	2(13.34)	15(25.00)
Medium (10-17)	1(4.17)	5(20.83)	18(75.00)	24(40.00)
High (above 17)	3(14.28)	5(23.80)	13(61.92)	21(35.00)
χ^2 *Cal*= 15.57*				
Social organization Participation				
No membership	5(41.67)	3(25.00)	4(33.33)	12(20.00)
Member of one organization	2(8.33)	9(37.50)	13(54.17)	24(40.00)
More than one membership	2(8.33)	6(25.00)	16(66.67)	24(40.00)
χ^2 *Cal*= 9.48*				
Socio-economic Status				
Low (12-18)	3(20.00)	9(60.00)	3(20.00)	15(25.00)
Medium (19-24)	3(14.30)	5(23.80)	13(61.90)	21(35.00)
High (25-31)	3(12.50)	4(16.67)	17(70.83)	24(40.00)
χ^2 *Cal*= 11.16*				

Figures in parentheses indicate percentage; *Significant at 5% level of significance

fifty percent of the farmers (53.84%) of middle age group had high adoption level while in old age fifty percent had it low with chi-square value 12.69*. Education was also found significantly associated with adoption level; illiterate farmers (57.14%) had low level of adoption while farmers educated up to senior secondary (50.00%) and up to middle level (60.00%) had medium level of knowledge followed by high level of knowledge 44.44% and 10.00%. Size of land holding was found significantly associated. Farmers having income between Rs. 75000-150000 had low knowledge while 81.00 per cent of the farmers with family income>300000Rs. had high level of knowledge. Mass media exposure, social participation and socio economic status were found significantly associated with knowledge level. Farmers with nil social participation had low level of knowledge (41.67%) while with medium level social participation farmers had high level (54.17%) of knowledge. Farmers with high socio economic status had high level of knowledge (70.83%) and low economic status farmers had medium (60.00%) level of knowledge. Caste was also found significantly associated with knowledge level of the farmers.

Regarding comparative advantages between Super Seeder adoption and conventional practices data revealed (Table 3) that Super Seeder takes 5h/ha while by conventional practices 14 h/ha is required means 64 per cent of time saving was reported by adopters. Saving in Fuel consumptions, labour requirement and cost of sowing were reported 42, 64 and 47 per cent respectively. In the same way other advantages with Super Seeder adoption were saving in gross return from grain (1.85%), cost of operation (3.32%), net return (11.59%) and total benefit over conventional practices was reported 5225 Rs /ha by the farmers. Kirandeep *et al.* (2020) also found in a study conducted in Punjab that yield of different varieties of wheat namely: variety Unnat PBW 343 was obtained highest using super seeder (51.7q/ha) whereas lowest was obtained using happy seeder (46.7q/ha). Regarding constraints in adoption of Super Seeder (Table 4) near about half of the farmers were somewhat agreed about the higher cost of Super Seeder/More custom charges being a constraint which got rank I, other constraints reported by farmers were non-availability of Super Seeder when required and inadequate extension contacts with ADOs and SDOs got rank II and III respectively. Other constraints reported were that sowing of wheat crop is difficult in high moisture straw and soil condition and Choking of machinery while working which were given IV rank. Lack of adequate training programme and shortage of information on Super Seeder were given rank V and

Table 3: Comparative advantages between Super Seeder Adoption and Conventional Practices (n=120)

	Super Seeder	Conventional practices	SAVING (%)
Time (h/ha)	5	14	64%
Fuel (l/ha)	28	48	42%
Labour requirement (man-h/ha)	10	28	64%
Cost of Sowing (Rs /ha)	3200	6000	47%
Benefit in cost of saving (Rs)	2800	-	-
Yield (q/ha)	55	54	1.85%
Increase in yield (q)	01	-	-
Gross return from grain (Rs/ha)	108625	106650	1.85%
Gross return from straw (Rs/ha)	23200	22750	1.98%
Total gross return (Rs/ha)	131825	129400	1.87%
Cost of operation (Rs/ha)	81500	84300	3.32
Net Return (Rs/ha)	50325	45100	11.59
Total Benefit over conventional Practice (Rs/ha)	5225	-	

All the agronomic practices remain same in both the practices.

Table 4: Constraints in adoption of Super Seeder technology (n=60)

S.No.	Constraints	Agree (3)	Somewhat Agree (2)	Don't Agree (1)	WMC	Mean score	Rank
1.	Sowing of wheat crop is difficult in high moisture straw and soil condition.	09(15.00)	27(45.00)	24-(40.00)	105	1.75	IV
2.	Choking of machinery while working	12(20.00)	21(35.00)	27(45.00)	105	1.75	IV
3.	Inadequate extension contacts with ADOs and SDOs	14(23.33)	28(46.67)	18(30.00)	116	1.93	III
4.	Shortage of information on Super Seeder	07(11.67)	11(18.33)	42(70.00)	85	1.41	VI
5.	Lack of adequate training program	12(20.00)	19(31.67)	29(48.33)	103	1.71	V
6.	Higher cost of Super Seeder/ More custom charges	29(48.34)	20(33.33)	11(18.33)	138	2.30	I
7.	Non-availability of Super Seeder when required	17(28.33)	30(50.00)	13(21.66)	124	2.06	II

Figures in Parentheses indicate percentage; Responses were multiple.

VI as 48.33% and 70.00% did not agree upon these constraints.

CONCLUSION

Thus, adoption of Super Seeder farm technology is the most successful implement for sowing wheat in paddy residue without burning straw. More than fifty percent of the farmers had high level of adoption regarding Super Seeder. Socio economic factors like Age, Caste, and Education of the respondents, land holding, income, mass media exposure, social organization participation and socio economic status were found significantly associated with adoption of the super seeder farm technology. Regarding comparative advantages between Super Seeder adoption and conventional practices data revealed that Super Seeder takes 5h/ha while by conventional practices 14 h/ha is required means 64% of time saving was reported by adopters. Saving in Fuel consumptions, labour requirement and cost of sowing were reported 42, 64 and 47 per cent respectively. Other advantages with Super Seeder adoption reported were saving in gross return from grain (1.85%), cost of operation (3.32%), net return (11.59%) and total benefit over conventional practices were reported 5225 Rs /ha by the farmers. Regarding constraints in adoption of Super Seeder were higher cost of Super Seeder/more custom, non-availability of Super Seeder when required and inadequate extension contacts with ADOs and SDOs and sowing of wheat crop is difficult in high moisture straw and soil condition and choking of machinery while working. Overall Super seeder is a successful and eco-friendly farm machine.

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A Review - Strategies, Policy and Extension Models in Agriculture an Approach to Rural Community Development

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ABSTRACT

Rural development usually refers to the strategy of enhancing the standard of life and financial well-being of people, specifically living in populated and remote areas. It is the method of helping rural communities to strengthen themselves and develop towards their full potential. Good communication contributes to successful collaborative efforts and transformation of communities which in time help to create social change among marginalized or vulnerable groups. Various strategies that are adopted for enhancing development of rural population are multi-purpose strategy, growth oriented strategy, target group strategy, area development strategy, spatial planning strategy, holistic strategy, participatory strategy. Rural development remains the core of the general development of the country. There are seven major rural development policies i.e. land Policy, technology policy, agricultural Policy, employment policy, education, research and extension policy, rural institutions policy, price policy. In rural communities, there are number of aspects that require to be developed. Education, job possibilities, agricultural and farming practices, administration and management, infrastructure, civic amenities, health care, and medical and environmental conditions are a few of them. There are various models of rural community development and the important ones are sectoral, multisectoral, territorial, and local. The three major programmes that were introduced for increasing the agricultural production in India are Intensive Agricultural Area programme (IAAP), Intensive Agricultural District programme (IADP) and High Yielding Variety Programme (HYVP). A number of the programmes were designed to assist special areas such as Drought Prone Area Programme (DPAP), Hill Area Development Programme (HADP), Command Area Development Programme (CADP) and Tribal Area Development Programme (TADP).

Keywords: Rural community, Administration, Development, Policies, Models

INTRODUCTION

Rural development is a comprehensive socio-economic method undertaken by the government for the aim of improving the economic and social conditions of people living in rural areas. It also represents planned programmes to change and to improve the quality of life style of rural people. Rural society often known as village community is made up of individuals who live in a small geographic region and share common interests and means of grafting them. There are number of factors that must be developed. So as to originate improvements within the living conditions and overall quality of lives, it is necessary to get a source of income. Fundamentally, development is the creation of wealth – wealth meaning the goods people value (Shaffer, 1989). Agriculture and farming techniques are listed as the most common vocations in rural areas. It is vital for the farmers and agricultural labourers to place into operation, innovative and scientific methods to augment productionTwo complete approaches for increasing agricultural income that can be implemented are, stabilizing the costs of agricultural products and intermediary exploitation and improving agricultural productivity and infrastructure. Bringing about developments within the health care and medical facilities is regarded to be of major significance. When the individuals are experiencing health problems or illnesses, then they might certainly experience problems

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in getting involved in any tasks or activities. For the aim of generating income, it is vital to make improvements within the educational standards. When the individuals possess the essential literacy skills, they will easily acquire information in terms of policies, measures and programs that are put into operation, resulting in their well-being. Rural development should bring improvement in political capabilities. Political capabilities are the capabilities that facilitate the participation of the individuals in policy-making and in the making of selections on an independent basis in situations, where human rights are guaranteed. The development of infrastructure is integral to the development of rural areas. The infrastructural facilities that require to be developed in rural communities are roads, transportation, communications, power supplies, water supplies, public services, broadcasting and telecommunications. The development of training programs among rural communities is crucial for the progression and well-being of the individuals as well as to enhance them to augment productivity and profitability.

STRATEGIES IN RURAL DEVELOPMENT

A strategy consists of an ordering of varied policy parameters to attain the required goals. Different strategies emphasize and provide importance to different mixes of agrarian relations, techniques of production and state policies so as to attain the goals of rural development. To illustrate some of the relevant issues, there are various types of rural development strategies.

Multi-purpose strategy: The country's rural development strategy began with a multi-purpose approach. In 1952, the Community Development Program (CDP) was established. It constituted the primary organized effort at rural reconstruction. Community Development Programme was a programme which sought to vary the economic, social and cultural life of rural population and to remodel the stagnant villages into progressive rural communities. Its principal goal was to promote the development of material and human resources through individual cooperation and state help. It was absolutely thought to be an academic and an organizational process. Since, it also aimed towards bringing about changes within the practices and procedures, which proved to be barriers within the course of implementation of desired objectives. The foremost objective was social and economic improvement. The rationale of the approach was, all aspects were linked with one another. The activities of CPD included agriculture, animal husbandry, irrigation, water resources, co-operation, village and small scale industries, health and sanitation, communication, housing so forth. Blocks were used to accomplish the community development programme. Initially, this project was only available in 55 blocks. By March 1979 it had been extended to 5,123 blocks covering a population of about 47 crores spread all over the villages in the country. Each block covered a section of about 400-500 Sq.Kms. in about 100 villages and a population of about one lakh. It was implemented through project officers, block development officers, technical experts and gram sevaks. Therefore, it may be stated that development of welfare and livelihoods opportunities was one of the most important objectives of multi-purpose strategy.

Growth oriented strategy: The growth oriented strategy was based on rural individuals. Though rural individuals are residing within the conditions of poverty and backwardness, but they also possess sharp mind-sets and may take wise decisions. So as to participate in effective decision making processes, they should be provided with rights and opportunities. The most important objective of rural individuals is to reinforce their living conditions and to realize this purpose; they are trying to find employment and income generating opportunities. Therefore, may be stated that the implementation of opportunities that will promote growth of the individuals in an efficacious manner are referred to as growth oriented strategies. The education is considered as the main instrument that lays the foundation for the individuals to steer to progress in all areas and enrich their overall quality of lives. Acquisition of education would enable the individuals to reinforce their skills and abilities, in order to perform their tasks and activities to sustain their living conditions in an appropriate manner. Agricultural sector is the major area of employment and livelihood opportunities for the rural people therefore; the implementation of programs, such as, Intensive Agriculture District Program (IADP), Intensive Cattle Development Program (ICDP) and High Yielding Varieties Program

(HYVP) was launched. This gave rise to Green Revolution. The main aspect of green revolution consists of agricultural production and extensive use of technology. The revolution also basically encouraged private investment in agriculture. The high yielding varieties have been tried in case of wheat, rice, jowar, sugarcane, maize etc. Green revolution contributed to rise in agricultural production. It has improved the financial position of farmers. It has provided better employment opportunities in the rural areas. It has contributed to an overall growth of Indian economy.

Target group strategy: Within target group strategy, a particular group is selected and researched upon. Normally, like in this case, rural development initiatives are being investigated. When focusing upon rural development, the development of individuals is regarded to be of utmost significance as they're mostly illiterate and unaware. The conditions are analyzed of small and marginal farmers, as well as wealthier farmers. Small and marginal farmer's living conditions have not changed. They are residing within the conditions of poverty and backwardness and so are unaware of contemporary and innovative strategies and methods that are considered essential to reinforce production. They are instead making use of traditional farming practices and methods within the production processes. On the opposite hand, wealthy farmers are making use of technical and scientific methods to boost production. It has been studied upon that farmers have gotten enrolled in training centers and academic institutions to develop their knowledge and generate awareness in terms of scientific, modern and innovative methods and practices. The Antyodaya Schemes is the target approach. Antyodaya is a special programme for the upliftment of the poorest of society. This programme was launched for the first time by the then government of Rajasthan on October 2, 1972. Some conditions were laid all the way down to select the poorest families for Antyodaya scheme as beneficiaries: Families which are under the grip of utter poverty and the families which do not have any visible means of subsistence, families with no single member within the age of 15-59 years capable of economic production, families which do not have any productive assets like land, cattle etc. The target strategy also focused on landless agricultural labourers for whom special programmes such as Small Farmer Development Agency 47 (SFDA) was started. This agency was founded in accordance with the recommendations of All India Rural Credit Survey. It was operational since 1971covering 1,818 blocks within the country. This approach produced the client-oriented design and the ultimate goal is to transfer the responsibilities of planning and development to the client themselves.

Area development strategy: Under area development strategy emphasis has been put upon the development of backward regions. This approach contemplates that development of a section depends not only on the development of an adequate infrastructure network but also the way factors of the local economy are activated round the production infrastructure. In other words, for development of an area, spatial and functional integration is important. The main programs that have been formulated under this strategy are, Drought Prone Area Program (DPAP), Tribal Area Development Program (TADP), Command Area Development Program (CADP), Hill Area Development Program, and Desert Development Programme (DDP). The tribal population is scattered throughout the country. They're mostly residing in hilly and mountainous regions. They're dependent upon the natural environmental conditions for his or her survival. As a result, it is critical to put in place policies and strategies that are geared toward the development of tribal territories. In order to generate the desired outcomes, it is necessary to allocate the resources in an appropriate manner, so development of backward regions can promote well-being of the individuals.

Spatial planning strategy: The spatial planning strategy is the strategy that demands for implementation of special programs in their respective locations, induction of the production plans, employment programs and fulfilling the basic needs of rural population. In order to achieve these objectives, the programs and the strategies have to be rural oriented. Within the fifth five year plan, multi-level planning is that planning that was focused upon to a large extent. Additionally to multi-level planning, it was absolutely vital for the individuals to generate awareness in terms of techno-economic, socio-political and administrative functions. As is obvious, when improvements or changes are required, the emphasis must be placed on the use of new technology and innovative methods. In some of the areas, when there's lack of materials and resources, then it would lead to hindrances within the course of feat of desired objectives. On the opposite hand, shortage of techniques has to be analyzed and plans should be efficiently put into operation to promote welfare and goodwill of rural population. Several programmes for providing employment to rural poor, namely, rural works programme, rural employment guarantee programme, Development of Women and Children in Rural Areas (DWCRA), Jawahar Rozgar Yojana (JRY) were introduced. Jawahar Rozgar Yojana (JRY) was announced by the Prime Minister Rajiv Gandhi on 28th April, 1989 and intends to assist a minimum of one member of each poorest family by providing employment for about 90-100 days in a year at his own work place or residential area. This scheme was implemented in 2,20,000 villages all over the country.

Integrated or holistic strategy: An integrated or holistic strategy has been developed taking into account the viewpoint that growth should be holistic.The concept of "integrated rural development" came into vogue with the necessity for a multipurpose thrust to rural planning. It stresses that various facets of rural development, which have a bearing on rural life, are interrelated and cannot be checked out in isolation. Thus, an integrated approach towards rural development is crucial. The various dimensions of rural life-growth of agriculture and allied activities, rural industrialization, education, health, public works, poverty alleviation and rural employment programmes -all form part of an integrated approach to the issues of rural development. All programmes, assuming they are infrastructural development programmes, human resource development programmes, sectorial development programmes, and social welfare programmes, have links established. Through their interconnections, the various programmes have an impact on one another's performance. The different programs influence the functioning of others through connections. The integrated strategy combines all the features of the previous strategies and is structured to attain the goals and objectives of growth, welfare, equity and community participation. This paradigm takes a holistic but integrated approach to fundamental issues that affect rural populations, such as poverty, unemployment, and illiteracy. The goals of this strategy are expected to induce accomplished by building the capacity of the community to participate within the development processes in partnership with the government. This standard was supposed to be followed by the anti-poverty programmes that were launched, such as the IRD programme, the National Rural Employment Program, and the Training of Rural Youth for Self-Employment. Training Rural Youth for Self-Employment (TRYSEM) was started on 15th August to provide technical skills to rural youth and to assist them to get employment in the fields such as agriculture, industry services and business activities.

Participatory strategy: This concept has been developed from participatory development. Stakeholders can influence and share power over development initiatives, as well as the decisions and resources that affect them, through participatory development. Within the tenth five year plan, the government has devised participatory strategy to promote the development of rural communities. Provision has been made to enhance social and economic opportunities for the individuals and groups, by encouraging their participation in the decision making processes. Individuals are needed to undertake an examination of the alternatives and implement the one that is most relevant and advantageous throughout decision-making processes. Individuals must use rational and logical thinking when participating in decision-making processes. When the individuals are participating in the decision making processes, then they are required to implement rational and logical thinking. The rural individuals are well-aware in terms of opportunities, which may cause improvements in their living conditions.

RURAL DEVELOPMENT POLICIES

Policy is a set of principles created with the intent of guiding actions and achieving sensible outcomes. A policy may be a statement of intent and is implemented as a procedure or protocol. Policies are generally adopted by a governance body within a corporation. The recent increase in emphasis on evidence-based policy must be applauded from a variety of perspectives. It is good from a social point of view because policy-making should be more precisely developed and targeted as a result of taking research findings under consideration.

Land policy: In a rural development strategy, land policy is critical. It is well-known that distribution of land and other assets is much skewed in India, because large majorities have small land holdings. This incorporates a direct impact on the ability to earn incomes in rural areas. As a result, land reforms and a land policy aimed at achieving distributive justice may also boost agricultural output. It's also been said that small farms productivity levels are generally higher than large farms. This can be attributed to the very fact that the small peasant puts in more intensive labour on the small plot that belongs to him. Thus land reforms and a land policy that seeks to provide distributive justice may also result in greater agricultural productivity.

Technology policy: Improvements in rural civilizations' access to technology can have a significant influence. On the one hand, it is critical that newer technology be adapted to rural communities, while on the other side, existing technologies be expanded to rural areas. Technological planning, research and development are very vital In India. The genetic research will still be a mainstay of agricultural technology. We can expect the continued development of new varieties through conventional plant breeding, increasingly assisted by the techniques of biotechnology (Persely and Lantain, 2000). The agricultural sector is especially at the risk of ravage of the weather. Technological improvements can play an important role in insulating agriculture from the effects of weather. On the one hand, rural societies are marked by widespread unemployment and on the other, poor production. Therefore care needs to be taken when new technologies are introduced in rural areas. Technologies appropriate to rural societies must be chosen in order that there is no large-scale displacement of labour. A judicious balance between achieving higher productivity and increasing employment opportunities to rural communities must be struck. Rural development strategies should take this under consideration in formulating their programmes.

Agricultural policy: The term agriculture is a comprehensive term and includes cultivation of crops, animal husbandry, horticulture, pisciculture, sericulture, silviculture and floriculture etc. Agriculture remains the most important avenue for providing incomes and employment in rural areas. Indian economy relies on agriculture. About 70 per cent of Indian population is directly or indirectly dependent on agriculture. Needless to mention, agricultural planning is important for rural development strategies. The balanced growth of the agricultural sector can play an important role in creating better conditions for those reckoning on this sector. The government of India announced "New National Agriculture policy, 2000". This policy has been formulated taking into consideration the provisions of the World Trade Organization (WTO) with an objective to achieve 4% agriculture growth target in order to provide food for hundred crore population, adequate raw material to its growing industrial base and sufficient surplus for export.

Employment policy: Given the extent of unemployment problem in rural India, the requirement for well-formulated employment programmes can hardly be over stated. Such programmes can insulate fluctuations in rural incomes on account of poor weather conditions that is the case when the monsoon fails. Agricultural employment is usually seasonal. Rural employment programmes can help ensure a more even distribution of work throughout the year under these circumstances. The expansions of non-agricultural activity within the village economy can also relieve the pressure of population on the land.

Education, research and extension policy: In India the matter of illiteracy is especially acute in rural areas. The dearth of education can act as a constraint in furthering rural development. Rural societies, are also characterized by wide spread inequalities within the distribution of incomes and assets. The lack of education creates a situation in which this problem is perpetuated. The spread of education on the one hand, can enable the rural poor to ensure distributive justice and, on the other, help them inactively participating in rural development programmes. Research and extension may be a vital ingredient of rural development strategies. Research enables furthering knowledge which is acceptable to rural cultures and extension ensures that the gains are literally delivered to the target groups. Trained staff is extremely important for any rural development programme since they really interact with the community for whom the programmes are meant. There is growing interest in the privatization of extension services (Umil and Schwardz, 1994). The public must take the lead in providing the information that allows farmers to make the best use of new technology (Naylor, 1994). This demands high quality field research from the public sector (Way and Van Emden, 2000). There is much to be done in strengthening the managements and priority –setting capabilities of national research institutes (Byerlee and Alex, 1998).

Rural institutions policy: Rural institutions have to be reformed and utilized for successfully carrying out rural development. The institutional aspects of rural societies are often ignored when strategies are formulated. Institutional frameworks such as panchayats must be strengthened to encourage public engagement in rural development. These structures have the potential to be powerful agents in the implementation of development initiatives. Since rural settlements are detached and are often isolated, they cannot be monitored successfully from outside. Contrarily, local monitoring by institutions like panchayats can actually make sure that programmes are successfully implemented and that the target group actually benefits from such programmes. Rural institutions like banks and co-operatives may also play a significant role in rural development.

Price policy: The use of a price is also a vital element in a rural development policy. Agricultural produce should be priced in such a way that the farmers enjoy adequate returns. The price policy through the use of subsidies can act as a method of providing essential items of mass consumption to people residing in rural areas. This is often particularly essential for those below the poverty line. The spread of the public distribution system through its network of ration shops in rural areas can be used to solve this problem. This can be particularly important during the times of poor rainfall when rural incomes are adversely affected, which successively features a negative effect on consumption. Subsidies can also take various forms, such as input subsidies for the agriculture industry. This can be particularly important in the case of fertilizers, pesticides and seeds. As a result, price policy can be an effective tool for accomplishing rural development goals. The recent thinking along the neo-liberal lines has led to significant changes within the various aspects of the price policy, and it is quite clear that rural India During the liberalization era, they have been subjected to a great deal of stress, part of which is due to changes in price policy. Government of India introduced minimum Support Price Scheme (MSP) to safeguard the interests of farmers. Under this scheme the government of India declares the minimum support price of agricultural products for the agricultural year (July-June) each year and assures the farmers that their agricultural produce will be purchased at MSP, thereby preventing its distress sale.

RURAL COMMUNITY DEVELOPMENT MODELS

A sectoral approach: After the Second World War there have been overwhelming priorities that dictated the approaches taken to agricultural policy. During this plan era, increasing agricultural productivity and related activities was given primary attention. The increase in the agricultural production and allied activities received top priority during this plan period. These were driven by a necessity to confirm domestic food security and also the central role of agriculture in rural economies. This placed support for the agricultural sector at the center and promised a method of meeting a variety of objectives for food security, rural development, farm incomes and environmental protection simultaneously through a single agricultural policy approach. In this model, agriculture represents the most important sector in the rural economy and its success determines the performance of the local economy more generally. A policy to stimulate agricultural production not only supports domestic food supply, agricultural employment and farm incomes, it also deters outmigration from rural areas and supports the rural economy and service provision more generally. In order to bring about improvements in agricultural productivity, various steps were taken e.g. Production of multiple crops, making use of advanced agricultural techniques. The most important aspects that was taken into consideration to enhance agricultural productivity was, development of small-irrigation systems, i.e. Construction of irrigation infrastructure and establishment of water user organization's; capacity building for agricultural extension workers, i.e. improved cultivation techniques, crop and vegetable production, and agroforestry; empowerment of community-based farming activities, i.e. organization of shipping and distributive co-operatives and rice banks and comprehensive rural and agricultural development, i.e. Projects that combine the development of small-scale irrigation with integrated projects. However in the mid-20th century, a variety of, by now familiar, factors undermined this approach and also the general consensus about the appropriate policies. The high costs, inefficiencies, and environmental consequences of commodity price supports, particularly in the context of agricultural product surpluses, have cast doubt on the strategy to agricultural protection pursued (Buckwell *et al.,* 1982). Agriculture's local economic influence was reduced due to the changing nature of technology used in agriculture, which included increased mechanization and the use of inputs imported from outside the local economy.

A multisectoral approach: The support directed exclusively through the agricultural sector faced increasing exchequer costs in terms of addressing the agricultural surpluses that may result from increased production and with the declining relative importance of agriculture within rural areas which may have less local economic impact more generally. This suggests an alternative, multisectoral approach. The relatively small contribution of agriculture to several rural areas means inevitably that other economic sectors have come to play an increasing role within the rural economy. For the aim of generating income, it is vital to bring about improvements within the educational standards. When the individuals possess the essential literacy skills, they will easily acquire information in terms of policies, measures and programs that are put into operation, resulting in their well-being. Furthermore, they are able to perform various tasks and activities in a manageable manner, including the implementation of household responsibilities, health care, diet and nutrition, child development and so forth. When they are engaged within the production processes, then they would be able to acquire satisfactory information in terms of marketing strategies and approaches and able to enhance productivity and profitability. The service and industrial sectors, as well as recreation and tourism, have risen to prominence. With a continued focus on farm income assistance, policymakers began to look for other options, and farm "diversification" became the "buzzword in policy circles" in the late 1980s (Newby, 1988). Farmers were urged to diversify their income streams by adding value to agricultural goods, repurposing farm assets, particularly land and buildings, for non-agricultural purposes, working on other farms, and participating in non-agricultural economic activities off the farm. The focus on farm business diversification shifted to a broader examination of farm households and the potential for pluri activity, relying on numerous household income sources, as a long-term farm household survival strategy (Shucksmith *et al.,* 1989).

A territorial approach: The focus towards a more general analysis of conditions within particular types of area, is known as territorial approach and in practice, this implies a focus on rural areas. When acquiring an understanding of rural development approaches it is essential to acquire an efficient understanding of areas in rural communities, which are in a backward and underdeveloped state and which require to be improved. Rural areas offers attractive locations for the establishment of new economic activity, often associated with the most advanced sectors of a contemporary economy, such as in information technology and many areas have gained employment from the establishment of new firms and types of employment (Keeble and Tyler, 1995; North, 1998). In practice, we are able to recognize rural areas in a variety of different circumstances and facing quite different kinds of problem. But given the variety of circumstances found in rural areas, we may then suggest that most generalizations about the character of "rural" areas will be wrong (Hodge and Monk, *op. cit.*). In areas with low activity rates and high unemployment, it should not matter substantially what kind of economic stimulus is introduced. Any type of new activity can have multiplier effects that work through to other sectors should successively promote new opportunities for farm diversification, thus supporting the farm population. In fact, it will often be easier to make employment opportunities through the development of non-land based activities. The relative accessibility of different types of localities has changed as a result of increased traffic congestion in urban areas and improved road and rail networks outside of them; less remote rural areas are generally more accessible than central urban locations that suffer from traffic congestion. Rural areas are attractive to new forms of employment, often based on entrepreneurs choosing to establish new businesses in places where they want to live.

A local approach: A response to these sorts of factors may be to adopt a "local" or even an "individual" approach. The rural individuals have to recognize the importance of education. It is vital for them to get enrolled in educational institutions and training centers and generates information in terms of varied strategies and ideas. Acquisition of education in terms of varied strategies and ideas would help the individuals to differentiate between appropriate and inappropriate, provide solutions to varied problems, look for employment and chances for revenue production and to maintain their living conditions in a suitable manner. In principle, resources have to be directed towards particular problems at the individual household or business level. This is often clearly an impossible task for a central or federal government and indicates the necessity for decentralization of decision- making. But it may still not be feasible for a regional government and should demand a more localized approach. The complexity of the issues and the diminution of traditional agricultural relationships have increased the attention given to the role of social capital and networks in the delivery of rural development (Lee *et al.*, 2005). There has to be a system whereby local circumstances can be assessed against national priorities and knowledge disseminated to individual households and businesses on the opportunities and resources that can be made available in support of the objectives. This may not occur at a single step and the ease with which it occurs at all will depend upon local institutions and the level of social capital. Experience with rural development schemes to date suggests that they can be successful employed in the development of institutions and social capital, especially as embodied in the organizations. In order to make the schemes easier to apply, tools have been created. Local institutions have a vital role in dealing with the increasing complexity of policy implementation by building social capital for dissemination of information, networking amongst participants and co-ordination of activities. A variety of institutional arrangements and networks at the local level are involved, such as in public sector facilitation, by organizations like local authorities or National Parks, development, housing and service provision associations, collective supply associations for environmental goods, local dedicated environmental funds, or conservation trusts. A number of these are purely within the public sector, such as local government facilitation. Others are essentially private, non-profit organizations, but generally substantially supported through government funding. Some develop horizontal associations, like as land management co-operatives, while others develop vertical associations, such as facilitation for the implementation of policy. In the delivery of rural development policies, more focus is needed on the best form and level of administrative intervention.

PROGRAMMES FOR INCREASE IN AGRICULTURE

Intensive Agricultural Area Programme (IAAP): It was introduced in 1960-61 on the recommendations of the agricultural production team sponsored by the Ford Foundation. It selected one district out of every state on experiment basis for intensive agriculture. The most important concern of the programme was growing of special crops. Under this programme 20-25 per cent of the cultivated area of the country was brought under the intensive agricultural development.

Intensive Agriculture district programme (IADP): During July 1960, the programme was launched in seven districts throughout seven states. The selections of those districts were done on the basis of their high potentiality for increasing the yield in shorter time. It covered various aspects of agriculture like consolidation of land, land leveling and land shaping, realignment and lining of water courses, provision of drainage of ditches.

High Yielding Variety Programme (HYVP): This programme was implemented in 1996 and has become a popular programme in agricultural development. It is this programme which has resulted in green revolution. This programme introduced agricultural inputs of high yielding quality within the production. Chemical manure, seeds, equipment, and livestock were all introduced with these improved kinds.

Area Development Programmes

Drought –prone area programme (DPAP): It was started in 1973. The target of this programme is to minimize the adverse effects of drought on production of crops and livestock and productivity of land, water and human resources through integrated adoption of relevant technology to develop the area's natural resource base.

Command Area Development Programme (CADP): This programme was initiated in the year 1974-75 under centrally sponsored scheme with the target of fast utilization of created irrigation potential and optimum agricultural production from irrigable land. Initially three medium irrigation projects were included under the centrally sponsored command area development programme which has since been completed.

Hill Area Development programme (HADP): It is specifically meant for hill areas. The key thrust of this programme lies in the identification of backward regions of state with sizeable hill areas and formulation of a separate sub–plan for the development of these areas. The main strategy of development in these projects was the integrated development of agriculture, animal husbandry, and horticulture, minor irrigation etc.

CONCLUSION

Rural community development involves ongoing economic, social and environmental improvement - sustaining a desirable environment; having a vital social system that fosters collaboration, equity and freedom; and an important economy that is diverse, competitive and accessible. Poverty, poor health, illiteracy, exploitation, inequitable distribution of land and other assets, and a lack of infrastructure and public services characterize India's economy and social structure. The programmes that have been taken for the development of rural community development have created socio-political consciousness among people, employment of rural people, attainment of self-sufficiency in food production, establishment of educational and banking institutions etc. but a more comprehensive agenda needs to go beyond service delivery, information dissemination and discrete initiatives to incorporate additional approaches. Access, collaboration, coordination, new assumptions, and developing local motivation are all part of this. These approaches involve greater recognition of community values, new forms of participation, managing local perceptions, fostering community confidence and new approaches by government. Changes are required to be brought about in the rural development strategies in accordance to the needs and requirements of the community.

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Optimization of Different Drying Methods in Fig

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ABSTRACT

During ancient time, the technology of drying of fruits and vegetables was mainly adopted to extend the shelf life, neglecting the retention of quality attributes. Nowadays, attempts have been made for the development of high-quality dried products. Adoption of novel drying methods have proved to be a boon for maximizing quality attributes accounting to flavor, texture, color, nutrition, etc. Fig is a very nutritive fruit and is mainly consumed in the dried form. For enhancement of its shelf life, drying of it is considered as a crucial technique. In the research study, the drying methods: sun the user view the building they be the only thing other be the main benefits all the, shade, hot air oven, tray and microwave drying of pre treated fig fruits was done. The fig cv. Brown Turkey pre-treated with 50^0Brix fructose and sucrose, 1% sodium and potassium metabisulphite was assessed for their effect on the nutritional and physico- chemical properties of dried fig fruits. The outcome of the results showed that the pre-treatment of fig fruits with 50^0Brix fructose and dried through tray drying method proved to be the most efficient in the adequate retention of moisture, reduction of drying time and maintained the physico-chemical quality properties such as sugars, ascorbic acid and mineral content. Also, it maintained the sensory properties and enhanced acceptability by maintaining taste, texture, colour and flavor of the dried fig fruits. Hence, the major requirements in drying of fig pertaining to short duration of drying, retention of adequate moisture and quality of dried fig can be met with pre-treatment of 50^oBrix fructose and tray drying method.

Keywords: Acceptability, Drying, Fig, Quality attributes, Pre-treatments, Sensory properties

INTRODUCTION

Fig (*Ficus carica* L.) also known as "Nature's most perfect fruit is considered as an aggregate fruit with arrangement of small individual drupes termed as drupelet which develop from the ovaries in a closed inflorescence known as the syconium, in the form of fleshy, hallow receptacle with a narrow aperture at the tip with many small flowers lining the inner surface. It is an integral sub tropical fruit crop native to Southern Arabia. It is considered as the most common fruit which is used for trade purposes in the international market (Zare, 2021). Phyto chemicals present in fig has therapeutic effects including anticancer, hepatoprotective, hypoglycemic, hypolipidemic and anti microbial activities. Its leaves, bark and fruits are used for the treatment of diabetes, skin diseases, ulcers and sores. It is also taken as purgative and vermifuge. The latex of fig has promising effects as a potent anti tumour agent. It is also valued for its laxative properties and in the treatment of skin infection. It maintains the pH of the human body and also purifies the blood. Fig is delicious and nutritive fruit being packed with higher nutritional values with a good source of carbohydrates, vitamin K and minerals like calcium, magnesium, phosphorus and strontium. An average amount of protein, dietary fiber and traces of fat are used in numerous desserts, eaten raw and is used in baked commodities, jam and various preserves. Some savory and meat dishes are being garnished by figs. It is used for producing wine in some regions and is a substitute to coffee in European countries. Fruit cake prepared from the fig holds a signification among all the bakery products. It is widely used snacks by the people (Vora *et al.*, 2017). Fig fruit is perishable in nature and also poses problems during storage at ambient

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conditions. Dried figs are in a great demand among people. Drying of fig is advantageous for preserving food quality by reducing microbiological activity and by maintaining biochemical changes. The dried figs can be stored for 6 – 8 months. It is the most effective way of preservation of fig. The necessary pre – requisites for dehydration of fig is the pre - treatment of fruits to prevent unnecessary physico – chemical changes and to retain the qualitative traits of the fruits during the drying mechanism (Nagaraja *et al.*, 2016). No sincere efforts have been made to improvise the drying technique of fig in India. At present, only a few quantity of fig is being preserved by sun drying using crude methods at farm level resulting in contamination, discoloration and deterioration in quality of dried fruit due to lack of professional guidance and research. To get good quality dehydrated product, osmotic dehydration in combination with other drying methods is a useful activity. Therefore there is an urgent need to standardize and refine the techniques for the production of dehydrated fig fruits. Dehydration of fig not only increases the revenue, which the farmer earns, but also helps in saving the foreign exchange.

MATERIALS AND METHODS

Sulphuric acid stock solution (10% w/v), sulphuric acid working solution (1.25%), sodium hydroxide stock solution (10% w/v), sodium hydroxide working solution (1.25%), antifoam, CCl_4,metaphosphoric pellets, glacial acetic acid, ascorbic acid standard solution, indophenol standard solution, sodium bicarbonate, 30 per cent ethyl alcohol, 60 per cent aqueous ethyl alcohol.

Fully grown and firm mature fig fruits (cv. Brown turkey) were procured from a well maintained, healthy and uniform fig orchard of Department of Horticulture at Khalsa College, Amritsar (located at 31.6° North latitude and 74.9°East longitude with an average altitude of 234 m above the mean sea level). Fruits were harvested in the month of November, 2020. Fruits of uniform size, shape, colour and without any defects were selected. Diseased and damaged fruits were discarded. Fresh fruits of fig at mature stage were pre-treated and dried until they attained constant weight. The dried samples were grinded in an electric grinder using 0.5 mm sieve size to fine powder and filled in LDPE pouches.

Fig slices were treated with fructose syrup (50°B) for 24 hours, sucrose syrup (50°B) for 24 hours, sodium metabisulphite 1% solution for 30 minutes, potassium metabisulphite 1% solution for 30 minutes and control (no treatment).

The five main technologies used for dehydration were sun drying, shade drying, hot air oven drying, tray drying and microwave drying. Pre-treated figs were dried in a sun (22-24°C), shade (16-18°C), hot air oven (50-55°C), tray (50-55°C) and microwave (40-45°C) till reaching a safe wet basis moisture level of 23- 18 per cent. The time required for drying in different pre-treatments to reach the safe and optimum moisture level was recorded in minutes.

Crude fiber was estimated by employing standard method of analysis (AOAC, 1990). One gram of dried sample was put in one litre tall beaker and 200 ml 1.25 per cent H_2SO_4 was added along with few drops of antifoam. Then, the solution was kept for boiling under bulb condenser for 30 minutes. Beaker was rotated occasionally to mix the contents and removed the particles from the sides. The contents of beaker were filtered through funnel. Then, the sample was washed back into tall beakers with 200 ml 1.25 per cent sodium hydroxide and again brought to boiling point followed by boiling exactly for 30 minutes. Thereafter, all insoluble matter was transferred to the sintered crucible by means of boiling distilled water and washed tillit become acid free. It was washed twice with alcohol and thrice with acetone. Then, dried at 100°C temperature till it attained constant weight followed by ashing in a muffle furnace at 550±10°C temperature for 1 hour.

Muffle furnace (TANCO model) was used to determine the ash content of the samples (Rao and Xiang, 2009). The crucible and lid was placed in the furnace at 525°C temperature overnight and next day both of them were cooled. Then, the crucible and the lid were weighed. 10 gm of sample was weighed into the crucible. The crucible was placed in the muffle furnace for 6 hours at 525°C temperature. After this, the crucible was cooled down and crucible was again weighed with the ash left.

Estimation of Non enzymatic browning: 5 gm fruit pulp (0.05 gm dried powder) was dissolved in 40 ml of 30 per cent ethyl alcohol. The resulting solution was kept overnight and filtered next day to obtain a clear solution. The colour intensity of solution was measured at 440 nm using 60 per cent aqueous ethyl alcohol as blank. The increase in absorbance of the sample at 440 nm was taken as a measure of non enzymatic browning (Srivastava and Kumar 1998).

Organoleptic evaluation of dried fig fruit slices was done just after preparation by the method given by Ranganna (1986). It was carried out by a panel of 10 judges consisting of teachers and post-Graduate students of Department of Horticulture, Khalsa College, Amritsar. They scored the quality attributes such as colour and appearance, taste, texture, flavour and overall acceptability of the sample with the help of five point hedonic rating scale (1 = dislike extremely; 5 = like extremely. About 5-6 pieces of samples for evaluation were served in disposable, clean, plastic plates to each panelist. Water was provided to the panelists for rinsing their mouth after each. The mean score was obtained from the values given by all the judges.

Statistical analysis: The data on physico-chemical parameters and organoleptic characters recorded was subjected to (Split Plot Design). The data was analysed with the help of R studio software. The graphs were also made in R studio software. Mean values significantly different $p < 0.05$ and significant differences between means were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

The appropriate moisture content (wet basis) was founded in fructose pre-treated fig dried through tray dryer followed by fructose pre-treated fig dried through sun. Moreover, the lowest moisture content was observed in untreated fig dried by microwave (Table 1). The moisture content of dried fig is considered as an important component aiding its quality. The pre-treatments had a very little significant effect on the moisture content of dried figs although they played a role determining the drying time to bring moisture content in fig fruits to pre determined safe moisture level. Lower moisture level might be due to the dissolution of waxy bloom on the skin of fruits leading to formation of cracks on the skin. This results in the hastening of moisture loss from fresh fruit during drying. The fruits in which pre-treatments did not dissolve the waxy layer had retained the moisture content. The maximum moisture retention in sugar solutions have been advocated (Sowjanya, 2004 and Kaggodi, 2005) in fig.

Minimum moisture content in microwave drying can be attributed to the increment of drying air temperature which increases the drying potential. Higher retention of moisture content in tray dryer might

Table 1: Moisture content (MC) wet basis % and dehydration ratio (DR) of pre-treated fig dried through different methods

Treatments	M_1	MCDR	M_2	MCDR	M_3	MCDR	M_4	MCDR	M_5	MCDR	Mean	MCDR
T_1	23.68^{ab}	4.36^{l}	23.47^{b}	4.37^{k}	23.35^{bc}	4.38^{j}	23.84^{a}	4.35^{m}	22.26^{fg}	4.44^{e}	23.32	4.38
T_2	23.49^{b}	4.43^{f}	23.17^{c}	4.39^{i}	23.41^{bc}	4.37^{k}	23.58^{ab}	4.36^{l}	22.01^{ghi}	4.45^{d}	23.13	4.39
T_3	22.41^{f}	4.43^{f}	22.86^{d}	4.41^{h}	22.33^{f}	4.44^{e}	22.45^{ef}	4.37^{k}	22.21^{fgh}	4.43^{f}	22.45	4.42
T_4	22.44^{ef}	4.42^{g}	22.37^{f}	4.43^{f}	22.31^{f}	4.44^{e}	22.69^{de}	4.43^{f}	21.73^{ij}	4.48^{a}	22.31	4.44
T_5	22.73^{de}	4.41^{h}	22.72^{de}	4.41^{h}	21.98^{hi}	4.46^{c}	22.24^{fgh}	4.43^{f}	21.50^{j}	4.47^{b}	22.24	4.43
Mean	22.95	4.41	22.92	4.40	22.68	4.41	22.96	4.38	21.94	4.46	113.45	22.06
For comparing the means					C.D (0.05)			MCDR				
Treatments (T)					0.21			0.0				
Drying methods (M)					0.13			0.0				
Interaction (T x M)					0.28			0.0				

Superscript values with in columns by Duncan Multiple Range Test at 5% level of significance

T1– Pre-treatment of fructose, **T2**- Pre-treatment of sucrose, **T3**- Pre-treatment of sodium metabisulphite, **T4**- Pre-treatment of potassium metabisulphite, **T5**– Control; **M1–** Sun drying, **M2–** Shade drying, **M3**– Hotairoven, **M4**– Tray dryer, **M5**– Microwave be due to the low and fluctuating temperature prevailing inside the dryer and higher relative humidity as a result of reduction in flow of air as well as recirculation of air. The present results closely resembles (Thuwapanichayanan *et al.,* 2012) in banana slices.

The lowest dehydration ratio was recorded in fructose pre-treated fig dried through tray dryer whereas the highest was in potassium metabisulphite pre-treated fig dried through microwave (Table 1). Lowest dehydration ratio in pre-treatment of steeping of fructose might be due to the transfer of sugars from the solution to the fruit slices by the process of osmosis (Agarwal and Singh, 1997). Inverse relationship is indicated between dehydration percentage and dehydration ratio. These results are further supported by the fact that during osmotic dehydration for getting higher yield of dehydrated fruit lower dehydration ratio is preferable which was obtained in sugar solution in papaya (Singh and Kumar, 2010) and in sapota (Patil, 2001). Increase in dehydration ratio in tray dryer might be attributed to higher moisture retention, temperature, humidity and rate of heat transfer on surface of food as in fig (Pawar *et al.*, 1992 and Chaudhary *et al.*, 2019).

In this study, it was observed that the crude fiber content (Figure 1A) of dried fig was the highest in untreated fig dried in tray dryer. Simple processes such as soaking and drying tends to modify the composition and nutrient availability. It leads to the modification of cell wall material having important physiological effects (Roehrig, 1988). Thermal treatments increases the crude fiber content increased retention of crude fiber in the dried fig might be due to the formation of fiber protein complexes that are resistant to heating (Caprez *et al.,* 1986). Retention in crude fiber on drying of fruits and food materials has been reviewed (Dhingra *et al.*, 2012) in food products.

The effect of pre-treatment and drying method depicted maximum ascorbic acid (80.33 mg/100g) in fructose pre-treated dried through sun, while the minimum (24.33 mg/100g) was found in potassium metabisulphite pre-treated fig dried in microwave (Figure 1B). Considerable retention of ascorbic acid in fructose treated and tray dried fig samples can be attributed to the sufficient availability of moisture in the samples. Adequate amount of moisture prevented

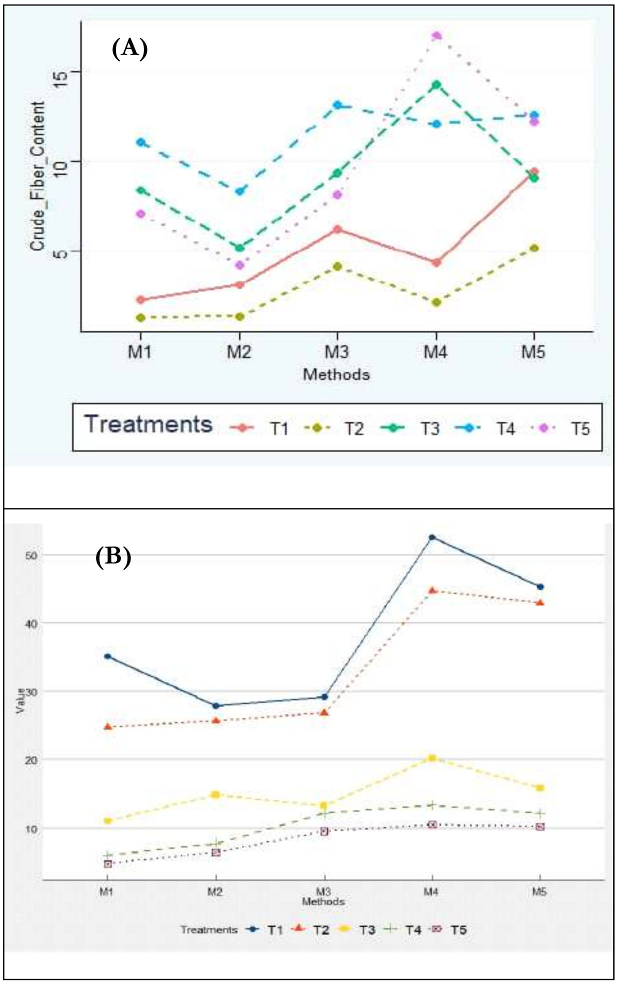

Figure 1: Crude fiber (A) and ascorbic acid (B) of pre-treated fig dried through different methods

degradation of the ascorbic acid which might be the reason of maximum ascorbic acid content in the samples. The present research findings are in line with the findings (Indudhara, 2003) in fig.

It is evident from the data that significant differences existed between pre-treatments and drying methods. Untreated fig slices when dried under shade had higher ash content (5.35%) Lowest ash percentage (0.65%) fructose pre-treated dried in microwave statistically similar to 1.21 per cent in sucrose pre-treated dried in microwave at 40-45°C (Table 2). Ash is the inorganic residue remaining after water and organic matter have been removed by food. It is a measure of total amount of minerals present within a food. Increase in ash content observed throughout the research can be attributed to the removal of moisture which tends to an increase in the concentration of

Table 2: Ash content of pre-treated fig dried through different methods

Treatments	M_1	M_2	M_3	M_4	M_5	Mean
T_1	1.66^{i}	1.63^{i}	1.33^{j}	1.62^{i}	0.65^{k}	1.38
T_2	1.37^{j}	1.33^{j}	1.35^{j}	2.34^{h}	1.21^{j}	1.52
T_3	3.62^{f}	3.67^{f}	3.34^{g}	5.11^{b}	4.65^{c}	4.08
T_4	4.47^{cd}	4.29^{de}	4.65^{c}	4.59^{c}	4.65^{c}	4.53
T_5	5.27^{ab}	5.35^{a}	4.21^{e}	5.34^{a}	4.64^{c}	4.97
Mean	3.28	3.26	2.98	3.80	3.16	16.48
For comparing the means			C.D (0.05)			
Treatments (T)			0.17			
Drying methods (M)			0.11			
Interaction (T x M)			0.24			

Superscript values within columns by Duncan Multiple Range Test at 5% level of significance.
T_1 – Pre-treatment of fructose, **T_2** - Pre-treatment of sucrose, **T_3**- Pre-treatment of sodium metabisulphite, **T_4**- Pre-treatment of potassium metabisulphite, **T_5** – Control; **M_1 –** Sun drying, **M_2 –** Shade drying**, M_3**– Hot air oven**, M_4**– Tray dryer**, M_5**– Microwave

Table 3: Non-enzymatic browning of pre-treated fig dried through different methods

Treatments	M_1	M_2	M_3	M_4	M_5	Mean
T_1	0.0063^{lm}	0.041^{f}	0.11^{jklm}	0.014^{jklm}	0.105^{b}	0.050
T_2	0.0070^{lm}	0.003^{m}	0.009^{lm}	0.009^{klm}	0.044^{f}	0.015
T_3	0.021^{hij}	0.020^{hijk}	0.044^{f}	0.093^{c}	0.022^{hij}	0.04
T_4	0.041^{f}	0.016^{hijkl}	0.063^{e}	0.034^{fg}	0.196^{a}	0.07
T_5	0.025^{ghi}	0.013^{ijklm}	0.028^{gh}	0.093^{c}	0.082^{d}	0.049
Mean	0.021	0.019	0.051	0.049	0.084	0.23
For comparing the means			C.D (0.05)			
Treatments (T)			0.012			
Drying methods (M)			0.009			
Interaction (T x M)			0.020			

Superscript values within columns by Duncan Multiple Range Test at 5% level of significance.
T_1 – Pre-treatment of fructose, **T_2** - Pre-treatment of sucrose, **T_3**- Pre-treatment of sodium metabisulphite, **T_4**- Pre-treatment of potassium metabisulphite, **T_5** – Control; **M_1 –** Sun drying, **M_2 –** Shade drying**, M_3**– Hot air oven, **M_4**– Tray dryer, **M_5**– Microwave

nutrients (Morris *et al.*, 2004). Low temperature application during drying process might also be the reason for increased ash content. Similar results of an increased ash content under shade drying also supports the findings (Sonkamble and Pandhure, 2017) in vegetables.

Significantly lowest non-enzymatic browning (0.003) was noted in sucrose pre-treated fig dried under shade which was statistically at par with 0.0063, 0.0070 and 0.009 in fructose and sucrose pre-treated dried under sun and sucrose pre-treated dried in hot air oven respectively. The highest non-enzymatic browning (0.196) was noticed in fig treated with potassium metabisulphite and dried in microwave (Table 3). The non-enzymatic browning found lowest in shade drying as compared to other drying methods might be due to the exposure of fig to low temperature which leads to slowing of non-enzymatic browning (Sonkamble and Pandhure, 2017) in leafy vegetables. Non-enzymatic browning is commonly observed in dehydrated commodities. In the present research outcomes, it was measured to be the lowest in T_3 (Sodium metabilsulfite) as compared to other treatments. This might be due

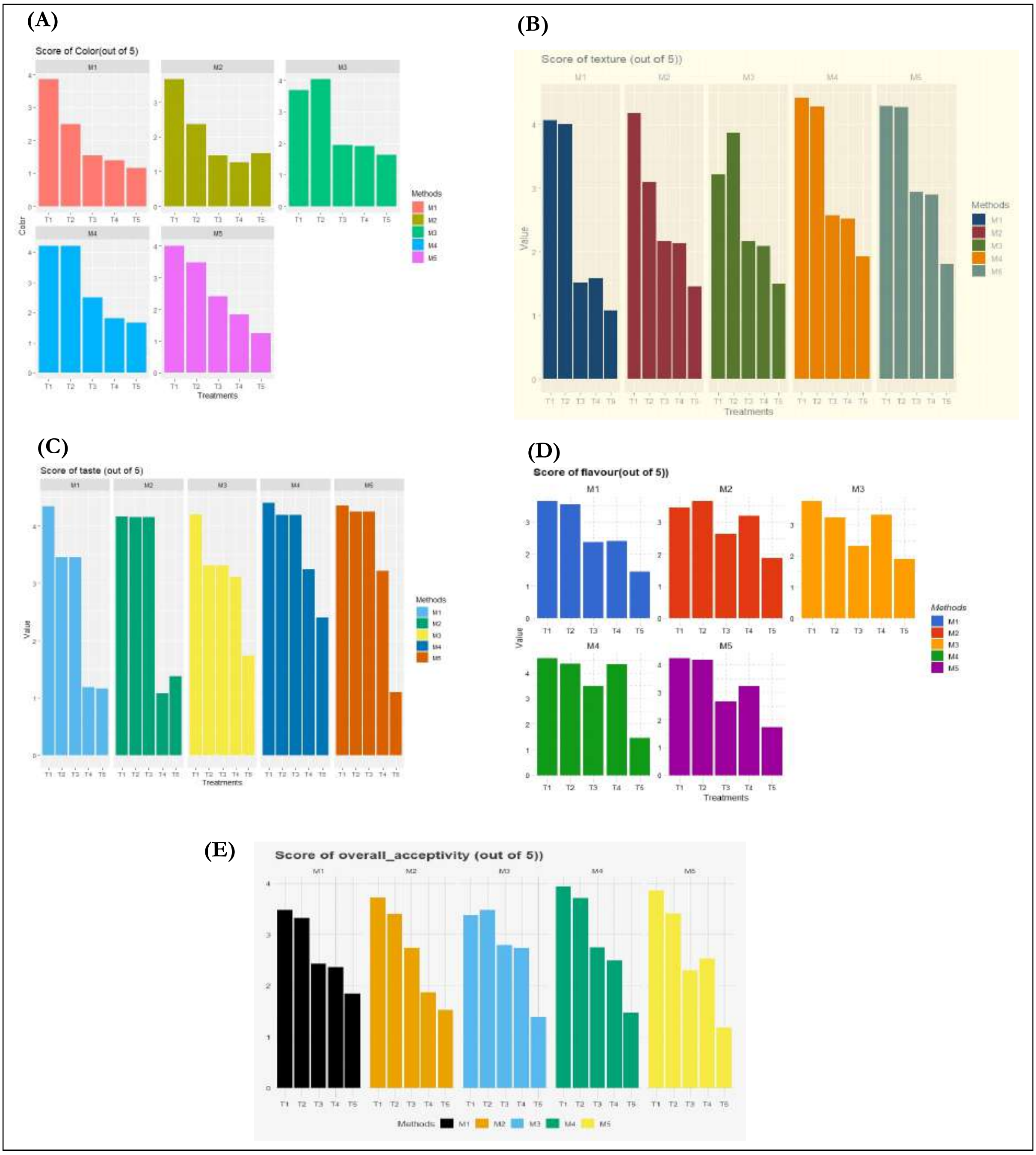

Figure 2: Effect of pre-treatments and methods on (A), colour and appearance (B), texture (C), taste (D), flavour (E), overall acceptability (on 5 point hedonic scale) of dried fig fruit

to the antioxidant properties of the treatments used as reported in fig (Kaggodi, 2005) and in peach (Di Persio *et al.,* 2004).

Improved colour and appearance of fig dried fruits steeped in sugar solution can be attributed to the acidic reaction with sugars resulting in non-enzymatic browning. The loss of intercellular air caused by sugar impregnation might have increased the light refraction which resulted in good colour and appearance. Tray dryer (M_4) proved to be superior in maintaining the colour and appearance (4.21) score of fig dried fruits pre-treated with fructose (T_1), where as minimum score (1.16) was in control fruit dried under Sun (Figure 2A). Similar results are in consonance (Kaggodi, 2005; Piga *et al.,* 2008) in fig dried fruits. Improved colour and appearance in tray drier might be due to low uniform temperature enabling proper moisture removal preventing enzymatic and biochemical changes, thus preventing the discoloration of samples. The present findings are in line with the results in banana (Thuwapanichayanan *et al.*, 2012) and pineapple slices (Chaudhary *et al.*, 2019).

The highest texture score (4.41) was noticed (Figure 2B).in fructose pre-treated dried in tray dryer. Furthermore, the lowest score (1.07) was found in untreated fruit dried in microwave. An important quality parameter of dehydrated fruits is texture. The highest texture in sugar steeped fig slices can be attributed to the higher sugar concentration in the dipped slices. The present observations are in agreement with the research findings in ber (Agarwal and Singh, 1997) and fig (Kaggodi, 2005). Superior texture in tray dryer might be due to the uniform temperature of drying in shorter exposure to drying, adequate removal of moisture giving crisp texture as compared to other drying methods.

The taste of the product has a key role in the acceptability of the product by the consumer. Maximum taste score in prelevement of fructose might be because of the absorption of more sugar (Rastogi and Raghavarao, 1998). Higher taste with sugar syrup was also observed in sapota (Lakkond, 2002), amla (Chandan, 2004) in aonla, fig (Kaggodi, 2005; Patil, 2007). In this study observed that fruit treated with fructose and dried in tray dryer was more tasty and sweet as compare to others (Figure 2C). Electric tray dryer yielded dried fig with better taste which might be related to the compactness of the dryer, maximum proportion and maintenance of uniform temperature continuously with the help of mechanism in the dryer throughout the drying period.

Considering the interaction between treatments and drying methods the highest flavour score (4.58) was achieved in fructose pre-treated dried in tray dryer, while lowest (1.45) flavor score was noticed in control fruit dried under sun (**Figure 2D**). Flavour plays a great role in the quality of commodities with consumer's point of view. Highest flavor score with steeping of fig fruits in sugar solution. The prevention of off flavor development maintained the fruit quality. The present findings are in collaboration with the research in mango (Giraldo *et al.*, 2003), fig (Indudhara, 2003; Abhay, 2004). Maintenance of flavor in fig dried through tray dryer might be due to the checking off enzymatic and related bio-chemical changes which prevented the off flavoured by low temperature and quick drying in tray dryer.

Appreciable overall acceptability might be ascribed to constant immersion of products in sugar solution avoiding exposure to air thus minimizing oxygen related undesirable reactions. Improvement in colour, flavour, texture and taste of the dried figs lead to good acceptability. It was best noticed in fructose pre-treated fig dried through tray dryer. The research findings in fig (Kaggodi *et al.*, 2005; Piga *et al.*, 2008) are in agreement with the present results. Overall acceptability of dried fig tray drying might be due to improved colour, taste and texture by exposure to low temperature for a shorter period (Figure 2E).

CONCLUSION

The proximal analysis of the experimental studies confirmed that the fig fruits pre-treated with fructose syrup of 50°Brix and dried in the tray dryer showed reduction in drying time and exhibited high organoleptic acceptable profile. The improved novel drying methods minimize the loss of essential nutrients and bioactive compounds during the drying process. However their application and impact on phytochemicals such as phenols, flavonoids and antioxidants is still limited. Therefore, further studies should be carried out for better understanding of the impact of these novel drying methods on the nutritional activity in dried fig which will create awareness about the health benefits of consumption of dried fig and will pave way for untapped potential for its marketing as nutraceutical formulations to enhance human wellness.

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Popularization of Marigold Flower for Income Generation Through Frontline Demonstration Among the Farmers of Samba District

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ABSTRACT

Marigold is one of the important commercial crop among floriculture supplementing the regular income to small and marginal farmers of the Samba district of J&K Union Territory. Jammu being a city of temples consumption of flowers is more, but as compared to consumption production is very less. However, the major constraints of marigold cultivation are low productivity due to the lack of good quality seed, non adoption of recommended package of practices and lack of awareness regarding the economics of the crop as compared to cereals. To solve this problem, front line demonstration were conducted at the farming situation of Samba district with the participation of farmers after the baseline survey. The cultivation practices in this FLD (use of improved variety, proper nursery techniques, balance dose of fertilizers, important inter-culture operations and plant protection measures) increased the yield by 40.2 percent on an average over the farmer practice. The highest extension gap was 56.2 q/ha while the technology index, which is inversely correlated to the feasibility of the improved technology in the farmers field was 21.6 percent. The adoption of improved technology under FLDs resulted in higher gross returns (Rs 685300/ha), net return (Rs 597300/ha) and benefit : cost ratio(1:6.7) as compared to farmer practice.

Keywords: Marigold, Frontline demonstration, Yield, Technology gap, Extension gap, Technology index

INTRONDUCTION

Floriculture has been a major thrust area for diversification of horticulture. Growing of flowers and ornamental crops is rapidly expanding enterprise. Flowers have always remained an integral part of the social fabric of human life due to its essence and fragrance being essential on all social, cultural and religious functions of any society since time immemorial. Floriculture is an age old farming activities in India having massive potential for generating gainful self-employment among small and marginal farmers. In the recent years, it has emerged as a profitable agribusiness in India and worldwide, standards of living and growing consciousness among the people across the globe to live in environment friendly atmosphere has led to an increase in the demand of floriculture products in the developed as well as in the developing countries worldwide. An area under flower cultivation can support a family consisting of 5-6 members. Flowers are the beauty in human life. Marigold flower cultivation is getting popular among the farmers. It is an important and popular flower and ranks third in number after roses and chrysanthemum. The commercial cultivation of marigold is a source of income and employment to marginal as well as large farmers and this crop fetch more price per unit area as compared to cereals. Marigold is used for making garlands, garden disc play, loose flower and perfume industries. Marigold is one such potential flower crop for natural colour extraction.

J&K, Union Territory is blessed with some world famous religious shrines and huge amount of flowers are needed for worship. But most of the produce comes from out of the state for worship. Inspite of

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the increasing demand for the crop the production is low to fulfill the domestic demand. Main reason for low production and less adoption of marigold in their farming system is lack of awareness regarding scientific package of practice and its economic importance (Indira *et al.,* 2001). The improved technologies developed by research institutes were also found to be financially attractive. Yet adoption levels for several components of the improved technology were low emphasizing the need for better dissemination (Kiressur *et al.*, 2001). Several biotic, abiotic and socio-economic constraints inhibits the exploitation of the yield potential. Demonstration is one of the most powerful extension tools in communication of new ideas, methods and techniques in agricultural development. It helps to convince the farmers faster than any other method through the process of observing, hearing, learning by doing and experiencing things (Pathak, 1999). The main objective of the front line demonstration is demonstrate the newly released crop production and protection technologies and its management practices at the farmer's field under different agro-climatic regions and farming situations. The improved cultivation practices followed in the national demonstrations have already shown high yield potentials (Anonymous, 2012).

Samba district has very less area under marigold cultivation due to paddy –wheat farming system. The low productivity of marigold poses a threat to economic security of the small and marginal farmers. Keeping the above points in views, the front line demonstration on marigold was initiated with the objective of the improved production technologies under real farm situations over locally cultivated marigold crop.

MATERIALS AND METHODS

The present study was carried out by Krishi Vigyan Kendera Samba during 2020-21 to 2021-22 in the farmers field of Samba district. Samba is a new district in the Indian Union Territory of Jammu and Kashmir. It is situated at an elevation of 384 meters and located on the Shivalik hills range alongside the National Highway on the bank of river Basantar. The district covers Samba town and adjoining tehsils. Samba district Consists of four blocks : Samba, Vijaypur, Purmandal and Ghagwal. About 2/3 area of the District Samba is rainfed. The area on the southern side of National highway is irrigated through Ravi Tawi Irrigation canal network. Samba district of Jammu and Kashmir (UT) has a longitude of 75.12°E and latitude of 32.57°N. Total area under agriculture in district is 0.71 lakh ha. Forty five front line demonstrations in 2.5 ha area in four villages of above mentioned blocks were conducted. Nursery of marigold was raised in first week of September. Planting of seedling was done after twenty five days of nursery raising with the spacing of 45x45 cm along-with seedling dip in Trichoderma to avoid the problem of wilting in demonstration plot, while check plots traditional method was followed. Manure and fertilizers were given as per improved package of practice as basal dose as well as in top dressing. All the intercultural operations were adopted according to package of practice. Materials for the present study with respect to FLD's and farmer practice were given in the table A. In case of local check existing practices were used. Data on output of marigold cultivation from FLD plots as well as local practices adopted by the farmers were collected. In demonstration plots critical inputs like seed/seedlings, agrochemicals and technical guidance regarding transplanting, seedling treatment, pinching, weeding, earthing-up, plant protection measures and harvesting were also provided to beneficiaries, where as traditional practices were opted in local checks. Trainings, field days and regular monitoring were also conducted. Study of the technology gap, extension gap and technology index were calculated as suggested by (Samui *et al.,* 2000).

RESULTS AND DICUSSIONS

A comparison of yield parameter and productivity levels between improved practices in demonstration plots and farmer practices is shown in Table 1. Yield and yield attributing parameters viz., number of flowers, size of flowers, number of branches and yield per plant were recorded highest in demonstration plots as compared to farmers traditional practices. On an average 193.5 qt/ha and 194.0 yield was recorded in demonstration plot as compared to the farmers practices (140.3 and 139.3 qt/ha) during 2020-21 and 2021-22 and there was 37.9 and 39.2 per cent increase in yield over farmer practices. Singh *et al.* (2011) also reported the increase in yield in Rajasthan condition through FLDs on improved production technology.

Table 1: Productivity, technology gap and technology index of marigold under FLDs and existing practices

Year	Area (ha)	Number of FLDs	Yield (q/ha) FLD	Farmer practice	% increase over farmer practice	Technology gap (qt/ha)	Extension gap (qt/ha)	Technology index (%)
2020-21	2.5	40	194.5	140.0	38.9	55.5	54.2	22.0
2021-22	2.5	40	195.8	139.6	40.2	54.02	56.2	21.6

Table 2: Cost of cultivation (Rs/ha), gross return (Rs/ha), net return (Rs/ha) and B:C ratio as effected by improved and local practices

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Net Return (Rs/ha)		B:C ratio	
	FLD	Farmer practice	FLD	Farmer practice	FLD	Farmer practice	FLD	Farmer practice
2020-21	86850	85000	680750	420,000	593900	335,000	6.8	3.94
2021-22	88000	86000	685,300	418800	597300	332,800	6.7	3.86

Similarly, yield enhancement in different crops in front line demonstration has amply documented by (Haque, 2000; Sagar and Ganesha, 2003; Singh *et al.,* 2007; Mishra *et al.,* 2009; Kumar *et al.,* 2010). The resulted that the front line demonstration have given a good impact over the farming community of Samba district as they were motivated by the new agricultural technologies applied in the FLD plots. This findings is in corroboration with the findings of (Poonia and Pithia, 2011).

Data indicated in table1 revealed that the technology gap in the demonstration yield was 55.5 qt/ha and 54.02 qt/ha for 2018-19 and 2019-20 respectively over the potential yield, 250 qt/ha for marigold. The technological gap may be attributed to the dissimilarity in the soil fertility status and weather conditions by (Mukurjee, 2003). Hence, variety wise location specific recommendation appear to be necessary to minimize the technology gap for yield levels in different situations

The highest extension gap of 54.2 qt/ha and 56.2 qt/ha (Table 1) was recorded during the period of study respectively. This emphasized the need to educate the farmers through various means for the adoption of improved agricultural production technologies to reverse this adoption of wide extension gap. More and more use of latest production technologies with high yielding varieties will subsequently change this alarming trend of galloping extension gap. The new technologies will eventually lead the farmers to discontinue the old technologies and to adopt new technology. This finding is in corroboration with the finding of (Hiremath and Nagarajun, 2010)

The technology index shows the feasibility of the evolved technology at the farmer's fields. The lower the value of technology index more is the feasibility of the technology (Jangeer *et al.,* 2006). The technology index were 22.0 and 21.6 per cent during both the year of study

The input and output prices of the commodities prevailed during the demonstration were taken for calculating cost of cultivation, gross returns, net returns and benefit : cost ratio (Table 2). With the adoption of improved technology under FLDs, higher gross return (Rs. 680750 and 685,300/ha), net return (Rs 593900 and 597300/ha) and B:C ratio (1:6.8 and 1:6.7) was recorded as compared to farmer practices having the gross return of (Rs420,000 and 418800/ha), net return (Rs 33500 and 332,800/ha) and B:C ratio of (1:3.94 and 1:3.86). This may be attributed due to higher yields obtained under improved technologies compared to farmers traditional practice. These results are in close conformity with the findings of (Hiremath *et al.,* 2009 and Mokidue *et al.,* 2011).

Optimum sowing time was not followed due to non-availability of quality seed. Moreover, farmers raise the nursery in traditional way by broadcasting the seed in flat bed. Use of inadequate and imbalance dose of fertilizers especially the recommended dose of nitrogenous, phosphoric and potash by the farmers could not results into potential yield. Lack of knowledge regarding weedicide, plant protection measures, other cultural operations and post harvest management techniques are also factors responsible for lower yield. Traditional implements and tools are still in practice due to small holdings which have poor working efficiency. The lack of simple modern tools for small holdings also hinders the adoption of improved technology. Small and marginal farmers have less capability to take risk and do not dare to invest in the costly input due to high risk and poor purchase capacity of small farmers. Thus the adoption of well proven technology is considered due to small size of holding and poor farm resources.

CONCLUSION

Frontline demonstration is the most suitable method for assessing the performance of the improved technology as it directly involves the scientists in conducting the demonstration at the farmer's field which enables them to have first knowledge related to the technology. Technological and extension gap extended can be bridged by improved package of practices with emphasis on improved production technology including all cultural operations. Replacement of local variety with the improved variety of marigold would increase the production and net income of the farmers also. Hence the concept of FLD may be applied at more farmer's field for speedy and wider dissemination of the recommended practice which will subsequently improve the livelihood of the farming community

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Food Security and Climate Change in Uttarakhand: Role of Small Millets

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ABSTRACT

Small millets are climate resilient crops that can grow in drought conditions. Therefore, they can be grown to adapt to climate change. Climate change has adversely affected food security with direct effect on food availability and indirect effects on other dimensions of food security namely, food accessibility, food affordability and food utilization. Small millets being rich in minerals like Calcium and having low Glycemic Index not only help to combat diseases like osteoporosis, diabetes, mineral deficiencies etc. but also help to have nutritional security. A vast literature is available on potential of small millets, their production and underutilization in Uttarakhand. In this study, this literature has been reviewed. The main small millets grown in Uttarakhand are finger millet, barnyard millet, foxtail millet and proso millet. Despite their benefits, area under small millets in Uttarakhand has been declining. Small millets are being neglected. For example, in Nainital district, most farmers grow small millets on fallow or abandoned land and allocate only a small share of their land to small millets. Consumption demand is one of the elements that drives production. In case of small millets, consumption demand is low mainly due to ignorance of rural population towards benefits of small millets, lack of palatable food items made up of small millets, lack of government initiatives to prioritize small millets, lack of marketing facilities, low profitability and lack of processing facilities and technologies. Youngsters are not favouring small millets due to disliking towards the taste and appearance of traditional small millet products. Creating awareness among masses to consume healthy small millet-based products, development of post-harvest technologies and facilities for small millets, improving the availability of small millet-based products in local market, development of marketing facilities for small millets, assuring purchase of small millets at Minimum Support Price (MSP), development of low-cost value-added small millet products and including small millets in Public Distribution System (PDS) are few strategies that can be adopted to promote the consumption of small millets. Mass campaigning for increased production and consumption of millets could be quite effective as with increased adoption, the neighbours, friends and relatives of adopters are also likely to produce and consume small millets.

Keywords: Public distribution system, Minimum support price, Food security, Climate change

INTRODUCTION

Millets are small grained cereals. On the basis of grain size, millets have been classified as major millets and minor millets. Minor millets are also known as small millets. The major millets include sorghum and pearl millet while small millets include finger millet, barnyard millet, foxtail millet, proso millet, kodo millet and little millet. Minor millets are a group of small seeded cereal crops (NAAS, 2013). Millets have short growing season and grow well under marginal conditions of soil fertility and moisture. They are also well adapted to perform well under various agro-climatic conditions.

Unlike cereals such as wheat, rice or maize, millets are capable of growing under drought conditions or non-irrigated conditions even in very low rainfall regimes and have a low water footprint. Millets can address some of the biggest global challenges together - nutrition and health needs, poverty of smallholder

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and marginalized farmers in the dry zones, mitigation and adaptation to climate change - some of the toughest areas that will take longer to reach the sustainable development goals. Owing to the nutritional value and climate-resilience of small millets, the year 2023 has been declared as International Year of Millets by FAO. A vast literature is available on potential of small millets, their production and underutilization in Uttarakhand. In this study, this literature has been reviewed.

Small Millets in Uttarakhand

The main small millets grown in Uttarakhand are finger millet, barnyard millet, foxtail millet and proso millet. Table 1 shows area, production and yield of small millets in districts of Uttarakhand. Comparing the years 2011-12 and 2019-20, the area under small millets has declined in all the districts except Rudra Prayag. In Rudra Prayag, area under small millets showed increase. The highest level of decline in area was registered in Pauri Garhwal. The production figures are conform with the area trend. Yield of small millets showed increase in all the districts except that in Nainital, Rudra Prayag and Pithoragrh, it showed a decrease.

Role of Small Millets in Nutrition and Health

Millets are playing a secondary role in the agriculture as compared to cereal grains like wheat and rice (Weber and Fuller, 2008). However, as food, they are either nutritionally equivalent or superior to many cereals. Inspite of good nutritive value, uses of millets are limited in India. The main reasons are low availability of processing technology and lack of availability of variety of products at commercial level.

Small millets are rich source of nutrients like protein. They contain high levels of methionine, cystine, and other vital amino acids, micronutrients like minerals (zinc, copper, iron, calcium) and B-complex vitamins *viz.*, thiamine, folic acid, riboflavin, and niacin. The range of protein, fat and carbohydrate contents of small millets has been reported to be between 8-12, 2-5 and 60-75 per cent, respectively. The dietary fibre content of small millets varies between 15-20 per cent. So they have a major role to play in combating various lifestyle diseases. Compared to maize, the essential amino acid profiles of small millets protein are better. Also, the protein quality present in finger millet is better because of the presence of sulphur containing amino acids. Both small millets and cereals are poor source of lysine but when they are combined with lysine rich pulses and legumes, the protein profile of both millets and pulses complement each other making them nutritionally rich (Gopalan *et al.,* 2007). Hence, nutritionally small millets are richer compared to cereals. They are high in calcium eg. finger millet has very high amount of calcium that varies between 300-350 mg/

Table 1: Area, production and yield of small millets in districts of Uttarakhand

District	Area (ha)		Production (tonnes)		Yield (tonnes per ha)	
	2011-12	2019-20	2011-12	2019-20	2011-12	2019-20
Almora	14870	12387	18366	13919	1.235	1.124
Bageshwar	881	614	543	776	0.616	1.264
Chamoli	5074	4914	5061	6285	0.997	1.279
Champawat	1369	718	1773	1059	1.295	1.475
Dehradun	1497	733	1330	823	0.888	1.123
Nainital	538	157	696	178	1.294	1.134
Pauri Garhwal	15536	9003	19438	12074	1.251	1.341
Pithoragarh	1250	1029	1891	1516	1.513	1.473
Rudra Prayag	2833	3135	4382	4805	1.547	1.533
Tehri Garhwal	16354	14165	21691	22040	1.326	1.556
Udham Singh Nagar	NA	NA	NA	NA	NA	NA
Uttar Kashi	3741	3450	4693	4492	1.254	1.302

NA=Not Available

100g. Small millets contain lecithin also in high amount. Lecithin is considered good for imparting strength to the nervous system (Dayakar Rao *et al.,* 2016).

Small millets are also very good sources of phytochemicals having nutraceutical properties. Small millets are rich source of dietary fibre, which is a non-nutrient content and possesses various therapeutic properties providing many health benefits like improvement in gut health, reduction in high glucose levels and blood cholesterol. Saleh *et al.* (2013) reported that there are lower incidences of diabetes in millet consuming populations. This is because of low Glycemic Index (GI) of millets.

Small milets act like major detoxifying agents in the body and that is how they protect from various degenerative diseases (Rao *et al.,* 2011). The high dietary fibre content and antioxidants present in millet-based diets are good to cure cardiovascular diseases and diabetes, cancer and obesity. Besides, small millets are good for gluten sensitive or celiac disease patients. Small millets are non-acid forming foods and non-glutinous and therefore are easy to digest (Michaelraj and Shanmugam, 2013). Small millets can also be used as staple food substitute for celiac patients as they require gluten-free cereal (Shahidi and Chandrasekara 2013).

Ways to Improve Production and Consumption of Small Millets

Small millets also termed as super food. However, there are many constraints at production and consumption level. Small size and hard outer surface of small millets makes it difficult to process. Unavailability of machines for processing of small millets forces the women to process the small millets manually which consumes energy and time. Lack of local market to sell small millets is another constraint. At consumption level, high price of the limited products available, lack of variety and unavailability of small millet-based food products, cheap availability of refined cereals such as rice and wheat through public distribution system, ignorance considering millets as food for poor and animals are some of the reasons of neglecting small millets at consumer level.

However, in recent past the importance of small millets has been recognised by producers, consumers and policy makers. Promotion of sustainable agricultural practices like plant population management, promotion of varietal improvement and mixed farming system, breeding strategies, availability of quality seeds, use of dehuller and improved harvester, introduction of low-cost implement, development of local processing infrastructure, post-harvest infrastructure and market is being done which is helping in increasing production. Creating awareness among masses to consume healthy small millet-based products, development of low-cost value-added products, improving the availability of small millet-based products in local market and making small millets part of welfare schemes like Public Distribution System are few strategies adopted to promote the consumption of small millets. Beside these, government is also focusing on strengthening of research institutes working in the fields of small millets improvisation (RESMISA Project, 2014; Meena and Meena, 2018).

Role of Small Millets in Food and Nutritional Security

Millets have many characteristics which make them unique amongst staple crops. With an ever increasing world population, the need of a food-secure world has also increased, thereby getting rid of hunger and malnutrition along with emphasis on sustainable development.

Small millets are an excellent example of climate resilient C4 crops. Small millets are drought, temperature and pest tolerant. They require very few external inputs. Fearing the climate change challenges in near future, small millets can serve as an excellent example of climate-resilience. They can address food security including nutritional security and can be used to adapt to climate change.

The term nutrition security not only implies to availability and access to balanced diet at affordable cost but also includes provision of climate change adaptation. In this respect, millets contribute towards balanced diet as well as safe environment (Connor 2016). Programmes like Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP) was started under Rashtriya Krishi Vikas Yojna by Government of India to uplift the level of millets from production to consumption. The major aim behind the initiative was to make millets easily available to the people at affordable price, thus addressing food accessibility and affordability. The other aim was to spread awareness regarding the health benefits and nutritional value of millets to encourage their inclusion in the diet on regular basis. Finger millet and pearl millet were covered under minimum support price (MSP) under this scheme. However, MSP needs to be effective for these millets. This scheme is now merged with National Food Security Mission. National Mission on Sustainable Agriculture, Rainfed Area Development Project, and National Food Security Act are few programmes implemented to promote utilization of millets for food and nutrition security (RESMISA Project, 2014; Anbukkani *et al.,* 2017). Many start-ups were seen emerging in the recent past specialising in small millet products.

CONCLUSION

Small millets address food security and nutritional security concerns as they have high nutritional value. Government is making efforts to make small millets and their products affordable and accessible, thus addressing two of the four dimensions of food security. Small millets are hardy crops requiring fewer inputs. They can be grown under drought conditions thus can help in an excellent way to adapt to climate. Evidences show that small millets can be excellent part of functional food thereby helpful in treating diabetes, cancer, cardiovascular diseases, obesity and celiac diseases. Efforts are being made to popularise millets both at production and consumption levels 2023 has been declared as International Year of Millets. Various initiatives are being taken to remove the constraints in cultivation and usage of small millets, so as to combat food and nutritional insecurity. Thus, there is a need to bring millets as they can address various issues in unison-environmental, nutritional and health issues.

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Alternate Wetting and Drying (AWD): An Irrigation Management System for the Enhancement of Water Productivity in Rice Cultivation

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ABSTRACT

Rice production accounts for roughly three-fourths of the world's rice grown in flood-prone conditions and its cultivation requires more water than all other arable crops. A result of increased evapotranspiration (ET) and global warming due to climate change is likely to increase agricultural water requirements (Jing *et al.,* 2015; De Fraiture and Wichelns, 2010) resulting, water scarcity will put pressure on the agricultural sector to increase output while using less water by improving agricultural practices of by enhancing water productivity/water use efficiency because improving agricultural water productivity (WP) is still one of the most pressing concerns in the agriculture sector, especially in rice cultivation. Rice is a water-intensive crop especially when it is grown with the flooded and puddled transplanted rice (PTR) system needs a thin layer of water and transplanting of nursery seedlings (Thakur *et al.,* 2010) which consumes nearly half of all freshwater used in agriculture (Jehangir *et al.,* 2007).

Keyword: Alternate, Drying, Enhancement, Irrigation, Management, Rice, Wetting, Water

INTRODUCTION

India is facing a major challenge in producing more food for a growing population while using less water, as the quantity and reliability of water supply have become an issue. According to a report, many rice-growing regions in Asia are expected to face severe water scarcity (IWMI, 2000; Ahmad *et al.,* 2007) consequently the productivity of rice will be hindered severely. Bihar has a comparatively low gross sown irrigated area of roughly 50 per cent, compared to 95 per cent in Punjab, 67 per cent in Uttar Pradesh, and 60 per cent for India as a whole. Considering the situation of water availability under changing climate, water-saving rice production systems have a high potential for productivity enhancement and profit maximization. So, there is a need for "more rice with less water" which is critical for food security, and irrigation will play a crucial role in fulfilling the future demand of food for the ever-growing population. For this purpose, an alternative approach to flooded irrigation rice cultivation system, several water-saving rice systems such as alternate wetting and drying (AWD), and aerobic rice can play a crucial role in saving irrigation water in rice cultivation. Tan *et al.* (2013) stated that AWD irrigation systems have significantly less water input (saving 39-50%) and can produce subsequently more yield (17%) and water use efficiency as compared to the puddled transplanted rice with a flooded irrigation system. Jabran *et al.* (2015a), also found that the aerobic rice and AWD used 18–27 per cent less water than under the continuously flooded condition. So, for the improvement of water productivity in rice crops in Bihar, there is an effective irrigation method for supplementary irrigation developed i.e. alternate wetting and drying (AWD) irrigation system which is a

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cheap and simple system that is helping the farmers in saving irrigation water and increasing rice production consequently improving water productivity. However, irrigation problems in Bihar are due to various reasons like poor infrastructure, inequitable irrigation water distribution, an insufficient number of tube wells, ineffective use of rainwater, a lack of appropriate rainwater storage facilities, and inefficient irrigation water use. Alternate wetting and drying irrigation system in rice cultivation is being promoted by Bihar Agricultural University, Bhagalpur by conducting a Climate-Resilient Agriculture program in five villages of every block of each district.

Water Productivity (WP)

The amount of grain yield obtained per unit of water used is referred to as water productivity. In India, water productivity is relatively low in comparison to other rice-growing areas (Zwart and Bastiaanssen, 2010). According to a recent study, rice WP ranges from 0.24 kg/m^3 to 0.57 kg/m^3 in rice-growing states in India. WP was relatively high (more than 0.50 kg/m^3) in Punjab, West Bengal, and Assam but it is very low in case of Bihar (0.28 kg/m^3), Madhya Pradesh (0.25 kg/m^3), and Karnataka (0.24 kg/m^3) (Sharma *et al.,* 2018). Low water productivity (WP) is a major concern in Bihar, despite favorable soil and weather conditions for rice crops. In Bihar, rice WP was calculated across several districts and shows the spatial distribution of WP (values by district) in the Kharif season and found that Saharsa recorded the maximum water productivity and no districts had a WP above 0.30 kg/m^3 and five districts have a value below 0.22 kg m^3 (Figure 1). The overall average rice WP in the Koshi river basin districts of 0.22 kg/m^3 is very low compared to other parts of India such as Haryana (0.40 kg/m^3), and Punjab (0.57 kg/m^3) (Sharma *et al.,* 2018). Water productivity in Bihar is much lower than the average WP of 0.60–1.60 kg/m^3 in other parts of the world (Cai and Rosegrant, 2003). It is even lower than that of Bangladesh (0.30 to 0.46 kg/m^3), although they have similar biophysical conditions (Alauddin and Sharma, 2013). It is critical to improving rice WP in Bihar to support economic development, increase food security, and ensure the sustainability of water resources (Guerra, 1998). The main difficulty for agricultural planners in Bihar is how to boost WP so that more food can be produced and distributed among the large food insecure population while utilizing limited water

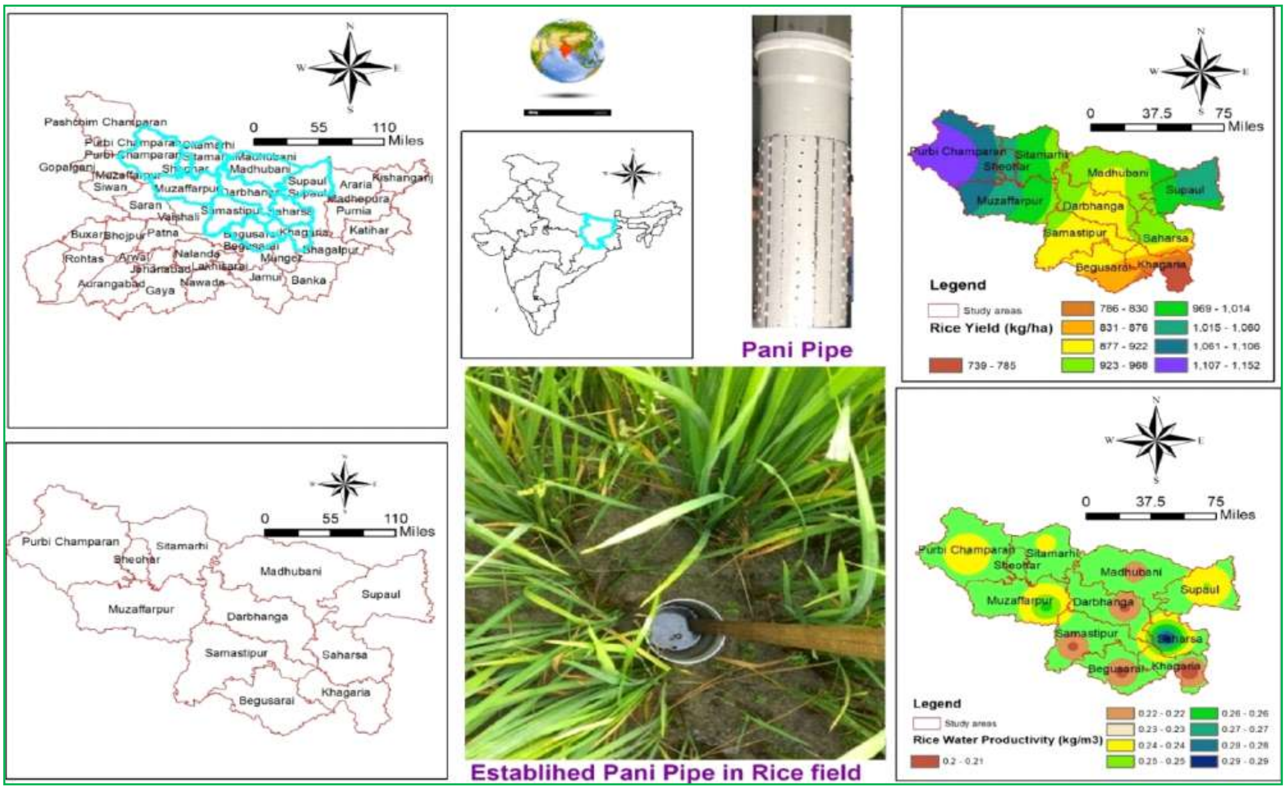

Figure 1: Rice yield and water productivity (WP) of different districts of Bihar (average 1991-2010)

resources. However, in recent years, climate change has resulted in dwindling water resources, and labor shortages are threatening the sustainability, productivity and eventually reducing the water use efficiency of puddled transplanted-flooded rice.

Alternate wetting and drying (AWD) irrigation

AWD is water-saving technology that farmers are adopting to reduce the amount of irrigation water being utilized in the paddy fields without any yield reduction meanwhile increasing the land and water productivity. The principle behind the following AWD irrigation system is to obtain flooded conditions after a certain number of days have passed after the disappearance of ponded water or irrigate when a hair-line crack appears. AWD is regulated by a simple PVC pipe which indicates to the farmers to visualize the depth of the perched water table. The farmer can assess the water level in the soil by simply looking for the presence of the water table or can measure the depth of water in the pipe. The number of days of the flooded and non-flooded interval depends on several factors like soil type, weather, and crop growth stage. As per several kinds of research, most lowland rice varieties can withstand a 30% reduction in total irrigation volume without significantly reducing yield (Richards and Sander, 2014) so, this practice allows the soil to dry out before re-irrigating.

Key points of AWD are following:

- To implement the AWD Irrigation system use a PVC pipe (called as field water pipe or pani pipe) in puddled soil and establish it 2 weeks after transplanting of the young seedling.
- The size of the PVC pipe should be 7-10 cm in diameter, insert 15-20 cm below the soil surface while keeping 10 cm above the soil surface and remove the soil from inside the pipe (Figure 2).
- Start AWD irrigation after the establishment of the PVC pipe and allow the field to dry out and re-flood the field to a standing water layer of 5 cm when groundwater is 15-20 cm below the soil surface in the pipe.
- AWD is practiced during the vegetative stage of rice but at the anthesis and flowering stages, the field is kept continuously flooded because the crop is more sensitive to water stress at this stage.

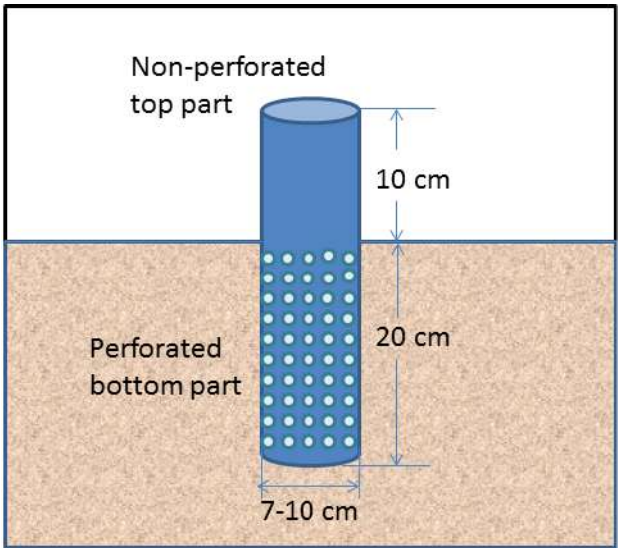

Figure 2: Sketch of PVC or perforated pipe or field water pipe or pani pipe

- AWD is unfavorable in sandy soil because water drains at a faster rate and water saving is minimal; however, AWD is not required in heavy clay soil with a shallow water table since the depth of the soil water table never lowers below the lowermost roots.

Effect of AWD on grain yield and water productivity

If we practice control irrigation in any crop, we can save a significant amount of labor, time, water, and cash i.e. about 16-24 per cent of irrigation water, and on an average 20-25 per cent of irrigation, the cost can be reduced without any significant yield reduction as compared to farmer's practice (flood irrigation system) (Palis *et al.,* 2004). The biomass and grain yield do not significantly vary between AWD (alternate wetting and drying) and continuous submergence (CS) but water productivity was reported to be significantly higher under AWD (alternate wetting and drying) than continuous submergence (CS) (Belder *et al.,* 2004). The reason behind the increment of yield and improvement of water use efficiency may be a due increase in the proportion of productive tillers by reducing the angle of the topmost leaves which allows more light penetration into the canopy resulting modification in the shoot and root activity (Yang and Zhang, 2010) consequently, a greater amount water extracts from the soil and uses efficiently to convert into dry matter production resulting in more partitioning and remobilization of photosynthates into grain which turns in to greater yield in limited water situation (Foulkes *et al.,* 2002).

High yield under water-limited conditions is generally associated with increased WUE mainly because of high water use. As per the study conducted by Zhao *et al.* (2007), 5.53 per cent, Zhang *et al.* (2009), 10 per cent, Norton *et al.* (2017) 9.4 per cent more grain yield was recorded which were significant from 25-50 per cent, 30% (Lampayan, 2013), 20% (IARI, 2014), 17 to 38%, Lampayan *et al.* (2015) less water use in AWD (alternate wetting and drying) technique as compared to the continuous flooding in rice without reducing the rice yield while increasing the farmer's income by 30 per cent. Paul and Rashid (2013) revealed that the highest water productivity (7.3 and 7.6 kg/ha-mm) and higher grain yield was found when irrigation was applied (5-7 cm) after 20 and 15 cm depletion of water level from pipe below the soil surface with 20% saving of irrigation water in both years. According to Chaurasiya *et al.* (2022), with the application of AWD 10–15 cm there was 18-27 per cent water saving under puddled transplanted rice (PTR) and in direct-seeded rice (DSR) 34-46 per cent, whereas deeper AWD treatment depths i.e. 20–25 cm was reduced by 36–43 per cent under PTR and 54–61 per cent under DSR. So, here we can see that using an AWD irrigation system through a perforated PVC tube to measure the field water depth in the farmers' field is a convenient, straightforward, and cheap method that will enable farmers to schedule irrigation events as needed and thus replace the unnecessary and unsustainable conventional continuous flooding system of rice irrigation.

Factors affecting water productivity

Rice is primarily grown as a rain-fed crop in Bihar, and climate change could have a significant impact on yield and WP; floods and droughts, which are common, also possess significant challenges. Waterlogging and poor drainage systems exacerbate the negative impacts in flood-prone areas, whereas inadequate water conservation technologies exacerbate the problems in drought-prone areas. The following factors affect water productivity most;

- Among the factors, irrigation had a statistically significant positive influence on rice water productivity, the incidence of flood and drought, and cropping intensity had a significant negative influence.
- Agriculture intensification necessitates increased water and fertilizer inputs because increasing cropping intensity in the absence of an adequate supply of water and fertilizer will decrease the water productivity.
- To get maximum yield and water productivity there is a need to support the farmers for tube well installation, especially solar pumps which will help farmers to meet their irrigation needs on time with maximum water productivity/ water use efficiency.
- In Bihar, because of low rural electrification especially from an agriculture point of view poor access to electricity, farmers cannot extract sufficient groundwater for irrigation, leading to low water productivity and crop production.

Benefits of AWD Experienced by Farmers

- Due to a decrease in the number of irrigation (1-2), there is a considerable reduction in total pumping and labour cost as compared with conventional flooded irrigation systems.
- No lodging has been noticed with AWD irrigation system (B) in rice crops as compared with flooded irrigation system (A) (Figure 3).
- Net profit was increased.
- Incidences of diseases and pests were less because of low humidity inside the crop.

Figure 3: Comparison of flood irrigation system (A) and AWD irrigation (B)

- Grain quality i.e. size and boldness were better with the AWD irrigation system. So, there is no yield reduction.
- The most important thing was after using the AWD irrigation system farmers do not need to worry even if the paddy field does not have water.

CONCLUSION

The water productivity of Bihar is very low as compared to other parts of the country having almost the same biophysical situation. In Bihar, Rice is primarily grown as a rain-fed crop, and due to a lack of good irrigation facilities, variations in precipitation have a significant impact on water productivity. Because of its low cost, simplicity, and ability to be locally built, the safe AWD irrigation practice and concept of employing field water tubes installed in rice fields was proven to be technically practical for field use. Rice irrigation with AWD had a substantial impact on water conservation and productivity. There was a 20-50 percent reduction in irrigation water usage compared to regular submergence. In a field water tube, a safe AWD threshold level of 5 – 20 cm water fall below the surface was discovered, which must be validated in various soil types and meteorological circumstances.

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Effect of Salicylic acid and Sodium Silicate on Growth and Flowering of Cut Roses (*Rosa hybrida* var Top Secret) Under Protected Conditions

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ABSTRACT

This experiment was conducted to investigate the effects of different concentrations of Salicylic acid and Sodium silicate as a foliar spray on greenhouse rose (*Rosa hybrida* var. Top Secret) to improve growth, flower quality and yield of rose. A total of 10 treatments T_1= control, T_2= Sodium silicate @ 1mM and Salicylic acid @ 1mM , T_3 = Sodium silicate @ 1mM and Salicylic acid @ 3mM, T_4 = Sodium silicate @ 1mM and Salicylic acid @ 5mM, T_5 =Sodium silicate @ 3mM and Salicylic acid @ 1mM, T_6 = Sodium silicate @ 3mM and Salicylic acid @ 3mM, T_7 = Sodium silicate @ 3mM and Salicylic acid @ 5mM, T_8 =Sodium silicate @ 5mM and Salicylic acid @ 1mM, T_9 = Sodium silicate @ 5mM and Salicylic acid @ 3mM, T_{10} = Sodium silicate @ 5mM and Salicylic acid @ 5mM, were tested in randomised complete block design with three replications. All the treatments improve growth, flower quality and yield as compared to control treatment. The results of the study revealed that T_{10} significantly improved vegetative and flowering parameters of rose (*Rosa hybrida* var. Top Secret). The parameters viz. maximum plant height (76.84 cm), plant spread (44.25 cm), number of basal shoots (3.07), diameter of basal shoots (1.01), number of compound leaves per flowering shoot (12.06). Minimum number of days to first flower bud appearance (106.77) and minimum number of days to colour break stage (20.95) was also recorded in T_{10} and flowering parameters viz maximum flower bud diameter (1.34), neck girth (0.71), length of cut stems (60.30 cm), girth of cut stems (0.76 cm), flower diameter (6.93 cm), duration of flush (38.00 days), number of cut stems plant^{-1} (5.75) and number of cut stems m^{-2} (28.00) maximum stem dry matter (6.80g) was recorded in $T_{10.}$ Maximum total fresh weight of cut stems harvested per plant (116.31g) and maximum vase life (11.33 days) was recorded in T_8.

Keywords: Rose, Salicylic acid, Sodium silicate, Growth, Flowering

INTRODUCTION

Roses belong to the family Rosaceae, the third-largest plant family including many ornamental landscape plants, such as berries and fruits, apples, raspberries, cherries, etc., however, the rose is considered the most important plant in this family (Hummer and Janick, 2009). The *Rosa hybrida* L. is mostly used as valuable decorative flowers in the world (Boskabady *et al.,* 2011; Mirjalili and Kavoosi, 2018). The rose has been called the 'Queen of Flowers' as well as the 'King of Flowers'. No other flower surpasses its beauty, colour and fragrance which is why it is universally considered a favourite flower (Gitonga *et al.,* 2014). Roses are considered important floral crops in the world and used as raw material in various industries like cosmetics and perfume (Ghadimian and Danaei, 2020). The number of species of genus Rosa varies among 200 species and it contained more than 35,000 commercial cultivars most of which are hybrids. The perfume, medicine and floriculture industries are mainly depended on the commercial cultivation of Roses (Gil *et al.,* 2020). There is great diversity in plant growth,

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colour of flowers, flower shape, fragrance, slow opening of flowers and good keeping quality which made roses so popular that roses are grown commercially to meet the demand of cut blooms.

Plant growth regulators (PGRs) play key role in life cycles of plants and these can be produced naturally by plants or synthetically by chemists (Davies, 2013). Plants quickly respond to change in hormonal balance due to growth substances' (PGS). Various PGRs are being used commercially in cut flower industry to modify plants behavior like compactness of growth, number and aesthetic value of flowers (Pal, 2019). PGRs modify growth and development in different ways under natural and stressful environmental conditions. The role of PGRs on various physiological processes in plants is well known and they enable a change in the phenotype of plants within one season to achieve desirable results. They are now being widely used to increase the production of many crop types (Barrett, 2001). The most important factor for success is that application of PGRs at a stage in growth where the physiological processes are at their peak. Some characteristics such as height and number of branches are important morphological parameters contributing to increase yields (Darasteanu *et al.,* 2005). Floriculture industry has been revolutionized through identification of various growth regulators which control growth and flowering for high quality end product (Sajid *et al.,* 2015). With advancements in technology, grower's main objectives in the cut flower industry are the quality of flowers and increased flower production. Various chemicals are now being trialed to control the growth and flowering of roses with a view of creating plants that are compact as well as stretching out or retarding the rates of plant growth (Hashemabadi, 2010).

Salicylic acid (SA) or orthohydroxybenzoic acid is a phenolic compound known as plant growth regulator and affects various processes, such as inhibition of ethylene synthesis and glycolysis (Martín-Mex *et al.,* 2015). It is known as a regulator of several physiological and biochemical processes such as thermogenesis, plant signaling or plant defense, and response to biotic and abiotic stress (Chen *et al.,* 2009; Wani *et al.,* 2017). Studies show that many phenolic compounds are involved in regulating physiological processes, including plant growth, stomatal closure, photosynthesis, and ion uptake (Kabiri *et al.,* 2014; Mohajeri *et al.,* 2018). Salicylic acid is a tool to increase plant tolerance against the adverse effect of biotic and abiotic stresses (Bosch *et al.,* 2007) either by foliar application or seed or plant treatment. It has a regulatory effect on activating biochemical pathways associated with tolerance mechanisms in plants (Najafian *et al.,* 2009). In some studies, the flower inducing factor is known as SA, which is consistent with reports of the use of SA in the induction of organic tobacco flowering (Muthulakshmi and Lingakumar, 2017). However, the precise mechanism of the SA inducer property has not yet been investigated. Therefore, it can be concluded that SA can act as a regulator that affects plant growth and productivity (Hayat *et al.,* 2010; Khatiby and Shadmehri, 2019). SA is involved in stimulating specific responses against various biotic and abiotic stresses (Kareem *et al.,* 2017).

Silicon (Si) is a non-toxic, useful, and abundant element that participates in a wide range of plant activities (Pozza *et al.,* 2015). Taking plant physiology as an example, Si can reinforce the photosynthesis at the cost of lower transpiration, thus benefiting the nitrogen metabolism and carbon accumulation. Silicon is absorbed and forms a double silicate layer on the leaf epidermis, allowing better leaf architecture and greater light assimilate capacity (Campos *et al.,* 2020). One of the most beneficial roles of Si that has been demonstrated is that it helps plants manage biotic and abiotic stresses (Li *et al.,* 2020). Moreover, many studies have suggested that Si plays an important role in increasing the rigidity of the cell walls of plants, leading to a more erect plant (Feng *et al.,* 2010). Si also reduces stomatal conductance in relation to turgor loss of guard cells resulting from Si deposition and modified cell wall properties (Zhu and Gong, 2014). When plants are grown under conventional environments (i.e., not subject to stress), Si probably makes plants more efficient in responding to environmental cues by activating different metabolic processes (Luyckx *et al.,* 2017) with crucial cascading effects on plant structure and function (Guntzer *et al.,* 2012; Coskun *et al.,* 2019). Si has biostimulant effects on plants (Epstein, 2009; Gómez-Merino and Trejo-Téllez, 2018) by modifying physiological processes in a way that provides benefits to growth, development or stress responses (Savvas and Ntatsi, 2015). Silicon has the potential to be used in the production of floriculture crops to increase flower and stem size, accelerate flowering and improve resistance to stresses including drought. Silicon is a non- essential nutrient for most plants, howeverin floriculture production, it is known to affect plant growth and quality, photosynthesis, transpiration and enhance plant resistance to stresses such as drought. Reduction of the transpiration rate could further benefit floriculture crop production. A study conducted to see the effect of supplemental silicon on stomatal conductance, mechanism of plants used to open and close "water vapor" valves. Under normal greenhouse conditions, leaf resistance (reduction of transpiration) increased with a high rate of sodium silicate foliar sprays. There is an indication that sodium silicate foliar spray applications can act as a film-forming anti-transpirant that increases leaf resistance (Wang *et al.,* 2017). The present investigation was undertaken to find out the use of growth regulators viz., Salicylic acid and Sodium silicate for improving growth, flower quality and yield in cut roses.

MATERIALS AND METHODS

A field experiment was conducted at the experimental farm of Division of floriculture and Landscape Architecture, Sher-e-Kashmir University of Agriculture Sciences and Technology of Kashmir during 2020-21. The experiment was laid out in randomized complete block design (RCBD) with ten treatments and three replications. The treatments were as follows: T_1= control, T_2= Sodium silicate @ 1mM and Salicylic acid @ 1mM , T_3 = Sodium silicate @ 1mM and Salicylic acid @ 3mM, T_4 = Sodium silicate @ 1mM and Salicylic acid @ 5mM, T_5 =Sodium silicate @ 3mM and Salicylic acid @ 1mM, T_6 = Sodium silicate @ 3mM and Salicylic acid @ 3mM, T_7 = Sodium silicate @ 3mM and Salicylic acid @ 5mM, T_8 =Sodium silicate @ 5mM and Salicylic acid @ 1mM, T_9 = Sodium silicate @ 5mM and Salicylic acid @ 3mM, T_{10} = Sodium silicate @ 5mM and Salicylic acid @ 5mM. Land area inside the polyhouse was thoroughly ploughed up to 40 cm deep prior to planting. Weeds stubbles were removed completely and brought the soil into a fine tilth. Raised beds of 5 m length, 1.5 m width and 40 cm in between two beds for passage were prepared for path way. Rooted cuttings were first dipped for about 6 hours in different concentrations of salicylic acid viz., 1mM, 3mM and 5mM. First spray of salicylic acid and sodium silicate was given at 30 days after transplanting and second, third spray was given after 30 days interval from the first spray date. After one month of the last spray observations of various parameters on growth and flowering were recorded by using standard methods. The data regarding various characters were statistically analyzed using SAS software with analysis of variance.

RESULTS AND DISCUSSION

In the present investigation, data recorded on growth parameters presented in Table 1 revealed that all treatments of salicylic acid and sodium silicate significantly affected plant height, plant spread, number of basal shoots per plant, diameter of basal shoots, number of compound leaves, girth of cut stems, length of cut stems, number of cut stems plant^{-1} and number of cut stems m^{-2}. All the growth parameters increase with increase in the concentration of salicylic acid and sodium silicate. However, maximum plant height (76.84 cm), plant spread (44.25 cm), and length of cut stems (60.30 cm) was observed in treatment combination of Sodium silicate @ 5 mM and Salicylic acid @ 5mM and minimum plant height (62.50 cm), plant spread (31.17 cm) and length of cut stems (49.52 cm) was recorded in control. This increase may be due to the reason that Salicylic acid could be involved in the regulation of cell enlargement and division in synergy with other substances such as auxin, IAA and phenolics which cause stimulatory effect to increase plant height, plant spread and length of cut stems (Padmapriya and Chezhiyan, 2002). Salicylic acid increased plant height by increasing Rubisco activity and photosynthetic rate (Nagasubramaniam *et al.*, 2007). The observations and findings of the present investigation are in conformity with the findings reported earlier by Al-Abbasi *et al.* (2015) and Zeb *et al.* (2017) in zinnia and Anwar *et al.* (2014) in tuberose. Similarly, sodium silicate may increase the plant growth due to the stimulation by silicon. It may be either indirect, owing to the protective effects of silicon against pathogens (Belanger *et al.*,1995) or direct originating from implications of silicon to both morphological changes and physiological processes in plants. The number of basal shoots per plant, number of cut stems plant^{-1}, and number of cut stems m^{-2} increased with the increase in the concentration of salicylic acid and sodium silicate. Maximum number of basal shoots per plant (3.07), number of cut stems plant^{-1} (5.75) and number of cut

Table 1: Effect of salicylic acid and sodium silicate on vegetative parameters of Rose (*Rosa hybrida* var. Top Secret)

Notation	Treatment	Plant height (cm)	Plant spread (cm)	Length of cut stems (cm)	No. of basal shoots plant^{-1}	No. of cut stems plant^{-1}	No. of cut stems m^{-2}	Diameter of basal shoots (cm)	Girth of cut stems (cm)	No. of compound leaves plant^{-1}
T_1	N_0S_0	62.50	31.17	49.52	1.57	3.56	10.00	0.74	0.48	9.78
T_2	N_1S_1	64.39	33.45	55.34	1.70	3.75	12.00	0.79	0.50	10.74
T_3	N_1S_2	64.51	33.69	56.09	1.95	3.97	14.00	0.81	0.53	11.27
T_4	N_1S_3	66.63	36.39	57.91	2.12	4.53	18.00	0.85	0.59	11.74
T_5	N_2S_1	65.30	35.14	56.60	2.05	4.19	16.00	0.83	0.58	10.86
T_6	N_2S_2	70.90	39.27	58.65	2.65	4.75	22.00	0.92	0.65	11.55
T_7	N_2S_3	73.28	40.72	59.08	2.83	4.97	24.00	0.94	0.66	11.85
T_8	N_3S_1	68.59	36.69	58.34	2.35	4.21	20.00	0.89	0.62	10.97
T_9	N_3S_2	75.03	41.92	59.39	3.01	5.17	26.00	0.97	0.72	11.92
T_{10}	N_3S_3	76.84	44.25	60.30	3.07	5.75	28.00	1.01	0.76	12.06
C.D		1.165	0.41	0.728	0.051	0.004	0.45	0.003	0.025	0.045
SE(d)		0.545	0.20	0.344	0.024	0.002	0.22	0.001	0.012	0.021

stems m^{-2} (28.00) was observed in treatment combination of Sodium silicate @ 5mM and Salicylic acid @ 5mM. Minimum number of basal shoots per plant (1.57), number of cut stems plant^{-1} (3.56) and number of cut stems m^{-2}(10.00) was recorded in control. Salicylic acid increased immunity endorsed plant through continuous supply of nutrients and well-acted response to environmental stresses, an important signal molecules altered physiological regulation. Eventually it was documented that potentially the plant regulator engendered extensive range of metabolic response in plants and finally photosynthetic factors of plant was positively affected (Zeb *et al*., 2017). Also, increase in number of shoots per plant might be due to stimulation of growth by the silicon application. These results were in accordance with Voogt and sonneveld (2001), Seung (2005) in rose. Diameter of basal shoots and girth of cut stems increased with increase in concentration of salicylic acid and sodium silicate. Maximum diameter of basal shoots (1.01 cm) and girth of cut stems (0.76 cm) was observed in treatment combination of Sodium silicate @ 5mM and Salicylic acid @ 5mM and minimum diameter of basal shoots (0.74 cm) and girth of cut stems (0.48cm) was recorded in control. It might be due to increase in photosynthetic activity and accumulation of more carbohydrates in the shoots. Similar results were reported by Saeed *et al.* (2009) in rose, Seung *et al.* (2005) in rose, Kamenidou *et al.* (2010) in gerbera. Maximum number of compound leaves per flowering shoot (12.06) was observed in treatment combination ofSodium silicate @ 5mM and Salicylic acid @ 5mM and minimum number of compound leaves per flowering shoot (9.78) was recorded in control. Anwar *et al.* (2014) found that the number of leaves increased by increasing of internodes distance and reduction of leaves due to the decreasing of internodes distance. Numbers of leaves were more at high salicylic acid concentrations and minimum leaves were obtained at low level of salicylic acid and control. It means that number of leaves increased by increasing concentration of salicylic acid. These findings are corroborated by zeb *et al.* (2017) in zinnia cultivars; Mahroof *et al.* (2017) in *zinnia elegans* and Chaudhary *et al.* (2015) in African marigold. It is involved in regulation of growth processes, such as in ornamental plants young shoots stimulate leaves (Singh, 1993).

In the present investigation, data recorded on growth parameters presented in Table 2 revealed that salicylic acid and sodium silicate significantly affected flowering parameters. Minimum days to first flower bud appearance (106.77 days) and days to colour break stage (20.95 days) was observed in treatment combinations of Sodium silicate @ 5mM and Salicylic acid @ 5mM and maximum days to first flower bud appearance (110.44 days) and days to colour break

Table 2: Effect of salicylic acid and sodium silicate on flowering parameters of Rose (*Rosa hybrid* var. Top Secret)

Notation	Treatment	Days to first flower bud appearance (day)	Days to colour break stage (day)	Flower bud diameter (cm)	Flower diameter (cm)	Neck girth (cm)	Duration of flush (day)	Total fresh weight of cut stems harvested plant^{-1} (g)	Stem dry matter (g)	Vase life (day)
T_1	N_0S_0	110.44	23.44	1.18	5.23	0.51	33.22	84.41	2.70	9.23
T_2	N_1S_1	108.89	22.94	1.19	6.07	0.52	33.88	100.70	4.33	10.44
T_3	N_1S_2	108.66	22.84	1.21	6.32	0.54	34.33	98.62	4.30	10.11
T_4	N_1S_3	107.89	22.26	1.23	6.66	0.61	36.66	95.81	4.60	9.89
T_5	N_2S_1	108.11	22.73	1.22	6.53	0.59	34.88	107.79	4.40	10.78
T_6	N_2S_2	107.93	22.12	1.260	6.73	0.65	36.00	103.70	5.50	10.55
T_7	N_2S_3	107.66	21.16	1.267	6.89	0.68	37.00	88.85	5.70	9.77
T_8	N_3S_1	107.93	22.47	1.24	6.71	0.64	35.11	116.31	5.30	11.33
T_9	N_3S_2	107.33	21.76	1.31	6.85	0.69	37.66	108.13	6.13	11.00
T_{10}	N_3S_3	106.77	20.95	1.34	6.93	0.71	38.00	89.20	6.80	9.55
C.D		0.099	0.230	0.028	1.758	0.775	2.478	3.598	0.155	0.010
SE(d)		0.046	0.107	0.013	0.830	0.366	1.170	1.699	0.072	0.004

N_1: Sodium silicate at 1mM; N_2: Sodium silicate at 3mM; N_3: Sodium silicate at 5mM; S_1: Salicylic acid at 1 mM; S_2: Salicylic acid at 3mM; S_3: Salicylic acid at 5mM.

stage (23.44 days) was recorded in control. Early flowering and floral bud sprouts have been induced by salicylic acid concentrations because this stimulating agent accelerates biosynthesis of secondary metabolites. Salicylic acid as a manager of blooming time, interacts with both photoperiod-dependent and self-governing pathways (Martinez *et al.*, 2004). Salicylic acid stimulated initiation of flowers subsequently involved in the physiological processes (Hayat *et al.*, 2010). The present results are agreed with the findings of Padmapriya and Chezhiyan (2002) in chrysanthemum and Pawan Kumar (2019) in rose. Also, the mechanism involved in accelerated anthesis remains unclear, even though several studies associated with Si supplementation with increased photosynthesis, decreased transpiration and phytochrome changes especially on agronomic crops (Ma and Takahashi, 2002). Increase in the concentration of salicylic acid and sodium silicate increases flower bud diameter, flower diameter and neck girth. Maximum flower bud diameter (1.34 cm), flower diameter (6.93 cm) and neck girth (0.71 cm) was observed in treatment combinations of Sodium silicate @ 5mM and Salicylic acid @ 5mM and minimum flower bud diameter (1.18 cm), flower diameter (5.23 cm) and neck girth (0.51 cm) was observed in control. Salicylic acid has positive effect on photosynthesis in leaves that results in accumulation of more carbohydrates in the shoots, due to this reason, flower bud size, flower diameter and neck girth increased. The increase in flower bud diameter, flower diameter and neck girth could be due to the synergism between SA and auxins. These results are in conformity with Zeb *et al.* (2017) in zinnia. Silicon application has been found to reduce evapotranspiration (McAvoy and Bernard, 1996) which could have contributed to increased turgor pressure within the flower, resulting in cell swelling and thus larger flower bud diameter, flower diameter and neck girth. Maximum duration of flush (38.00 days) was observed in treatment combinations of Sodium silicate @ 5mM and Salicylic acid @ 5mM and minimum duration of flush (33.22 days) was recorded in control. Increased levels of ethylene is synthesized several days after full opening of the flower during natural senescence (Woodson *et al.*, 1992). This increased ethylene production accelerates in rolling of petals resulting in wilting of the flower. PGR's are attributed to the improvement of vegetative growth in plants that leads to increased absorption of nutrient and promotion of photosynthetic activities and finally higher carbohydrate assimilation. This physiological mechanism increased both vegetative and floral development by maintaining hormonal balance that leads to extensive duration of flush of plants. These results are in conformity with Abbass *et al.* (2016) in *Antirrhinum majus* and Zeb *et al.* (2017) in zinnia. Maximum stem dry matter (6.80 g) was observed in treatment combinations of Sodium silicate @ 5mM and Salicylic acid @ 5mM and minimum stem dry matter (2.70 g) was recorded in control. The effectiveness of salicylic acid can be due to water relations enhancement, prevent vascular occlusion due to antimicrobial effect, anti-ethylene effect which reduces respiration rate of cut flowers and increased dry matter (Edrisi, 2009).

Maximum total fresh weight of cut stems harvested per plant (116.31 g) was observed in treatment combinations of Sodium silicate @ 5mM and Salicylic acid @ 1mM and minimum total fresh weight of cut stems harvested per plant (84.41 g) was recorded in control. The increases in water uptake and subsequently cut flower fresh weight may be due to the acidifying and stress alleviating properties of SA. Maximum vase life (11.33 days) was observed in treatment combinations of Sodium silicate @ 5mM and Salicylic acid @ 1mM. Minimum vase life (9.23 days) was recorded in control. At high concentrations of salicylic acid, vase life of flowers decreased. This could be due to the addition of low level of salicylic acid which delayed senescence while higher level promoted abscission and also significantly enhanced senescence in cut flowers (MacKay *et al.*, 2000). Application of salicylic acid could reduce the synthesis of ethylene and make the plant capable to block the synthesis of auxins (Shekari *et al.*, 2003). Kazemi *et al.* (2011) reported that SA treatment extended the vase life with maintaining chlorophyll content. The present results are agreed with the findings of Dumitras *et al.* (2002) in Gerbera and Gladiolus.

CONCLUSION

In conclusion, an attempt was made to investigate the effect of salicylic acid and sodium silicate, exogenously applied on rose plants under protected conditions. All treatments combinations of salicylic acid and sodium silicate levels affected significantly growth and flowering of rose. The results have shown that quantity and quality of rose production could be increased significantly through exogenous application of sodium silicate and salicylic acid and it could be a useful option to improve vegetative growth and hence leads to flowering of rose. Among different treatments, the application of sodium silicate @ 5mM + salicylic acid @ 5mM was found most effective in improving growth and flowering of rose except vase life and total fresh weight of cut stems harvested per plant which was found best with the treatment combinations of sodium silicate @ 5mM + salicylic acid @ 1mM.

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Assessment of the Knowledge of Mass Media for Agricultural Production Among Farmers in Haryana

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ABSTRACT

Since information is prerequisite for agricultural development farmers access to ICTs infrastructure is important for increasing the flow of information and this information could serve as a means of empowering the farmers to face the challenges of their immediate environment in the process of carrying out their agricultural activities effectively. For achieving this there is a need to focus on human resources for increased knowledge and information sharing about agricultural production, as well as on appropriate communication methodologies, channels and tools. The present study was conducted in the year 2020-21 Haryana state. Two blocks were selected randomly from Hisar district that is Hisar II and Adampur block. The study aimed to assess the knowledge regarding awareness about mass media. The results indicated that about 70.00 per cent of the respondents were fully aware about knowledge regarding mass media and 24.20 per cent of respondent were partially aware followed by 05.80 per cent of respondents were not aware about television regarding knowledge of mass media. More than three-fifth of the respondents (65.80%) were fully aware about mass media regarding knowledge and 25.00 per cent were partially aware followed by 09.20 per cent were not aware about radio regarding knowledge about mass media. However, nearly three-fifth of the respondents (58.30%) were fully aware about mass media regarding knowledge. Analysis revealed that more than three-fifth of the respondents (63.30%) were rarely used television and 16.70 per cent of the respondents occasionally used television followed by 10.80 never used television. Results showed that overwhelming of the respondents (80.00%) had found most useful information of mass media in improving the agriculture knowledge followed by 19.17 per cent found it useful and a few respondents (0.83%) found the information not useful. After that 86.67 per cent of the respondents were found information not useful and only 10.00 per cent of the respondents found information useful and a few respondents (0.33%) found information most useful about nursery management in different crop. Age of the respondents found highly significantly associated with level of knowledge about mass media. Highly significant association found between level of education of the respondents and level of knowledge about mass media.

Keywords: Mass media, Agricultural production, Knowledge, Socio-economic factor

INTRODUCTION

In developing countries, the media has played a critical role in agricultural growth. Many emerging countries have achieved better results in cutting-edge technologies. Making information available to farmers can help boost farm output and ensure the long-term growth of agricultural industries. Farmers benefit from timely and relevant information in making decisions about crop varieties, crop selection, insect pest control, market selection, and weather trends, among other things. Rural farmers' information requirements changes over time. Farmers must make timely decisions on crop production practises, rainfall estimates, soil nutrient management, varietal selection, crop diseases, and pest information based on accessible scientific knowledge and validated by crop experts in an era of rapid climate change. ICTs are electronic technologies for creating, acquiring, storing, processing, communicating, and using information. The ICTs in extension can lead to

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the emergence of knowledge workers that will result in the realization of a bottom-up, demand-driven paradigm for technology generation, assessment and transfer. The ICTs and its associated infrastructures help in the creation and dissemination of knowledge. ICT, particularly the internet are transforming all human activities dependent on information, including rural development and in other areas. Internet is cost effective, powerful, decentralized and it is in the hands of civil society who can share knowledge and produce information. Nain *et al.* (2015) also concluded in their study that access to and use of current information is critical, not only for financial success of farmers, but to support sustainable agricultural systems as the value of information has increased considerably due to knowledge intensive nature of changing agriculture The farmers are least equipped with proper tools for knowledge and information access to operate efficiently in a dynamic global environment. Strong dependence of agriculture on monsoon makes this sector yet more vulnerable to the vagaries of the climate change. Moreover, globalization of agriculture would demand existing systems to be more efficient and effective in harnessing the latest technologies. The most essential communication devices that offer farmers with knowledge and information about agriculture include newspapers, radio, television, smartphones, and the internet. It is a fact that the application of these modern technology has resulted in positive agricultural development outcomes in various countries. Radio is still the most preferred mode of communication in rural areas. It can transmit a variety of agricultural programming, and television has played an important role in the spread of agricultural information in developing countries. Higher level of adoption of agricultural technologies due to radio agricultural programmes were also observed in several researches. The farmers were benefitted with increased income and increased marketing opportunities by accessing marketing information from radio programmes. The success of agricultural development programmes in developing countries largely depends on the nature and extent of use of mass media in mobilization of people for development. Mukherjee *et al.* (2017) also concluded in their study that social network in virtual space has widened the scope of development in agricultural sector. The planners in developing countries realize that the development of agriculture could be hastened with the effective use of mass media. In several researches it was revealed that television had a significant role in increasing agricultural knowledge of the farmers. In addition, smartphones have reduced the distance between growers and consumers and now growers can communicate directly with customers and get product prices from the market. Mobile phone technology also offers growers a new way to get up-to-date information about weather conditions from the meteorological department before using pesticides and other related materials on their farms. The utilization of ICTs in agriculture to promote rural advancement is extremely essential. In remote areas, it is necessary to adopt such latest technologies to improve agricultural production, especially in India, because these technologies can provide farmers with latest agricultural knowledge and thus the farm productivity can be increased and ultimately there will be socio economic change in the farm families. Present investigation is an attempt to generate the data related to knowledge level of farmers regarding use of mass media for agricultural production.

MATERIALS AND METHODS

The present study was conducted in Haryana state. One district viz. Hisar were selected randomly as they are present in two different zones of Haryana. Further two blocks were selected randomly. Hisar II and Adampur block were selected from Hisar district. Two Villages were selected from each of the two blocks randomly. In Hisar II, Rawalwas and Hindwan were selected while Sadalpur and Khermpur were selected from Adampur block. Thirty respondents from each selected village i.e. Rawalwas, Hindwan, sadalpur and khermpur were selected. So, on the whole 120 respondents were taken as a sample for present study. A semi structured interview schedule was prepared keeping in view the both types of variables independent and dependent. The personal interview method was used for collecting data. Keeping in views the objective of the study the scholar visited all the selected villages and interacted with village functionaries and farmers before data collection. All the items prepared were designed in schedule form and schedule so prepared was pretested. The schedule was divided into two parts. The first part of the schedule was about personal and socio-economic profile of the respondents and the second part of the schedule dealt with the respondent's

Knowledge of mass media, mass media utilization, impact of mass media along with constraints. The data was collected personally with the help of an interview schedule consisting of measuring devices of dependent and independent variables and the respondents' data. The main statistical techniques used were percentages, averages and chi-square.

RESULTS AND DISCUSSION

The results in Table 1 indicated that about 70.00 per cent of the respondents were fully aware about knowledge regarding mass media and 24.20 per cent of respondent were partially aware followed by 05.80 per cent of respondents were not aware about television regarding knowledge of mass media. More than three-fifth of the respondents (65.80%) were fully aware about mass media regarding knowledge and 25.00 per cent were partially aware followed by 09.20 per cent were not aware about radio regarding knowledge about mass media. However, nearly three-fifth of the respondents (58.30%) were fully aware about mass media regarding knowledge. About two-fifth 21.70 per cent of the respondents were partially aware about mass media. Out of the total, only (20.00%) of respondents were not aware about newspaper regarding knowledge of mass media. Three-fourth of the respondents (75.00%) were fully aware about mass media followed by 21.70 per cent were partially aware. However, only a few respondents (03.30%) were not aware about internet regarding knowledge of mass media. Majority of the respondents 55.80 per cent were partially aware and 25.80 per cent were not aware about mass media followed by 18.30 per cent were fully aware about social media regarding knowledge of mass media. Overwhelming respondents (81.70%) were not aware followed by 17.50 per cent partially aware and only a few 0.80 per cent were fully aware about books regarding knowledge. Overwhelming of the respondents (88.30%) were not aware about followed by 09.20% were partially aware and about 2.50 per cent were fully aware about magazines regarding knowledge of mass media. Vanya *et al.* (2020) reported in her study that 35.00 per cent of farmers had medium level of knowledge about ICT tools followed by high (34.17%) and low (30.83%) level of knowledge about ICT tools. A considerable percentage (35%) of the respondents had medium level of knowledge about ICT tools, as they possess few important ICT tools and using regularly.

Table 1: Distribution of respondent according to knowledge of mass media

Sources	Level of awareness		
	Fully aware	Partially aware	Not aware
TV	84(70.00)	29(24.20)	7(05.80)
Radio	79(65.80)	30(25.00)	11(09.20)
Newspaper	70(58.30)	26(21.70)	24(20.00)
Internet	90(75.00)	26(21.70)	4(03.30)
Social Media	22(18.30)	67(55.80)	31(25.80)
Books	1(0.80)	21(17.50)	98(81.70)
Magazines	03(02.50)	11(09.20)	106(88.30)

Figures in parentheses denote percentage.

Table 2: Overall distribution of respondent according to awareness regarding knowledge of mass media

Level of awareness	Frequency	Percentage
Low (09-12)	30	25.00
Medium (13-16)	73	60.80
High (17-20)	17	14.20
Total	120	100

The data of overall awareness were calculated by summing all scores of 07 sources for each respondent and categorised in three different categories. Results in Table 2 indicated that out of total, three fifth (60.80%) of respondents had medium level of awareness followed by one-fourth (25.00%) of the respondents had low level of awareness. Only 14.20 per cent of respondents had high level of awareness about mass media regarding knowledge.

The Table 3 revealed that more than three-fifth of the respondents (63.30%) were rarely used television and 16.70 per cent of the respondents occasionally used television followed by 10.80 never used television. However, a few 09.20 per cent of the respondents regularly used mass media. More than half of the respondents (52.50%) occasionally used mass media and 29.20 per cent of the respondents rarely used radio followed by 11.70 per cent of the respondent never used radio and only 06.60 per cent of the respondents were used radio regularly.

Maximum number of the respondents (44.20%) had rarely used newspaper regarding knowledge of

Table 3: Distribution of respondent according to use of mass media regarding knowledge

Sources	Use of Mass Media regarding knowledge			
	Regularly	**Occasio-nally**	**Rarely**	**Never**
TV	11(09.20)	20(16.70)	76(63.30)	13(10.80)
Radio	08(06.60)	63(52.50)	35(29.20)	14(11.70)
Newspaper	12(10.00)	22(18.30)	53(44.20)	33(27.50)
Internet	61(50.80)	27(22.50)	24(20.00)	08(06.70)
Social Media	08(06.70)	21(17.50)	56(46.70)	35(29.20)
Books	2(01.60)	3(2.5)	14(11.70)	101(84.16)
Magazines	1(0.83)	1(0.83)	09(07.50)	109(90.83)

Figures in the parenthesis denote percentage

mass media followed by never used by 27.50 per cent of the respondents and occasionally (18.30%). However, in case of internet half of the respondents (50.80%) had regularly use and near about one-fourth of the respondents 22.50 per cent use occasionally followed by 20.00 per cent of the respondents rarely used internet. Majority of the respondents (46.70%) rarely used social media and clearly showed that 29.20 per cent of respondents never used social media followed by 17.50 per cent had occasionally even 6.70 per cent regularly used social media. In case of books 84.16 per cent of the respondents had never used books for knowledge about mass media followed by 11.70 per cent rarely used as well as most of the respondents (90.83) had never used magazines followed by rarely used by the respondents (07.50%). Nawab *et al.* (2020) also mentioned in their study that using the internet system, growers have gained new knowledge about yields from several markets in their area and from large markets in the country. They also further said that they get the latest knowledge about agriculture to improve the latest methods. The internet offers growers the opportunity to obtain new information and new knowledge on the market.

The data of overall use of mass media calculated by summing all scores of 07 sources for each respondent and categorised in three different categories. Results in Table 4 indicated that out of total, majority of respondents (54.16%) made medium used of mass media followed by 35.00 per cent of the respondents had low level of usage. Only 10.84 per cent of respondents had high level of usage regarding knowledge of mass media.

Table 4: Overall distribution of respondent according to use of mass media regarding knowledge

Use of Mass Media	Frequency	Percentage
Low (10-13)	42	35.00
Medium (14-17)	65	54.16
High (18-21)	13	10.84
Total	120	100.00

The present study reveals in Table 5 that three-fifth of the respondents (74.20%) followed their fellow farmers and 66.70 per cent of the respondents found role of internet important followed by pesticide agencies which was 57.50 per cent as well 53.30 per cent were found role of parents regarding knowledge of mass media. Kumar *et al.* (2015) mentioned in their study regarding knowledge level of farmers regarding climate and weather parameters and relationship with socio-economic and psycho-personal characteristics that highest number of farmers (41.7%) were in medium category followed by high (30%) and low (28.3%). They also further mentioned that farmers possessed highest knowledge in 'post harvest management' (70%) in comparison to other subject matter areas like 'general climate and weather parameters' (49.73%), 'crop planning' (46.47 %), 'crop production' (49.15) and 'crop protection' (56%). However, the variation among subject matter areas was less except 'post harvest management'.

Table 5: Distribution of respondent according toknowledge regarding role of mass media

Sources	Role of Mass Media	
	Frequency	**Percentage**
TV	26	21.70
Radio	45	37.50
Newspaper	41	34.20
Internet	80	66.70
Social Media	48	40.00
Extension field staff	50	41.70
Fellow farmers	89	74.20
Pesticide agencies	69	57.50
Parents	64	53.30
Books	19	15.80
Magazines	11	09.20

The data of conventionality of sources were calculated by summing all sources for each respondent and categorised in three different categories. Results in Table 6 indicated that out of total, maximum number of the respondents (45.80%) had medium level of conventionality about mass media sources followed by 27.50 per cent of the respondents who had low conventionality and near about one fourth of the respondents 26.70 per cent of respondents had high conventionality of mass media.

The data in Table 7 of accessibility of sources were calculated by summing all the sources for each respondents and categorised in three different categories. Results indicated that out of total, more than three-fifth of the respondents (62.50%) had medium level of accessibility about mass media sources followed by one-fifth of the respondent (20.00%) who had low accessibility and 17.50 per cent had high accessibility of mass media sources.

The present study reveals in Table 8 that relevancy of the sources which was calculated by summing all the sources for each respondents and categorised in three different categories. Results indicated that out of total, more than three-fifth of the respondents (64.20%) had medium relevancy of sources followed by 23.30 per cent had low relevancy and only 12.50 per cent respondents had high relevancy of sources of mass media.

Table 6: Distribution of respondent according to conventionality of sources of mass media

Sources	Conventionality of source(s) of Mass Media	
	Frequency	Percentage
Low (08-10)	33	27.50
Medium (11-13)	55	45.80
High (14-16)	32	26.70
Total	120	100.00

Table 7: Distribution of respondent according toaccessibility of sources of mass media

Sources	Accessibility of source(s) of Mass Media	
	Frequency	Percentage
Low (07-10)	24	20.0
Medium (11-14)	75	62.50
High (15-18)	21	17.50
Total	120	100.0

Table 8: Distribution of respondent according torelevancy of sources of mass media

Sources	Relevancy of source(s) of mass media	
	Frequency	Percentage
Low (07-10)	28	23.3
Medium (11-14)	77	64.2
High (15-18)	15	12.5
Total	120	100.0

The results in Table 9 revealed the total scores obtained from all the sources effectiveness on the basis of respondents. The total score for each sources calculated by multiplying the ranking with their inverse number from one to seven and summing all score obtained from the all respondents of that particular sources. It is evident from the data that the source, "Internet" ranked first with the highest score (738). Second rank was given to, "Television" that obtained score (701) followed by "Radio" that obtained score (583) from all respondents.

The results in Table 10 revealed the total scores obtained from all the socio-economic impact of mass media on the basis of respondents. The total score for each 07 sources was calculated by multiplying the ranking with their inverse number from one to seven and summing all score obtained from the all respondents of that particular sources. It was evident that increase in mass media exposure was ranked first with mean score 01.30. Second rank was given to water saving and the mean score was 01.10 followed by

Table 9: Distribution of respondent according toeffectiveness of mass media

Sources	Total Score	Ranking
TV	701	II
Radio	583	III
Newspaper	488	IV
Internet	738	I
Social Media	487	V
Books	230	VI
Magazines	128	VII

Table 10: Distribution of respondent according to their socio-economic impact of mass media

Sources	Socio-economic impact of mass media					
	Increase	Neutral	Decrease	WMS	MS	Ranking
Increase in mass media exposure	50(41.66)	56(46.66)	14(11.68)	156	01.30	I
Water saving	24(20.00)	84(70.00)	12(10.00)	132	01.10	II
Increase in urban and extension contacts	18(15.00)	90(75.00)	12(10.00)	126	01.05	III
SES increased	18(15.00)	86(71.67)	16(13.33)	122	01.01	IV
Increase in agricultural land on lease	20(16.67)	80(66.66)	20(16.67)	120	01	V
Investment on quality education of their children	19(15.83)	78(65.00)	23(19.17)	116	0.96	VI
Increase in quality of medical treatment	10(08.33)	92(76.67)	18(15.00)	112	0.93	VII
Increase in household assets	12(10.00)	74(61.67)	34(28.33)	98	0.81	VIII

Figures in the parenthesis denote percentage

increase in urban and extension contacts with the mean score 01.05 from all respondents. Whereas, investment on quality education of their children and increase in quality of medical treatment had lowest rank sixth and seventh with the mean score of 0.96 and 0.93 respectively. Yadav *et al.* (2020) concluded in their study that when there was no use of mass media regarding wheat crop practices, maximum farmers were having 35.00 per cent of low knowledge about land preparation practices, followed by high level of 36.25 per cent and medium level of knowledge 28.75 per cent respectively. But when mass media was in use regarding land preparation in crop, majority of the farmers 41.25 per cent were having high level of knowledge, followed by medium level 33.75 per cent and low level of 25.00 per cent. Rani *et al.* (2019) reported in their study that sufficient gain in knowledge regarding vegetable cultivation practices was recorded for each message *viz.*, tomato, okra and cucurbits cultivation practices. It may, therefore, be concluded that women succeeded in acquiring knowledge after exposing them to CD on vegetable cultivation practices.

It was found in Table 11 the field of the study that nearly three-fifth of the respondents (60.80%) had been partially aware about knowledge regarding mass media followed by the respondents who were not aware (25.00%) and fully aware (14.20%).

Age of the respondents found highly significantly associated with level of knowledge about mass media. Analysis further revealed that half of the respondents (67.30%) who were up to 35 years of age group were partially aware followed by 60.80 per cent were partially aware 36-50 years of age group regarding knowledge. On the other hand, half of the respondents (50.00%) who were belong to above 50 years of age group were not aware about knowledge of mass media.

Gender of the respondents not found significantly associated with level of knowledge about mass media analysis clearly reveal that more than three-fifth of the male respondents (61.70%) who were partially aware about knowledge of mass media followed by 60.00 per cent of female respondent who were not aware about knowledge of mass media.

Caste of the respondents found significantly associated with level of knowledge about mass media. More than half of the respondents (63.70%), who belonged to general caste, were partially aware about knowledge of mass media followed by (61.53%), who belonged to scheduled caste were not aware about knowledge of mass media. Contrary to that, three-fifth of the respondents (60.00%), who belonged to backward caste, were partially aware about knowledge of mass media.

Highly significant association found between level of education of the respondents and level of knowledge about mass media. Analysis clearly revealed that more than three-fourth of the respondents (77.94%), whose education level were middle and up to senior secondary/diploma, partially aware about knowledge of mass media. On the other hand, nearly half of the respondents (48.30%), who were educated up to graduation/post graduation, were fully aware about knowledge of mass media.

Type of family not found significantly associated with level of knowledge about mass media. Further analysis revealed that 64.40 per cent of the respondents,

Tab 11: Socio-economic factors associating with knowledge about mass media

Socio-economic variables	Level of awareness about mass media regarding knowledge			
	Not Aware	Partially Aware	Fully Aware	Total
Age				
Young (upto 35)	07(12.70)	37(67.30)	11(20.00)	55(45.80)
Middle (36 to 50)	16(31.40)	31(60.80)	4(07.80)	51(42.50)
Old (above 50)	07(50.00)	5(35.70)	2(14.30)	14(11.70)
Total	30(25.00)	73(60.80)	17(14.20)	120(100.00)
				χ^2=12.23**
Gender				
Male	27(23.50)	71(61.70)	17(14.80)	115(95.80)
Female	03(60.00)	02((40.00)	-	05(04.20)
				χ^2=3.66
Caste				
General Caste	21(20.60)	65(63.70)	16(15.70)	102(85.00)
Backward Class	01(20.00)	03(60.00)	01(20.00)	05(04.20)
Scheduled Caste	08(61.50)	5(38.50)	-	13(10.80)
				χ^2=11.12*
Education				
Illiterate & Primary	16(69.56)	6(26.90)	01(04.34)	23(19.16)
Middle & up to Senior Secondary/diploma	13(19.11)	53(77.94)	02(02.94)	68(56.66)
Graduation & Post-Graduation	01(03.40)	14(48.30)	14(48.30)	29(24.20)
				χ^2=69.26**
Family type				
Nuclear	17(28.80)	38(64.40)	04(06.80)	59(49.20)
Joint	13(21.31)	35(57.37)	13(21.31)	61(50.83)
				χ^2=08.78
Family size				
Small (up to 04 members)	17(30.90)	34(61.80)	04(07.30)	55(45.80)
Medium (05 to 08 members)	12(19.00)	38(60.30)	13(20.60)	63(52.50)
Large (more than 8 members)	01(50.00)	01(50.00)	-	02(01.70)
				χ^2=06.20
Annual family income (Rs.)				
Up to 100000	21(41.20)	26(51.00)	04(07.80)	51(42.50)
100001-200000	06(20.70)	20(69.00)	03(10.30)	29(24.20)
200001-300000	01(04.80)	14(66.70)	06(28.60)	21(17.50)
Above 300000	02(10.52)	13(68.40)	04(21.05)	19(15.83)
				χ^2=23.23**
Land holding				
Marginal (up to 1 ha)	13(48.10)	13(48.10)	1(03.70)	27(22.50)
Small (1-2 ha)	06(16.70)	25(69.40)	05(13.90)	36(30.00)
Semi-medium (2-4 ha)	05(18.50)	19(70.40)	03(11.10)	27(22.50)
Medium and Large (4 and above 10 ha)	06(20.00)	16(53.33)	08(26.66)	30(25)
				χ^2=4.50**

Tab 11 contd...

Socio-economic variables	Level of awareness about mass media regarding knowledge			
	Not Aware	Partially Aware	Fully Aware	Total
Subsidiary occupation				
None	05(12.50)	30(75.00)	05(12.50)	40(33.30)
Labourer	19(45.20)	21(50.00)	02(04.80)	42(35.00)
Business	-	03(100.00)	-	03(100.00)
Independent profession	03(27.30)	03(27.30)	05(45.50)	11(09.20)
Dairy	-	05(100.00)	-	05(04.20)
Service	03(15.80)	11(57.90)	05(26.30)	19(15.80)
				χ^2=31.67**
Social participation				
Not member of any organization	28(25.20)	68(61.30)	15(13.50)	111(92.50)
Member of one or more than one organization	-	04(80.00)	1(20.00)	5(04.16)
Office bearer and Public leader	02(50.00)	01(25.00)	01(25.00)	4(03.33)
				χ^2=13.26
Extension contacts				
Low (08-10)	21(42.90)	24(49.00)	04(08.20)	49(40.80)
Medium (11-13)	08(13.30)	43(71.70)	09(15.00)	60(50.00)
High (14-16)	01(09.10)	06(54.50)	04(36.40)	11(9.2)
				χ^2=18.09
Extension activities				
Less than two activities	05(22.70)	15(68.20)	02(09.10)	22(18.30)
Two activities	10(23.80)	26(61.9)	06(14.30)	42(35.00)
More than two activities	15(26.80)	32(57.10)	09(16.10)	56(46.7)
				χ^2=01.01
ICT sources				
Low (Less than two)	06(85.70)	1(14.30)	-	7(05.80)
Medium (Two)	11(24.40)	31(68.90)	03(06.70)	45(37.50)
High (More than Two)	13(19.10)	41(60.30)	14(20.60)	68(56.70)
				χ^2=19.00**
Socio-economic status				
Low (09-13)	18(38.30)	27(57.40)	02(04.30)	47(39.20)
Medium (14-19)	12(19.70)	39(63.90)	10(16.40)	61(50.80)
High (20-26)	-	07(58.30)	05(41.70)	12(10.00)
				χ^2=17.09**

Figure in parenthesis denote percentage
*Significant at 5% level; **Highly significant at 1% level

who belonged to nuclear family, were partially aware about knowledge of mass media. Contrary to that, majority of the respondents (57.37%) who belonged to joint family, were partially aware about of knowledge of mass media.

Size of family not found significantly associated with level of knowledge. It was clear from the field of the study that three-fifth of the respondents (61.80%), who hailed from small size of family *i.e.* up to 4 members, were partially aware about knowledge of mass media. Contrary to that, maximum number of the respondents (60.30%), who hailed from medium size of family *i.e.* up to 5-8 members, were partially aware about knowledge of mass media.

Annual income of the respondents was found highly significantly associated with level of knowledge about mass media. The data revealed that majority of the respondents (69.00%), who earned annual income *i.e.* up to Rs. 100,001 to 2,00,001, were partially aware of knowledge about mass media. Contrary to that 68.40 per cent of the respondents, who earned annual income above Rs. 3,00,000/-, were partially aware and 41.20 who had income upto 100000/- per cent were not aware about knowledge of mass media.

Highly significant association found between size of land holding and level of knowledge about mass media. It was clear from the data of the respondents (70.40%) were partially aware *i.e.* semi-medium followed by 69.40 per cent had small size of land holding of knowledge were partially aware about mass media. Contrary to that, 53.33 per cent of the respondents, who hailed from medium and large size of land holding *i.e.* medium and large, had partially aware of knowledge about mass media. Subsidiary occupation of the respondents not found significantly associated with level of knowledge about mass media. It was clear from the data that nearly three-fourth of the respondents (75.00), who were engaged in nothing as subsidiary occupation, had partially aware about knowledge of mass media. On the other hand, (100.00%) who were engaged in dairy, were partially aware about knowledge of mass media.

Highly significant association found between social participation and level of knowledge about mass media. Overwhelming of the respondents (80.00%), who had no member of any social organization, had partially aware of knowledge about mass media. Contrary to that (25.00%) of the respondents who were office bearer or public leader had had high level of knowledge about mass media.

Extension contacts found non-significantly associated with level of knowledge about mass media. Analysis clearly revealed that 71.70 per cent of the respondents, who had partially aware about extension contact, 54.50 per cent of the respondent who had high level were partially aware about knowledge of mass media. Contrary to that, more than one-third of the respondents (36.40%) who belonged to high level were fully aware about extension contact of knowledge about mass media. Joshi (2022) mentioned in his study that demonstration for the mobile application (e-sanchar) was organized and majority (71.79%) respondents have medium impact, followed by low 20.51 per cent and 7.69 per cent have high impact of mobile application after 6 months of usage. Most of the farmers were of the opinion that they have much access to information at their fingertips now and the mobile app also solved the constraint of mobility.

Extension activities found non-significantly associated with level of knowledge about mass media. Analysis revealed that revealed 68.20 per cent of the respondents who were involved in less than two activities were partially aware about knowledge of mass media and (16.10%) who were involved in more than two activities were fully aware about mass media.

ICT Sources found highly significant associated with level of knowledge about mass media. Analysis revealed that overwhelming of the respondents (85.70%) who belonged to low level were not aware about mass media 68.90 per cent were partially aware belonged to medium level followed by 60.30 per cent of the respondents belonged to high level were partially aware about mass media. Sharma *et al.* (2019) reported in their study that the agricultural production in India increased due to factors like bringing additional area under cultivation, extension of irrigation facilities, use of better quality seeds, advanced techniques like high yielding varieties, water management and plant protection practices and ultimately due to use of ICTs for updated knowledge regarding it.

Socio-economic status found highly significant associated with level of knowledge about mass media. It was clear from the field of the study that more than three-fifth of respondents (63.90%), who had high socio-economic status, were not aware level about knowledge of mass media. On the other hand (38.30%) respondents who had low socio- economic status were not aware of mass media.

CONCLUSION

ICT Sources found highly significant associated with level of knowledge about mass media. Analysis revealed that overwhelming of the respondents (85.70%) who belonged to low level were not aware about mass media 68.90 per cent were partially aware belonged to medium level followed by 60.30 per cent of the respondents belonged to high level were partially aware about mass media. Extension activities found non-significantly associated with level of knowledge about mass media. Maximum number of the respondents (44.20%) had rarely used newspaper regarding knowledge of mass media followed by never used by 27.50 per cent of the respondents and occasionally (18.30%). However, in case of internet half of the respondents (50.80%) had regularly use and near about one-fourth of the respondents 22.50 per cent use occasionally followed by 20.00 per cent of the respondents rarely used internet Age of the respondents found highly significantly associated with level of knowledge about mass media. Most effective source and young and middle age respondents used mobile and internet for gaining information about agriculture production. Creating social media channels on YouTube, Telegram and groups on WhatsApp and Facebook by University level and KVKs at district level that provide farmers with up-to-date information about new and improved seeds, irrigation, crop protection etc. so that farmers can make better use of research conducted by different departments of the university.

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Extent of Agrochemicals usage on Rice Crop in Punjab

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ABSTRACT

The use of agrochemicals has sympatric relationship with development of agriculture. About seventy percent of agrochemicals are being used in developing nation and remaining thirty percent are in developed countries. The pesticide use in India is increasing at rate of 2-5 per cent per annum and about 3 per cent of total pesticide used in world. Present study was conducted in Ludhiana district 100 rice growers were selected for the study. Out of 100 respondents 70 per cent of them were applying urea at very high rate and 40 per cent of the respondents were applying urea n less than recommended splits. Around 48 per cent of the respondents were applying it at earlier time than recommended. More than half of the respondents were applying DAP/SSP at very high rates. Around 63 per cent of the respondents were using Pendimethalin at high dose. More than half of the respondents were using Bispyrabac Sodium at high rate. Most of the respondents were using Chloropyriphos at very high rate. Forty percent of the respondents were using Cartap at recommended dose. The most used fungicide by the farmers was Carbendazim 12 per cent + Mancozeb 63 per cent, which was used by 61 respondents, out of which around half of them were using it at recommended dose whereas nearly half of the respondents were using the fungicide at higher than recommended dose. The agrochemicals used by respondents were classified according to Classification of toxicity levels of (oral) different pesticides/ weedicides/ fungicides (According to World Health Organization). It was found that on an average 29 per cent of the respondents use pesticides which belongs to moderately hazardous class, on average around 46 per cent of the respondents use agrochemicals which belong to slightly hazardous class and on average about 36.5 per cent of the respondents use agrochemicals which belongs to unlikely to cause hazard class. Most respondents use these agrochemicals in very high doses because of which they prove harmful to the environment as well as human being.

Keywords: Agrochemicals, Extent, Toxicity levels, WHO Classification

INTRODUCTION

Agriculture provides livelihood to most of the Indian people. Although, its intensification has reduced the economic capacity and sustainability of small farming systems by causing a remarkable growth in the use of production inputs. The use of modified seeds or high yielding varieties, fertilizers, and pesticides led to bumper produce. The use of these inputs is no doubt important for producing agricultural crops, but the so called green revolution was ally with unforeseen consequences from chemical pollution (Pepper, 2008).

The use of agrochemicals has sympatric relationship with development of agriculture. The ancient Romans and Chinese people used number of mineral and plant extract products against agricultural pest species. The manufacturing of agrochemicals began in the early 1930s and drastically evolve after Ward War II (1939-45). The universal use of agrochemicals were affect the environment, animal and human health (Anonymous, 2007).

The indiscriminate use of agrochemicals had caused several problems in crop production as well as outside the farms. Plants became more susceptible to pests and diseases with the use of high dosages of fertilizers. Their control could be done with use of high dose of pesticides. As the consequences their

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residue in plants and soil had led to health problems (Malathi and Bangarusamy, 2001).

The first case of lethal death in Indian history was reported in past 1958 in Kerala due to the ingestion of wheat flour mixed with parathion. In the developing nations, twenty five million agricultural labours or workers are getting affected by the incident of harming effect of agrochemicals poisoning every year. The lethal series pursues with many occurrences like Bhopal gas (methyal isothiocyanate) tragedy and Bihar, Saran District Tragedy in which more than 30 children killed because of ingestion of monocrotophos, a lethal organophosphorus group of pesticide. Beside this frightening figures long term exposure at even at lower concentrations cause serious health problems like reduction in the immunity, abnormal hormone production, reduction in mental health, abnormalities in the reproductive system and dangerous one and most common in now days, the cancer of various type.

Research data says that the obvious reason lies here is the only 0.1 per cent of these chemical usage aims at the pest rest 99.9 per cent remain and scatter in surroundings. Andhra Pradesh is the state which consumes most of the pesticides (23%) Punjab ranks 2nd and Maharashtra 3rd (Bhardwaj and Sharma, 2013) in pesticide consumption.

Punjab, the pivot state responsible for the Green Revolution, among various states of India, due to which Punjab's farmers were able to make themselves self-sufûcient, non-reliant on others for the fulfilment of their fundamental food requirements (Sidhu and Byerlee, 1992). According to the Statistical Abstract of Punjab (2005) report, the grain production in Punjab has been increased from about 3 million tons in 1960–1961 to about 25.5 million tons in 2004–2005. Similarly, the cotton production has been increased from 0.12 million tons in 1960–1961 to 0.37 million tons in 2007–08 with a meagre 1.35 fold increase cotton cultivating land (Barik, 2010). The heavy reliance of agriculture on synthetic chemical fertilizers and pesticides is having critical effects on public health and environment. Fertilizers, especially nitrogenous fertilizers are excessively used by the farmers that are responsible for making soil unfertile. Agro-chemical inputs are misused, especially, pesticides have adverse consequences on the environment.

The hackneyed use of pesticides in Punjab has altered the pest scenario, outbreak of several deadly diseases, environmental degradation, and increasing input cost for agriculture. Leading the farmers under debt.

The first case of lethal death in Indian history was reported in past 1958 in Kerala due to the ingestion of wheat flour mixed with parathion. In the developing nations, twenty five million agricultural labours or workers are getting affected by the incident of harming effect of agrochemicals poisoning every year. The lethal series pursues with many occurrences like Bhopal gas (methyal isothiocyanate) tragedy and Bihar, Saran District Tragedy in which more than 30 children killed because of ingestion of monocrotophos, a lethal organophosphorus group of pesticide. Beside this frightening figures long term exposure at even at lower concentrations cause serious health problems like reduction in the immunity, abnormal hormone production, reduction in mental health , abnormalities in the reproductive system and dangerous one and most common in now days, the cancer of various type.

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for making soil unfertile. Agro-chemical inputs are misused, especially, pesticides have adverse consequences on the environment.

The use of pesticides is also high (923 g/ha) especially in crops like cotton, rice, vegetables, etc. (Agnihotri, 2000). The hackneyed use of pesticides in Punjab has altered the pest scenario, outbreak of several deadly diseases, environmental degradation, and increasing input cost for agriculture. Leading the farmers under debt. So, this present study was organized to study the extent of use of agrochemicals in rice crop in Punjab.

MATERIALS AND METHODS

Out of Punjab state, using multistage and purposive sampling, Ludhiana district was selected for the study. It is located at Central Punjab and has significant area under rice cultivation. From Ludhiana district, 100 farmers were selected randomly and purposively for the study.

Extent of agrochemical use was measured as rate of agrochemicals applied to per acre of land. It was measured in terms of fertilizers and pesticides (insecticides, herbicide, fungicide and any other chemical) use in kg/ ha. Use of pesticide was converted into mass of active ingredient i.e. a.i./ ha which was also be classified into pesticide used belonging to WHO toxicity class I, class II, class III, class U and total no. of sprays.

All the three aspects of the agrochemicals application was measured i.e. dose of agrochemical, splits in which the agrochemical was applied and the time at which agrochemical was applied and then it was compared with the recommended dose, recommended time and recommended splits. Then the different aspects which were measured were categorized into three categories i.e. less than recommended, recommended and more than recommended.

RESULTS AND DISCUSSIONS

Extent of fertilizer use on rice crop

Urea: It is apparent from the Table 1 that 30 per cent of the respondents were applying urea at

Table 1: Distribution of respondents according to extent of fertilizer use on rice crop

Parameters		Categories	Frequency	Percentage
Urea (n=100)				
i.	Dose	Low (<90 kg/ acre)	0	00.00
		Recommended (90 kg/ acre)	30	30.00
		High (> 90 kg/ acre)	70	70.00
ii.	Splits	Less (<3)	46	46.00
		Recommended (3 splits)	26	26.00
		More (> 3)	28	28.00
iii.	Timeliness	Early (before 4 weeks)	48	48.00
		On time (4th week)	22	22.00
		Late (after 4 weeks)	30	30.00
DAP/SSP (n=100) (only if deficient)				
i.	Dose	Low (<27 kg/ <75 kg/acre)	12	12.00
		Recommended (27 kg/ 75 kg/ acre)	28	28.00
		High (>27 kg/ >75 kg/ acre)	60	60.00
ii.	Splits	Less (no DAP)	0	00.00
		Recommended (1)	88	88.00
		More (>1)	12	12.00
iii.	Timeliness	Early	0	00.00
		On time (before puddling)	82	82.00
		Late	18	18.00

recommended dose i.e. 90 kg/ acre whereas 70 per cent of them were applying urea fertilizer at very high rates. Recommended splits of urea for rice crop is in three splits and 26 per cent of the respondents were applying urea to their rice crop in recommended splits, 28 per cent of them were applying it in more than recommended splits and 46 per cent of the respondents were applying urea in less than recommended splits. In case of application time of urea, 22 per cent of the respondents were applying urea at recommended time, 30 per cent of them were applying it late then recommended time whereas 48 per cent of the respondents were applying it at earlier time then recommended.

DAP/SSP: It is apparent from the Table 1 that 28 per cent of the respondents were applying DAP/SSP at recommended dose i.e. 25 kg/ acre/ 75 kg/acre whereas 60 per cent of them were applying DAP/ SSP fertilizer at very high rates. Recommended splits of DAP/SSP for rice crop is in single split and 88 per cent of the respondents were applying DAP/SSP to their rice crop in recommended split, 12 per cent of them were applying it in more than recommended splits. In case of application time of DAP/SSP, 82 per cent of the respondents were applying DAP/SSP at recommended time, 18 per cent of them were applying it late then recommended time

Extent of weedicide use on rice crop

Table 2 depicts that Pendimethalin was used by 32 respondents, out of which only 31 per cent of the respondents were using it at recommended dose whereas 63 per cent of the respondents were using the pesticides at high dose. Among the rice growers 22 respondents were using Bispyribac Sodium, out of which around 36 per cent of them were using it at recommended dose whereas more than half of them were using it at high dose.

Table 2: Distribution of respondents according to extent of weedicide use on rice crop

Herbicide	Categories	Frequency *	Percentage
Glyphosate (BANNED FOR USE) (n=12)			
i) Dose	Low	0	00.00
	Recommended	0	00.00
	High	12	100.00
Pendimethlin (STOMP) (n=32)			
i) Dose	Low	2	6.25
	Recommended	10	31.25
	High	20	62.50
Bispyribac Sodium (Nominee gold/ Taarak) (n=22)			
i) Dose	Low	2	9.10
	Recommended	8	36.36
	High	12	54.54
Pretelachlor (Fire) (n=34)			
i) Dose	Low	0	00.00
	Medium	26	76.48
	High	8	23.52

*multiple response

Extent of agrochemicals used for pest control on rice crop

Data placed in the Table 3 reveals that Chloropyriphos was used by 75 respondents, 20 per cent of them were using it at recommended dose, 80 per cent of them were using the pesticide at high dose. Cartap was used by 25 respondents, out of which only 40 per cent of the respondents were using it at recommended dose whereas 60 per cent of the respondents were using the pesticides at high dose. Among the rice growers 16 respondents were using Acetamiprid, out of which half of them were using it at recommended dose whereas half of them were using it at high dose. Among the rice growers, 20 respondents were using Imidacloprid, out of which 40 per cent of them were using the pesticide at recommended doses, whereas 60 per cent of them were using it at high dose.

Extent of agrochemicals used for disease control on rice crop

Data placed in the Table 4 depicts that among the rice growers, Propiconazole was used by 21 farmers, among them more than half of the respondents were using them at high dose, whereas around 38 per cent of them were using it at recommended dose, about 5 per cent of the respondents were using the pesticides at lower doses than recommended. Pencycuron was used by 12 respondents, out of which around 33 per cent of the respondents were using it at recommended doses and more than half of the respondents were using it at higher doses than the recommended dose. Out of all the respondents 60 respondents were using the Azoxystrolin + Difernoconazole, out of the

Table 3: Distribution of respondents according to agrochemicals used for pest control on rice crop

Details of Pesticides			Frequency *	Percentage
CHLOROPYRIFOS (Dursban/Chloro) (n=75)				
i)	Dose	Low (< 1 litre/ acre)	0	00.00
		Recommended (1 litre/ acre)	15	20.00
		High (< 1 litre/ acre)	60	80.00
CARTAP (Caldan 4 G) (n=25)				
i)	Dose	Low (<1.70 g / acre)	0	00.00
		Recommended (170 g/ acre)	10	40.00
		High (>170 g / acre)	15	60.00
ACETAMIPRID (Pride) (n=16)				
i)	Dose	Low (< 800 ml/ acre)	0	00.00
		Recommended (800 ml/ acre)	8	50.00
		High (> 800 ml/ acre)	8	50.00
IMIDACLOPRID (Confidor) (n=20)				
i)	Dose	Low (< 2.5 litre g / acre)	0	00.00
		Recommended (2.5 litre g / acre)	8	40.00
		High (> 2.5 litre/ acre)	12	60.00
Lambda- Cyhalothrin (Karate) (n=70)				
i)	Dose	Low	2	2.857
		Medium	30	42.85
		High	38	54.28

Table 4: Distribution of respondents according to extent of agrochemicals used for disease control on rice crop

Details of fungicides		F	%tage
PROPICONAZOLE (Tilt) (n=21)			
i) Dose	Low < 200ml / acre	1	4.76
	Medium 200 ml / acre	8	38.10
	High >200ml / acre	12	57.14
PENCYCURON (Bavistin) (n=12)			
i) Dose	Low < 200 gm / acre	2	16.67
	Medium 200 gm / acre	4	33.33
	High >200 gm / acre	6	50.00
Dithane z-78, parzate (Zineb) (n=18)			
i) Dose	Low <500gm/ acre	2	11.11
	Medium 500 gm/ acre	3	16.66
	High >500 gm/ acre	13	72.23
Azoxystrolin+ Difernoconazole (Amistar Top) (n=59)			
i) Dose	Low	0	0
	Medium	22	37.29
	High	37	62.71
Carbendazim 12%+ Mancozeb 63 % (12-63) (n=61)			
i) Dose	Low	0	0
	Medium	31	50.81
	High	30	49.19

respondents using this fungicide more than half of them were using the fungicide at high dose than the recommended one whereas around 38 per cent of them were using the fungicide at recommended dose. The most used fungicide by the farmers was Carbendazim12 %+ Mancozeb 63%, which was used by 61 respondents, out of which around half of them were using it at recommended dose whereas nearly half of the respondents were using the fungicide at higher than recommended dose.

Distribution of respondents according to classification of different pesticides/ weedicides/ fungicides used by farmers on rice crop

Data placed in Table 5 depicts that on an average 29 per cent of the respondents use pesticides which belongs to moderately hazardous class, on average around 45.5 per cent of the respondents use agrochemicals which belong to slightly hazardous class and on average about 36.5 per cent of the respondents use agrochemicals which belongs to unlikely to cause hazard class. Most respondents use these agrochemicals in very high doses because of which they prove harmful to the environment as well as human beings.

Table 5: Classification of toxicity levels of (oral) different pesticides/ weedicides/ fungicides used by farmers on rice crop. (According to World Health Organization)

Classes (according to WHO)	Chemicals	f % (avg.)
Extremely hazardous	————————	————
Highly hazardous	————————	————
Moderately hazardous	Bispyribac sodium, Acetamiprid, Imidacloprid, propiconazole, Chlorpyriphos, Lambda Cypalothrin, Cartap.	29
Slightly hazardous	Azoxystrolin+ Difernoconazole, Pendimethalin.	45.5
Unlikely to cause hazard	Pencycuron, Chlorantraniliprole, Mancozeb, Carbandezim.	36.5

CONCLUSION

Most of the farmers were using very high doses of agrochemicals as compared to the recommended doses. Some of the farmers were still using banned or obsolete pesticides which are harmful. Majority of the farmers were using high doses of fertilizers specially urea as they have a perception of getting high yield with the use of more and more urea. Regarding the use of pesticides/weedicides/fungicides farmers use very high doses than the recommended doses. Some of the farmers were also using obsolete chemicals for pest / disease and weed control on their crop. Most of agrochemicals used by the farmers belongs to moderately to slightly hazardous class according to WHO classification and that too in high doses. Higher doses used by farmers are harmful for human health as well as environment. Farmers should be trained for the judicious use of the agrochemicals. They should be made aware about the harmful effects of excess use of agrochemicals by organizing various camps and campaigns.

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Evaluation of Marketing Structure and Sustainability of Mustard in Jammu District of JK-UT

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ABSTRACT

Mustard crop is among the oldest cultivated plants in human Civilization. Biologically, the Mustard plants belongs to the family Cruciferous and under the genus *Brassica*. The mustard crop grows all over the world but their cultivation is mainly confined to India, China, Canada, Germany, France, Australia, USA, etc. Mustard has largest area of 8 million ha in Canada followed by China (7 million ha) and India (6 million ha). Area of mustard crop in world is 355.20 lakh hectares, its Production is 714.50 lakh tones and Productivity is 2010 kg/ha respectively for the year 2015-16 (Anonymous, 2016). A study was conducted in Jammu district of JK-UT where out of 20 development blocks falling in Jammu district, we have selected two blocks named "R.S. Pura" and "Bishnah" randomly. The primary data on marketing of Mustard were collected by surveying through interview method with the help of pre-tested questionnaire. The study reported that the two marketing channels were prevalent in the study area that is Channel – I (Producer- Village Trader- Processor) and channel-II (Producer- Processor). The total marketing cost and marketing margin was evaluated to be higher in Channel-I followed by Channel-II. The marketing efficiency of channel-II (51.91) was found to be much higher than Channel-I. Also the producer's share in consumer's rupee was found maximum in case of Channel-II (98.11%) than Channel-I (94.20%).

Keywords: Mustard, Marketing cost, Marketing margin, Marketing efficiency, Producer's Share in Consumer's Rupee

INTRODUCTION

Agriculture plays a important role in the Indian economy. Although its contribution to the country's GDP is around 17 per cent, its share in total employment is about 48 per cent (World Bank, 2019). In India agricultural households were more than 57.8 percent of the total households of the country (Kumar *et al.,* 2021). Mustard crop is among the oldest cultivated plants in human Civilization. Biologically, the mustard plants belongs to the family Cruciferae and under the genus *Brassica*. The word 'mustard' is derived from latin word 'mustum' or "must", which denotes 'expressed juice of grapes" and "ardens" means "hot & burning". The Mustard *Brassica* plants yields the oils which characteristically have high content of long chain fatty acid called as "Erucic acid". The cultivation of mustard dates back to 2000 B.C. both in sub-tropical and tropical countries. India needs to produce 17.84 MT of edible oils to meet the nutritional fat needs of projected population of 1685 million by 2050 (Narayan, 2017). Mustard oil is traditionally the most important oil for the Northern, Central and Eastern parts of the country (Singh and Singh, 2014). Rapeseed-mustard group of crops is the major oilseed crop of India. India holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively (Das and Sharma, 2012). During 2018-19, rapeseed-mustard contributed 26.24 per cent to the total oilseeds production. Globally, India

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account for 19.80 per cent and 9.8 per cent of the total area and production of mustard. European Union is the leading producer of mustard seed in the world accounting for 30.87% of the world production - followed by Canada (26.36%), China (20.41%) and India (8.54%) (Mustard Crop Survey Annual Report, 2018-19). The mustard crop grows all over the world but their cultivation is mainly confined to India, China, Canada, Germany, France, Australia, USA, etc. Area of mustard crop in India for the year 2019-20 was 68.56 million hectares, its Production was 91.23 million tonnes and Productivity was 13.31 q/ha respectively. Also J&K contributing 0.86 and 0.43 per cent of total area and production respectively for mustard cultivation (Annual Report, 2018-19). In Jammu and Kashmir, total area under mustard crop is 47.61 thousand hectares with total production of 250.22 thousand quintals and productivity of 525.76 kg/ha (Directorate of agriculture, Jammu, 2017-18). The state is deficient in oil seed production. Among oilseeds, Mustard is the most important *rabi* oilseed crop of J&K state. Efficient marketing of Mustard plays an important role in increasing the producer's share in the consumer's price and maintain the tempo of increased production. Mustard marketing in particular is mainly in the hands of middlemen. Hence the producer is only a price receiver. In process of marketing the producer has to incur various marketing costs. The costs are determined by the performance and efficiency of different marketing functionaries in different channels, which in turn influence the return to the producer. In this study content, there is a need for the study of efficiency of marketing channels in the marketing of mustard that is cultivated and marketed in the study area.

MATERIALS AND METHODS

This study was conducted in Jammu district of JK-UT. A multistage sampling technique was used for the present study and Jammu district was purposively selected for the present investigation because the district occupies an important place in production of the mustard, as this was done at the first stage of sampling. Out of 20 development blocks falling in Jammu district, R.S. Pura and Bishnah blocks were selected randomly at the second stage of sampling. At the third stage of sampling, 4 villages each from these two development blocks were selected randomly to constitute a total of 8 villages. At the fourth stage of sampling, 10 farmers from each village were selected through random sampling technique without replacement to make a total sample size of 80 farmers. Further the farmers of study area were classified into four categories based on their landholdings viz; marginal farmers (1-2 ha), small farmers (2-4 ha), medium farmers (4-8 ha) and large farmers (> 8 ha). As the numbers of large farmers were meagre so we have not considered the large farmers. Both primary as well as secondary data were collected and used as per the requirements of the study. The primary data were collected by survey method by interviewing the mustard growers directly through a pre-tested schedule.

RESULTS AND DICUSSION

The marketing structure is efficient when it minimizes costs and benefits all section of society. Thus, marketing of any product is the ultimate or last stage of any production system. An efficient marketing system should be such that the produce should reach to consumer in good state without damage with least cost and within a shortest time span after harvest. An efficient marketing system is an important mean for raising the income level of the farmers. The main objectives of an efficient marketing system are: (a) to enable the primary producers to reap the best possible benefits; (b) to make available all products of farm origin to consumers at reasonable price without impairing the quality of the produce; (c) to provide facilities for lifting all the produce, the farmers are willing to sell at an incentive price; (d) to reduce the price spread between the primary produce and ultimate consumer. The marketing analysis for mustard in the study area has been presented below.

Per hectare production, consumption, marketable surplus and marketed surplus of mustard was found out and presented in Table 1 which revealed that on an average, marketable surplus of medium farms (13.56 quintal/ha) was highest followed by marginal farms (9.99 quintal/ha) and small farms (9.91 quintal/ha) and for overall farms it was found to be 11.49 quintal/ha. Therefore we analysed that mediums have more production which in turn have more marketable surplus but in small and marginal farms have a meagre difference in their marketable surplus and lower than medium farms. The marketed surplus was also highest in case of medium farms with 11.58 quintal followed

Table 1: Marketable Surplus and Marketed Surplus of Mustard on sampled farms

Particulars → Farms ↓	Production (qtl.)	Home Consumption (qtl.)	Given as wages (qtl.)	Retained for seed (qtl.)	Marketable Surplus (qtl.)	Marketed Surplus (qtl.)
Marginal	11.57	1.53	-	0.05	9.99	10.71
Small	12.87	2.10	0.80	0.06	9.91	8.00
Medium	16.15	2.52	-	0.07	13.56	11.58
Overall	13.86	2.05	0.26	0.06	11.49	9.13

by marginal with 10.71 quintal and small farms with 8.00 quintal. The average overall farms per family marketable and marketed surplus was 11.49 quintal and 9.13 quintal, respectively. Quantity of produce retained for home consumption was highest (2.52 quintals) in case of medium farms followed by 2.10 quintals in case of small and 1.53 quintals in case of marginal farms per ha. Quantity of produce retained for seed purpose 0.70 quintal/ha in case of medium farms, 0.60 quintal/ha in case of small and 0.50/ha quintal in case of marginal farms. Thereby we can analysed from this that medium farms are much benefitted and they sell less amount of their produce and retain some amount with them. So we concluded that there was no forced or distress sale in the market.

Marketing channels are the routes through the producer farmers sell their produce in the market and in the study we have identified two main marketing channels which were involved in the marketing of mustard produce can be summarized as follows:

Channel-I: Producer → Village trader → Processor

Channel-II: Producer → Processor

In case of channel-I, there is an intermediary in the form of village traders, who provides facilities to enhance the marketing of produce. These two types of marketing channels were worked out in the study area and are presented in Table 2.

The marketing cost, marketing margin and price spread under different marketing channels of mustard under study area was worked out and presented in Table 2, which revealed that price received by producer for one quintal of mustard in channel-I was Rs. 3980.00, marketing cost was Rs. 23.33 and net price received by producer was Rs. 3956.67 per quintal. For village trader, marketing margin and marketing cost was Rs. 138.00 per quintal and Rs. 82.00 per quintal, respectively, which indicates that his margin is low but more than his incurred cost and price received by village trader Rs. 4200.00 per quintal. Price paid by processor was Rs. 4200.00 per quintal. Total marketing cost for channel-I was Rs.105.33 per qtl. In marketing channel – II, the price received by producer was Rs. 3880.00 per quintal. The total marketing cost incurred by producer was Rs.

Table 2: Marketing costs and marketing margins of mustard under different Marketing channels for overall farms (in Rs. /qtl.)

S. No.	Particulars		Channels I	Channels II
1.	Price received by Producer		3980.00	3880.00
	Marketing cost of Producer			
	i)	Transportation cost	-	25.00
	ii)	Packing	10.00	10.00
	iii)	Cleaning	8.33	8.33
	iv)	Loading/unloading	-	10.00
	v)	Helping hand	-	5.00
	vi)	Others (Miscellaneous)	5.00	15.00
	Total marketing cost		23.33	73.33
	Net price received by producer		3956.67	3806.67
2.	Price paid by village trader		3980.00	-
	Marketing cost of village trader			
	i)	Transportation cost	25.00	-
	ii)	Packing	10.00	-
	iii)	Cleaning	-	
	iv)	Loading/unloading	10.00	-
	v)	Helping hand	5.00	-
	vi)	Spoilage	12.00	-
	vii)	Others (Miscellaneous)	20.00	-
	Total marketing cost		82.00	-
	Marketing margin of village trader		138.00	
3.	Price paid by Processor		4200.00	3880.00

Table 3: Marketing efficiency and price spread in marketing of Mustard through different channels (Rs./ qtl.)

Particulars	Marketing channels	
	I	II
Net price received by producer	3956.67	3806.67
Marketing Cost (MC)	105.33	73.33
Marketing Margin (MM)	138.00	-
Consumer Price	4200.00	3880.00
Producer's share in consumer's price (%)	94.20	98.11
Marketing Efficiency (ME)	16.26	51.91

Channel-I: "Producer – Village trader –Processor";
Channel-II: "Producer –Processor"

73.33 per quintal and net price received by the producer was Rs. 3806.67/qtl. Price paid by processor in marketing channel-II was Rs. 3880.00 per quintal of produce. No any marketing margin in channel-II because the produce was directly sold to processor. Eventually we can say that producer's share in consumer's rupee is more in case of channel-I than that of channel-II. So from the producer's point of view, channel-I is more profitable and efficient.

Table 3 indicated the marketing efficiency and price spread of mustard in two channels under study. It was found that net price received by the producer was Rs. 3956.67/qtl and Rs. 3806.67/qtl in marketing channel-I and II respectively. The marketing cost and marketing margin in channel –I was Rs. 105.33/qtl and Rs. 138.00/ qtl respectively and in channel-II marketing cost was Rs. 73.33/qtl and has no marketing margin. The marketing efficiency was found maximum in channel-II (51.91), when the produce was sold directly to processor when compared with channel-I. When the produce was sold through intermediaries, the marketing efficiency was lower as it was 16.26 in channel-I. As channel-I involves more marketing costs than channel-II, thereby having less efficiency in its marketing structure.

CONCLUSION

The marketing channels of two types mainly (1) producer – village trader- processor (2) producer – processor, were prevalent in the sampled area. The net price received by the producer was found to be Rs. 3956.67/qtl. and Rs. 3806.67/qtl. in case of marketing channel-I and II respectively. The marketing cost and marketing margin in channel–I was Rs. 105.33/qtl. and Rs.138.00/qtl. respectively and in channel-II, Rs. 73.33/ qtl. marketing cost but no any marketing margin. So, channel-I involves more marketing cost than channel-II. The marketing efficiency was found maximum in channel-II (57.11), when the produce was sold directly to processor, it involves less marketing cost. When the produce was sold directly to processor, it involves less marketing cost. When the produce was sold through intermediaries, the marketing efficiency was lower as it was 16.26 in case of channel-I, even though it had higher value of net price received by the farmer.

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Marketing Analysis of Harad (*Terminalia Chebula*) and Constraints Faced in Jammu District of Jammu and Kashmir – Union Territory

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ABSTRACT

The present study analysed marketing pattern of Harad and is conducted during the year 2019-20 in the Bhalwal blocks of Jammu district. The block selected was the major Harad producing areas of Jammu district and produce from Bhalwal block are transported to Amritsar Mandi for further export to Arab countries. A sample of 60 farmers from four villages viz., Mathwar, Rabta, Bhalwal and Ranjan were selected randomly. The table revealed that the quantity sold through channel I and II in Mathwar area was found to be highest with the value of 9432q and 3553q, respectively whereas lowest quantity sold was found in Bhalwal with the value of 7042q and 1065q, respectively. Net price received by the farmers was Rs. 2000/q and Rs. 2200/q whereas price paid by the consumer was found to be Rs. 3654.20/q and Rs. 4060.30/q for channel I and II, respectively. Channel - I with marketing efficiency 1.21 was found most efficient marketing channel but the farmers are interested to sell produce through channel – II due to the more net price received.

Keywords: Marketing, Harad, Price spread, Ranking, Constraints

INTRODUCTION

Terminalia chebula is one of the very important indigenous multi-purpose tree species belonging to Family Combretaceae and popularly known as "Myrobalan" (Krishna, 2015) and it is commonly known as Harrar, Harra, Hirda and Haritaki. India holds the monopoly in export of Chebulic myrobalans in the form of whole fruits or in crushed form or as extracts to the world market. UK, USA, Australia, Belgium, Pakistan and Malaya Federation are the main importers of crushed myrobalans, whereas, Australia, Bangladesh, France, Pakistan, UK and USA import whole myrobalans. Pakistan, New Zealand, Australia and Japan are the chief importers of myrobalans extract. The current market price of fresh fruit is Rs. 10-60/kg while dried and without seeds was about Rs. 60/kg (Ahmed, 2005). In India, production is estimated to be 1,00,000 tonnes of which 20 per cent is exported to countries like Europe and USA (World Agroforestry Centre, 2017). In Jammu and Kashmir State, few plantations of grafted Harad (with large size fruit size) have been undertaken by the farmers in different areas in sub-tropics of Jammu. In Jammu and Kashmir UT, the annual production of Harad fruit is about 500 tonnes (as per conversation with local trader of Jammu). The Harad fruits of this region were being sold in Majeetha Mandi, Amritsar and from where it is further sold to Arab countries. Large size fruits fetch more price than smaller ones and thus farmers have shown preference for large sized fruit trees on their crop land. The perishable nature of forestry produce makes its marketing an important aspect of study. Marketing of forestry produce involves various intermediaries' channels. In case of *Terminalia chebula*, being a medicinal fruit tree and involvement of various quality parameters like size, weight, pulp fruit ratio, etc., it needs special

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care in grading and marketing of produce. Keeping in consideration above points, the present study was undertaken to study the marketing pattern and constraints faced during marketing of Harad.

MATERIALS AND METHODS

The present study was conducted in Jammu district of Jammu region and Multi stage sampling design was used for the selection of samples where in the first stage of sampling, Bhalwal block was selected purposively on the basis of maximum number of Harad tree population. Four villages were selected from the Bhalwal block on the basis of highest area under Harad plantation. Thereafter four villages from Bhalwal block and fifteen farmers from each village were selected randomly to constitute a sample of 60 farmers in all for carrying out the study. The post-harvest loss at various stages of marketing has been included either in the farmer's net margin or market intermediaries' margin. In the present study, the marketing loss at different stages has been explicitly estimated. The modified formulae have been used for separating the 'post-harvest loss during marketing' at different stages of marketing as well as for estimating the producers' share, marketing margins and marketing loss.

RESULTS AND DISCUSSION

The chain of various intermediaries/functionaries commonly known as marketing channel comprising of agencies like producers, wholesalers, retailers and sometime, direct sale of producer help in distribution of Harad from producers to ultimate consumers in Jammu District.

The marketing channels operating in study area are as under:

1. Producer → Wholesaler → Retailer → Consumer
2. Producer → Wholesaler 1 → Wholesaler 2 (Amritsar) → Retailer → Consumer

The quantity of Harad sold through the different marketing channels is given in Table 1. The table revealed that the quantity sold through channel I and II in Mathwar area was found to be highest with the value of 9432q and 3553q, respectively whereas lowest quantity sold was found in Bhalwal with the value of 7042q and 1065q, respectively.

The channels wise decomposition of marketing costs components for Harad in Bhalwal block of Jammu district is given in Table 2. The table reflects the major items of marketing expenses incurred in both the channels at producers 'level including transportation cost, cost of carry bags and labour charges. These costs varied to the extent of Rs. 185.60/q and Rs. 159.50/q in channel I and channel – II, respectively. As far as per quintal marketing cost for intermediaries was concerned, retailer had incurred the cost of Rs. 40 and

Table 2: Channel wise decomposition of marketing cost components for Harad in Bhalwal Block of Jammu district (Rs./q)

Functionary	Channel I	Channel II
Marketing cost incurred at producer level	**185.60**	**159.50**
Transportation cost	45.60	39.50
Labour engaged	120.00	100.00
Cost of carry bags	20.00	20.00
Marketing cost incurred at wholesaler level	**120.00**	**120.00**
Cost of carry bags	20.00	20.00
Labour engaged	100.00	100.00
Marketing cost incurred at retailor level	**40.00**	**55.00**
Transportation cost	20.00	35.00
Cost of carry bags	20.00	20.00
Shop charges	0.00	0.00
Total marketing cost	**345.60**	**334.50**

Table 1: Disposal of Harad through different channels in the study area (in q)

Marketing Channels	Mathwar	Rabta	Bhalwal	Ranjan	Overall
Producer - Wholesaler – Retailer – Consumer	9432 (72.64)	8138 (75.24)	7042 (86.86)	9030 (86.11)	33642 (79.36)
Producer - Wholesaler 1– Wholesale 2- Retailer – Consumer	3553 (27.36)	2678 (24.76)	1065 (13.14)	1456 (13.89)	8752 (20.64)
Total	12985	10816	8107	10486	42394

(Figures in parenthesis indicates percentage of total)

Rs. 55 and while cost incurred at wholesaler level was found to be Rs. 120 in both the channels, respectively.

The price spread as per cent of consumers 'rupee for different market functionaries of Harad under different channels in Jammu district is presented in Table 3. The Harad growers received the net price of Rs. 2000/q and Rs. 2200/q whereas price paid by the consumer was found to be Rs. 3654.20/q and Rs. 4060.30/q for channel I and II, respectively. The producers' sale price of Harad was Rs. 2538.10/q in channel I while it was C2820/q in channel II. The table further revealed that the per quintal marketing loss incurred be the producer was Rs. 352.50/q in channel I and Rs. 460.60/q in channel – II. The wholesaler' sale price was Rs. 3076.20/q in channel I and Rs. 3440.2/q in channel II. Per quintal total marketing margin was found to be Rs. 956.10 in channel I and Rs. 1065.2 in channel II where as marketing loss of Rs. 352.50/q and Rs. 460.60/q in channel – I and Channel – II, respectively was only found at producer's level. The table also showed that producer's share in consumer rupee was high (54.73 per cent) in channel – I than channel – II. The net price received by the producer was high in Channel – II and the farmers' of the area preferred channel – II for marketing of produce but only quality produce was found to be marketed to Amritsar mandi from channel – II.

Table 3: Price spread of Harad under different marketing channels in Bhalwal block of Jammu district (Rs. /q)

Particulars	Channel I	Channel II
Net price received by the producer	**2000.00**	**2200.00**
Marketing cost incurred by the producer	185.60	159.50
Marketing loss of producer	352.50	460.60
Producer's sale price	**2538.10**	**2820.10**
Marketing cost incurred by the wholesaler	120.00	120.00
Marketing margin of the wholesaler	418.10	500.10
Wholesaler sale price	**3076.20**	**3440.20**
Marketing cost incurred by the retailer	40.00	55.00
Marketing margin of the retailer	538.00	565.10
Retailer's sale price/ Price paid by the consumer	**3654.20**	**4060.30**
Total marketing margin	**956.10**	**1065.20**
Producer's share in consumer's rupee	**54.73**	**54.18**

The marketing efficiency is an important tool and therefore requires more attention. The marketing efficiency of different marketing channels of study area is shown in Table 4. The Harad farmers received highest net return per kg form channel II (Rs. 2200/q) followed by channel I (Rs. 2000/q) whereas the marketing cost was found maximum in channel I (Rs. 345.60/q). Channel I with marketing efficiency 1.21 was found most efficient marketing channel for Harad farmers followed by Channel II.

The Table 5 illustrates that, out of 60 respondents 23 respondents faced constraints regarding distant markets, 16 respondents faced constraints regarding high transportation cost, 13 respondents faced constraints regarding high labour cost, 3 respondents faced constraints regarding high charges of forest stamp and 5 respondents faced constraints regarding malpractices by traders.

Table 4: Market efficiency of different channels of Harad

Particulars	Channel I	Channel II
Net price received by the producer	2000.00	2200.00
Total marketing margin	956.10	1065.20
Total marketing loss	352.50	460.60
Total marketing cost	345.60	334.50
Marketing efficiency	1.21	1.18

Table 5: Marketing constraints faced by the Harad farmers in the study area

Constraints	Response
Distant markets	23
High transportation cost	16
High cost of labour	13
High charges of forest stamp	3
Malpractices by traders	5

Table 6: Computation of Garret score and allocation of rank to the response

Constraints	Total	Garret score	Ranking
Distant markets	1725	17.25	II
High transportation cost	1960	19.6	I
High cost of labour	650	6.5	III
High charges of forest stamp	160	1.6	IV
Malpractices by traders	96	0.96	V

The Table 6 illustrates the allocation of rank for marketing constraints faced by the farmers with help of garret ranking technique. It concluded in terms of the high transportation cost rank number 1 followed by distant markets, high cost of labour, high charges of forest stamp and malpractices by the traders at 2nd,3rd,4th and 5th positions, respectively.

CONCLUSION

The major items of marketing costs in all the channels of study area for various market functionaries included labour cost and transportation cost. The average per quintal marketing cost at productions' level varied to the extent of Rs. 185.60 and Rs. 159.50 per quintal for channel I and II respectively. The average per quintal cost borne by the wholesaler in channel I and II was Rs. 120.00 and Rs. 120.00 per quintal while it was Rs. 40.00 and Rs. 55.00 per quintal in channel I and II respectively at retailer's level. A comparison of different channels thus showed that producers' share in consumers' rupee was highest in case of channel I. It was also observed that quality produce of Harad fetches higher price in Amritsar Market and farmers of the area preferred that there produce must be sold in Amritsar market. There are few contractors in the study area who purchases Harad from the local farmers and market it in Amritsar in bulk quantity.

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Price Model for Summer and Winter Tomato Crop through Discriminant Function

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ABSTRACT

Vegetables play an important role in human consumption but most of the time it is seen that a vegetable which is just Rs 20/kg in summer season suddenly touches to Rs80/kg in winter season. Due to this fluctuation of price, people stopped consuming that particular vegetable. The present study basically deals with the price fluctuation of tomato crop. The discriminant function analysis (DFA) is used to identify the existence of an overlap between two groups w.r.t. economic parameter(s), and then determining the group membership of a newly sampled observation. The price of the crops usually fluctuates with respect to the seasons. At some points these prices goes very high and at some point these prices goes very low. Also economic variable price shows a direct relation with the consumption of the crops which means that if price of any crop increases its consumption decreases. In this study, the price model(s) for tomato crops of Jammu region for the summer and winter are proposed. The Secondary data of specific crop taken from Narwal Mandi for a period of 72 months pertains to price, area, arrival, turnover production and yield. The normality of the data is checked through Kolmogorov Smirnov, Shapiro Wilk test, Z score and Box Whisker test. The DFA is used with Wilk's lambda, Box M discriminant scores and Mahalanobis distances. The predicted groups on the basis of discriminant scores are used for developing the price model(s). The F value, wilk's lambda and groups formed on the basis of price are significant which shows that groups varies. The Price model(s) for both summer and winter seasons are significant. It has been observed that the arrival and yield variables for winter whereas turnover and yield for summer showed direct and indirect effect to control the price of tomato crop of Jammu region.

Keywords: Price model, Tomato, Wilk's lambda, Cannonical correlation, Discriminant function

INTRODUCTION

Discriminant Analysis in general creates an equation and helps in minimizing the possibility of those cases which are misclassifying into their respective groups or categories. The origin of Discriminant Analysis has been done from the intergroup distances index was firstly originated by G.M. Morant (1920). Discriminant Function Analysis (DFA) is a statistical procedure that classifies unknown individuals and the probability of their classification into a certain group. In 1930, three different methods, Fisher linear Discriminant function by R.A. Fisher in UK, Hottelling's T^2 test by Hottelling in US and Mahalanobis D^2 distance by Mahalanobis, India were combined to devise a method, which is known as Discriminant Analysis. The main function of DFA to determine which continuous variable discriminate between the occurring groups. The equation of DFA is $D = W_1X_1 + W_2X_2 + \ldots + W_KX_K + \alpha$ Where, D is the discriminant function and W_i are the weights of the variable. X is the respondent scores for that variable and α denotes the constant.

India is an agrarian country as 70 per cent of the rural population depends on it. It is an important sector of Indian economy with share of the agriculture & allied sector in total GVA improved to 20.2 per cent in the year 2020-21 and 18.8 per cent in 2021-22. At global level, India is the second largest vegetable producer after China with 11 percent production share in the

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world. It is also second largest producer of important vegetable crops namely brinjal, cabbage, cauliflower, pea, onion, tomato and third largest producer of potato in the world. However, tomato is ranked first in terms of productivity. As we know, vegetables play an important role in the human consumption as they are rich in vitamins, carbohydrates, proteins and many other minerals which are good for human body as well as for all living beings which are present on this beautiful planet earth. But most of the times, it is being seen that due to rise in price, people stop consuming that vegetable till its price comes to normal point. The present study focus on this fluctuation of price which sometimes goes very high and sometimes very low. In the present study, it is seen that this fluctuation of price generally depends on many factors like seasons, transportation, consumption, demand etc. The present era is of contract, collective and corporate farming which provides benefit to farmers. Government tries to resolve this concept of APMC which may be beneficial to farmer as there is no role of middle man in this which themselves take a huge amount of profit (say 60-70%) but very little or negotiable benefit is given to farmer (say 30-40%). Almost all vegetable crops are perishable in nature so there MSP is not possible due to this reason also prices of that particular commodity increases. Maybe with this abolishing of APMC provides a benefit to farmer who is the feeder of the nation. This initiative by government may be helpful to the farmer in leading to better prices. If this policy of government works then maybe it is an act of direct exchange between producers and consumers without involving middle agents. The UT of Jammu & Kashmir is a hilly and varies with its topography and great agro biodiversity. As majority of the population of J&K depends on agriculture and allied sectors so agriculture plays the role of backbone for the economy of Jammu & Kashmir. The major vegetables growing in the UT are radish, tomato, cauliflower and okra. Variation due to seasons in prices and arrivals of vegetables is a well-known process in market areas. Market arrivals were affected by factors like climatic conditions, human and other institutional factors. Tomato production in J&K shares 1 percent of total production in the country. In Jammu region, Tomatoes are mainly produced in lower area along with the sides of Batote – Doda road such as Ramgarh, Assar, Jathi, Malhori, Khellani etc. Kumar *et al.* (2005) undertook the objectives to examine the variability pattern of market prices and arrivals of selected vegetable crops in order to study the relationship between them in metropolitan markets. Bhat *et al.* (2014) during the study seen that major portion of farmers produce is sold at lower price in post harvest period due to which income of farmers getting low. Qu *et al.* (2017) studied the influence of the vegetable price insurance on the fluctuation of price in Shangai. Kumar *et al.* (2014) discussed the impact of influential observations on the multiple linear regression model. Mahajan *et al.* (2018) proposed the forecasted models for the food grains production in India. Rajput and Bobde (2016) studied different techniques to predict stock price movement using the sentimental analysis from social media, data mining. It was found that sequence of seasonal fluctuations was changed by cost price insurance. Rohit *et al.* (2018) studied ground reality about, how to improve vegetable production. Pandey *et al.* (2017) an attempt was made on the application of discriminant analysis of metrological parameters so that they can develop statistical model in which they have to forecast yield of rice. Thus, by keeping such points in view, the study is considered for the most common vegetable tomato of Jammu region with the objective to develop groups and forecast model for price of tomato crop using discriminant score of economic variables with inputs and trend.

MATERIALS AND METHODS

The study had been conducted under the three stages: Firstly, the data related to monthly price, arrivals, turnovers of tomato for 72 months have been collected from the J&K Horticulture Planning & Marketing Department, at Narwal Mandi, Jammu. Secondly, two groups winter and summer seasons have been formulated and the discriminant score of all the items have been evaluated by using discriminant function w.r.t. price, arrival and turnover. Finally, the forecasting/ prediction model have been used for forecasting the price of vegetables using discriminant score of variables undertaken with inputs and trends. Before developing the price model for the tomato on season basis through DFA the procedures like normality, outliers, multicollinearity, mutually exclusive of the groups have been checked. The normality of all the variables is tested before applying the discriminant function through different procedures like test and Z score. The Box's M test has been used to test the homogeneity of variances. Outliers are detected through Box Whisker Plot. The multicollinearity is tested through Eigen Values, Variance Inflation factor and Condition number. The mutually exclusive groups formed through DFA is tested through Box's M Test. The other statistical techniques which had been used for validation of DFA are Canonical correlation and Wilk's lambda.

RESULTS AND DISCUSSION

Behavior of the economic variables like price, arrival and production taken for study purpose has been assessed through graphs which helped in finding out relationships among variables. Figure 1(a) shows that prices in summer season were more in comparison to winter season. The average rate of tomato was Rs 1784.00 per quintal in summer season whereas in winter season Rs 1558.00 per quintal. Further, arrivals in summer season were more when compared to winter season for tomato crop. The production remains constant in both the seasons i.e. 3826.72 MT.

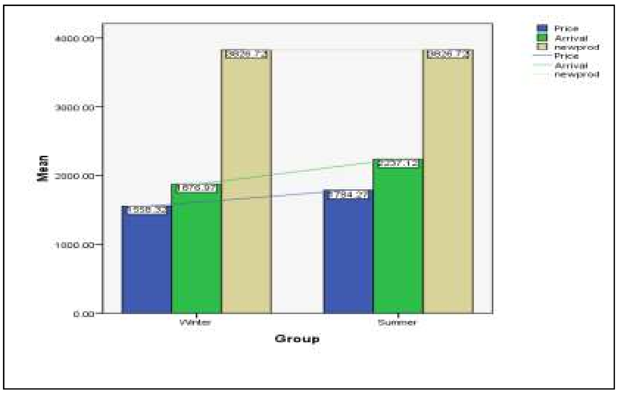

Figure 1(a): Comparison among price, arrival and production of tomato crop according to winter and summer seasons

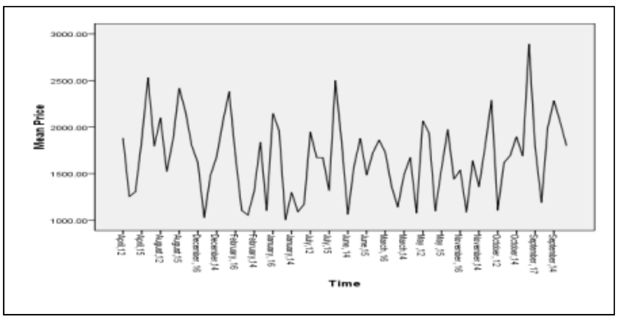

Figure 1(b): Comparison of mean price of tomato with respect to time

It was observed from Figure 1(b) that mean price of the tomato crop fluctuates with respect to the time period taken at some point of time, prices goes very high and sometimes goes very low. On the whole, the figure depicts that the price values fluctuates randomly with respect to time. Maximum mean price were seen somewhere during September where prices of tomato gradually increases and comes in ranges Rs 2500.00 to Rs 3000.00 per quintal and minimum mean price were seen somewhere during January where price of tomato gradually decreases and comes in ranges Rs 1000.00 to Rs 1500.00 per quintal of the study period 2020.Further, the data of tomato crop have been divided into two groups summer and winter group. Figure 1(c) shows the comparison of mean price of the tomato crop according to summer and winter groups which clearly indicates that there is significant change in mean price of tomato crop among the two groups. During winter, mean price of tomato gradually increases whereas it remains constant in summer season and does not fluctuate that much when compared to winter season. The descriptive statistics of the economic variables were presented in Table 1.

The Table 1 revealed that the mean and standard deviation of price, arrival and turnover of the tomato crop according to the groups clearly indicate a comparison between these three variables with respect to summer and winter seasons. Total of 72 observations recorded each for price, arrival and turnover for tomato crop in J&K has been discriminated in two groups for winter season and group 2 for summer season. On comparison, it has been observed that turnover has more variability in summer season (CV= 152.56

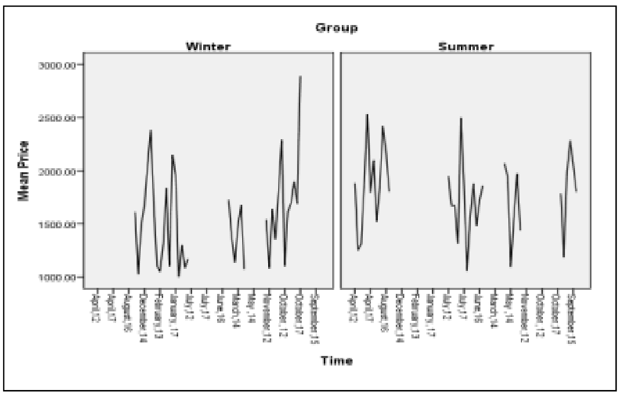

Figure 1(c): Comparison of mean price of tomato with respect to time according to winter group and summer group

Table 1: Season wise Group statistics of price, arrival and turnover of tomato crop

Group (Season)	Economic Variable	Mean	Std. Deviation	CV (%)
Winter	Price (in Rs/q)	1558.00	441.10	28.30
	Arrival (in q)	1877.00	678.40	36.14
	Turnover (Rs in lakhs)	356.50	145.40	40.79
Summer	Price (in Rs/q)	1784.00	369.00	20.68
	Arrival (in q)	2237.00	840.80	37.58
	Turnover (Rs in lakhs)	825.90	1260.00	152.56
Overall	Price (in Rs/q)	1671.00	419.50	25.10
	Arrival (in q)	2057.00	779.88	37.91
	Turnover (Rs in lakhs)	591.20	921.60	155.89

Table 2: Normality test for price, arrival and turnover of tomato crop w.r.t. seasons

Variable	Season	Kolmogorov-Smirnov Test			Shapiro-Wilk Test		
		Statistic	df	Sig.	Statistic	df	Sig.
Price (in Rs./q)	Winter	0.11	36	0.20^{ns}	0.92	36	0.01*
	Summer	0.11	36	0.20^{ns}	0.98	36	0.60^{ns}
Arrivals (in q)	Winter	0.15	36	0.03*	0.91	36	0.00**
	Summer	0.12	36	0.20^{ns}	0.92	36	0.01*
Turnover (Rs in lakhs)	Winter	0.10	36	0.20^{ns}	0.98	36	0.70^{ns}
	Summer	0.41	36	0.00**	0.56	36	0.00**

*=significant at 5% l.o.s; **=significant at 1% l.o.s.; ns= non significant

percent) as compared to winter season (CV=40.79 percent) whereas the price(s) have minimum variability as compared to other(s) i.e. arrival and turnover. The prices of tomato were consistent in summer season compared to winter. The average price of tomato was Rs 1558.00 per quintal in winter whereas for summer it was Rs1784.00 per quintal. Further the arrival and turnover of tomato crop were more in summer as compared to winter. The arrival and turnover for winter and summer were 1877 q, Rs 356.50 lakhs and 2237 q, Rs 825.90 lakhs, respectively. It was observed that the overall average price of tomato in J&K was Rs. 1671.00 per quintals. Maximum variability has been observed in case of turnover (CV=155.89 percent) whereas minimum variability (CV = 25.10 percent) was found in case of price of tomato crop in UT of J&K.

As per Table 2 it has been observed that the Kolmogorov-Smirnov test for economic variables price in case of winter and summer seasons were found to be non significant and hence follows normality. The arrival of the tomato crop for winter season was found to be significant and hence does not follows normality whereas found non-significant for summer and hence follows normality. Further, turnover in case of winter season was found non-significant and follows normality whereas in summer season, it was found significant and hence does not follow normality. On the other hand as per Shapiro-Wilk's test, price in case of winter season was found significant and hence does not follow normality inverse to Kolmogorov-Smirnov test. Also, arrival for summer season was found to be significant and hence does not follow normality whereas as per Kolmogorov-Smirnov test follows normality. The behavior of variability for turnover remains same through both the tests. One thing which has been observed from this table was that there were some economic variable which follows normality through one test but when checked through another test, they do not follow normality. So, we have also used Z scores.

Z score was applied to check normality of data by using skewness and kurtosis. If the value of Z score lies between +1.96 and -1.96, the data of variable tends

Table 3: Testing the Normality for price, arrival and turnover data through Z score of tomato crop

Variable	Season	Measure	Statistic	Standard error	Z Range
Price (in Rs/q)	Winter	Skewness	0.91	0.39	2.33
		Kurtosis	0.96	0.77	1.24
	Summer	Skewness	-0.03	0.39	-0.07
		Kurtosis	-0.21	0.77	0.27
Arrivals (in q)	Winter	Skewness	1.02	0.39	2.61
		Kurtosis	0.65	0.77	0.84
	Summer	Skewness	0.73	0.39	1.87
		Kurtosis	-0.37	0.77	-0.48
Turnover (Rs in lakhs)	Winter	Skewness	0.36	0.39	0.92
		Kurtosis	0.83	0.77	1.07
	Summer	Skewness	2.06	0.39	5.28
		Kurtosis	2.67	0.77	3.46

normality. It was clear that almost all the variables fall in between the range of +1.96 and -1.96 as observed from Table 3 and the Z range for skewness of price in winter season, skewness of arrivals in winter season, skewness and kurtsis of turnover in summer season does not fall in between that range and these variables did not follow normality whereas rest of the variables were obeying the normality condition. Thus, it was observed that maximum data of tomato w.r.t economic variables tends to normality. By observing the seriousness (sanctity) of real data the discriminant analysis was done. To observe the actual classification of groups i.e. summer and winter w.r.t. economic variables, the discriminant function was applied for predicting the groups w.r.t. economic variable(s).

Box Whisker plot also tells about the outliers which were present in the economic variables. Clearly seen from the Figure 2(c) that value of turnover was very compressed as compare to price and arrival so from here it was concluded that there were large number of outliers present in real data of turnover as compared to price and arrival see Figure 2(a) and Figure 2(b).

The Table 4 revealed that the Wilk's lambda statistics was significant for price, arrival and turnover variable which was 0.93**, 0.95* and 0.93**, respectively. Therefore, we can say that the means of the two groups

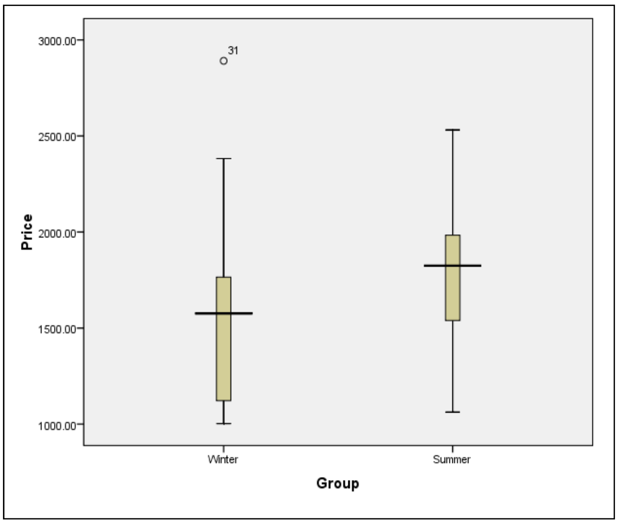

Figure 2(a): Box and whisker plot testing for price of tomato crop

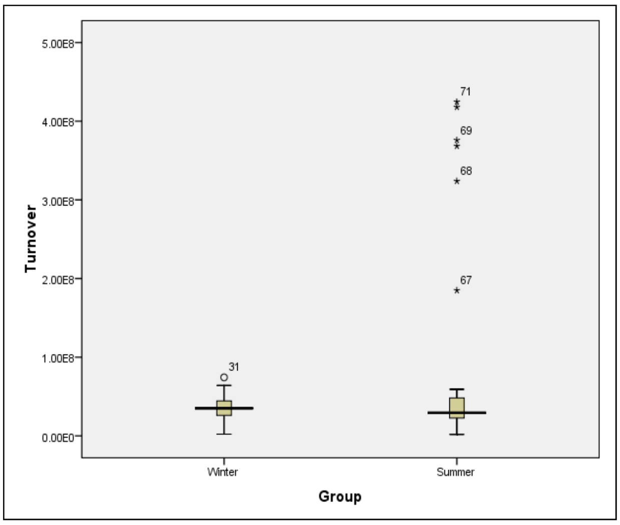

Figure 2(c): Box and whisker plot testing for turnover of tomato crop

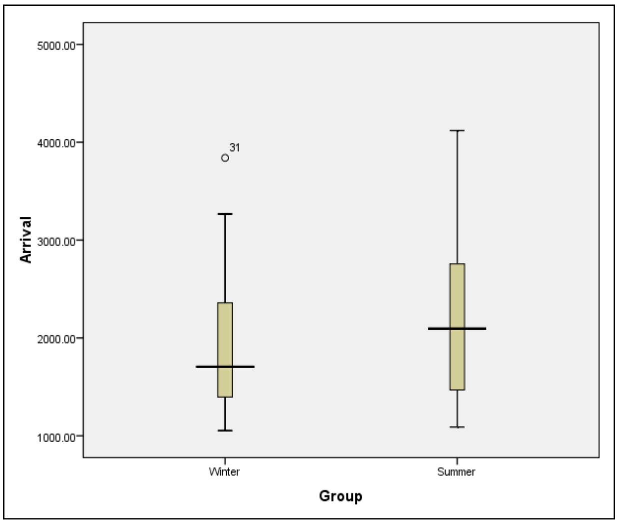

Figure 2(b): Box and whisker plot testing for arrival of tomato crop

formed on the basis of price or arrival or turnover of tomato crop have their means significantly different from each other. Further, it was a strong statistical evidence of significant difference between mean of summer and winter prices for all independent variable price, turnover and arrival. Further, it was observed that all the variables taken under study i.e. price, arrival and turnover were significant and F- value (5.56) for price was more as compared to others. The log determinant value of the winter and summer were 75.89 and 62.35, respectively. The pooled within group were large and approximately equal which indicates that there was more difference in the group covariance matrix. Box's M statistics (116.86) values was found to be highly significant which indicates that population covariances matrices were not equal which may be due to presence of some influential observation.

Table 4: Test of equality of group means with respect to seasons for price, arrival and turnover of tomato crop.

Variable	Wilk's Lambda	F (p-value)	Box's M Statistics (p value)
Price (in Rs/q)	0.93**	5.56(0.02)	116.86
Arrival (in q)	0.95*	4.00(0.05)	(< 0.01)
Turnover (Rsin lakhs)	0.93**	4.93(0.03)	

*=significant at 5% l.o.s; ** = significant at 1% l.o.s.

Table 5 displayed that the eigen values of the matrix product of the inverse of the within-group sums-of-squares and cross-product matrix and the between-groups sums-of-squares and cross-product matrix which describe the discriminating ability a function possesses. Here the function accounts for 100 percent of the discriminating ability of the discriminating variables. Since the dependent variable has two categories, therefore, it has only one degree of freedom. Further, canonical correlation was 0.42 which indicated that there was moderate degree of association between discriminant scores and the levels of dependent variables. Wilk lambda was found to be highly significant and reveals that the given function has statistically significant discriminating power in the variables included in the model. In the present case, the value was 0.82 which was highly significant and indicated that the group means appear to differ. The Chi-square value was 13.25 indicates the groups are independent.

Standardized canonical discrimination function coefficients in the Table 6 serves the beta weight in multiple regression (Partial coefficients), they indicated

Table 5: Eigen values and Wilk's lambda of the discriminant function of tomato crop

Function	Eigen value	% of Variance	Canonical Correlation	Chi Square	Wilk's Lambda
1	0.21	100.0	0.42	13.25*	0.82**

** = significant at 1% l.o.s.

Table 6: Standardized Canonical Discriminant Function Coefficients and structure matrix of the given discriminant function of the function 1 for tomato crop

Variable	Standardized Canonical Discriminant Function Coefficients	Structure Matrix	Fisher's linear discriminant function coefficients	
			Winter (1)	Summer (2)
Price (in Rs/q)	0.75	0.61	0.0120	0.0130
Arrival (in q)	0.61	0.57	0.0050	0.0060
Turnover (Rs in lakhs)	0.40	0.52	-0.0008	-0.0004

the relative importance of the independent variable in predicting the dependent. They allowed the researcher to compare variable measured in different scale. Coefficient with large absolute value corresponding to variable with greater discriminating ability. If the value of loading of independent variable in the structure matrix was less than 0.30 may be removed. In our case all the values were more than 0.30 so all the variables have been considered for study. Table 6 shows the discriminant function coefficients used for calculating the discriminant score for each case in particular. The discriminant function was $Z = 0.75Z_1 + 0.61Z_2 + 0.40Z_3$ where variables Z_1, Z_2 and Z_3 were standardized price, arrival and turnover variables, respectively. The size of the coefficients indicated the discriminant power of the predictor variables. Thus, it can be seen that the variables arrival (X_2), turnover (X_3) and price (X_1) discriminate best among the two groups. The structure matrix column in the table shows the correlations of each variable with each discriminant function. The correlation between price and the discriminant function was found to be moderate high (0.61) and positive whereas the association between arrival and discriminant function was positive and moderate (0.57). Further, it was observed that the relation between discriminant function positive but relatively moderate (0.52) as compared to others. It was clearly indicated that weight variable as per Fisher's discriminant linear function of Group 2 i.e. summer season were more when compared with weight variable of group 1 i.e. winter.

Table 8: Classification results of the group(s) w.r.t. economic variable of tomato crop

	Group	Predicted Group Membership		Total
		1	2	
Count (%)	1	30(83.3)	6(16.7)	36(100)
	2	12(33.3)	24(66.7)	36(100)

Table 7: Case wise statistics of tomato crop on the basis of discriminant analysis.

Case No.	Actual Group	Highest Group					Second Highest Group			Discrimin. Scores
		P (D>d | G = g)				Squared	Group	P(G=g |	Squared	Func-
Original		Predicted group	P	df	P (G=g | D=d)	Mahalanobis to centroid		D=d)	Mahalanobis to centroid	tion 1
17	1	2**	.925	1	.581	.009	1	.419	.667	.361
18	1	2**	.893	1	.573	.018	1	.427	.604	.321
21	1	2**	.782	1	.541	.077	1	.459	.402	.178
31	1	2**	.001	1	.967	10.67	1	.033	17.453	3.722
32	1	2**	.829	1	.648	.046	1	.352	1.269	.671
33	1	2**	.608	1	.707	.263	1	.293	2.028	.968
39	2	1**	.681	1	.688	.169	2	.312	1.747	-.866
42	2	1**	.820	1	.651	.052	2	.349	1.295	-.683
43	2	1**	.797	1	.657	.066	2	.343	1.364	-.712
47	2	1**	.903	1	.575	.015	2	.425	.623	-.334
48	2	1**	.652	1	.501	.204	2	.499	.211	-.004
49	2	1**	.340	1	.783	.911	2	.217	3.481	-1.410
50	2	1**	.732	1	.674	.118	2	.326	1.573	-.799
52	2	1**	.787	1	.659	.073	2	.341	1.395	-.726
57	2	1**	.976	1	.609	.001	2	.391	.886	-.486
62	2	1**	.764	1	.535	.090	2	.465	.373	-.155
63	2	1**	.911	1	.578	.012	2	.422	.639	-.344
66	2	1**	.926	1	.582	.009	2	.418	.670	-.363

From the Table 7, it has been observed that there were many observations which were actually of group 1 but were in group 2 and vice versa. There were 12 observations which were actually of Group 1 but were in group 2. These observations were 39, 42, 43, 47, 48, 49, 50, 52, 57, 62, 63 and 66. There were 6 observations which were actually of group 2 but were in group 1. The observation numbers were 17, 18, 21, 31, 32 and 33.

It has been observed that from the Table 8 out of 36 observations in group one, 30 i.e. 83.3 percent observations were correctly classified and 6 i.e. 16.7 percent observations were misclassified. Whereas, in case of group 2, 12 i.e. 33.3 percent observations were correctly misclassified and 24 i.e. 66.7 percent observations were correctly classified. Since from the Figure 3 and 4, it can be seen that the bar graph of group 1 (winter) and group 2(summer) do not overlap which indicated two groups were well discriminating from each other and was the requirement. The correlation between all the economic variables taken under study has been reflected in this table to understand the relationship between variables. It can be depicted from the Table 9, that the correlation between price and arrival of tomato crop was significant and negative (r =-0.41*) whereas the correlation between arrival and area under tomato crop for summer group was positive and significant (r = 0.33*). Further, the relation of turnover of tomato crop with production (r = 0.67*) and yield (r =0.74*) of tomato crop was found to be positive and highly significant. Also, positive, high and significant correlations were observed between yield and production of tomato crop for summer group.

CONCLUSION

The Wilk's lambda and F value of for the seasons wrt tomato crop were significant which indicated that the average value of the price, arrival and turnover w.r.t. the winter (1) and summer (2) groups are varying. As per the discriminant fisher functions the 12 entries of second group lies in the first group whereas the 06 entries of first group lies in the second group according

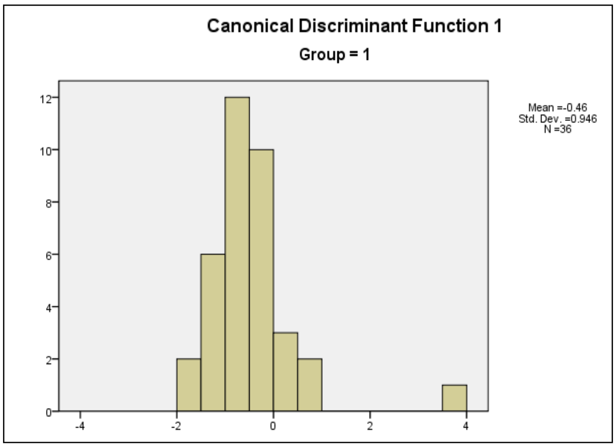

Figure 3: Separate group plot (group 1) using discriminant analysis of tomato crop.

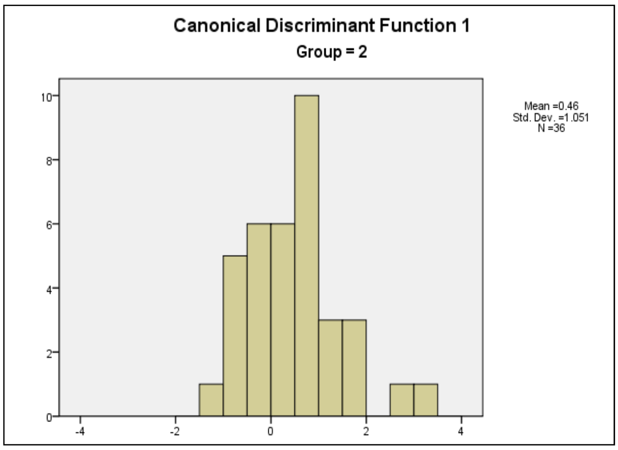

Figure 4: Separate group plot (group 2) using discriminant analysis of tomato crop

Table 9: Correlation between price, arrival, turnover, area, production and yield of tomato crop for summer group

Variable(s)	Price (Rs/q)	Arrival (in q)	Turnover (Rs in lakhs)	Area (in ha)	Production (MT)	Yield (MT/ha)
Price (Rs/q)	1.00					
Arrival (q)	-0.41*	1.00				
Turnover (Rs in lakhs)	-0.23	0.22	1.00			
Area (ha)	-0.09	0.33*	-0.05	1.00		
Production (MT)	0.09	0.23	0.67**	0.40*	1.00	
Yield (MT/ha)	0.13	0.13	0.74**	0.07	0.94**	1.00

*=significant at 5% l.o.s; **=significant at 1% l.o.s

to discriminant score and Mahalanobis distance in order to develop the models for the seasons. The proposed price model(s) for summer and winter are significant. TheVariables which generally affect the price of the crop are arrival, yield and turnover which show both direct and indirect effect on the price of vegetable crop.

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Trends and Growth Pattern of Major Pulses Crops in India

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ABSTRACT

India is the world's largest producer and consumer of a wide range of various pulses, predominately tropical and sub-tropical crops such as chickpea, black gram and green gram (mungbean) and others, which are high in protein, fibre, and vitamins, as well as high-quality carbohydrates, minerals, and vitamins. The study is attempted to examine trends and growth pattern of major pulses crops in India based on secondary data collected from various published sources for the period 1980-2020. The major pulses crops: Green gram, Black gram and Chickpea have been taken under consideration and data on area, production and yield of selected crops have been utilized at India level. Standard deviation (SD) and Coefficient of Variation (CV) were used to measure the variability in the collated data. The compound annual growth rates (CAGR) for area, production and yield were estimated and found to have best fitting with the data. The linear model was fitted to estimate the trends of area, production and yield of crop. The study revealed that highest average area in India was under chickpea followed by black gram and green gram and that production and yield follow the same pattern. In terms of area and production, black gram showed largest fluctuations, followed by chickpea and green gram. The most stable yield was found in chickpea among all selected crops.

Keywords: Black gram, Chickpea, Green gram, Growth, Pluses and Trends

INTRODUCTION

India is the world's largest producer and consumer of a wide range of pulses, dominated by tropical and sub-tropical crops like chickpea, black gram and green gram (mungbean) and others, which are high in protein, fibre, and vitamins, as well as high-quality carbohydrates, minerals, and vitamins. Pulses have a high value for maintaining optimal blood sugar levels and restoring energy over a lengthy period of time after meals since their carbohydrates are released slowly compared to cereals. Pulses are one of the most water-efficient crops, requiring only 359 litres of water to produce one kilogramme of pulses (Choudhary and Suri, 2014). In India, production of pulses is around 25.57 million (India stat, 2021). Legumes have long been considered the only source of protein for the poor in India. Legumes are important in agriculture and society for a variety of reasons including their nutritional value, vegetarian diet, ability to improve soil fertility, minimal resource and water requirements, etc. The growing demand for food from the population cannot be overlooked. Grains and legumes have long been an important part of their diet. Grain production in India has gained the momentum it needs to feed the growing population, but it is not the same in the case of legume production, the importance of which is to provide nutritionally balanced meals to meet the growing needs of the rapid attention.

Greengram (*Vigna radiata* L.) is one of the most important legumes grown worldwide. It is known for its high nutritional content (24.0% protein, 1.3% fat, 56.6% carbohydrate, 3.5% minerals, 0.43% lysine, 0.10% methionine, and 0.04% tryptophan). It was a primary source of plant-based protein in the diet. It is grown in all tropical and subtropical regions of the world. Greengram has been cultivated in India since prehistoric times (Mohbe *et al.,* 2015). Among the Indian states, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar, Gujarat and Orissa are the main producers of Greengram. It is grown on around

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300 million hectares in India. It also helps maintain and improve soil fertility by allowing root nodules to fix atmospheric nitrogen in the soil. Rhizobium bacteria form nodules on Greengram roots, which fix around 35 kg of atmospheric nitrogen per hectare (Yadav, 1992).

Blackgram (*Vigna mungo* (L.) Hepper), additionally referred to as Urd bean is an erect, speedy developing annual, herbaceous legume crop belonging to the own circle of relatives Leguminaceae and the genus Vigna. It is a self-pollinating crop having a well-advanced faucet root gadget and its stems are diffusely branched from the base. It is broadly cultivated in Indian subcontinent and different Asian and South Pacific countries. India is the biggest manufacturer and customer of black gram withinside the world (GOI, 2018). The annual manufacturing of black gram in India is 3060 thousand tonnes from 5602 thousand hectares with a mean productiveness of 546 kg/ha (GOI, 2018). Black gram seeds made out of protein (25-26%), carbohydrates (60%), fat (1.5%), minerals (3.2%) and moisture (10-11%). It is likewise a wealthy supply of calcium (154 mg/100g), phosphorus (385 mg/100g) and iron (9.1 mg/100g). The calorific cost of black gram is 347 kcal/100m (Mishra and Lavanya, 2021).

Chickpea is a treasured plant, supplying nutritious meals for the developing international population, and turns into an increasing number of vital with weather exalternate because of its herbal drought and warmth tolerance ability. At the equal time, it's miles the maximum vital meals legume cultivated amongst cool season meals legumes withinside the arid and semi-arid areas of the arena beneathneath rainfed conditions. Globally, it changed into cultivated on 13.7 Mha with an annual manufacturing of 14.2 million tons"1, and had a change extent of $ 2.7 billion in 2019.

(FAOSTAT, 2021). Cultivated chickpeas are divided into two main types as "desi" and "kabuli" (Maessen and Cicer, 1972). The "desi" sorts have pigmented vegetative elements and purple flora, and the seeds are usually small and coloured (on the whole dark) with a thick seed coat. The "desi" chickpeas occupy approximately 80–85% of the chickpea cultivation regions withinside the international and are specifically grown in South Asia, East Africa and Australia (Gaur *et al.,* 2015). The "kabuli" sorts have non-pigmented vegetative elements, white flora and comparatively large, cream-coloured seeds with a skinny seed coat and are on the whole cultivated withinside the Mediterranean Basin, the Near East and East Asia (Toker, 2021).

MATERIALS AND METHODS

The study is based on secondary data collected from various published sources for the period 1980-2020. The major pulses crops: Green gram, Black gram and Chickpea have been taken under consideration and data on area, production and yield of selected crops have been utilized at India level. To measure the variability in the collated data, Standard deviation (SD) and Coefficient of Variation (CV) have been used. Coefficient of variation is the statistical measure of the dispersion of data points in a series around the mean. It is a useful statistic for comparing the degree of variation form one data series to another, even if the means are drastically different form each other and is given by:

$CV = \sigma / X \times 100$

where, σ = S tan dard Deviation, X = Mean

The compound annual growth rates (CAGR) for area, production and yield were estimated using the following model: $Y = ab^t$

where, Y = harvest area / production/ yield of selected crops

a = constant, b = (1+r), r=compound growth rate, t= time in years

Line graphs were also used to show the trends in selected crops area, production and yield over the years.

RESULTS AND DISCUSSION

It was revealed from the Table 1 that average area, production and yield of last 40 years under green gram

Table 1: Mean, SD, CV and CAGR for Area, Production and Yield of Green gram (1980-2020)

Green gram	Area	Production	Yield
Mean	3254.20	1332.89	403.70
SD	486.16	402.27	68.85
CV	14.94	30.18	17.06
CAGR	0.74	1.18	0.44

Table 2: Mean, SD, CV and CAGR for Area, Production and Yield of Black gram (1980-2020)

Black gram	Area	Production	Yield
Mean	3291.01	1561.75	466.67
SD	621.04	523.79	74.90
CV	18.87	33.54	16.05
CAGR	0.78	1.78	0.99

Table 3: Mean, SD, CV and CAGR for Area, Production and Yield of Chickpea (1980-2020)

Chickpea	Area	Production	Yield
Mean	7511.61	6204.78	810.33
SD	1245.41	1962.30	127.99
CV	16.58	31.63	15.80
CAGR	0.87	2.08	1.20

was 3254.20 ('000 ha), 1332.89 ('000 tonnes) and 403.70 (kg/ha), respectively. Highest variability was observed in production (30.18%) followed by yield (17.06) and area (14.94%). Growth rates were found very low in area (0.74%), production (1.18%) and yield (0.44%) during the study period.

It was observed from Table 2 that average area, production and yield of last 40 years under Black gram was 3291.01 ('000 ha), 1561.75 ('000 tonnes) and 466.67 (kg/ha), respectively. Highest variability was observed in production (33.54%) followed by area (18.87%) and yield (16.05%). Growth rates were found very low in area (0.78%), production (1.78%) and yield (0.99%) during the study period.

Table 3 shows that average area, production and yield of last 40 years under Chickpea was 7511.61 ('000 ha), 6204.78 ('000 tonnes) and 810.33 (kg/ha), respectively. Highest variability was observed in production (31.63%) followed by area (16.58%) and yield (15.80%). Growth rates were found very low in area (0.87%), production (2.08%) and yield (1.20%) during the study period.

CONCLUSION

Pulses are essential source of nutrients however additionally boom the soil fertility. Since majority of the consumers in India have low incomes, their dependence on pulses as a key source of protein is high. The present study has discussed trends and growth pattern of major pulses crops. It was revealed from the study that highest average area in India was under Chickpea followed by Blackgram and Green gram, following the same pattern for production and yield also. In case of area and production, fluctuations have been maximum in Black gram followed by Chickpea and Green gram. Most stable yield was found in Chickpea among all selected crops. As yield and area growths were highest in chickpea so the production and the same pattern were followed by Black gram and Green gram.

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Management of Gram Pod Borer *Helicoverpa Armigera* (Hubner) in Chickpea with New Insecticide

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ABSTRACT

Gram Pod Borer is a very destructive and serious pest of Gram and causes serious damage to gram. They feed on leaves and tender shoots and bore into the pod to feed on seeds, sometimes half of the body remains outside the pod if the pod is small. One larva may feed on several fruits before completing development. In severe infestation cases, it causes about 50-90 per cent losses in seed yield. Gram is the important pulse crop grown in Rabi season by the farmers of District Samba. Every year infestation due to Pod borer in gram causes huge economic loss results in low yield. Therefore, KVK-Samba had conducted On Farm Trials during *rabi* 2019-20 and *rabi* 2020-21 at farmer's field to assess the efficacy of insecticides for the management of Gram Pod Borer (*Helicoverpa armigera)* in Gram. On the basis of three treatments assessed i.e. (a) Chloropyriphos 20 EC @ 2 ml per litre (Farmer's practice) (b) Cypermethrin 25EC @1.5ml./lt. of water (recommended) (c) Chlorantraniliprole 18.5 SC @ 0.5ml./lt. of water (Intervention). The results of OFT during 2019-20 revealed that use of Chlorantraniliprole 18.5 SC @ 0.5ml. /lt. of water was observed to be superior resulting in 81.63 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 81.25 per cent over Chloropyriphos 20 EC @ 2 ml per litre followed by Cypermethrin 25EC @ 1.5ml./lt. of water resulting in 61.22 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 50 per cent over Chloropyriphos 20 EC @ 2 ml per litre and the results of OFT during 2020-21 revealed that use of Chlorantraniliprole 18.5 SC@ 0.5ml. /lt. of water was observed to be superior resulting in 82.97 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 74.11 per cent over Chloropyriphos 20 EC @ 2 ml per litre followed by Cypermethrin 25EC @1.5ml./lt. of water resulting in 61.70 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 47.05 per cent over Chloropyriphos 20 EC @ 2 ml per litre. In terms of cost benefits Chlorantraniliprole 18.5 SC was the best among all treatments. Therefore, the use of Chlorantraniliprole 18.5 SC @ 0.5ml./lt. of water can be recommended for control of pod borer under rainfed conditions of district Samba.

Keywords: Gram pod borer, On farm trial*, Helicoverpa armigera,* Chlorantraniliprole, Cypermethrin, Chloropyriphos

INTRODUCTION

Pulses are an important group among the food crops which occupy a unique position in agriculture by virtue of their high protein content. Chickpea (*Cicer arietinum* L.), commonly known as Bengal gram, gram or chana, originated from South Western Asia, is an important *rabi* pulse crop of India, which has been considered as king of Pulses (Bhatt and Patel, 2001). Chickpea was cultivated in an area of 135.4 lakh hectares with a production of 131.02 lakh tones and a productivity of 968 kg/ha in the world (Tiwari and Shivhare, 2016). Chickpea was cultivated in an area of 73.7 lakh hectares with a production of 58.9 lakh tones and a productivity of 799.19 kg/ha in India. In north India, states like Uttar Pradesh, chickpea is cultivated in an area of 5.05 lakh hectares with a production of 3.78 lakh tones with a productivity of 7481.51 kg/ha (Anonymous, 2015). Among biotic factors chickpea is infested by nearly 60

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insects' species in which cutworm, *Agrotis ipsilon* (Ratt.), gram pod borer, *Helicoverpa armigera* (Hub.), semilooper, *Autographa nigrisigna* (Walk.), and aphid, Aphis craccivora (Koch.) are the pests of major importance (Acharjee and Sharma, 2013). Among these, the major damage is caused by gram pod borer which is polyphagous in nature; *Helicoverpa armigera* is one of the serious pests of chickpea, which feeds more than 150 crops throughout the world (Vinutha *et al.,* 2013). Gram pod borer is widely distributed and a serious pest of chickpea causing heavy crop losses (20-60%) throughout the India (Anonymous, 2013). *Helicoverpa armigera* is the major and most devastating pest of chickpea which can cause crop loss up to 80% under congenial weather conditions. In terms of monetary value, the estimated annual loss due to this pest in chickpea is Rs. 2030 million in India (Anonymous, 2013a). It is estimated that *Helicoverpa armigera* alone is responsible for losses over Rs. 3500 million annually in India, despite heavy application of pesticides inputs (Kumar and Kapur, 2003). *Helicoverpa armigera* alone accounts for the consumption of half of the total pesticides used in India for the protection of different crops (Suryavanshi *et al.,* 2008).

MATERIALS AND METHODS

The experiment was conducted at farmer's field during *rabi* 2019-20 and *rabi* 2020-21 with an objective to assess the efficacy of different insecticides for the management of Gram Pod Borer (*Helicoverpa armigera)* in Gram. During 2019-20 and 2020-21, five farmers were selected and a trial of Chickpea was sown in four Kanals of each of farmer's field as described in Table 1. The recommended agronomical practices were followed to raise the good crop. The detail of treatment for management of *Helicoverpa armigera*, are as follows: Table 2. Three treatments were (a) Chloropyriphos 20EC @ 2 ml per litre (Farmer's practice) (b) Cypermethrin 25EC @ 1.5ml./lt. of water (recommended) (c) Chlorantraniliprole 18.5 SC @ 0.5ml. /lt. of water (new Intervention). The incidence of *H. armigera* was recorded on regular basis to apply different treatments at appropriate time. The treatments were applied, as and when larval population was reached Economic Threshold Level *i.e.* 01 larvae m^{-1} linear row length. The required amounts of insecticides were calculated by using the formula as given below:

$$\text{Required amount of insecticides} = \frac{\text{Vol. of water (lit/ha) x Desired cons. (\%)}}{\text{Strength of insecticides formulation}}$$

Insecticides were sprayed with the help of hand Sprayer. The care was taken to avoid drift of spray from one plot to another plot. The pre and post treatment observations on larval population of *H. armigera* were taken in each treatment at five places. The percentage reduction of larval population was determined for each treatments using following formula.

$$\text{Percent reduction in population} = \frac{\text{Control – treatment}}{\text{Control}} \text{ X 100}$$

Seed yield of chickpea was recorded on the basis of individual plot and expressed in kg per plot and converted in to kg/ha. The increase in seed yield of chickpea over control was calculated for each treatment separately by using the following method given by Pradhan, (1964).

$$\text{Increase in Yield (\%)} = \frac{\text{Yield in treatment - Yield in control}}{\text{Yield in control}} \text{ X 100}$$

The benefit: cost ratio was determined for each treatment by using the following formula:

$$\text{Benefit: Cost ratio} = \frac{\text{Monetary gain over control (Rs/ha)}}{\text{Cost of plant protection (Rs/ha)}}$$

RESULTS AND DISCUSSION

Field trial was conducted during *rabi* 2019-20 and *rabi* 2020-21 to evaluate the efficacy of insecticides against

Table 1: Details of On Farm Trial in farmers field

Crop	Title of OFT	Area (ha)	No. of farmers
Gram	Management of pod borer in Gram	2.0	5

Table 2: Details of technologies selected for assessment/ refinement

Treatments	Technology Assessed
Treatment 1	Chloropyriphos 20 EC @ 2 ml per litre (Farmer's practice)
Treatment 2	Cypermethrin 25 EC@ 1.5ml. /lt. of water (recommended Practice)
Treatment 3	Chlorantraniliprole 18.5 SC@ 0.5ml. /lt. of water (New Intervention)

Table 3: Evaluation of new insecticide for the management for pod borer in gram in 2019-20

Technology Assessed	Yield (q/ha)	Damage (%)	B:C ratio
Chloropyriphos 20 EC @ 2 ml per litre (Farmer's practice)	8.0	24.50	3.48
Cypermethrin 25 EC @ 1.5ml. /lt. of water (recommended)	12.0	9.50	5.72
Chlorantraniliprole 18.5 SC @ 0.5ml. /lt. of water (New Intervention)	14.50	4.50	7.12

Table 4: Evaluation of new insecticide for the management for pod borer in gram in 2020-21

Technology Assessed	Yield (q/ha)	Damage (%)	B:C ratio
Chloropyriphos 20 EC @ 2 ml per litre (Farmer's practice)	8.50	23.50	3.76
Cypermethrin 25 EC @ 1.5ml. /lt. of water (recommended)	12.50	9.0	6.0
Chlorantraniliprole 18.5 SC @ 0.5ml. /lt. of water (New Intervention)	14.80	4.0	7.28

gram pod borer. In order to ascertain the time of application of treatments, population of gram pod borer, *H. armigera* was recorded at weekly interval and treatments were applied as and when mean larval population of *H. armigera* reached ETL *i.e.* 1 larvae m^{-1} row length during both the years. The trend of effectiveness of different insecticides has been presented below:

Efficacy of treatment (2019-20): The data presented in Table 3 reveals that both insecticides lowered down and reduced percentage of the population of gram pod borer in comparison to control. The results of OFT during 2019-20 revealed that use of Chlorantraniliprole 18.5 SC @ 0.5ml. /lt. of water was observed to be significantly superior resulting in 81.63 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 81.25 per cent over Chloropyriphos 20 EC @ 2 ml per litre followed by Cypermethrin 25EC @1.5ml./lt. of water resulting in 61.22 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 50 per cent over Chloropyriphos 20 EC @ 2 ml per litre.

Efficacy of treatment (2020-21): The data presented in Table 4 reveals that all insecticides lowered down and reduced percentage of the population of gram pod borer in comparison to control. The results of OFT during 2018-19 revealed that use of Chlorantraniliprole 18.5 SC @ 0.5ml. /lt. of water was observed to be superior resulting in 82.97 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 74.11 per cent over Chloropyriphos 20 EC @ 2 ml per litre followed by Cypermethrin 25EC @ 1.5ml./lt. of water resulting in 61.70 per cent reduction in damage to pods of Gram and increased the grain yield to an extent of 47.05 per cent over Chloropyriphos 20 EC @ 2 ml per litre. In terms of cost benefits Chlorantraniliprole 18.5 SC was the best among all treatments in both the years. Farmers were satisfied and ready to adopt insecticide for control of pod borer of Gram. Therefore, the use of Chlorantraniliprole 18.5 SC @ 0.5. /lt. of water can be recommended for control of pod borer under rainfed conditions of Samba.

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Review on Use of Mobile Applications in Digital Agriculture

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ABSTRACT

Digital technology in the form of mobile phone applications possess tremendous potential to transform Indian agriculture. Government of India as well as various other organizations have launched a number of web and mobile based applications for dissemination of information on agriculture related activities. Agriculture benefits greatly from technological advancements. Major challenges confronting Indian agriculture include unsustainable use of resources, declining farm productivity and stagnating farm incomes. For this, smart farming technologies using mobile applications that help reduce costs, maximize yields and increase profits are being employed. Also, mobile technologies are often considered revolution inducer in smallholder agricultural systems. The challenge lies in the effectiveness of these technologies in addressing the field level issues and making these applications user friendly given that farmers are not always educated or technological savvy. Hence the focus needs to be on integrating several of these applications on user friendly platforms, designed with in-built data interpretation and predetermined actions to equip users with end-to-end solutions. This study will present an overview of several mobile apps (i.e., Plantix, Kisan Suvidha, Kheti Badi, etc) available for traceability in agriculture, discuss their features, and functions.

Keywords: Mobile applications, Digital Agriculture, Technology

INTRODUCTION

With the virtual world buzzing with heavy information load, it is often confusing for 21st century users to decide which information is needful for them. The information givers in order to attract audience, views and make profit margins dump irrelevant information. As a results, users often end up receiving wrong information or even misinterpreting or not comprehending the information. Agriculture sector has not remained untouched by this heavy inflow of information through ICT. The need for right information at right time and at right place is of prime importance in this sector for better and quick decision making by different stakeholders. The introduction of ICT in agriculture in form of mobile phones resulted in shrinking the information gap (Bardhan *et al.*, 2022).

Agriculture mobile applications potentially deliver timely information to different subscribers such as farmers, traders and producers. The information delivered includes weather, rainfall, crop information at large, while some applications also help update the market data of commodity prices and facilitate the local buying / selling via hand held devices (Shah *et al.*, 2014).

Mobile apps are helping to boost overall business performance and reducing negative environmental impacts of farming. The main advantages of mobile apps for farmers are that they give timely information in response to the farmer's specific needs. Farmers can interact and get guidance from agriculture experts across the country via apps (Balkrishna *et al.*, 2021).

The dynamic growth of mobile communications technology is creating opportunities for economic growth, social empowerment, and grassroots innovation in developing countries. One of the areas with the greatest potential impact is in the contribution that mobile applications can make to agricultural and rural development (ARD), by providing access to information, markets, and services to millions of rural inhabitants. For both agricultural supply and demand,

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mobile phones can reduce waste, make delivery more efficient, and forge closer links between farmers and consumers (Qiang *et al*., 2012).

MATERIALS AND METHODS

This paper focuses on understanding the use of mobile phones in digital agriculture and how it propels the development of Indian agriculture. There are multiple companies which have and are tying up with the Government of India with respect to how to build and enable the agriculture sector in this Digital Transformation with the help of mobile applications. There are many agriculture related apps available on google play store but only 23 of them is described in the study based on the number of downloads and ratings. The research is descriptive in nature. The study is conceptual and based on secondary data collected from websites, google play store, and previous studies. The scope of the study is restricted to agricultural sector only.

Plantix: PEAT-Berlin based start-up working on agricultural technology has come up with deep learning Application known as Plantix meant for finding nutrient deficiencies of soil where Algorithms are being used which will correlate particular foliage patterns with certain soil defects, plant pests and diseases. A system cable of detecting strength and weaknesses of soil with the help of ML has been brought up by Lead investor Illumina aiming at producing healthy crop and preventing defects in growth (Plantix, 2022).

Kisan Suvidha

a) Suvidha for Kisaan (Farmers):

- Live auction of any commodity of any Marketing Yard (APMC)
- Average, Minimum and Maximum Price of any commodity at any yard for Selected Date and Month

b) Suvidha for Brokers:

- Day wise bought commodity details
- Day wise sold commodity details
- Auto calculation of Bought and Sold Commodities

c) Suvidha for APMC (Marketing Yard):

- Auto send Email of daily Average, Minimum and Maximum grade wise price to Media.
- Easy Management of SES records
- Auto calculation for all kind of SES (from the yard and outside the yard as well)
- Village wise annual production details

Saillog Agrio: Saillog is an AI solution answer to help farmers in recognizing and treating crop diseases and pests. Agrio is an intuitive cell phone application included by Saillog and is liberated from cost. Clients of this app click the photo of toxic plants and transfer them through an advanced mobile phone. These images then broke down, and programmed recognition of diseases is completed (https://agrio.app/).

Kheti Badi: It is a farmer guide app, aims to promote and support 'organic farming' and provide important information/issues related to farmers.

This App has following features:

- Detailed information about Organic / Natural farming.
- Cultivation techniques of fruits and vegetables.
- Recipes of ZBNF (Zero Budget Natural Farming) by Dr. Subhash Palekar ji.
- Ask questions to experts.
- Government schemes for Organic / Natural farmers.
- List of all resources to do chemical free farming.
- Farmers can list & sell their Organic / Natural farm produce.

RiceXpert (ICAR-NRRI): This App provides information to farmers in real time on insect pests, nutrients, weeds, nematodes and disease-related problems, rice varieties for different ecologies, farm implements for different field and post harvest operations. It is a web-based application systems which facilitates flow of information from the farmer to the farm scientist and get their instant solution. Farmers can use this App as a diagnostic tool in their rice fields and make customize queries for quick solution of their problems by sending text, photo and recorded voice and solution received through SMS (ICAR-NRRI, 2022).

Rent a tractor app: It is a place where farmers can contact nearby tractor owners and book the tractors for service in their fields at a reasonable rate. Payment can be done through mobile money. The farmers can also take the help of booking agents to book the tractors. The booking agent gets commission from Rent-a-Tractor. This app helps tractor owners to optimize the use of their tractors and also helps farmers, who do not own tractors, to avail tractor services. It is a win for all stakeholders.

Krishidhan Agro: Krishidhan agro provides quality agro inputs to farmers door step. Krishidhan Agro is a one stop shop for all your agri-input needs. Krishidhan Agro aims at providing hassle free shopping experience to farmers with the widest range of brands and products on its portal. Through this app we aim to bring transparency in the market and serve our end consumers. Farmers can order us through our app and the product will be delivered to their destination. Krishidhan agro deals with 35+ brands. Prominent brands include BAYER, SYNGENTA, DOW DUPONT, FMC, UPL, NSC, PI INDUSTRIES, DHANUKA, ADAMA AND COROMANDEL.

Bharat agri: Smart Kisan App: BharatAgri has made a mark by helping more than 10 Lakh+ Indian farmers doing smart farming throughout India. BharatAgri is a Smart Kisan & Smart Farming App for Farmers using all-new Agri tech solutions (Kheti Badi) with the help of available technology like Smart Satellite Mapping, Weather Forecasting, Soil Testing, and Water Testing to increase farmers overall farm income.

Krishi Network Indian Agri App: This app is the expert of crops, farm and horticulture associated with famers. Their experts are farmers associated with Krishi App who have found a sustainable and profitable approach in farming and horticulture through training and their experience. One can find experts and get advice from them on your crop, seed, organic pesticide, farming and horticulture information. On this App, farmers also get a list of shopkeepers whom they can call. These shopkeepers sell everything needed by the farmer such as seeds, tractors, insecticides, fungicides, manures, fertilizers, harvesting, sorting, all equipment and machines related to irrigation. (https://play.google.com/store/apps/details?id=com.krishi.krishi&hl=en_IN&gl=US).

AgroStar: Kisan Agridoctor: AgroStar is India's foremost AgTech start-up working on the mission of #Helping FarmersWin by providing a complete range of Agri solutions at the fingertips of farmers. AgroStar's best agriculture application provides a combination of agronomy advice from Agri doctors/ experts coupled with agriculture information and Agri products that enable farmers to significantly improve their productivity and income. AgroStar currently operates in Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, and Uttar Pradesh and has over 5 Lakh farmers on its Kisan agriculture Helpline app. Farmers can avail Agri solutions for the entire crop life-cycle with a simple "missed call" or through its Android app.

AgriCentral: AgriCentral is a technology-based agriculture app to help Indian farmers make better decisions in their farming business to increase profitability. It harnesses state of the art technologies like Global positioning, satellite imagery, big data analytics, machine learning and image analytics to usher the farmers into the era of digital farming. Absolutely free of cost.

Krishe: Farming Kisan Krishi: Krish-e by Mahindra group is the best in-class agriculture app that provides valuable agriculture information and a personalized crop calendar for your farm. This farm app leverages the combination of technology and experience to provide crop information which improves the crop yield for each farmer. This app provides you with premium agriculture consulting services and useful agriculture information for various crops and boosts your crop yield. These Agri advisory services provide you a scientific and personalized crop calendar for every farm. The crop calendar offers personalized farming information for each farm based on your farm location, crop, season, farm size, planting material, sowing date and other parameters that are unique to the farm and crop. Along with valuable agriculture information, the crop calendar provides you the exact date for implementing each activity which is calculated scientifically based on our research and weather forecast for your farm. It also provides the correct dosage of the required fertilizer, chemicals, and input products to boost your crop yield.

CALL KISAN

This app give farmers and rural communities, the power to advertise and expand market for their products and services, tools to grow their business and share ideas to improve the quality of their livelihood. It is online network of Farmers and Agricultural professionals. Farmers can create posts to market their products and services across various categories like Agriculture, Fisheries, machinery, handlooms, handicrafts etc. One can find jobs and services required in rural India, follow other professionals to learn the latest trends, and build relationships to become successful.

FarmRise: This app is available across 11 states in 6 languages. It provides information on the package of practices based on crop cycle. This is the only agriculture app where farmers can listen to all crop practices in his preferred languages.

BigHaat Smart Farming App: BigHaat is the largest Agriculture Digital Platform for Farmers in India. Combining years of experience in agriculture with the power of data, science, and technology, BigHaat's Farmer Centric Platform is empowering the farmers to acquire the right knowledge about crops, get timely and vital advice, shop for a wide range of Agri products (seeds, pesticides, fertilizers, and instruments) and connect with strong farmer communities. BigHaat enables farmers to add crop details to the platform and gets access to seed to harvest personalized crop advisory, which helps farmers to reduce the cost of cultivation and increase yield, productivity, and crop quality.

Gramophone: Gramophone app has emerged as the most trusted agriculture app for Indian farmers in last 5 years. It's full-stack technology platform which is completely made in India and on this Farm app, Kisaan get solutions to their every agricultural query or problem immediately. Gramophone Krishi Mitra App proves to be very useful for farmers in every step such as field preparation, sowing, complete crop cycle management, post-harvest crop storage, and sale of produce. On this agri app, farmers get agronomy expert advice, can buy from a wide range agri-input product with free home delivery and GST bill at best rates; even better than market rates at times. With this new update of the Gramophone app, you get two types of app modes 'Kheti' and 'Vyapaar'. Farmers can use both these modes and switch between the two anytime with just a single click. In Kheti mode, farmers can use all smart farming tools like Farm Management, Weather Advisory, Agri-Expert Advice, Buy Input products, and in Vyapaar mode they can list their crops to sell and connect with buyers directly from comfort of their home.

Grain Bank Farmer App of Ergoes: GrainBank is a Technology enabled marketplace focused on establishing market linkages for farmers, end buyers, and Banks/NBFCs through Grid-of-micro-warehouses at the farm-gate. In other words, it is a transformational bank for the farmer which leverages technology to seamlessly provide custodial services (warehousing), loans (warehouse receipt financing) and liquidity (market linkages) thereby enabling the farmer to convert his produce to a financial asset. Through their grid of digitally connected rural micro warehouses, we enable farmers to store their produce, avoid distress sales during harvest season, reduce wastage by scientific warehousing, tide over their immediate liquidity/ financing needs by working with NBFCs/ Banks and thereby empower farmers to sell their produce as and when they desire, thereby resulting in farmers achieving 25%-30% higher incomes.

Krishify Agriculture Kisan: Their mission is to empower every professional in the Indian agriculture space, to improve their business prospects. Krishify connect farmers with all the relevant stakeholders including fellow farmers, traders, distributors, farm equipment sellers, cattle doctors, transportation service providers, etc. by leveraging a unified mobile-first and vernacular platform. This app bridges the gap between the brands and the community of farmers. By harnessing state-of-the-art Artificial Intelligence technology, it extracts valuable insights from the ground, to help companies connect with the farmers directly to fulfil their respective objectives.

IFFCO Kisan: It is a modern farmer toolkit helping them not only stay updated with latest practices, can now adopt modern tools and services through the app. IFFCO Kisan brings customized advisory services with more visual content for the farmers. This version comes with crop advisory services containing modern farming practices curated on basis of agro-climatic region, climate-smart agriculture practices, nutrition

Table 1: List of mobile applications used in agriculture sector (Google Play Store, 2022)

Application	Offered by	Update	Downloads
Plantix	PEAT GmbH c/o Plantix	March 10, 2022	10,000,000+
Kisan Suvidha	Gaurav Ladani	June 24, 2015	10,000+
Saillog Agrio	Saillog Ltd.	April 24, 2022	100,000+
Kheti Badi	kheti-badi.com	January 14, 2019	10,000+
RiceXpert	ICAR - National Rice Research Institute	November 18, 2021	500+
Rent a tractor	ETC Agro Tractors & Implements Ltd.	April 13, 2022	1,000+
Krishidhan Agro	Sworn Agritech Pvt. Ltd.	August 6, 2021	1,000+
Bharat agri: smart kisaan app	bharatagri.com	April 22, 2022	1,000,000+
Krishi network Indian agri	krishi.network	April 26, 2022	1,000,000+
Agrostar: kisan agridoctor	AgroStar	April 18, 2022	5,000,000+
AgriCentral	AgriCentral	January 24, 2022	5,000,000+
Krishe: farming kisan Krishi	Krish-e krishe@mahindra.com	April 15, 2022	1,000,000+
CALLKISAN	CALLKISAN	April 14, 2022	500,000+
FarmRise	FarmRise	April 7, 2022	500,000+
BigHaat Smart Farming	BigHaat	March 19, 2022	100,000+
Gramophone – Smart Farming	Gramophone	April 25, 2022	100,000+
Grain Bank Farmer	Ergos Business Solutions Pvt. Ltd.	April 21, 2022	10,000+
Krishify Agriculture Kisan	farmstock.in	April 23, 2022	5,000,000+
IFFCO Kisan	IFFCO Kisan	April 23, 2022	500,000+
Agri Market	Static Starter	December 7, 2020	1,000+
Fasal Salah	BKC WeatherSys Pvt. Ltd.	March 21, 2022	100,000+
PMKISAN	National Informatics Centre, GoI	March 17, 2022	5,000,000+
Agri10x: e-marketplace for farmer	Agri10x	March 14, 2022	10,000+

management, use of precision technology, and mechanization.

Agri Market: The mobile application has been developed with an aim to keep farmers abreast with the crop prices and discourage them to carry-out distress sale. Farmers can get information related to prices of crops in markets within 50km of their own device location using the AgriMarket Mobile App. This app automatically captures the location of the farmers using mobile GPS and fetches the market prices of crops which fall within the range of 50 km. The prices of agri commodities are sourced from the Agmarknet portal. Currently, the app is available in English and Hindi languages. http://mkisan.gov.in/downloadmobileapps.aspx

Fasal Salah: Fasal Salah is an agro advisory path breaking app that provides highly personalized farmer specific crop weather advisories for Indian farmers. This application provides real-time location specific, crop specific, weather-based agro advisories across India. Fasal Salah advisories are available in Hindi, English and regional languages as well as in audio format for non readers.

PM KISAN

The Government of India launched a new Central Sector Scheme, "Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)" in order to augment the income of the Small and Marginal Farmers (SMFs). The scheme was launched in February 2019. It is being implemented by the Department of Agriculture, Co-operation & Farmers Welfare (DAC&FW) under the Ministry of Agriculture & Farmers Welfare through the Department of Agriculture of all the States and Union Territories Governments. Under the Scheme, a direct payment of Rs. 6000 per year will be transferred in three equal instalments of Rs. 2000 every four months into the bank accounts of eligible landholding families. To broaden the reach further, the PM-KISAN mobile app designed and developed by National Informatics Centre (NIC), Ministry of Electronics and Information Technology, Government of India is being launched.

Using Mobile app, farmers can

- Register themselves
- Know the status about their registration and payments
- Correct name as per Aadhaar
- Know about the scheme
- Dial Helpline Numbers

Agri10x: e-marketplace for farmer: Agri10x is a new age Agriculture platform that connects farmers to buyers and traders digitally. Farmers can make decisions in their farming business to increase profitability. It harnesses the state of the art technologies like Blockchain, Artificial Intelligence to usher the farmers into the era of digital farming. Farmers have access to global traders which in turn ensures better rates for their produce. Traders get residue-free fruits, pulses AND vegetables and can trace the origin of the produce, which will help sustain a well-balanced healthy lifestyle for generations to come. Free of cost.

CONCLUSION

The benefits of mobile applications in agriculture includes that farmer can do any new experiment in farming with confidence. Every knowledge related to crop and farming i.e., seed selection, seed treatment, seed varieties, soil testing, soil and soil preparation, nursery, plant or seed preparation and planting, selection of organic and chemical fertilizers, irrigation, Crop protection, insecticide, fungicide, harvesting, cultivation, storage. Apart from this, farmers can also see nearby weather information and market prices. Warnings are also given according to the selected crop and cultivation. However, mobile apps are working as a boon for farmers and transforming agriculture but still they have some gaps which should be checked and removed. Either farmers unaware about the app or they have very limited users, because most of them are not user friendly. Only few apps work at the ground level. Also, most of the applications does not consist of the local languages of the famers which also becomes a hindrance in the use of the mobile applications. It was also seen that most of the applications are area specific and therefore not all the famers can utilise the benefits of the application.

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Perception of Tribal Farmers about Extension Services Provided by Krishi Vigyan Kendra Kanker, Chhattisgarh

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ABSTRACT

Krishi Vigyan Kendra (KVK) is one of the Milestone of Indian Council of Agriculture Research and is an integral part of National Agricultural Research System (NARS). It is an Innovative science-based Institution which conduct OFT, FLD undertakes vocational training of farmers, farm women and rural youths. KVK maintains healthy relationship between Scientist and Farmers. The present study was conducted in Kanker district of Chhattisgarh state during 2021-22, to assess the perception of beneficiaries about Extension services provided by Krishi Vigyan Kendra. The study was conducted with 110 beneficiaries by using proportionate random sampling in 6 villages under 3 blocks. The findings of the study revealed that tribal farmers were of comparatively middle age group, education up to high school, medium annual income & landholdings, agriculture as a main occupation, medium farming experience, high attitude towards technological demonstration, high knowledge about KVK activities, medium innovativeness and high training exposure. Regarding the perception of KVK beneficiaries toward KVK services was found most favourable. Based on the findings of the study, it can be concluded that KVK changed the perspective of the tribal farmers from traditional to modern technology which helps in uplifting their economic status.

Keywords: Beneficiaries, FLD, ICAR, Krishi Vigyan Kendra, NARS, OFT, Tribal farmer

INTRODUCTION

Agriculture is the invaluable asset of Indian economy. agriculture is the primary source of livelihood for about 58 per cent of population. Agriculture sector plays vital role for health and growth of national economy, as it contributes around 17 per cent in GDP,13 per cent to exports and 55 per cent to employment, and most important point is that during the COVID-19 only agriculture emerged as the bright spot with the growth rate as positive. Then coming to Krishi Vigyan Kendra, it plays crucial role in agriculture towards the technology dissemination. At the KVK SMS's plays crucial role in fulfilling the mandates that are framed (Sarnaik, 2020) Also, Krishi Vigyan Kendra (Farm Science Center) has excelled in bringing the modern technology packages at the farmers doorstep with the help of various instructional units (Rajan *et al.,* 2015). It also works like super vehicle to technologies decentralization. The concept of KVK was given by Dr. M. S. Swaminathan and was based on the recommendation of Education commission (1964-66) and further consideration was done by the planning commission, inter-ministrial committee and the ICAR. The first Krishi Vigyan Kendra was established in 1974 at Puducherry. KVK also provide vocational trainings to rural people which help in uplifting their economic conditions. KVK has district as jursidiction which plays a vital role in agricultural technology transfer and in turn increasing productivity and income of the farming community, primary focus of KVK on learning by doing to impart training (katole *et al.,* 2017) KVK work at the ground level on the farmers field for assessment of location specific problems and find out the proper solution to a particular problem and then provide training for allocation of resources and in resources use efficiency in order to minimize the costs and maximize the profits. The KVK's are serving as the light house for overall rural development in the district (Rajan *et al.,* 2020). KVK organizes many training programme for bringing

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awareness towards new technologies and make them familiar to rural people. All Krishi Vigyan Kendra's falls under the jurisdiction of the 11 Agriculture Technology Application Research Institutes (ATARIs) throughout the India, as of April 2022 there are 731 KVKs including 28 KVKs of Chhattisgarh were established and functioning in the country. Now around 28 KVKs functioning in Chhattisgarh and KVK Kanker is one of them. The Krishi Vigyan Kendra, Kanker has been recognized as the one such center in the country for its initiatives like developing nutrition gardens and promoting integrated farming techniques and received the 'Pt Deendayal Upadhyay Krishi Vigyan Prothsahan Award -2017' from the Prime Minister of India.

MATERIALS AND METHODS

The study was conducted in the kanker district (longitude of 20.6 -20.34 and latitude 80.48) is located in the Southern region of Chhattisgarh. It was selected purposively because it is tribal dominated district. The district comprises seven tribal blocks namely Kanker, Charama, Narharpur, Bhanupratapur, Antagarh, Durgukondal and Koyalibeda. Out of which only three blocks were selected, having maximum tribal population. From the selected 3 blocks, two villages were selected from each block based on maximum number of beneficiaries and those villages which have been adopted by the Krishi Vigyan Kendra, in the past three years. A list of respondents was prepared with the help of the Krishi Vigyan Kendra, Kanker. Out of which 110 beneficiaries were selected from 6 villages by taking 30 per cent proportionate sample. The Primary data was collected with the help of interview schedule, which is to be prepared based on the objectives of the study while taking independent variable into consideration. The statistical analysis was done by using appropriate statistical tools like mean, standard deviation, Range, percentage, frequency and correlation coefficient.

RESULTS AND DISCUSSION

The study reveals that the majority of beneficiaries 67.27 per cent belonged to middle age group followed by 22.72 per cent old and 10.00 per cent young age, KVK always work toward the promotion and adoption of new technology and sustainable agriculture and using of ICT tools is more in the present time

Table 1: Distribution of Beneficiaries as per their profile

Categories	Frequency	Percentage
Age		
Young	11	10.00
Middle	74	67.28
Old	25	22.72
Education		
Illiterate	11	10.00
Primary School	17	15.45
Middle School	31	28.20
High School	36	32.72
Higher Secondary	13	11.82
Graduate & above	2	1.81
Occupation		
Agriculture	67	60.90
Agriculture + Labour	22	20.00
Agriculture + Indep. Business	9	8.20
Agriculture + other	12	10.90
Annual income		
Low	34	30.00
Medium	49	45.10
High	27	24.18
Land holding		
Small	29	26.36
Medium	49	44.55
Large	32	29.09
Farming experience		
Low	16	14.55
Medium	72	65.45
High	22	20.00
Attitude towards technological demonstration		
Low	22	20.00
Medium	15	13.61
High	73	66.39
Knowledge about KVK activities		
Low	11	10.00
Medium	7	6.38
High	92	83.35
Innovativeness		
Low	25	22.72
Medium	80	72.74
High	5	4.54
Training exposure		
Low	9	8.10
Medium	14	12.72
High	87	79.18

KVK work in a process of adoption of new technology and sustainable farming for all age group farmers, even for young farmers those have more intrest in new technology or also for middle and old age farmers group which have least intrest in new technology but the response of the farmers of all age group are quite the similar for adoption of new technology Their level of education was high school and middle school of 32.72 per cent, 28.18 per cent respectively and followed by 15.45 per cent primary and 11.81 per cent higher secondary school while 10.00 per cent illiterate and 1.81 per cent graduate. According to the study majority of beneficiaries main occupation for their livelihood was agriculture of 60.90 per cent followed by agriculture + labour 20.00 per cent and 10.90 per cent agriculture + other and 8.18 per cent on agriculture + Independent business. Whereas majority of the beneficiaries 45.10 per cent had medium annual income and followed by 30.65 per cent low and 24.25 per cent high income. In the case of land holding most of the beneficiaries 44.50 per cent had medium land holding and followed by 29.09 per cent and 26.36 per cent of them had large and small categories respectively. In kanker district most of the land holder population is tribal farmers and agricultural land is most important factor of income generation for farmers. In kanker district all farmers with more or less agricultural land holding have limited income because of shortage and limited irrigation facilities availabilities in kanker. Regarding the farming experience 65.45 per cent had medium experience followed by 20.00 per cent high and 14.54 per cent had low experience. About 66.36 per cent had high attitude towards technological demonstration followed by 20.00 per cent low and 13.63 per cent medium attitude. While in the case of knowledge about KVK activities 83.30 per cent had high knowledge whereas 10 per cent had low and 6.36 per cent medium level of knowledge. The data indicates that their innovativeness was of medium level (80 .00 per cent) followed by 22.72 per cent and 4.45 per cent of them had a low and high respectively. In the case of 87.00 per cent had high level of training exposure whereas 12.72 per cent had medium and 8.10 per cent low level of training exposure.

Table 2: Distribution of the beneficiaries according to their perception about extension services provided by Krishi Vigyan Kendra (N=110)

Category	Frequency	Percentage
Less favourable	6	5.45
Favourble	24	21.81
More favourable	80	72.72
Total	110	100.00

Table 3: Coefficient of correlation between selected characteristics of the farmers with their perception about extension services provided by KVK

Variables	Coefficient of correlation (r)
Age	0.008
Education	0.237*
Occupation	0.224*
Annual Income	0.215*
Land holding	0.014
Farming experience	0.211*
Attitude towards technological demonstration	0.303**
Knowledge about KVK activities	0.405**
Innovativeness	0.254**
Training exposure	0.351**

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

CONCLUSION

It can be concluded through the investigation, perception of the beneficiaries about extension services provided by Krishi Vigyan Kendra, Kanker were found more favourable (79.18%) whereas around one tenth (12.72%) of the beneficiaries were favourable, while less than one tenth (8.10%) beneficiaries were less favourable. Regarding the relationship between socio-economic, psychological and communication characteristics with their perception of the beneficiaries about extension services provided by KVK, showed that variables namely Age and Land holding had a non-significant association with perception of KVK (Vohra, 2016) and (Saklani, 2018) whereas variable like Farming experience, education, occupation which is positive and significant, while attitude, knowledge about KVK activities, innovativeness and training exposure was found to be positive and highly significant.

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Perception of Tribal Farmers towards Pradhan Mantri Van Dhan Vikas Yojana in Andhra Pradesh

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ABSTRACT

Pradhan Mantri Van Dhan Vikas Yojana (PMVDVY) scheme was launched on 14th April 2018. This scheme is one such effort of the government to improve the tribal livelihood and tribal income through value addition of various tribal products and to make them self-reliant especially the tribal women. The present study was conducted in East Godavari district of Andhra Pradesh state during 2021-22. The study was undertaken to assess the perception of beneficiaries towards PMVDVY, in which total 105 sample size was taken by using proportionate random sampling method in eight villages under two mandals. The findings of the study revealed that, majority of the beneficiaries were of young age group, belonged to female gender. The study also revealed that most of them are illiterates, having low annual income, small land holdings, majority of the beneficiaries had medium level of utilisation of source of information, with medium economic motivation and market orientation. Then coming to the perception of beneficiaries towards PMVDVY was found favourable.

Keywords: Perception, Pradhan Mantri Van Dhan Vikas Yojana (PMVDVY), Beneficiaries, Livelihood

INTRODUCTION

The word tribe means a group of families who were bound together by the kinship, usually descending from common mythical or legendary ancestor, living in a contiguous region, speaking common language and having common historical past. Around 200 million tribal population approximately were present in the entire globe, which constitute 4 per cent of the total global population. According to 2011 census, In India there is around 8.43 crores of scheduled tribes which constitute 8.6 per cent out of the total population. The tribal economy is culturally rich, mainly based on agriculture and minor forest produce (Ministry of Tribal welfares, 2011). Andhra Pradesh which is a traditional home of tribals, has the largest tribal population in south Indian peninsula and occupies eighth position among the states having tribal population (Rajan *et al.,* 2015). After independence, government started many development programmes with the advent of Integrated Tribal Development Agency (ITDA) which act as single window system, aimed at integrated development of tribal's (Hareesh, 2017). Pradhan Mantri Van Dhan Vikas Yojana (PMVDVY) scheme was launched on 14th April 2018, is a component of the MSP for Minor Forest Product (MFP) scheme to boost livelihood of tribes living in forest areas. With the Ministry of Tribal Affairs as the nodal department at the central level and the Tribal Cooperative Marketing Federation of India (TRIFED) as the nodal agency at the national level, the government aimed to implement this scheme across the country and help to generate tribal income by harnessing the wealth of forest, i.e., Van Dhan. Around 200 million peoples who live in and around forests depends on forest resources for their livelihood (Tariq Iqbal *et al.,* 2021). Minor forest produce is one of the major sources for livelihoods of tribals living in forest areas. Around 20-40 per cent of tribal annual income derived from the minor forest produce (MFP), on which they spend major portion of their time. Most of the MFP'S are collected and sold by the women, so this activity has strong linkage to women's financial empowerment (IBEF, 2021).

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Under this scheme the tribals form into MFP groups similar to SHG's which contains nearly 30 members. Then a cluster of 10 MFP groups called as Van Dhan Vikas Samuh form a Van Dhan Vikas Kendra (VDVK). In Van Dhan Vikas Kendra's (VDVK), they provide primary processing, value addition facility and thereby providing skill upgradation and capacity building training. In VDVK'S tribals are trained and provided with working capital for doing primary processing and value addition of various minor forest products like bamboo candles, making hill brooms etc. Thus, these Kendra's will act as an important milestone in economic development of tribals. This Van Dhan Yojana also ensure livelihood amid COVID pandemic (Priscilla Jebaraj, 2021). Therefore, based on the importance of tribals and minor forest produce the present study is entitled as "Perception of Tribal Farmers towards Pradhan Mantri Van Dhan Vikas Yojana in Andhra Pradesh."

MATERIALS AND METHODS

Descriptive research design was used in this study. The present study was carried out purposively in East Godavari district of Andhra Pradesh state during 2021-22. In East Godavari district under ITDA-Rampachodavaram comprises seven tribal mandals, out of which only two mandals i.e., Rampachodavaram, Maredumilli mandals were selected by using random sampling, whose tribal population is more compared to others and from each mandal four villages were selected randomly. A comprehensive list of beneficiaries of each selected mandal was prepared with the help of ITDA. From the list, a proportionate sample of 2 per cent beneficiaries from each mandal was selected for the investigation. Thus, the total 105 beneficiaries were taken randomly as the sample size of the study. The data was collected through a well-structured interview schedule. Mean, frequency, percentage, correlation coefficient was used to assess the perception of tribal farmers towards PMVDVY.

RESULTS AND DISCUSSION

The results of the present study from the Table 1 reveals that majority of the beneficiaries were of young age group (50.48%), followed by middle age group (40.00%) and then old age group (9.52%). Through this we can understand that most of the beneficiaries were of young age, because this scheme was started from past 3-4 years and main focus was on value addition and in developing entrepreneurial skills so young age group are more interested compared to middle and old age group. Most of the beneficiaries were belonged to female gender (84.76%) followed by Male (15.24%), because most of the forest products were collected by the woman and they are involved, required in various processing activities. The data also reveals that most of the beneficiaries are illiterates (33.33%) followed by schooling up to high school (22.86%), then up to intermediate (18.09%), primary (16.19%) and with less percent (2.86%) were completed their education up to graduation. Even though most of the young age group completed their education up to high school and intermediate, but by combining middle age and old age group most of them were belonged to illiterate, primary school category. Most of the beneficiaries comes under low annual income (60.00%) i.e., from Rs. 36,000 to Rs. 84,000 followed by medium (32.38%) and high annual income (7.62%), with small land holdings (92.38%). The reason for low annual income is because respondents having small land holdings and their dependence on agriculture and related products for their livelihood requirements. The study also reveals that majority of the beneficiaries had medium level of utilisation of source of information (60.00%), followed by low and high (20.00%). The reason was that, most of them utilise the information sources like friends, neighbours, progressive farmers and DWACRA instead of other sources like journals, internet etc. Through the findings, it was also revealed that majority of the beneficiaries comes under medium level category in economic motivation (79.05%) and market orientation (92.38%). Economic motivation and market orientation were depended on other factors like source of information, annual income and land holdings.

The data in the Table 2 indicates that out of the total beneficiaries around 64.76 per cent were found favourable towards the PMVDVY scheme, followed by less favourable (21.91%) and more favourable (13.33%). On the basis of below data, majority of the beneficiaries were found to be favourable towards Pradhan Mantri Van Dhan Vikas Yojana (PMVDVY). This was mainly due to the scheme generated employment opportunity through value addition, helps in improving their annual income and there by their

Table 1: Profile of the beneficiaries (N=105)

Categories	Beneficiaries	
	Frequency	Percentage
Age		
Young age group (Up to 35 years)	53	50.48
Middle age group (36-55 years)	42	40.00
Old age group (more than 55 years)	10	9.52
Gender		
Male	16	15.24
Female	89	84.76
Education		
Illiterate	35	33.33
Up to primary	17	16.19
Up to middle	7	6.67
Up to high school	24	22.86
Up to intermediate	19	18.09
Up to graduation	3	2.86
Annual income		
Low (Rs.36,000-Rs.84,000)	63	60.00
Medium (Rs.85,000-Rs.1,33,000)	34	32.38
High (Rs.1,34,000-Rs.1,82,000)	8	7.62
Land holding		
Small (Up to 2 ha)	97	92.38
Medium (2.1- 4 ha)	8	7.62
Large (more than 4 ha)	0	0
Source of information		
Less (Up to 9)	21	20.00
Moderate (10-13)	63	60.00
More (more than 13)	21	20.00
Economic motivation		
Low (Up to 19)	15	14.28
Medium (20-26)	83	79.05
High (Above 26)	7	6.67
Market orientation		
Low (Up to 13)	0	0
Medium (14-16)	97	92.38
High (more than 16)	8	7.60

livelihoods, improving their entrepreneurial skills and making them self-reliant.

In this study the relationship of socio-personal, economical, communicational and psychological traits of the beneficiaries with their level of perception was calculated with the values of Correlation coefficient and are presented in Table 3. The Table 3 depicts that variable like annual income (0.220), size of land holdings (0.225), source of information (0.343), economic motivation (0.425), market orientation (0.208) was found to exercise significant bearing on level of perception towards PMVDVY, which indicates that those a unit increase in one variable may leads to increase in other variable and vice versa. While other variables like Age (-0.009), gender (0.062), education (0.037) did not exert any association with the level of perception. In this source of information and economic motivation are positive and highly significant at 0.01 level where as annual income, size of land holding and market orientation are positive and significant at 0.05 level. While age is negatively non-significant, others like gender and education has been positively non-significant.

Table 2: Distribution of tribal farmers according to their perception towards PMVDVY

Categories	Beneficiaries	
	Frequency	Percentage
Less favourable (Up to 68)	23	21.91
Favourable (69-81)	68	64.76
More favourable (more than 81)	14	13.33

Table 3: Correlation coefficient of perception towards PMVDVY with their selected traits

Traits	Correlation coefficient 'r' value'
Age	-0.009NS
Gender	0.062NS
Education	0.037NS
Annual income	0.220*
Size of land holding	0.225*
Source of information	0.343*
Economic motivation	0.425*
Market orientation	0.208*

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

CONCLUSION

From the findings of the current study, it can be concluded that, majority of the beneficiaries has favourable perception towards Pradhan Mantri Van Dhan Vikas Yojana (PMVDVY). Earlier, some of the minor forest products were sold without any value addition directly to middleman, who may exploit the farmers. This exploitation results in farmers getting less share of price in their products itself. This PMVDVY scheme helps them by providing necessary support, training and facilities required for processing and value addition and thereby generating employment especially to the women through various value addition activities like grading, standardisation etc. Thus, beneficiaries have positive perception towards the scheme, as it aids in improving their livelihood by employment generation and increasing income and thereby improving socio-economic conditions and making them self-reliant. But still more efforts were needed on the part of overall stakeholders to improve, extend the area and the products covered under this scheme and which leads in effective implementation of the scheme.

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Knowledge and Adoption Behaviour of Orange Growers Towards Improved Production Technology of Orange

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ABSTRACT

This study was carried out in order to assess the knowledge and adoption of the orange growers about improved production technology of orange cultivation. The present investigation was carried out in Amravati and Nagpur district (Vidarbha region) of Maharashtra. A sample of 240 respondents constituted for the research study. The present study revealed that majority of orange growers was having high level of knowledge (55.84%) but medium level of adoption (60.00%) about improved production technology of orange. The study found that many orange growers in this region do not follow the recommended pit size for planting, fruit drop control measures, recommended nutrient doses, poor (less) management of insect pests for orange crop due to lack of awareness about it. The present study indicates the need to constantly update the improved production technology of orange and persuaded to follow it for increasing profitability.

Keyword: Knowledge, Adoption, Orange cultivation, Improved production technology

INTRODUCTION

Fruit cultivation in India is one such major commercial and business for exporting, merchandise and shipping from which much of the international revenue is incurred. India has diverse climates and soil for cultivation of horticulture crops providing ample opportunities for the development of fruit industry but the greatest challenge in present is to produce sufficient fruit to feed the ever-increasing human population. Maharashtra is the one of the largest producer of orange in the country. The orange is one of the most important fruit crops of Vidarbha region of Maharashtra. Vidarbha region is known to the entire world for its awesome quality of oranges. The area, production and yield per hectare of orange in vidarbha during the year 2017-18 were 103956 hectares, 103956 tones and 7.80 tones/ha respectively. This shows that the average yield of orange in vidarbha region is 7.80 tones/ha., which is obviously less than average yield of India (9.23 tones/ha) and world (16.32 tones/ha) (Source-HAPIS, 2017). Some of the obvious reason besides other for low productivity may be due to unaware of knowledge and non adoption or poor adoption of improved production technology of orange by the orange growers. Globally, technology is changing very fast and improved production technology of orange has revolutionized the orange fruits cultivation in India. The increasing demand of orange fruits clearly indicates that there is an urgent need to boost up the production of orange fruit to cater the demands of growing population. The complete knowledge and adoption of improved production technology by the orange grower will helpful to increase overall orange production, productivity and income in this major orange growing area of Maharashtra. Hence this study is undertaken to assess the knowledge and adoption of improved production technology by the orange growers.

MATERIALS AND METHODS

The exploratory design of social research was used in present investigation. The present study was carried out during 2020-21 in Amravati and Nagpur districts which were selected purposively on the basis of higher

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area under orange cultivation in Vidarbha region of Maharashtra. On the basis of maximum area under orange cultivation, two taluka namely Morshi and Warud from Amravati district and Katol and Narkhed from Nagpur district were selected purposively. Then 6 villages were selected from each taluka having larger area under orange cultivation and 10 orange growers from each selected village were selected by random sampling method. Thus 240 orange growers constituted the sample size for the present study.

Knowledge is operationally defined as the body of understood information possessed by orange growers about improved production technology of orange. Knowledge of respondents about improved production technology of orange was measured on two point continuum i.e. yes and no with the score 1 and 0 respectively. The obtained knowledge score then converted in to knowledge index with help of following formula.

$$\text{Knowledge index} = \frac{\text{Obtained score}}{\text{Maximum otainable score}} \times 100$$

The orange growers were categorized on the basis of their knowledge index with the help of equal interval method into three categories that is low, medium and high. Adoption is operationally defined as the actual use of the improved production technology of orange by the orange growers. Adoption of orange growers about the improved production technology of orange will be collected on three point continuum i.e. complete adoption, partial adoption and no adoption by assigning score of 2, 1, and 0 respectively. The obtained adoption score then converted in to adoption index with help of following formula.

$$\text{Adoption index} = \frac{\text{Obtained score}}{\text{Maximum otainable score}} \times 100$$

The orange growers were categorized on the basis of their adoption index with the help of equal interval method into three categories that is low, medium and high. Data were collected by personally interviewing the respondents with help of pre-tested and structured interview schedule. The data collected were tabulated and the statistical tools namely frequency and percentage were employed for interpretation of the findings.

RESULTS AND DISCUSSION

Knowledge indicates the awareness of the orange growers about improved management practices of orange. Knowledge of orange growers is directly or indirectly related to resource management behaviour and decision making ability of orange growers. Hence, it was considered necessary to assess the knowledge of the orange growers about improved production technology of orange cultivation. Table 1 present the distribution of orange growers according to their extent of knowledge about improved production technology of orange.

It is observed from Table 1 that, in case of suitable land, majority of orange growers had knowledge about soil type (82.92) and $caco_3$ (60.00%). While 78.75 per cent orange growers didn't have knowledge about soil pH. Regarding selection of planting material, orange growers had knowledge about recommended rootstock (95.83%), selection of healthy and disease free budling (95.00 %) and budling height (79.17%). Majority of orange growers didn't have knowledge about budling thickness (63.33) and buding height (61.67%). In case of planting of oranges, all (100.00%) orange growers had the knowledge about season of planting, followed by 65.83 per cent orange growers had the knowledge about spacing. While 77.92 per cent orange growers didn't have knowledge about pit size. Most of (93.75%) orange growers had knowledge about varieties of orange.

The data in Table 1 about irrigation management revealed that 82.08 per cent orange growers had knowledge about double ring method of irrigation and 55.82 per cent orange growers had knowledge about drip irrigation. In case of nutrient management, most of orange growers had knowledge about method of application of fertilizers (88.75%), time of application of fertilizer (75.83%) and doses for nutrient management (52.50%). Regarding intercropping in orange orchard, it is found that 75.83 per cent orange growers had knowledge about recommended time for intercropping, while 54.75 per cent orange growers didn't have knowledge about recommended crop for intercropping.

The data in Table 1 about training and pruning shows that most of the orange growers had knowledge about time (87.92%) and practice (86.67%) of training

Table 1: Distribution of the orange growers according to their extent of knowledge about improved production technology of orange

S.No.	Improved production technology	Knowledge			
		Yes		No	
		Number	Percentage	Number	Percentage
1.	**Suitable land**				
	i. Soil type	199	82.92	41	17.08
	ii. Soil Ph	51	21.25	189	78.75
	iii. Caco3	144	60.00	96	40.00
2.	**Selection of planting material**				
	i. Recommended rootstock	230	95.83	10	4.17
	ii. Quality budling- a. Buding on 20 to 30 cm height,	92	38.33	148	61.67
	b. Budling should be pencil size thickness	88	36.67	152	63.33
	c. Budling height : 75 to 100 cm	190	79.17	50	20.83
	d. Budling should be healthy & disease free	228	95.00	12	5.00
3.	**Planting**				
	a. Season of planting	240	100.00	0	0.00
	b. Spacing	158	65.83	82	34.17
	c. Pit size	53	22.08	187	77.92
4.	**Varieties** –	225	93.75	15	6.25
5.	**Irrigation management**–				
	a. Drip irrigation	133	55.42	107	44.58
	b. Double ring method	197	82.08	43	17.92
6.	**Nutrient Management** –				
	i. Doses	126	52.50	114	47.50
	ii. Time of application	182	75.83	58	24.17
	iii. Method of application	213	88.75	27	11.25
7.	**Intercropping**				
	i. Recommended crop	110	45.83	130	54.17
	ii. Recommended time	182	75.83	58	24.17
8.	**Training and Pruning**				
	i. Time	211	87.92	29	12.08
	ii. Practise	208	86.67	32	13.33
9.	**Borduex paste application**-				
	i. Preparation of Borduex paste	179	74.58	61	25.42
	ii. Time of application	110	45.83	130	54.17
10.	**Weed Management**				
	i. Weeding	240	100.00	0	0.00
	ii. Spraying of weedicide	226	94.17	14	5.83
11.	**Bahar Treatment**				
	1. Mrig Bahar	235	97.92	5	2.08
	2. Ambia Bahar	226	94.17	14	5.83
12.	**Fruit drop control**				
	i. Fungal Fruit drop	95	39.58	145	60.42
	ii. Hormonal deficiency	43	17.92	197	82.08

Table 1: contd....

S.No.	Improved production technology	Knowledge			
		Yes		No	
		Number	Percentage	Number	Percentage
13.	**Insect Pest Management**				
	i. Citrus psylla	146	60.83	94	39.17
	ii. Bark eating caterpillar	181	75.42	59	24.58
	iii. Fruit sucking moth	171	71.25	49	20.42
	iv. White fly	88	36.67	152	63.33
14.	**Disease Management**				
	i. Phytopthora	58	24.17	182	75.83
	ii. Tip drying	129	53.75	111	46.25
15.	**Thinning**	12	5.00	228	95.00
16	**Supporting/ Staking**	240	100.00	0	0.00
17.	**Harvesting**				
	i. Harvesting time	240	100.00	0	0.00
	ii. Scientific characteristics	240	100.00	0	0.00

and pruning. The data regarding borduex pest application indicate that 74.58per cent orange growers had knowledge about preparation of borduex pest, while 54.17 per cent orange growers didn't have knowledge about time of borduex pest application. In case of weed management in orange orchard, all (100.00%) orange growers had the knowledge about weeding followed by weed management by spraying of weedicide (94.17%). Most of orange growers had knowledge about bahar treatment for mrig bahar (97.92%) and ambia bahar (94.17 %). Regarding fruit drop control, orange growers didn't have knowledge about fruit drop control for hormonal deficiency (82.08) and fungal fruit drop control (60.42%). In case of insect pest management, majority of orange growers had knowledge about management of bark eating caterpillar (75.42%), management of fruit sucking moth (71.25%) and citrus psylla pest management (60.83%). While 63.33 per cent orange growers didn't have knowledge about soil white fly control. In case of disease management, nearly half (53.75%) of the orange growers had knowledge about management of tip drying disease. While 75.83 per cent orange growers didn't have knowledge about phytopthora management. Most (95.00%) orange growers didn't have knowledge about thinning of extra fruits for maintain better quality. It is observed from Table 1 that, all (100.00 %) orange growers had the knowledge about staking and harvesting of oranges.

Knowledge of orange growers about improved production technology of orange measured and the orange growers categorized on the basis of their knowledge index with the help of equal interval method as given in Table 2.

It could be depicted from the Table 2 that more than fifty per cent (55.84%) of the orange growers were having high level of knowledge about improved cultural practices of orange, while 40.83 per cent and 03.33 per cent of the orange growers having medium and low level of knowledge about improved production technology of orange respectively. Thus it could be concluded that majority of orange growers were having high level of knowledge about improved production technology of orange. But to increase the knowledge level of the remaining orange growers from medium to high knowledge level; there is need to organise training, demonstrations etc. to equip the

Table 2: Distribution of the orange growers according to their knowledge about improved production technology of orange

Category	Respondents (n=240)	
	Frequency	Percentage
Low	08	03.33
Medium	98	40.83
High	134	55.84
Total	240	100.00

Table 3: Distribution of the orange growers according to their extent of adoption about improved production technology of orange

S. No.	Improved production technologies	Adoption					
		CA		PA		NA	
		No.	%	No.	%	No.	%
1.	**Suitable land**						
	i. Soil type	149	62.08	79	32.92	12	5.00
	ii. Soil Ph	61	25.42	86	35.83	93	38.75
	iii. Caco3	136	56.67	64	26.67	40	16.67
2.	**Selection of planting material**						
	i. Recommended rootstock	189	78.75	51	21.25	00	0.00
	ii. Quality budling a. buding on 20 to 30 cm height,	52	21.67	153	63.75	35	14.58
	b. budling should be pencil size thickness	46	19.17	169	70.42	25	10.42
	c. budling height : 75 to 100 cm	127	52.92	108	45.00	5	2.08
	d. budling should be healthy & disease free	163	67.92	77	32.08	0	0.00
3.	**Planting**						
	a. Season of planting	226	94.17	14	5.83	0	0.00
	b. Spacing	119	49.58	19	7.92	102	42.50
	c. Pit size	5	2.08	50	20.83	185	77.08
4.	**Varieties**	240	100.00	00	00.00	0	0.00
5.	**Irrigation management**						
	a. Drip irrigation	103	42.92	33	13.75	104	43.33
	b. Double ring method	39	16.25	62	25.83	139	57.92
6.	**Nutrient Management**						
	i. Doses	89	37.08	137	57.08	14	5.83
	ii. Time of application	126	52.50	96	40.00	18	7.50
	iii. Method of application	161	67.08	55	22.92	24	10.00
7.	**Intercropping**						
	i. Recommended crop	33	13.75	143	59.58	64	26.67
	ii. Recommended time	79	32.92	119	49.58	42	17.50
8.	**Training and Pruning**						
	i. Time	66	27.50	118	49.17	56	23.33
	ii. Practise	97	40.42	89	37.08	54	22.50
9.	**Borduex paste application**						
	i. Preparation of Borduex paste	84	35.00	89	37.08	67	27.92
	ii. Time of application	17	7.08	156	65.00	67	27.92
10.	**Weed Management**						
	i. Weeding	44	18.33	122	50.83	74	30.83
	ii. Spraying on weed	82	34.17	105	43.75	53	22.08
11.	**Bahar Treatment**						
	1. Mrig Bahar	97	40.42	87	36.25	56	23.33
	2. Ambia Bahar	95	39.58	107	44.58	38	15.83
12.	**Fruit drop control**-						
	i. Fungal Fruit drop	29	12.08	68	28.33	143	59.58
	ii. Hormonal deficiency	6	2.50	39	16.25	195	81.25

Table 3: contd...

S. No.	Improved production technologies	Adoption					
		CA		PA		NA	
		No.	%	No.	%	No.	%
13.	**Insect Pest Management**						
	i. Citrus psylla	68	28.33	88	36.67	84	35.00
	ii. Bark eating caterpillar	49	20.42	134	55.83	57	23.75
	iii. Fruit sucking moth	87	36.25	94	39.17	59	24.58
	iv. White fly	16	6.67	74	30.83	150	62.50
14.	**Disease Management**						
	i. Phytopthora	4	1.67	47	19.58	189	78.75
	ii. Tip drying	24	10.00	100	41.67	116	48.33
15.	**Thinning**	0	0.00	0	0.00	240	100.00
16	**Supporting/ Staking**	178	74.17	62	25.83	00	0.00
17.	**Harvesting**						
	i. Harvesting time	214	89.17	26	10.83	00	0.00
	ii. Scientific characteristics	210	87.50	30	12.50	00	0.00

orange growers about improved production technology of orange. The present findings are in consonance with findings reported by Dhole (2006) that majority of orange growers (98.67%) belong to high knowledge level. This finding is supported by the results reported by Baghel (2013).

Table 3 present the distribution of orange growers according to their extent of adoption about improved production technology of orange. It is observed from Table 3, in case of suitable land for orange, majority of orange growers had complete adoption about soil type (62.08%) and Caco3 per cent in soil (56.67%). Nearly one-third of orange growers had partial adoption about soil pH (35.83%) and soil type (32.92%). While nearly one-third of orange growers did not adopt soil pH (35.75%) for selecting suitable land for orange.

Regarding selection of planting material, majority of the orange growers had complete adoption about recommended rootstock (78.75%), healthy and disease free budling (67.92%). Most of the orange growers had partial adoption about budling thickness (70.42%) and buding height (63.75%). In case of planting of orange, Majority of orange growers had complete adoption about season of planting (94.17%). Nearly half of orange growers had complete adoption about recommended spacing for orange plant (49.58%).While three-fourth of the orange growers did not adopt pit size for planting orange (77.08%). All (100.00%) orange growers had complete adoption about varieties of orange. Regarding irrigation management for orange,42.92 per cent orange growers had complete adoption about drip irrigation, while 57.92 per cent orange growers did not adopt double ring method of irrigation.

The data in Table 3 about nutrient management indicate that, nearly two-third (67.08%) of the orange growers had complete adoption about recommended method for application of nutrients and 52.50 per cent of the orange growers had complete adoption about recommended time for application of nutrients. But nearly half (57.08%) of orange growers had partial adoption about doses for nutrient management. In case of intercropping; growers had partial adoption about recommended crop for intercropping (59.58%) and recommended time for inter cropping (48.58%). Regarding training and pruning, 40.42 per cent orange growers had complete adoption about practice for training and pruning. While 49.17 per cent orange growers had partial adoption about time for training and pruning.

The data in Table 3 shows that, orange growers had partial adoption about time of borduex paste application (65.00) and preparation of borduex paste application (37.08%). In case of weed management, orange growers had partial adoption about weeding (50.83%) and spraying of weedicide (43.75%). Regarding bahar treatment, 40.42 per cent orange growers had complete adoption about mrig bahar; while 44.58 per cent orange growers had partial adoption about ambia bahar. The data regarding fruit drop control shows that most of orange growers did not adopt fruit drop control for hormonal deficiency (81.25%) and fungal fruit drop control (59.58%). In case of insect pest management, orange growers had partial adoption for control of bark eating caterpillar (55.83%), fruit sucking moth (39.17%) and citrus psylla (36.67%). While nearly two-third (62.50%) of the orange growers did not adopt white fly pest management. Regarding disease management, three-fourth (78.75%) of the orange growers did not adopt phytopthora disease management and tip drying disease management was not adopted by 48.33 per cent orange growers. All (100.00%) orange growers did not adopt thinning of extra fruit for better quality. Nearly three-fourth (74.17%) of the orange growers had complete adoption about staking to bearing trees.

It is observed from Table 3, in case of harvesting of orange, most of orange growers had complete adoption about harvesting time of orange (89.17%) and scientific characteristics for harvesting (87.50%). It could be concluded that many orange growers in this region do not follow the recommended pit size for planting, fruit drop control measures, recommended nutrient doses, poor (less) management of insect pests for orange crop due to lack of awareness about it. Many orange growers in this region do not follow the recommended crop and time for intercropping. Also irrigation method used by many orange growers is not water use efficient. Hence there is a need to increase awareness mostly regarding the package of practices of orange cultivation by conducting regular training programmes in this region. Adoption of orange growers about improved production technology of orange measured and the respondents were categorized on the basis of their adoption index with the help of equal interval method as given in Table 4.

Table 4: Distribution of the orange growers according to their adoption of improved production technology of orange

Category	Respondents (n=240)	
	Frequency	Percentage
Low	27	11.25
Medium	144	60.00
High	69	28.75
Total	240	100.00

The data of Table 4 reveals that out of the total 240 orange growers, 60.00 per cent of orange growers were observed in medium adoption level, followed by 28.75 per cent of orange growers had high level of adoption and 11.25 per cent of orange growers were in low adoption level. Thus, it may be concluded that the higher percentages of orange growers (60.00 %) were having medium level of adoption. There exists lot of scope for increasing the adoption level of the orange growers to increase production in a scientific way. Orange growers need to be constantly updated on technology and persuaded to follow it for increasing profitability. This finding is supported by Thakare *et al.* (1996), Dohtare (2014), Dhumal (2017) and Singh *et al.* (2019).

CONCLUSION

It may be concluded that nearly half of the orange growers were having high level of knowledge and medium level of adoption about recommended orange cultivation practices. Majority of orange growers didn't have knowledge about thinning of fruit for better quality, fruit drop control for hormonal deficiencies, soil pH, pit size, etc. Hence there is a need to increase awareness mostly regarding the improved production technology of orange by conducting regular training, demonstrations etc. Many orange growers in this region were found in medium level of adoption of improved cultivation practices of orange. In case of nutrient management practices, management of insect pests and disease, intercropping, irrigation method used, etc. were different than the recommended package of practice. Hence there is a need to increase adoption about these packages of practices of orange cultivation by conducting regular training programmes through state department of agriculture, Agriculture University and KVK.

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Effect of Land Configuration and Planting Methods on Growth and Yield of *Kharif* Onion (*Allium Cepa* L.)

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ABSTRACT

The experiment was laid out in randomized block design with four replications. The experiment comprised of six treatments involving T_1- Broadcasting on flat bed, T_2- Line sowing on flat bed, T_3- Broadcasting on broad bed furrow, T_4- Line sowing on broad bed furrow, T_5- Transplanting on ridges and furrow and T_6- Transplanting on flat bed. The soil of experimental field was sandy loam in texture low in available nitrogen (190.63 kg ha^{-1}), low in available phosphorus (12.80 kg ha^{-1}) and high in available potassium (436.20 kg ha^{-1}). It was moderately alkaline in reaction (pH 8.25). The electrical conductivity of soil was 0.34 dSm^{-1} with 0.48% organic carbon. The growth parameters *viz.*, plant height, number of functional leaves, dry matter and neck thickness recorded highest values due to transplanting on ridges and furrows. The yield contributing characters *viz.*, polar diameter, equatorial diameter, average weight of bulbs were obtained highest on transplanting on ridges and furrows. The highest bulb yield (23.39 t ha^{-1}) and leaves yield (1.21 t ha^{-1}) were recorded with the transplanting on ridges and furrows. The economics of onion production was significantly influenced by the different land configuration and planting methods. The highest gross monetary returns (193885 Rs. ha^{-1}) and net monetary returns (116356 Rs. ha^{-1}) were recorded on transplanting on ridges and furrows. But highest benefit: cost ratio (2.85) was recorded with line sowing on broad bed furrow. The maximum reduction in cost of cultivation of Rs. 21200 ha^{-1} was observed with line sowing on flat bed followed by line sowing on broad bed furrow Rs. 20200 ha^{-1}, whereas in respect of reduction in net monetary returns, it could be seen that minimum reduction of Rs. 9540 ha^{-1} was found with transplanting on flat bed followed by line sowing on broad bed furrow with Rs. 10235 ha^{-1}. Based on reduction in cost of cultivation and net monetary returns the line sowing on broad bed furrow was found next best treatment after transplanting on ridges and furrow method.

Keywords: Onion, Land configuration, Planting methods, Growth, Yield

INTRODUCTION

Onion (*Allium cepa* L.) popularly known as "Queen of Kitchen" is a hardy bulbous crop grown all over the world. It originated in western and eastern Asia. It belongs to family *alliaceae* and sub family *allioideae.* It is one of the most important monocotyledonous, cross-pollinated and cool season vegetable crop. *Kharif* onion bulb production is a peculiarity of Maharashtra state in the country. However, the major constraints in *kharif* onion cultivation are lower bulb productivity, high cost of production, lower quality of fresh, stored bulb, unstable prices etc. Furthermore, high risk of diseases such as leaf blight, downy mildew, damping off, purple blotch and pest occurrence such as thrips, weed management, long spell of either dry period or cloudy days (i.e. varied climatic conditions) are principle parameter which often make *kharif* onion production more instable. Land configuration (flat bed, broad bed furrow, ridge and furrows) plays a major role in increasing productivity of onion and also in maximizing infiltration, minimizing soil erosion and improving water use efficiency and aeration of different crops.

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Planting of onion on raised beds significantly increased plant height, number of leaves per plant, plant stand, bulb yield and reduced bulbing ratio (neck diameter: bulb diameter) and small bulb yield as compared to flat planting (Farrag, 1995). Considering all these facts in a view present study was undertaken to investigate the "Effect of land configuration and planting methods on growth and yield of *kharif* onion (*Allium cepa* L.)."

MATERIALS AND METHODS

A field experiment was undertaken during *kharif,* 2019 at Post Graduate Instructional Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra). The experiment was laid out in randomized block design with four replications. The experiment comprised of six treatments involving T_1- Broadcasting on flat bed, T_2- Line sowing on flat bed, T_3- Broadcasting on broad bed furrow, T_4- Line sowing on broad bed furrow, T_5- Transplanting on ridges and furrow and T_6- Transplanting on flat bed. The soil of experimental field was sandy loam in texture low in available nitrogen (190.63 kg ha^{-1}), low in available phosphorus (12.80 kg ha^{-1}) and high in available potassium (436.20 kg ha^{-1}). It was moderately alkaline in reaction (pH 8.25). The electrical conductivity of soil was 0.34 dSm^{-1} with 4.8 g kg^{-1} organic carbon. The sowing of onion was done as per treatments. Under line sowing treatment, spacing of 15 cm x 10 cm was maintained on flat bed and ridges and furrow treatment, while for broad bed furrow treatment the spacing of 10 cm x 10 cm was maintained. Transplanting was done later in remaining land configuration treatments at spacing of 15 cm x 10 cm. The recommended fertilizer dose (100:50:50 kg ha^{-1} N, P_2O_5, K_2O) was used common to all treatments through urea, SSP and MOP.

RESULTS AND DISCUSSION

The significant effect were observed with land configuration and planting methods in case of height of plant, number of leaves plant^{-1}, dry matter and neck thickness (Table 1). The transplanting on ridges and furrow recorded significantly higher plant height (54 cm), number of functional leaves plant^{-1} (8.55), dry matter (16.61 g) and neck thickness (1.26 cm) at harvest which was at par with transplanting on flat bed. Whereas minimum plant height (44.55 cm), number of functional leaves plant^{-1} (7.35), dry matter (14.86 g) and

Table 1: Effect of land configuration on growth, yield and economics of onion

Treatment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T_1 : Broadcasting on flat bed	44.55	7.35	14.86	0.94	4.73	4.04	73.00	17.44	1.10	59819	139075	79256	2.32	17710	37100
T_2 : Line sowing on flat bed	48.05	7.74	15.13	1.03	4.81	4.51	74.46	19.00	1.14	56329	154400	98071	2.74	21200	18285
T_3 : Broadcasting on broad bed furrow	45.25	7.44	14.90	0.99	4.77	5.56	75.14	18.01	1.13	60819	143935	83116	2.37	16710	33240
T_4 : Line sowing on broad bed furrow	49.13	7.79	15.86	1.12	4.86	5.72	76.51	19.98	1.15	57329	163450	106121	2.85	20200	10235
T_5 : Transplanting on ridges and furrow	54.00	8.55	16.61	1.26	5.01	5.87	79.86	23.39	1.21	77529	193885	116356	2.50	-	-
T_6 : Transplanting on flat bed	52.25	8.39	15.95	1.23	4.88	5.76	76.68	22.20	1.18	76529	183345	106816	2.40	1000	9540
S.E(m) ±	0.29	0.06	0.07	0.02	0.02	0.08	0.30	0.13	0.01	-	1071.40	1071.40	-	-	-
C.D at 5%	0.88	0.20	0.21	0.07	0.06	0.26	0.91	0.41	0.03	-	3229.55	3229.55	-	-	-
General Mean	48.87	7.88	15.55	1.09	4.84	5.24	75.94	20.00	1.15	64726	163015	98289	-	-	-

1. Plant height (cm); **2.** Number of leaves plant^{-1}; **3.** Dry matter plant^{-1}; **4.** Neck thickness (cm); **5.** Polar diameter (cm); **6.** Equatorial diameter (cm); **7.** Average weight of bulbs (g); **8.** Bulb Yield(t ha^{-1}); **9.** Leaves Yield (t ha^{-1}); **10.** Cost of cultivation (Rs ha^{-1}); **11.** Gross monetaryreturns (Rs ha^{-1}); **12.** Net monetary returns (Rs ha^{-1}); **13.** B:Cratio; **14.** Reduction in cost ofcultivation over T_5 (Rs ha^{-1}); **15.** Reduction in netmonetaryreturn over T_5 (Rs ha^{-1})

neck thickness (0.94 cm) were recorded on broadcasting on flat bed. This might be due to the fact that in transplanting, the root system of plant was already developed immediately after transplanting start to absorb moisture and nutrients at transplanted site. Similarly, the ridges and furrow create congenial environment in root rhizosphere for increasing the availability of moisture, nutrients and aeration which resulted in increasing the plant height. Whereas in broadcasting method uneven plant population which create competition for moisture and nutrients in flat bed as well as broad bed furrows. These findings are in accordance with Muthal (2018) and Kadari *et al.* (2019).

The yield attributes viz., polar diameter, equatorial diameter, average weight of bulb, bulb yield and leaves yield. Yield attributes differed significantly with land configuration and planting methods. Maximum polar diameter (5.01 g), equatorial diameter (5.87 g), average weight of bulb (79.86 g), bulb yield (23.39 t ha^{-1}) and leaves yield (1.21 t ha^{-1}) were recorded on ridges and furrow which was at par with transplanting on flat bed. The higher bulb yield with ridges and furrow and transplanting of onion seedling might be because of ridges and furrow provides continuous soil aeration, optimum moisture and available nutrients throughout the crop growth period. Similarly transplanting of six weeks old seedlings having well established root system with stored food material in bulb which immediately start the absorption of moisture and nutrients. The cumulative effect of these factors help to enhances all the growth and yield attributes *viz.*, plant height, number of functional leaves, neck thickness, polar diameter, equatorial diameter, average weight of bulb resulted in increased bulb yield of onion. Whereas the flat bed and broadcasting of onion seeds create unfavourable environment to crop i.e. soil compaction, less availability of moisture and nutrients, higher plant population in per unit area which increase the competition for growth resources throughout the growth period resulted in minimum values of growth and yield attributes and finally less bulb yield. These results are in accordance Muthal (2018) and Kadari *et al.* (2019).

The significant effect were observed with land configuration and planting methods in case of cost of cultivation, gross monetary return, net monetary return, B: C ratio. The highest gross returns (Rs.193885 ha^{-1}) and net monetary returns (Rs. 116356 ha^{-1}) were recorded on transplanting on ridges and furrows. But the highest benefit: cost ratio (2.85) recorded with line sowing on broad bed furrow. Looking to the different land configuration and planting methods, the maximum reduction in cost of cultivation of Rs. 21200 ha^{-1} was observed with line sowing on flat bed followed by line sowing on broad bed furrow Rs. 20200 ha^{-1}. Whereas in respect of reduction in net monetary returns, it could be seen that minimum reduction of Rs. 9540 ha^{-1} was found with transplanting on flat bed followed by line sowing on broad bed furrow with Rs. 10235 ha^{-1}. This might be due to reduction in cost of transplanting where maximum manpower was required as compared to line sowing by tractor drawn automatic seed drill. Based on reduction in cost of cultivation and net monetary returns the line sowing on broad bed furrow found next best treatment after transplanting on ridges and furrow method. Therefore under constraint situation, the line sowing on broad bed furrow found suitable alternative land configuration and planting method for onion cultivation in *kharif* season. These results corroborate with Muthal (2018) and Kadari *et al.* (2019).

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High-tech Agriculture Tools and Techniques for Sustainable Agriculture and Doubling Farmer Incomes by Adopting Holistic Ecosystem

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ABSTRACT

Adopting a holistic ecosystem approach to address challenges faced by the Indian agriculture sector is of national interest, to achieve objectives, like doubling farmer incomes and sustainable development. Thus, a multi-stakeholder approach will be required for the wide-scale adoption of digital agriculture in India, with the government playing a key enabler's role in the ecosystem. As a result, it can be stated that information technology is an important aspect of farming and should be fully embraced, we need to move away from the local and traditional agricultural methods. When compared to traditional farming, IT integrated farming has the potential to produce higher yields. Many new technologies for farming have been developed in recent decades, ranging from the worldwide navigation system to numerous sensors for measuring soil and crop conditions.

Keywords: Doubling farmer incomes, High-tech agriculture, Holistic ecosystem, Sustainable agriculture, Tools and techniques

INTRODUCTION

With the growth of human population in geometric progression, there is a need for smart farming methods as just growing more crops and increasing cattle to feed the population will not solve the issue of feeding the fast-growing world population. This is where Precision Agriculture (PA) technology comes in. It is simply described as incorporating technologies to current farming methods with the goal of farming smarter (Mcconnell and Burger, 2017). The application of precision agriculture is expected to yield an increase in productivity which ultimately ends in profit to the farmer, to the society increase sustainability and also improve the economy. It is one of the key approaches in the agricultural sector that links both environmental and economic interests (Ullah *et al.*, 2017). The technologies integrated with precision agriculture includes Global Positioning System (GPS), Mobile devices, robotics, driverless tractor, Internet of Things, Sensors, Variable Rate Seeding, Weather modelling, Unmanned Aerial Vehicle (UAV) etc. (Antonio *et al.*, 2016). Incorporating these technologies has increased efficiency of farming methods, can control global food crisis, monitor crop and animal health thus increasing yield and brings about smarter ways to grow food thus regulate the use of land. The four main phases of precision agriculture are: The data collection deals with the boundary of field remote sensing, weather data, crop condition, and irrigation testing. The analysis phase determines the variability, determine possible causes of variability, how much do measure soil and crop characteristics, and how much do the variations affect crop yield and crop quality. The management and decisions phase we check either it is possible to change the variability, how to change increase yield and quality while decrease input, and how to implement these changes. The end phase which is the farming phase is where we apply the decisions. Digitalization, the socio-technical process of applying digital innovations, is an

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increasingly ubiquitous trend. Digitalization in agriculture is thus expected to provide technical optimization of agricultural production systems, value chains and food systems. Furthermore, it has been argued that it may help address societal concerns around farming, including provenance and traceability of food, animal welfare in livestock industries and the environmental impact of different farming practices (Balafoutis *et al.*, 2017). Digitalization is also expected to enhance knowledge exchange and learning, using ubiquitous data and improve monitoring of crises and controversies in agricultural chains and sectors (Stevens *et al.,* 2016). The convergence of agriculture and information and communication technology (ICT) is a new development in India which is intended to increase efficiency in every process of production, distribution and consumption. This system can be also described as an integrated agricultural system. The main keys of the integrated agricultural system includes data processing and digital control machinery for digitization, data transmission, data collection, network and automation of agricultural activity (Tang, 2002). The current agriculture has converged with technologies such as information technology (IT), biotechnology (BT), environment technology (ET), and nano technology (NT). It mainly focuses on areas such as cost reduction during production level, reduction in labor burden, high quality and organic production, and quality management in facility. Second, it is important to meet consumers' needs at the production and distribution stages through building a system, which delivers food safety information. This means, IT applications need to be expanded in the agriculture farming automation system. Furthermore, at the distribution and processing stages, advanced distribution technologies using IT need to be introduced including the convergence of distribution data. These are the very small portions of the digital agriculture system that is part of making big database of the whole agriculture system.

REVIEW OF LITERATURE

Shepherd (2000) showed that usage of digital technologies in agriculture has proved the ability to increase in the production of commodities, food that can benefit the farmers. Considering marketing agriculture as the use of extensive digital data to support agricultural decision-making across the whole agricultural value chain, not only on farms or in production. It encompasses the application of "big data" to generate actionable information. As a result, it provides "the potential for a "nearly direct contact" between the customer and the food provider. They also recognize that integrating digital agriculture and equitably distributing its potential benefits will necessitate considerable agricultural system adjustments as well as the resolution of critical socio-ethical and technical concerns.

Salam (2020), in his study identified the Main Barriers to Digital Agriculture Technologies Adoption. According to his study, among the major issues in adoption, first is return on investment. The cost of digital agriculture equipment and services is still higher than their benefits. Thus naturally interest is low due to economic reasons. Secondly, digital agriculture technology business is mostly targeted to the big farms and thus smaller farm owners are excluded. Thirdly, enormous data is generated due to the application of digital technologies on the farm but there is a lack of decision tools. Thus, interception of this data and decision making become very time consuming for the farmers. Fourth, farmers prefer the educated guess based on their own experience rather than trust the sensing (*in situ* and remote), yield maps, and soil maps based recommendations. To add to the above, "the cost and availability of specialists for complex equipment, lack of manufacturer support, difficulty in putting up encompassing high value, precision portfolios are the limiting factors for precision business". Because of the above barriers, the digital agriculture business is not profitable.

Vasconez *et al.* (2019) focused on impact of digital technologies on method of farming, demanding different knowledge, skills and labour management among farmers. One strand of enquiry is rooted in systems design and focused on the practical issues of human-robot interaction in farming, such as ergonomics, health and safety.

Lioutas *et al.* (2019) examined how big data may affect farmers, both as users and co-producers of big data, and how it may guide their decision making, as well as how this affects and is affected by the wider community and institutional setting that farmers operate within farming system.

Bronson (2019) highlighted the norms and values embedded in digital agriculture concept, tool and artefact design and how this relates to the distribution of roles and balances power in various North American supply chains. She found that social actors working in private and public contexts to shape these innovations hold a narrow set of values that characterise a 'good farmer', 'good farming' and 'good technology' in such a way that their data practices privilege large scale and commodity crop farmers. The principle of research and innovation includes engaging engineers and designers, paying particular attention to social innovations in an emerging socio-technical system, which has had a rather technological innovation focus. Such an approach also identifies the need for necessary legal measures to regulate control over data and distribution of power connected to streamlined and standardized interoperable data systems.

Regan (2019) identified a range of risks perceived by agricultural sector stakeholders in Ireland. These include consumer rejection of technologies, inequitable distribution of risks and benefits within the farming community, adverse socio-economic impacts of increased farmer-technology interactions, and ethical threats presented by the collection and sharing of farmers' data. Her research demonstrates how ambiguity can surround the discussion. Based on this assessment, she called for a reflexive and transdisciplinary perspective to anticipate, with key governance actors, the risks of 'Smart Farming' in Ireland, through a responsible innovation approach.

Wiseman *et al*. (2019) revealed a lack of transparency and clarity around issues such as data ownership, portability, privacy, trust and liability in the commercial relationships governing digital agriculture. They found that these are contributing to farmers' reluctance to engage in the widespread sharing of their farm data. At the heart of farmers' concerns is the lack of trust between the farmers as data contributors, and those third parties who collect, aggregate and share their data. They found that farmers currently feel that they bear too much of the risk and vulnerability and argue that broader legal and regulatory issues must not be ignored. Current complex data licences presented to farmers are on a 'take it or leave it' basis. However, they argued that it is essential to ensure that the terms and conditions of data licences are understandable and transparent, in terms of who has access to the data, who derives the benefits of data sharing as well as how privacy concerns are addressed.

Ingram and Gaskell (2019) examined the organisation of digital knowledge systems and the process of digital co-design, and reflected on how languages and ontologies matter in terms of accessibility and use of search engines. Their analysis showed how involving users in the design of the user-centred ontology moves the search engine from an information processing synaptic capacity to a semantic capacity (beyond current web semantic abilities), where common meaning concerning specific agricultural domains can be represented and shared. They illustrated that the remaining interpretative differences can be overcame by building pragmatic capacity and managing knowledge at a pragmatic boundary through further multiple interactions with users.

Ayre *et al*. (2019) demonstrated that creating and adapting to these new advisory roles is not easy. Digital innovation presents challenges for both farmers and advisors, due to the new relationships, skills, arrangements, techniques and devices required to realise value for farm production and profitability from digital tools and services. They analysed how a co-design process supported farm advisers to adapt their routine advisory practices and identify the value proposition of digital farming tools and services for their and their clients' businesses. This co-design process supported an adaptation of advisory services in both their front-office and back-office dimensions. This process involves finding ways to harness and mobilize diverse skills, knowledge, materials and representations for translating digital data, digital infrastructure and digital capacities into better decisions for farm management.

Ullah *et al*. (2017) surveyed about the technologies and challenges in precision agriculture. They begin by identifying a greater need for efficiency in current farming methods to be able to meet the goal of feeding an ever-growing population, which the FAO expects to reach 9.2 billion by 2050. They proceed to list different technologies, challenges and state-of-the-art methods based on artificial intelligence and image processing for efficient precision agriculture. They mentioned artificial neural networks (ANNs) and fuzzy logic controllers for regulation of temperature and humidity in artificially conditioned greenhouses and UAV based pest controllers and sprayers as some of the solutions.

Tanvi Deshpande (2017) highlighted about the agriculture output becoming volatile. Findings of the study shows that 86 per cent of the landholdings are less than 2 hectares and informal sources of credit constitutes 40 per cent of loans.

Zhao *et al.* (2016) described different methods for acquiring spatial information about farmlands using remote sensing techniques towards the requirements of decision making in precision agriculture. They noted that to achieve the goals of precision agriculture, high-density, high speed, and low-cost supply of spatial information on crops, soil, and environmental conditions is necessary. They listed remote sensing techniques to estimate chlorophyll in crops, Nitrogen in crops, water content of crops and crop LAI (leaf area index). They also listed the data that can be captured using sensors and calculators in tractors and reapers. They also described an automatic soil sample collection system consisting of a sampling device and a recording device to determine soil nutrition and fertility. At the same time, they made it clear that remote sensing data cannot be directly applied in agricultural decision and suitable models are needed to interpret the collected information to provide support for farmland production management.

Yang *et al.* (2016) studied precision agriculture in large scale mechanized farming. According to the, the central concept of precision agriculture is identification and management of within field variability with the aim to improve farm input efficiency, increase farm profits, reduce environmental impacts and improve sustainability. They listed four steps for automatic implementation of the concept of precision agriculture:

1. Measuring spatial variability
2. Analyzing data and making site-specific recommendations
3. Implementing the variable-rate application (VRA) of farm inputs
4. Evaluating the economic and environmental benefits.

Thus in their opinion, "A broader view of precision agriculture would include more than VRA. It is more about helping farmers better manage their operations and correct inadvertent errors using sensing and control to automate and more precisely carry out field operations." As far as adoption of precision agriculture is concerned, they are clear that any new farming practice is adopted only for economic gains and precision agriculture requires a high initial investment cost which may not be immediately compensated in the initial years of adoption and thus despite technological advances and potential benefits, the global adoption of precision agriculture is slower than expected. Owing to these challenges they recommend 3 broad areas for further work:

1. Development and integration of low-cost variable-rate components (i.e., sensors, controllers, and actuators) into/with existing fertilizer application equipment
2. Development of low-cost and easy-to-use tools to determine site-specific fertilizer application rates and create prescription maps so that field profitability can be enhanced more effectively with minimum inputs; and
3. Long-term systematic studies on the economic feasibility and environmental impacts of variable-rate fertilization.

Mulla and Khosla (2015), noted that the terms site-specific and precision farming were introduced into scientific literature by John Schueller from the University of Florida. He helped organize an important symposium on this topic at the 1991 Annual Meeting of the American Society of Agricultural Engineers (ASAE) in Chicago. According to Schueller, "the continuing advances in automation hardware and software technology have made possible what is variously known as spatially-variable, precision, prescription, or site-specific crop production." They noted that the economics of precision farming is still a work progress as technologies and management techniques improve. However, the major factor that continues to influence the economics of precision farming is commodity prices. They found that increased commodity prices, which result in higher economic profits for farmers, also result in greater investment in new technologies including precision farming. They also found that the decline in commodity prices slow down and reverse the adoption of precision farming.

Strobel (2014) observed that the development of precision agriculture technology started in the 1960s, listed the 5 major tools of technology out of the several tools used in precision agriculture, namely: yield mapping, guidance and global positioning systems (Global National Satellite System, GPS), variable rate technology (VRT), con- trolled traffic farming (CTF), and Geographic information systems (GIS). Farmers appreciate the value of this data but are also apprehensive about its uses once it is freely available, it can be used for selective marketing of inputs, or to manipulate prices and other such uses which may be detrimental to farmer interests. Thus the question about data privacy and ownership of such data arises. The most common ways of ensuring data privacy is through confidentiality agreements but that has its limitations. To ensure continued protection to the data from precision agriculture and protect farmers' interests, is through legislative and policy changes to prevent the leak of data produced by precision agriculture to maintain privacy, and to retain ownership of data in the hands of the farmers. In this regards, Personal Information Protection Electronics Document Act (PIPEDA) of Canada and Health Insurance Portability and Accountability Act, or HIPAA of the US are suggested as templates, which should be followed.

Lawes and Robertson (2011) designed a model known as the economic optimization model to analyze VRT. This model is applied to 20 crops with different cost and nutrient levels, showed that only a third of the fields in our study achieved a significant return from VRT. The number of areas that will benefit from VRT is influenced by commodity and input prices, but these factors are uncontrollable.

Fountas *et al.* (2006) discussed about the designation of the systems-based model to describe farmers' decision-making processes in data activities, as well as its validation in Precision Agriculture. To describe a farm manager's decision-making process, twenty-one decision-analysis elements were developed. The information flows from data to decision were then described using a general data flow diagram (DFD). The designed model was demonstrated in different university and concluded that its adaptable enough to accommodate different farm management plans and practices. It aided farm managers in organizing their decision-making processes and thinking more rationally.

Diederen *et al.* (2003) studied the adoption of innovations in the agriculture industry, as well as the behavior that guides adoption decisions, were investigated. They claimed that the advantage of their method is that the results are more reliable when they are not tied to a specific breakthrough. The primary focus of the research is on the search for, handling, and exchange of knowledge about innovations under the ideal market situation. And explain about the reason of using different techniques by the adopters vary from different criteria such as scale, business strategy, age, and solvency.

FUTURE OF DIGITAL AGRICULTURE IN INDIA

Application of digital agriculture: Technological interventions based on remote sensing, soil sensors, unmanned aerial surveying and market insights, etc., permit farmers to gather, visualise and assess crop and soil health conditions at different stages of production, in a convenient and cost-effective approach. They can act as an initial indicator to identify potential challenges and provide options to deal with them in a timely manner. Artificial Intelligence/Machine Learning (AI/ ML) algorithms can generate real-time actionable insights to help improve crop yield, control pests, assist in soil screening, provide actionable data for farmers and reduce their workload. Blockchain technology offers tamper-proof and precise data about farms, inventories, quick and secure transactions and food tracking. Thus, farmers don't have to be dependent on paperwork or files to record and store important data.

Benefits of Digital Agriculture

Access to Finance: The farmers in India today face acute shortage of money due to the various challenges. Digital transformation helps the farmer in getting access to funds from various sources due to the exposure and awareness they get from being digital.

Forecasts on Climate Change: In India, the ability to forecast weather changes and in turn the impact that it would have on farming, has been a difficult task. Having the right inputs on potential Climate

Change will help the farmer in deciding the right seed to grow and in turn fulfill the demand that is out in the market.

Access to Farming Equipment and New Technology: In many of the developed countries, Robotics play a bigger role in farming. India is yet to see this advancement and hence there is a crucial need for this transformation. - Inputs for Better Soil Fertility and Soil Structure: The farmer in India rarely does an investigation of the fertility of the soil and hence the kind of seed to grow. What has been done in the past generations is what the Indian farmer today develops. There is thus a need to have a more scientific approach to agriculture.

Access to Markets: The farmer, though he does all the hard work today, is not compensated fairly for the work he does. Due to middle-men involved in the buying and selling of the farmer's products, the actual farmer gets a pittance compared to the profits that the middle-men make. There is thus a need for a platform which will enable the farmer to sell directly to the buyers (rather than go through middle-men.

Access to Information: The farmer today bases his produce based on his peers and what has culturally been grown in his land. What worked yesterday or for someone else, does not always mean a success for today or for ourselves. The farmer will have to try out new experiments based on the information available which will enable him/her to produce more and get the right financial backing. The digital transformation is expected to handle this appropriately.

Predictive Analytics: Using the latest technology available in the market, if the agriculture sector is ignited with this digital transformation, the amount of data that would be available will help the farmer in growing the right crops at the right time. Thus the standard of living for the Indian farmer would go up, which would in turn encourage others to get engaged in farming

The Future of Agriculture with Digital Technology

As previously stated, effective software solutions can be developed using information technology to address the demands of Indian farmers. Efficient web tools and communications protocols can ensure the availability of these types of technologies. The collection of the entire range of application packages and databases is required to complete the work. Agriculture is a mixture of many little locations, needing an ocean of data inputs, combining all of this data is a large process. As a result, the most feasible choice is to develop technical solutions personalized. It is advisable that the system design be framed only after thoroughly reviewing the problem; we must depart from the usual way of developing the system first and then adding inputs in order to achieve realistic outcomes. Crop stress, soil issues, obstacles, natural disasters, and other issues can all be addressed efficiently with this technique. Farmers today have access to a variety of information. They have so much data that they don't know what to do with it. AI is capable of assessing large volumes of data in a short amount of time and recommending the best course of action. This data may then be used to predict the ideal time to plant, predict pest and disease outbreaks before they happen, and provide in-field inventory management that could predict yields before harvest.

CONCLUSION

Precision Agriculture have helped the farmer in getting a good amount of the crop compared with the normal way, and the amount of expenditure are also reduced by following this new technology. Furthermore, precision farming, which is based entirely on data, can boost yields and enhance crop quality while also conserving the environment. This new technique has a bright future, especially because it adds to every farmer's most crucial goal. Hence it can be concluded that the technology platform will bring the desired outcomes in agricultural sector like reduced costs, improved productivity and quality, improved prices, reduced risks and ultimately sustainable ecosystem. Policies need to adapt to this changing Digital world to overcome the challenges and lead to increased efficiency in the production, distribution and consumption of agriculture produce.

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Documentation of Medicinal Plants Used for the Treatment of Hypertension in Jammu Division of Jammu and Kashmir

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ABSTRACT

The current study takes a relook into the traditional knowledge of medicinal plants. The study area is rich in plant biodiversity that is being exploited by the indigenous community for their benefit. The study has proved that plants being used for the treatment of hypertension are playing very important role in meeting the primary health care of indigenous communities of the study area. The elder people of the study area have deep knowledge about the medicinal use of the local plant species that has been transferred to them over generations. Thus, the results of the study will not only broaden the list of species used against hypertension, but will also provide the basis for further pharmacological and phytochemical studies that are critical for the discovery of anti-hypertensive drugs.

Keywords: Hypertension, Medicinal Plants, Treatment

INTRODUCTION

Modern sedentary lifestyle has resulted in numerous lifestyle diseases in humans. Most common among them are hypertension and diabetes. Hypertension is a medical condition during which the systolic/diastolic pressure of the heart exceeds 120/80 mm/Hg. It is regarded as a silent killer because most of the people that have it do not realize it. According to an estimate, 1.13 billion people suffer from hypertension across the globe (WHO, 2013). Hypertension is a common asymptomatic, identifiable and usually treatable disease but if left untreated the consequences can be fatal. Hypertension is also the primary reason for cardiovascular and kidney disease (Stamler *et al.,* 1993; Vasan *et al.,* 2002). Lowering blood pressure reduces the chance of stroke by 35 to 40 per cent while other conditions including heart attack and heart failure can be reduced by 25 and 50 per cent, respectively (Weiss, 2011). The prevalence of hypertension is higher in low and middle income countries than higher income countries. Hypertension has been reported to be the fourth contributor to premature death in the developed countries and the seventh in developing countries (Kilbert and Mesfin, 2015).

Man has been dependent on nature for treating various ailments. It has been proved that natural resources such as wild plants are a source of biologically active compounds and products that can be used as medicines and are a potential source of modern drugs (Togola, 2008; Newman, 2008).

Out of approximate 250000 higher plants on earth, more than 80000 species are reported to be of some medicinal value. In India, about 20000 plant species are having medicinal uses. A large population in India depends upon herbal medicines for treating common to severe heath conditions since these are easily available and cheap. Another reason for people's dependence on herbal medicines may be due to weak healthcare system in the rural areas (Bhandari and Dutta, 2007).

The present study was framed to collect and document the information on traditional use of medicinal plants for the treatment of hypertension by the Himalayan people. It is assumed that the results of the present study will provide the basis for further pharmacological and phytochemical studies that are critical for the discovery of anti-hypertensive drugs.

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MATERIAL AND METHODS

Study area: Union territory of Jammu and Kashmir (J&K) is predominantly a Himalayan region in the north-western part of India (between 32° 172 and 36° 582 North latitude and 73° 262 and 80° 302 East longitude) with an area of 222236 sq. km. It is bigger in size than combined geographical area of nearby Himalayan countries of Bhutan and Nepal. J&K is mainly mountainous, except for a short belt adjoining the Punjab plains and the valley of Kashmir. Jammu region possesses great altitudinal variation, diverse geological formations and different climatic zones like sub-tropical, tropical, temperate, alpine and cold desert and is bestowed with a variety of natural resources including numerous important medicinal and aromatic plants. In Jammu, two districts viz., Doda and Samba were selected for the present study. Doda district lies in the outer Himalayan range between 32° 53´ and 34° 21´ North latitude and 75° 01´ and 76° 47´ East longitude and has an average elevation of 1107 metres. Samba district is situated on the foothills of Himalayas and lies between latitude of 32° 342 North and 75° 072 East and longitude of 32° 572 North and 75° 122 East and has an average elevation of 384 m.

Sampling plan: There are 10 districts in Jammu region, out of these, Doda and Samba districts were selected purposively for the present study as they represent two contrasting agroclimatic zones, wherein Doda being temperate to sub-temperate and Samba being predominantly subtropical. There are 8 blocks in Doda district and 4 blocks in Samba district. From each district, half of the blocks were selected purposively, so that no adjacent blocks get selected and the whole of the district is represented. By this way, 6 blocks namely Assar, Bhaderwah, Gundna and Thatri from district Doda and 2 blocks namely Purmandal and Vijaypur from district Samba were selected. Within each block, villages were selected on the basis of random sampling. In all, 24 villages from 6 blocks were selected. The selected villages were Humbal, Khronti, Recho, Assar, Barwah, Balote, Bhalra, Bhatoli, Gadater, Gundna, Bhart, Dal khankote, Chegsu, Bhela, Agrika and Banoia from the district Doda. Gurgani, Sangar, Nandak, Padal, Sarna, Kabilla, Lovely and Kherdi from the district Samba. Five respondents were selected randomly from each village. By this way, 80 respondents from Doda and 40 respondents from Samba were selected, making a total of 120 respondents.

The data pertaining to ethnopharmacological survey was collected during the year 2018 and 2019, respectively. Visits to the study area were carried during February to May each year. The aim of the survey was to interact with maximum number of indigenous communities, particularly the tribes and people living in remote areas. During the survey, herbal healers, elder people were contacted and the objective of his study was explained to them, in order to conduct the personal interview to document the plants used for treating hypertension. Only those who agreed were further interviewed. The questions were asked in the local language (Dogri/Urdu) based on the pre-structured questionnaire. Questions were asked regarding the local name of the plants, medicinal use (hypertension), plant part used, habit, status, method of crude drug preparation, mode of consumption, method of collection and storage.

Plant collection, identification and deposition in herbarium: The medicinal plants were collected from different sites of the study area during the field trips. In case of herbs, whole plants were collected, while fruiting or flowering shoots of trees and shrubs were collected. In field note book, the detailed information of the collected specimens' were recorded that included their local name, habit, date of collection, and locality. During collection of plants from the field, help from informants such as herbal healers, elderly peoples, shepherds was taken for identification of plants and their local names were recorded. The plant specimens were finally brought to Division of Agroforestry. Final identification of the specimens was done according to their field characters and confirmation was done by consulting various floras. Finally, the plants were mounted on herbarium sheets and deposited in the Division of Agroforestry, Chatha, SKUAST-J for future records.

RESULTS AND DISCUSSION

Demographic profile of the respondents: A total of 180 respondents were interviewed in the present study out of which 105 were male and 15 were female. Most of the respondents were illiterate (29.16%), 19.16 per cent had primary school education, 22.5 per cent

Table 1: List of plants used for treating hypertension in Jammu Division

Scientific name	District	Local name	Family	Growth habit	Mode of consumption	FC
Achillea millefolium L.	Doda	Gandna	Asteraceae	Herb	Powder	19
Ajuga bracteosa Wall. ex Benth.	Doda	Neelkanthi	Lamiaceae	Herb	Decoction	12
Allium sativum L.	Samba	Thom	Amaryllidaceae	Herb	Eaten raw	23
Angelica glauca Edgew.	Doda	Chora	Apiaceae	Herb	Powder	16
Artemisia annua L.	Doda	Tarkha	Asteraceae	Shrub	Decoction	13
Atropa belladonna L.	Doda	Sagangur	Solanaceae	Shrub	Powder	7
Carica papaya L.	Samba	Papita	Cariaceae	Tree	Ripe fruits eaten	21
Cedrus deodara (Roxb.) Loud.	Doda	Diar	Pinaceae	Tree	Decoction	15
Diospyros lotus L.	Doda	Amlook	Ebenaceae	Tree	Ripe fruits eaten	11
Inula racemose Hook f.	Doda	Pushkarmol	Asteraceae	Herb	Powder	18
Juglans regia L.	Doda	Akhrot	Juglandaceae	Tree	Ripe fruits eaten	27
Moringa oleifera Lam.	Samba	Swajan	Moringaceae	Tree	Powder	11
Origanum vulgare L.	Doda	Marzanjosh	Lamiaceae	Herb	Decoction	17
Prunus armeniaca L.	Doda	Haadi	Rosaceae	Tree	Ripe fruits eaten	33
Rauvolfia serpentina Benth. ex Kurz.	Samba	Sarpgandha	Apocynaceae	Herb	Powder	9
Saussurea costus (Falc.) Lipsch.	Doda	Kuth	Asteraceae	Herb	Powder	14
Terminalia arjuna Wight & Arn.	Samba	Arjan	Combretaceae	Tree	Decoction	17
Terminalia bellerica Roxb.	Samba	Behera	Combretaceae	Tree	Powder	15
Tinospora cordifolia (Willd.) Miers	Samba	Giloe	Menispermaceae	Climber	Decoction	14
Valeriana officinalis L.	Doda	Murmou	Valerianaceae	Herb	Decoction	17
Viola odorata L.	Doda	Banafsha	Violaceae	Herb	Decoction	30
Withania somnifera Dunal.	Samba	Ashgandh	Solanaceae	Herb	Powder	12
Ziziphus mauritiana Lam.	Samba	Ber	Rhamnaceae	Tree	Ripe fruits eaten	8

Cultivated=C, Wild=W, FC= Frequency of citation

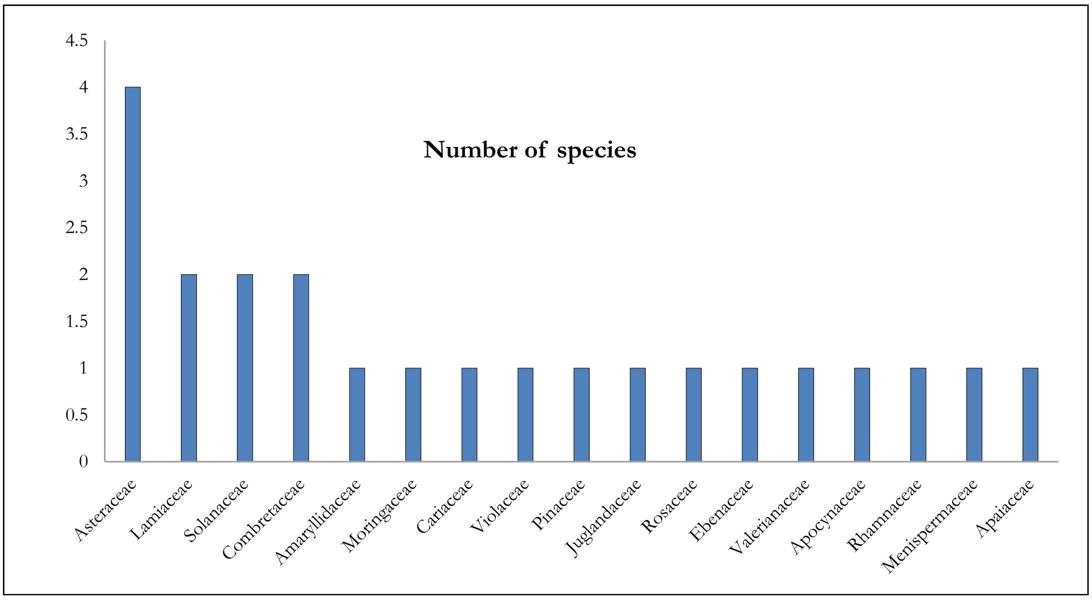

Figure 1: Number of plant species in different families

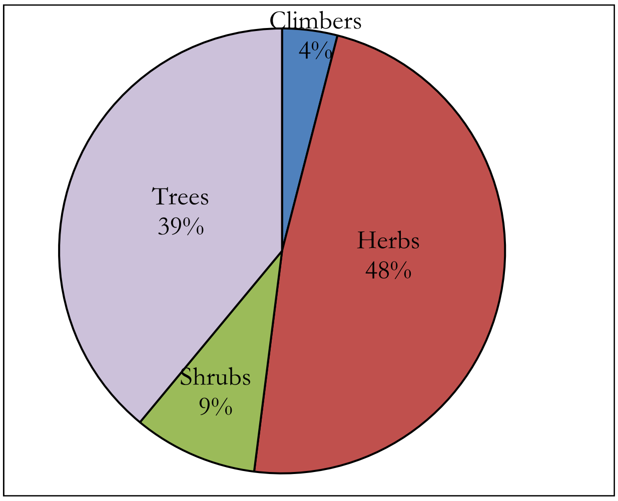

Figure 2: Growth habit of plants used to treat hypertension in Jammu Division (%)

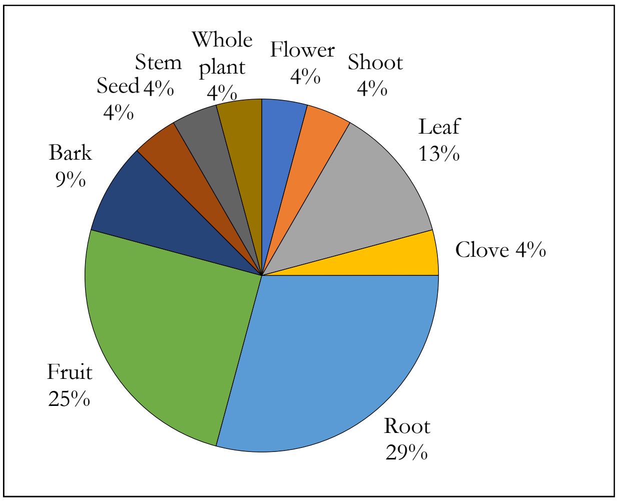

Figure 3: Plant parts used to treat hypertension in Jammu Division (%)

had middle school education, 19.16 per cent had completed matric and only 10 per cent were above matric. Majority of the respondents were farmers who had agriculture as their main occupation.

Plants used for treating hypertension: The ethnopharmacological survey conducted in Jammu Division reveals that a total of 23 medicinal plant species belonging to 22 genera from 17 families are being used to treat hypertension (Table 1). In terms of number of plant species used for treating hypertension in the Jammu Division, the results reveal that the most utilized plant families were Asteraceae (4 species) followed by Solanaceae, Lamiaceae and Combretaceae with 2 species each. Apiaceae, Moringaceae, Cariaceae, Amaryllidaceae, Apocynaceae, Rhamnaceae, Menispermaceae, Juglandaceae, Ebenaceae, Pinaceae, Violaceae, Valerianaceae and Rosaceae had one species each (Figure 1).

Growth form, part used and mode of consumption: Analysis of the growth habit of the medicinal plants used for the treatment of hypertension showed that most of the plants were herbs (47.8%) followed by trees (39.1%), shrubs (8.6%) and climbers (4.34%) (Figure 2). In traditional systems and folk uses, herbs are primarily used for the preparation of drugs as herbs are a rich source of secondary metabolites/ bioactive compounds that have medicinal properties.

The various parts of the plant used for the treatment of hypertension were root, fruit, flower shoot, leaf, bark, stem, seed and cloves**.** The most frequently used plants part was root (29%) followed by fruit (25%), leaf (13%), bark (9%), flower, shoot, seed, stem and clove (4%). In 4% of the species, whole plant was used to prepare the crude drug (Figure 3).

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Knowledge Level of Farmers Towards use of Social Media for Seeking Agricultural Information: A Study in Udham Singh Nagar District of Uttarakhand

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ABSTRACT

The study entitled "knowledge level of farmers towards use of social media for seeking agricultural information: A study in Udham Singh Nagar district of Uttarakhand" was undertaken with objective to find the knowledge level of farmers towards use of social media as a source of agricultural information and to analyze the relationship between socio-personal characteristics and knowledge level of farmers towards social media. The study was conducted in two purposively selected villages Malsagirdharpur and Saijani of Kichha block in Udham Singh Nagar district of Uttarakhand. Every third respondent was selected by systematic random sampling. Findings of the study revealed that majority of farmers had medium level of knowledge about "social media" *viz.* Facebook, WhatsApp, YouTube and Twitter. It was also noted that farmers had low knowledge about use of twitter for agricultural information. Further it was found that most of the farmers were linked with social media platforms for exchange of agricultural information. Education, Social media exposure, Innovativeness, Achievement motivation had positive and significant relationship with knowledge level towards use of social media as a source of agricultural information. The findings of the study will be helpful to researchers and policy makers for creating farmer friendly content and develop farmer oriented platforms on social media that can be accessed with ease and will be reliable.

Keywords: Social media, Knowledge level, Agricultural information

INTRODUCTION

Agricultural information creates awareness among farmers about agricultural technologies which is needed for overall development of agriculture and for the improvement in the living standard of farmers (Bello and Obinne, 2016). Agricultural information sources like extension services, research and educational institutions disseminate useful information to farming community, so that farmers can fully utilize the information for better decision making and take advantage of the market opportunities and be able to cope with the continuous changes in their production systems. Information is critical in agriculture development because it acts as a tool between stakeholders and serves as a channel for accessing trends and shaping decisions (Kalusopa, 2005). Extension services are an important tool for disseminating agricultural information to farmers and have been highlighted as critical agent needed to transform subsistence farming into modern and commercial agriculture to promote household food security, improve income and reduce poverty. Despite this, it has been observed that extension services are still limited in most parts of the country and that farmers' preference for any information source is significantly influenced by various socio-economic factors. Due to lack of reach of extension personnel to each and every household only small number of farmers are reached directly and it is often not possible to tackle and listen to individual problems because in India one extension

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officer served 1162 operation holding, i.e. the ratio of extension workers to operational holding is low at 1:1162 at the national level as against recommended 1:750 (Nandi and Nedumaran, 2019) also extension workers to farmers ratio is 1:5000 (Ragasa *et al.,* 2013). New approaches in extension system are needed to make the system more participatory in approach and farmers driven, as extension empowers farmers' with new knowledge and skills to improve the profitability in agriculture and giving farmers' a livelihood security. Social media is the most recent creation which has revolutionized the way people communicate worldwide and also helps in fast delivery of information. Social media serves a great place to start conversation, connect with both the young and old generation alike. Aided by mobile phones, social media is spreading fast across the world and has tremendous potential to be the biggest hub of agricultural information where farmer friendly content can be generated with the association of farmers, scientists, agricultural institutions and extension agents to bring about fruitful interaction for agricultural development. In India there are various examples where intervention of social media proved to be of great use to farmers. The "Young Innovative Farmers" WhatsApp group was started by Gurdaspur ADO (Agriculture Development Officer), Dr Amrik Singh on August 15, 2014 to educate farmers about crop health and other issues. Facebook page of turmeric farmers of Sangli, Maharashtra was created by Atul Salunke on 13th January 2012 to connect with other turmeric farmers of India for sharing critical information related to turmeric farming in real time to eliminate the problem of middle men. Baliraja -WhatsApp group of Maharashtra was created by Anil Bandawne on August 2015 to connect farmers with experts of varied backgrounds in agriculture. Gokak WhatsApp group of Karnataka farmers for organic vegetables was created by R.G. Nagannvar, Assistant Director of Agriculture Department of Karnataka in year 2015 to improve communication between farmers and consumers.

Agriculture plays an important place in the economy of India and can be revolutionized with the use of social media tools and platforms. The researcher has attempted to find out the knowledge level of farmers towards use of social media for seeking agricultural information and also analyzed the relationship between knowledge level of farmers towards use of social media and socio-economic characteristics of farmers for seeking agricultural information as it will help agricultural universities to identify areas where social media platforms are lacking and how it can be utilized for creating farmer friendly content and aid in building farmers' communities online to connect with one another. Also the study will throw light on social networking sites that are more in use among the farmers as there are various agriculture related sites, websites, applications available for farmers and they are useful to enhance the knowledge as well as utilizing the same in the field, it is important to study the knowledge level of farmers towards use of social media. Moreover, it will help extension agents to design training sessions for farmers who lack knowledge of using social media.

MATERIAL AND METHODS

The Universe of the study was the state of Uttarakhand formerly known as Uttaranchal in northern part of India is divided into two divisions, Garhwal and Kumaon with a total of 13 districts. Kumaon division was chosen purposively as State Agricultural University is in the division and it includes Almora, Bageshwar, Champawat, Nainital, Pithoragarh and Udham Singh Nagar district. Udham Singh Nagar district, the locale of the study was selected purposively because major occupation of the people in district is agriculture making it one of the most prosperous districts of the state surrounded by fertile land which is cultivated by the large farmers who are using improved seeds, fertilisers, irrigation and technology. Kichha block was selected purposively for the study where resides most of the farming communities and has large amount of agricultural available land in the district. Out of 95 villages in Kichha block two villages namely Malsagirdharpur and Saijani were selected for the present study purposively because they were nearest to the city of Rudrapur and Pantnagar University where various agricultural information sources are available thus creating suitable conditions for farming community to get updates of recent information about agriculture. Systematic random sampling was used to select one farmer from every third house making a total sample size of 106 from the selected block Kichha of Udham Singh Nagar district and villages *viz.*

Malsagirdharpur and Saijani. The purpose of using random sampling was to maintain uniformity in the sample and equally represent farmers from each village lowering down the biasness. Social media that were in use for agricultural information purposes in India have been selected purposively for the study. These include Facebook, WhatsApp, YouTube and Twitter as it was seen from various cases that these social media platforms were widely in use for agricultural purposes.

Knowledge level of farmers towards use of social media was the dependent variable which refers to the familiarity of respondents about the existence of social media and its utilization in agriculture sector for accessing agricultural information. For measuring knowledge level of respondents about social media, knowledge test with 16 knowledge statements was carefully designed and administered to find out the knowledge level of the farmers regarding social media as a source of agricultural information. For 'known' statements one score was given and for 'unknown' statements zero score was given. Nine independent variables were selected for the study *viz.* age, education, size of land holding, years of farming experience, media ownership, social media exposure, information seeking behavior, innovativeness and achievement motivation of farmers. Analytical research design was used for the present study. Pre tested interview schedule containing structured questions and knowledge test was designed and used for data collection. Appropriate statistical tools such as mean, frequency, standard deviation, Karl's Pearson coefficient of correlation and testing significance of coefficient of correlation were used to arrive at some result and conclusion.

RESULTS AND DISCUSSION

The information regarding socio-personal characteristics of the farmers which included age, education, size of land holding, years of farming experience, media ownership, social media exposure, information seeking behavior, achievement motivation and innovativeness has been presented in Table 1.

Statement wise analysis of knowledge level of farmers towards use of social media is presented in Table 2. It is clear from the data that majority (85.85%) of farmers had knowledge about social media and its benefits of use in agriculture while 14.15 per cent of

Table 1: Socio-Personal Characteristics of farmers (n=106)

Category	Frequency	Percentage
Age		
<39	15	14.15
39-59	73	68.87
>59	18	16.98
Education		
Illiterate	10	9.43
Primary education	4	3.77
Middle school	13	12.26
High school	35	33.02
Intermediate	28	26.42
Graduation	14	13.21
Post graduation and above	2	1.89
Size of land holding		
Landless (<=0.002 hectares)	0	0
Marginal (0.002-1.000 hectares)	0	0
Small (1.000-2.000 hectares)	0	0
Semi - medium (2.000-4.000 hectares)	15	14.15
Medium (4.000-10.000 hectares)	29	27.36
Large (>10.000 hectares)	62	58.49
Years of farming experience		
Less than 5 years	0	0
5-10 years	2	1.89
10-15 years	15	14.15
15 years or more	89	83.96
Media ownership		
Radio	5	4.72
Television	106	100
Mobile phone	106	100
Fixed phone	0	0
Computer with internet	53	50
Newspaper	57	53.77
Social media exposure		
Low (upto 1)	30	28.30
Medium (1-3)	63	59.44
High (above 3)	13	12.26
Information seeking behavior		
Low (<5)	1	0.94
Medium (5-15)	88	83.02
High (>15)	17	16.04
Innovativeness		
Low (<13)	2	1.89
Medium (13-15)	85	80.19
High (>15)	19	17.92
Achievement motivation		
Low (<26)	3	2.83
Medium (26-30)	80	75.47
High (>30)	23	21.70

Table 2: Distribution of respondents on the basis of knowledge level of farmers about social media (N=106)

Statements	Know	Don't know
Social media such as Facebook, Twitter, YouTube and WhatsApp provide agricultural information.	91(85.85)	15(14.15)
Social media provides retrievable agricultural information.	91(85.85)	15(14.15)
Social media provides information related to crop insurance and government policies.	91(85.85)	15(14.15)
Social media provides information about new agricultural innovations.	91(85.85)	15(14.15)
Social media allow users to share video, audio and images related to agricultural problems.	91(85.85)	15(14.15)
You can send information about agriculture to many different places within a short time period through social media.	91(85.85)	15(14.15)
Social media allow user to create agriculture businesses and help in increasing farmers' income.	91(85.85)	15(14.15)
Social media can be used to communicate directly with experts in various fields of agriculture	91(85.85)	15(14.15)
Various social media accounts can be linked to each other.	91(85.85)	15(14.15)
Social media provides information directly to individual farmer about weather, soil, fertilisers, harvesting time,etc.	91(85.85)	15(14.15)
Social media allow users to create account without any cost.	91(85.85)	15(14.15)
Social media provides agricultural information in multiple languages.	91(85.85)	15(14.15)
Social media allows farmers to be directly linked to various agricultural institutions & Govt. schemes.	91(85.85)	15(14.15)
Social media allow user to post information publicly, send and receive messages directly.	91(85.85)	15(14.15)
Social media allow user to form community groups to help in exchange of ideas and solutions to farmers' problems.	91(85.85)	15(14.15)
Social media allow user to contact with other farmers groups worldwide.	91(85.85)	15(14.15)

*Data in parenthesis denote percentage

farmers had no knowledge about social media, its use and its benefits in providing agricultural information. From the above data it can be concluded that majority of farmers had medium level of knowledge about social media that were selected for the study *viz.* Facebook, WhatsApp, YouTube and Twitter and their use for agricultural information related to crop insurance, new agricultural innovations, weather, soil, fertilisers, harvesting time, etc. Also, they had knowledge that social media is a useful tool to connect directly with various institutions, government agencies and farmers of other nations as well. Most of the farmers were linked with various social media platforms for exchange of information, ideas and getting solution to their problems by sharing posts, messages, video and audio clips. It was also noted that few farmers had low knowledge level about social media specifically about use of Twitter for agricultural information.

Data in Table 4 reveals factors affecting the knowledge level of farmers towards use of social media in agriculture. The result of the analysis indicated that among the nine independent variables, six were found to be statistically affecting the knowledge level of the farmers.

Table 3: Category wise distribution of respondents on the basis of knowledge level towards use of social media as a source of agricultural information (n=106)

Category	Frequency	Percentage
Low (less than 8)	15	14.15
Medium (between 8-20)	91	85.85
High (more than 20)	0	0

Table 4: Relationship between characteristics of farmers and knowledge level about social media as a source of agricultural information

Independent variable	Correlation coefficient (r value)	't' value
Age	-0.313**	-3.361
Education	0.611**	7.871
Size of land holding	-0.087	-0.891
Years of farming experience	-0.338**	-3.662
Media ownership	0.084	0.860
Social media exposure	0.548**	6.681
Information seeking behaviour	0.058	0.592
Innovativeness	0.237*	2.488
Achievement motivation	0.219*	2.289

* - 5% level of significance, degree of freedom =104, $t_{tab=\pm1.983}$

**- 1% level of significance, degree of freedom =104, $t_{tab=\pm2.624}$

Farmers age had significant relationship with knowledge level because majority of farmers were middle aged who had knowledge about use of social media for agriculture. Educational qualification of farmers was found to be positive and significantly related with knowledge level of farmers about social media as a source of agricultural information and therefore, it can be generalized that increase in level of education increases knowledge level about social media. It was also inferred that size of land holding had no effect on the knowledge level of farmers about social media and there was no significant relationship. Years of farming experience had significant relationship with knowledge level of farmers about social media which reveals that farmers who traditionally practiced agriculture for more than 15 years as an occupation were more knowledgeable about use of social media as a source of agricultural information. Media ownership was found to be non significant with the knowledge level of farmers about social media indicating that possession of various media tools does not increase the level of knowledge towards use of social media for agricultural information. Social media exposure of farmers was significantly related to knowledge level of farmers therefore, it can be generalized that greater the use of various social media platforms on a regular basis higher will be the knowledge level about use of social media for agricultural information. The information seeking behavior of farmers had no significant relationship with knowledge level of farmers about social media which meant that the farmers were not utilizing social media for seeking agricultural information while in reality they were using social media for other purpose like sending message, sending images and video calling. Innovativeness and achievement motivation of the farmers was significantly related with knowledge level of farmers towards use of social media as a source of agricultural information indicating that majority of farmers were prone to change in life and were ready to use various new sources of information.

CONCLUSION

The results of the study revealed that majority of the farmers had medium knowledge level towards use of social media and its utilization for agricultural information where WhatsApp was found to be most popular and widely used medium of communication allowing farmers to create agricultural groups focusing on one specific topic of farming and increasing connections in that group to send message, video, audio instantly related to their problems and also gaining access to information shared by scientist and others acting as a medium to start agribusiness and help in increasing income sources. Facebook was another most popular social networking site used by farmers for creating user profile, following pages related to farming and agriculture, connecting with farming communities of other places and nation, commenting, discussing, sharing and liking. YouTube provided farmers an opportunity to watch, upload and download video demonstrations, lectures, discussions, farming methods etc. with the feature of commenting and liking on the video. The findings gave an overview about the knowledge farmers had about social media as a source of agricultural information and will help the government, policy planners, web developers to understand the gaps in information service sources provided by social media and generate solutions to combat the problems.

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