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ABOUT THE SOCIETY

MOBILIZATION Society was established in 2003 as a non-profit professional society aimed at sensitizing and mobilizing development partners and community for sustainable development. The Society, during these ensuing years has successfully mobilized researchers, academicians, planners, grass root mobilizers and student and created conducive intellectual atmosphere for introspective deliberations and conducted National seminars/workshop to address the emerging problems experienced by the agrarian mass. Presently the Society has more than 2000 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 5.02 and Journal ID J171. 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 application of behavioural nudges in agricultural extension research and field implementation represents a scientifically grounded and cost-effective approach to fostering sustainable agricultural practices, accelerating technology adoption, and improving on-farm decision-making. Given the complex interplay of cognitive, social, and economic factors influencing farmer behaviour, especially in resource-constrained and risk-prone environments, there is a pressing need to move beyond conventional linear models of information transfer. Strategically designed interventions such as timely digital prompts (e.g., SMS reminders), commitment mechanisms, default choices, social norm reinforcement, and framing of extension messages have demonstrated potential in steering farmers toward desired behavioural outcomes. For maximum efficacy, these nudges must be context-sensitive and participatorily developed, aligning with the local socio-cultural fabric and decision-making contexts. To institutionalise this paradigm, it is essential to embed behavioural insights within national and regional extension policy frameworks, invest in capacity building of extension personnel in behavioural science methodologies, and promote interdisciplinary collaboration among behavioural economists, social scientists, and extension practitioners. Furthermore, robust monitoring and evaluation systems incorporating behavioural indicators are crucial to measure the impact, adaptability, and scalability of such interventions across diverse agro-ecological and socio-economic settings.

I proudly place the current issue of the MOBILIZATION journal, which encapsulates a multi-dimensional exploration of research themes that matter most to practitioners, scholars, and policymakers in rural development. The articles explore diverse yet interconnected themes, including technology adoption and knowledge dissemination, as seen in studies on ginger cultivation, FMD vaccination, and zero-budget natural farming, while highlighting the role of participatory approaches like Farmer Field Schools and willingness to adopt climate-resilient practices. Gender and youth perspectives are addressed through investigations into women's access to agri-resources, time-saving devices, and digital addiction among adolescents, emphasizing inclusive rural development. Health and nutrition are focal points in studies examining jaggery consumption, lifestyle diseases, and diabetic-friendly diets, reinforcing the relevance of nutrition-sensitive agriculture. Educational research adds depth through analyses of pragmatic learning methods and faculty attitudes toward online education. Sustainability and climate adaptation emerge through evaluations of natural farming, eco-friendly practices, and adaptation barriers. Technological and agronomic innovations are presented through cluster demonstrations and advanced processing techniques, contributing to enhanced productivity. Further, socio-economic realities are reflected in assessments of mechanization, indebtedness, and livestock census methods, while price trends and market behaviour are examined via time-series analysis. The issue also sheds light on psychosocial aspects through studies on workplace environments and stress management. Methodologically, the journal introduces tools like validated knowledge tests and conceptual frameworks such as Quantum Social Science (QSS), showcasing its commitment to both empirical precision and theoretical advancement.

On behalf of the editorial board, I extend sincere thanks to all contributors for their valuable research, which enriches this issue and advances the discourse on agricultural and rural development. I also commend the editorial team for their professionalism and dedication, and express heartfelt gratitude to our readers for their continued support and engagement..

J.P. Sharma
Chief Editor



Review Article

A Review on Different Research Studies on Adoption Process

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ADOPTION

Adoption as a process composed of learning, deciding and acting over a period of time. The adoption of a specific practices is not the result of a single decision to act but a series of actions through decisions. (Wilkenning, 1956). Adoption is a decision to continue full use of an innovation (Rogers 1962).

Copp (1958) expressed that the adoption of recommended farm practices has been conceptualized as a latest behavioral predispositions, which is manifested in the acceptance of specific recommended practices. He further, added that adoption could be viewed as a product of the farm operator's life situation, including such aspects as economic status, social position and characteristics of work orientation.

Ramsey *et al.* (1959) had different approach to the concept. They contended that adoption was of two types.

- i. Behavior adoption and
- ii. Cognitive adoption involving critical evolution of practices

Where behavioral adoption was observe by the number of practices actually put into practice, cognitive adoption involved the complex decision and change including obtaining knowledge, critically evaluating the practices in terms of individual situation.

Adoption of farm practices has been conceptualized as a process involving a number of successive stages by rural sociologists. One of the important contributions made by adoption researches is the concept of sequential nature of adoption. Rural sociologist have come out with a number of

conceptual propositions regarding the stages of adoption related to farm innovation. For analytical purpose, adoption behavior of an individual farmer has been conceptualized by Ryan and Gross (1943), North Central Rural Sociology Sub-committee (1955), Beal, Rogers and Bholen (1957) and Wilkenning (1956) as a process composed of number of successive stages.

Wilkenning (1956) postulated the acceptance of innovation may be viewed as a function of social relations in an ideological system (ideas, values and sentiments) of farmers. One finds support of this view in work of Copp (1958) and Rogers (1962). However Rogers went a step further and analyzed technological change by conceptual variable analysis. According to him the paradigm of the adoption of an innovation by individual contains three major division

- i. Antecedents
- ii. Process and
- iii. Results

Antecedents are those factors present in the situation prior to the introduction of an innovation. Antecedents are of two major types

- i. The actor's identity, and
- ii. His perception of the situation

The actor's identity, which effects of the adoption of innovation, is comprised of his sense of security, his dominant values, his mental ability and conceptual skills, his social status, and his Cosmo politeness.

The actor's perception of the situation affects his adoption behavior. The social system norms on innovations serves as incentives or restraints on his behaviors. The economic constraints and incentives, and

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the characteristics of the unit such as the farm, business, or school) and also affects adoption behavior.

According to Copp, Sills and Brown (1958), it is quite natural that adoption of technology innovation in agriculture should be regarded as a process. Adoption is an activity of the farmers taking place over a period of time. From first awareness to regular use, there must be a transformation in the orientations and behaviors of the farm operator. Adoption of a farm practice is a bundle of related events following through time, not an instantaneous metamorphosis.

Coughenour (1960) viewed adoption as a function of dynamic interrelationship of independent elements expressed in terms of variables.

Emery and Oeser (1958) viewed adoption of farm practices as a “consequences of communication”.

ADOPTION PROCESS

Rogers (1962) defined adoption process as the mental process through which an individual passes from first hearing about an innovation to final adoption.

The process of adopting new innovations has been studied for over 30 years, and one of the most popular adoption models is described by Rogers in his book, *Diffusion of Innovations* (Sherry & Gibson, 2002). Much research from a broad variety of disciplines has used the model as a framework. Dooley (1999) and Stuart (2000) mentioned several of these disciplines as political science, public health, communications, history, economics, technology, and education, and defined Rogers' theory as a widely used theoretical framework in the area of technology diffusion and adoption. Rogers' diffusion of innovations theory is the most appropriate for investigating the adoption of technology in higher education and educational environments (Medlin, 2001; Parisot, 1995).

Adoption process is one type of decision-making:

The adoption of innovation requires a decision by and individual. He must begin using a new idea and in most cases, decides to cease using an idea that the innovation replaces.

Decision-making is the process by which an evaluation of meaning and consequences of alternative lines of conduct is made. Johnson and Haver (1953) listed the following steps in decision making

- i. Observing the problem
- ii. Making an analysis of it
- iii. Deciding the available course of action
- iv. Taking courses and
- v. Accepting the consequences of the decision.

Decision-making is thus a process that may be divided into a sequence of stages with a different type for activity occurring during each stage. Likewise, the way in which an individual adopts an innovation is viewed by researchers as a process. Adoption of a new idea is a bundle of related events following through time in short, it is a process.

Stages in adoption process: The adoption process may be arbitrarily broken down into stages for conceptual purposes. This breakdown is

- i. Consistent with the nature of phenomena
- ii. Congruent with previous research findings, and
- iii. Potentially useful for practical applications.

The adoption process has been depicted in terms of various models verifying from three to seven stages. The one advocate by Singh (1956) consist of seven stages:

- i. **Need:** This is a stage of discontent when an individual wishes to change the existing practices.
- ii. **Awareness:** The individual just comes to know about an innovation without knowing the details of it.
- iii. **Interest:** He makes an attempt to know more about the innovation.
- iv. **Deliberation:** This is a stage of deliberating on “to try or not to try” (mental evaluation)
- v. **Trial:** An individual uses an innovation in part or sometimes on full scale.
- vi. **Evaluation:** The individual evaluates the performance of the innovation.
- vii. **Adoption:** It is a decision to use the practices on a continued basis.

The North Central Rural Sociology Subcommittee for the study of Diffusion of Farm Practices (1955) identified five stages of adoption process.

i. **Awareness stage:** At the stage individual is exposed to the innovation but later complete information about it. For instances, he may know only the name and may not know what the idea or product is, what it will do or how it will work. The primary function of the awareness stage is to initiate the sequence of later stage that lead to eventual adoption or rejection of the innovation.

ii. **Interest stage:** The primary functions of the interest stage in mainly to increase the individual's information about the innovation. The 'cognitive' component of behavior is involved at the interest stage (Lavidge and Steiner, 1961). At this stage the individual is more psychologically involved with the innovation than at the awareness stage.

The interest stage has been referred to as the 'Information' stage by Beal and other (1957) as the 'knowledge' step by Lavidge and Steiner (1961).

iii. **Evaluation stage:** The evaluation stage is probably least distinct of the five adoption stages and empirically one of the most difficult about which to question respondents. At this stage, the individual makes a mental trial of new idea or practices. He applies the information obtained in the previous stage to his own situation.

Other research workers have termed the evaluation stage 'application' (Bael and others, 1957; Bael and Rogers (1960), 'acceptance' (Copp and others, 1958), 'Conviction' (Rogers and Yost 1960, Rogers and Pitzer, 1960). The evaluation stage and to some extent the trial stage also, is essentially similar and to the 'liking' and 'preference' steps of Lavidge and Steiner (1961). All these terms imply that an affective component of behavior, a favorable or unfavorable feeling towards the idea is involved at evaluation stage

iv. **Trial stage:** The main function of the trial stage is to demonstrate the new idea in the individuals own situation and determine its usefulness for possible complete adoption. It is thus a validity test or 'dry-run'. Most persons will not adopt an innovation without trying in first on s probationary basis. While rejection of the innovation may occur of any stage in the adoption process, it sometimes happen when the results of the trial stage are misinterpreted.

v. **Adoption stage:** At this stage the individual decides to continue full use of the innovation. According to Lavidge and Steiner (1961) the conative or motivational component of behavior is involved at the adoption (and trial) stage.

These five stages are not necessarily rigid patterns, which people follow, nor a set of exclusive and discrete categories with no overlap. Rather they present five sequence that can be clearly identified very frequently by both researchers and farmers. At any stage the recommendation can be thrown off. There can be jumping from one stage to another. If the farmers have confidence in the extension workers and his recommendation they may jump from 'evaluation to adoption stage'.

Rogers (1983) have used the term "Innovation-decision process" in preference to 'adoption process' and have conceptualized the following five stages.

i. **Knowledge:** The individual is exposed to the innovations existence and gains some understanding how it functions.

ii. **Persuasion:** The individual forms a favorable or unfavorable attitude toward the innovation.

iii. **Decision:** The individual engages in activities which lead to a choice to adopt or reject the innovation.

iv. **Implementation:** It occurs when an individual or other decision making unit puts an innovation into use.

v. **Confirmation:** The individual seeks reinforcements for the innovation decision he has made but he may reverse his previous decision if exposed to conflicting messages about the innovation.

Adopter categories and the diffusion S-curve

Adopter categories are the classification of individuals within a social system on the basis of innovativeness (Rogers, 1962).

Most diffusion researchers have classified adopters into categories on the basis of relative time at which they adopt an innovation. In a number of empirical cases, adopter distribution were either normal or closely approached normally. The normal distribution

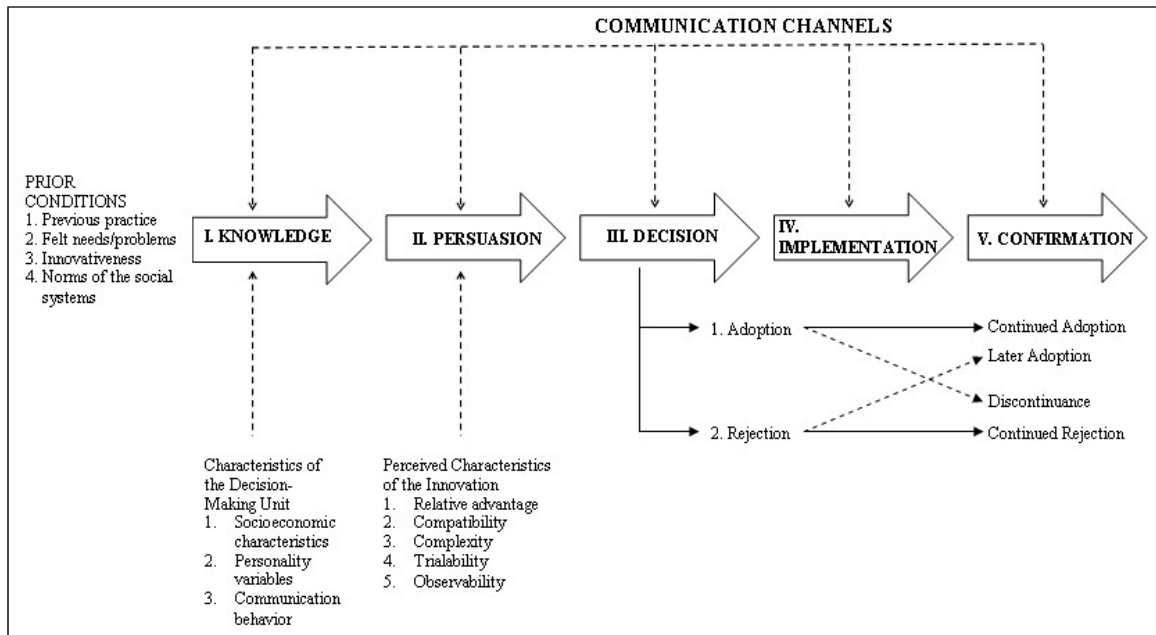


Figure 1: A Model of Five Stages in the Innovation-Decision Process

(Source: Diffusion of Innovations, Fifth Edition by Everett M. Rogers. Copyright (c) 2003 by The Free Press. Reprinted with permission of the Free Press: A Division of Simon & Schuster.)

has two parameters, the mean and the standard deviation, which may be used to divide the distribution into five portions. These five areas under the normal curve are labeled as innovators, early adopters, early majority, late majority, and laggards.

Their usual distributions are indicated by the percentages after the categories, based on the

percentages associated with standard deviations of the normal curve of innovation adoption. Curve with a sigmoid pattern (from Dearing & Kee, 2012, published with permission from Oxford University Press)

Innovators (2.5%), early adopters (13.5%), early majority (34.0%), late majority (34.0%), and laggards (16.0%). The cumulative version of this curve for

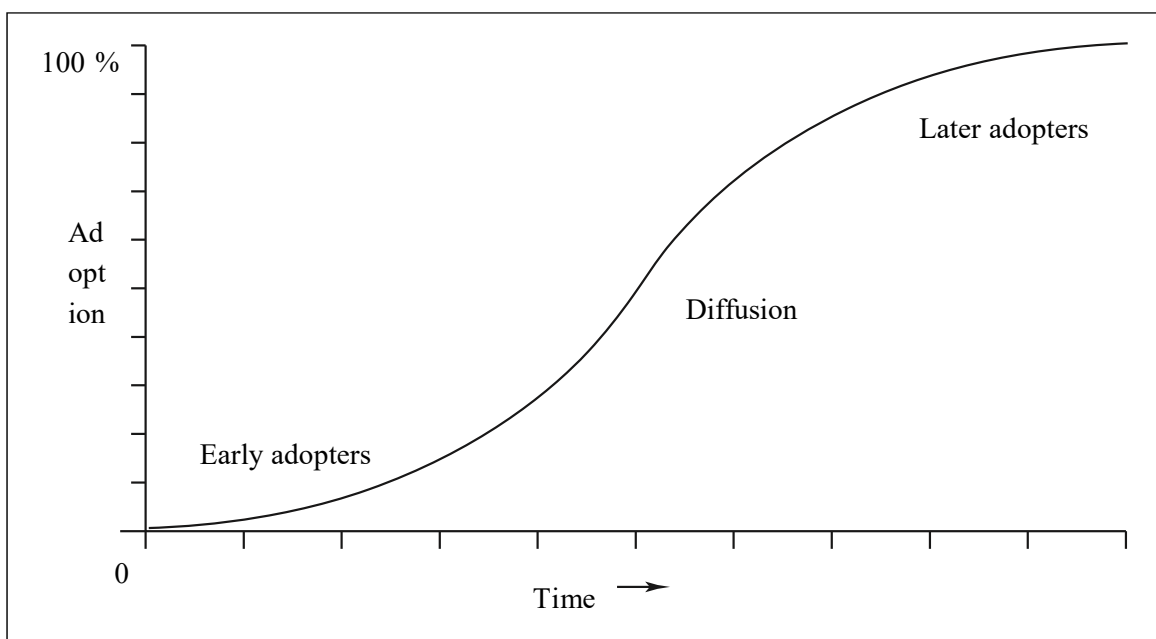


Figure 2: The cumulative adoption curve over time forms

adoption over time forms what is known as the S-shaped curve (sigmoid pattern: Figure 2).

Innovators are usually venturesome. They have the ability to understand and apply complex technical knowledge. They are able to cope with a high degree of uncertainty. They have also been referred to as technology enthusiasts. Early adopters usually accept an innovation after a careful evaluation of its attributes. After adoption, they put a stamp of approval on the innovation, and others like to seek out their opinions and evaluations. A key characteristic is the respect they have from their peers. They have also been called visionaries. The early majority adopts the innovation right before the average member of a system does. However, they may deliberate for some time before completely adopting a new idea. Therefore, they are also termed pragmatists in the literature. The late majority is usually cautious about the innovation. Adoption may be both an economic necessity for them and the result of peer pressure. They are the conservatives. Laggards tend to be suspicious of innovations and change agents. They are also usually lagging far behind awareness knowledge of a new idea. They are labeled as skeptics. In addition to these five categories, a related concept introduced in later research was the notion of the lead users. These are users who contribute to product design during the innovation development phase. Because they themselves are users

of the product, their design concepts can foreshadow the needs and interests of the marketplace (Figure 3).

Once a new product attracts a substantial number of adopters, a condition to spark a takeoff of the product is referred to as achieving critical mass. Achieving critical mass refers to attracting the number of users necessary to influence and trigger a rapid and wide adoption by other members within a social system. The concept of critical mass implies that adopters have varying network thresholds which prevent individual adopters from acting until the thresholds are met, at which point adoption occurs.

New technology adoption cycle

Every new technology and product experience an adoption life cycle by the market. In an attempt to understand this process better in particular for high tech products and technologies, Geoffrey A. Moore had studied this thoroughly. The outcome of his research is a term that is well known today among every professional who works in the technology field and it is the chasm.

So after understanding what Rogers *et al.* defined in terms of social adoption as mentioned above we can talk about Moore's development. Moore claims that there is a gap between the early adopters and the early majority (Figure 4). This gap is what he and other

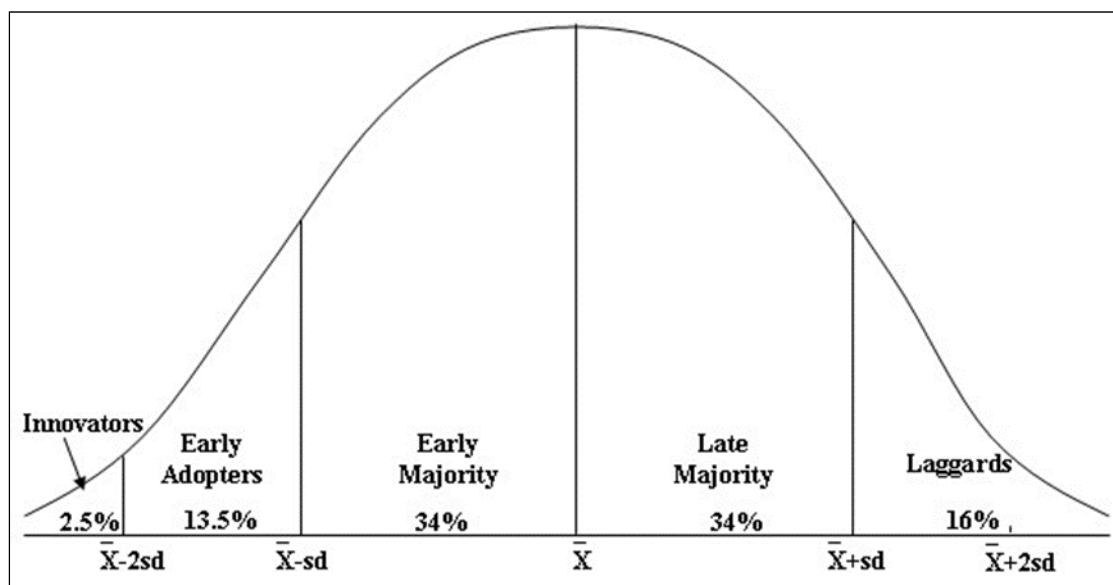


Figure 3: Adopter Categorization on the Basis of Innovativeness

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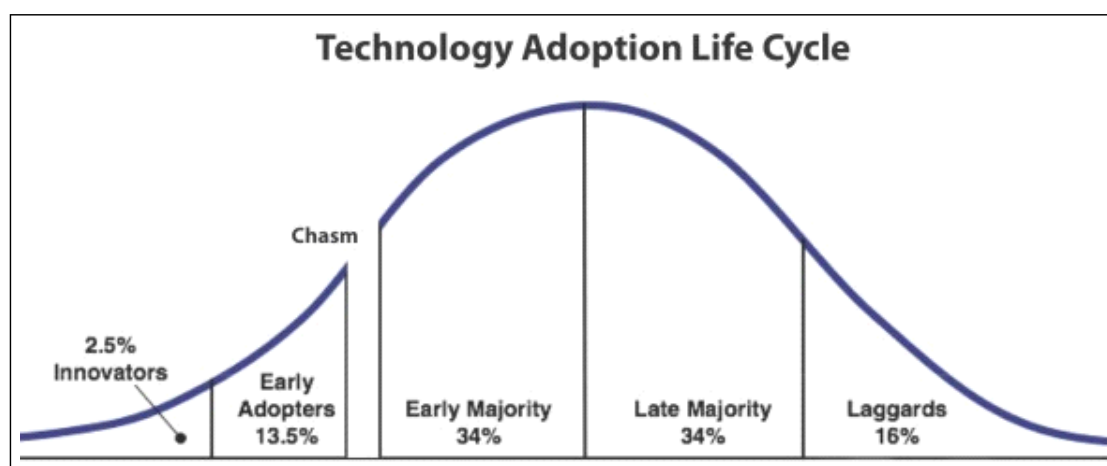


Figure 4: Technology adoption life cycle

professionals in the field refer to as the chasm. According to their perspective, the chasm is what defines success or failures to new ventures. If a company will succeed in crossing the chasm, it will be adopted by the market. That means that once an innovation will be adopted by more than ~16% of the market its probability to succeed will grow dramatically.

Mode and sequence of agricultural technology adoption

Attentions have also been given to explaining the mode (approach) and sequence of agricultural technology adoption. Two approaches are common in the agricultural technology adoption literature. The first approach emphasizes the adoption of the whole package while the second one stresses step-wise or sequential adoption of components of a package. Technical scientists often recommend the former approach while field practitioners specifically farming system and participatory research groups advance the latter. There is a great tendency in agricultural extension programs of developing countries to promote technologies as a package and farmers are expected to adopt the whole package.

Opponents of the whole package approach strongly argue that farmers do not adopt technologies as a package, but rather adopt a single component or a few suitable technologies (Mann, 1978; Byerlee and Hesse de Polanco, 1986). Several adoption studies reviewed by Nagy and Sanders (1990) and Leather and Smale (1991) concluded that farmers choose to adopt inputs sequentially. Initially, adopting only one

component of the package and subsequently adding components over time, one at a time. The major reasons often given for sequential adoption of a package of technologies are profitability, riskiness, uncertainty, lumpiness of investment and institutional constraints (Byerlee and Hesse de Polanco, 1986; Leather and Smale, 1991). A farmer first selects the technology that best exhibits these attributes. Another study by Ryan and Subrahmanyam (1975) revealed that farmers might look upon each part of the technological package as a less risky activity than the complete package in terms of what the farmer could lose if crop failure occurs in that season. Their study concluded that sequential adoption of components of technological package is a rational choice for farmers with limited cash. As cash is accumulated from previous adoption of a component of a package, farmers will add another component based on the relative advantage and its compatibility under their condition. This process will continue until the whole package is fully adopted.

A study by Rauniyar and Goode (1996) defined patterns of technology adoption based on the relationship between the technological components adopted. First, the study termed the adoption pattern independent, if the technologies (practices) are independent of one another. Under such conditions the adoption pattern of a farmer will be largely random (Rauniyar and Goode, 1996). This assertion is not in agreement with a study by Rogers (1983), which showed that farmers' adoption decision is not random. Farmers make rational decisions taking into account the environment under which they operate. The probability of adopting a given technology is not

conditioned by the adoption of the other technology. Secondly, if farmers adopt technologies in a specific order, the adoption pattern is sequential. This implies that the probability of adopting a technology is conditional on adopting technologies that precede it in the sequence. Thirdly, the adoption pattern becomes simultaneous if more than one technology is adopted as a package and no specific adoption of a technology precedes or follows the adoption of another technology.

REFERENCES

- Anderson, T.; S. Varnhagen and K. Campbell. 1998. Faculty adoption of teaching and learning technologies: Contrasting earlier adopters and mainstream faculty. *The Canadian Journal of Higher Education*, 28(23), 71-78.
- Barnett, H.G. 1953. *Innovation-The Basis of cultural change*. McGraw-Hill Book Company, New York.
- Beal, G.M. and E.M. Rogers. 1960. The adoption of two Farm Practices in a Central LOWA Community, Arnes. *IOWA Agricultural and Home Economics Experiment Station Special Report*, 26.
- Beal, G.M.; E.M. Rogers and M.J. Bholen. 1957. Validity of Concepts of Stages in Adoption Process. *Rural Sociology*, 22(2): 166-168.
- Bradbury, F.R. 1978. Technology Transfer. In: Bradbury, F.R. *et al.* (eds.) *Transfer Process in Technological Change*. Sintoff and Noordhoff, pp. 109-117.
- Copp, J.H. 1958. Towards Generalization in Farm Practices Research. *Rural Sociology*, 23: 105-111.
- Copp, J.H.; Sills and E.J. Brown. 1958. The Functions of Information Sources in the farm Practices Adoption Process. *Rural Sociology*, 23: 146-157.
- Coughenour, M.C. 1960. The Functioning Farmers Characteristics, in Relation to Contact with Media and Practice Adoption. *Rural Sociology*, 25: 183-297.
- Coughenour, M.C. 1968. Some General Problems in Diffusion from the Perspective of the Theory of Social Action. *Diffusion Research Needs*, Columbia: North Central Regional Research Bulletin, University of Missouri, USA.
- Lavidge, R.J. and G.A. Steiner. 1961. A Model for Predicting Measurement of Adoption Effectiveness. *Journal of Marketing*, 25: 59-62.
- Rogers, E.M. 1962, 1983, 1995. *Diffusion of Innovations*. The Free Press, New York
- Wilkening, E.A. 1953. Adoption of Improved Farm Practices as related to Family Factors, Wisconsin Experiment Station Research Bulletin 1283, Wisconsin.

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Research Article

Integrated Management of Anthracnose of Commons Beans (*Phaseolus vulgaris* L.) Amidst Temperate Conditions of Kashmir Valley

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ABSTRACT

The cultivation of common beans is subjected to various production constraints, with anthracnose emerging as a prominent challenge. The reliance on chemical fungicides in conventional agricultural practices not only jeopardizes agricultural systems but also disrupts ecological equilibrium. To address this concern, alternative approaches involving the utilization of bio-control agents and plant extracts in seed treatment for sowing are imperative. Consequently, the present investigation titled “Integrated management of anthracnose of commons beans (*Phaseolus vulgaris* L.) amidst temperate conditions of Kashmir Valley” was undertaken during the Kharif season of 2020. A comprehensive disease management strategy was formulated, demonstrating that seed treatment with a combination of mancozeb (63%) and carbendazim (12%) at 0.3% concentration, followed by two foliar sprays, the first utilizing carbendazim 50 WP at 0.1% during the first trifoliate stage and the second employing mancozeb (63%) + carbendazim (12%) at 0.3% during the second trifoliate stage, resulted in the lowest disease incidence (3.19%), disease intensity (1.61%), and the highest pod yield (82.37 q ha⁻¹) among all treatment combinations. In contrast, the control plot exhibited the highest disease incidence (46.51%), disease intensity (23.29%), and the lowest pod yield (51.40 q ha⁻¹). This research underscores the significance of integrated disease management practices for mitigating anthracnose in common bean cultivation, thereby contributing to sustainable and eco-friendly agricultural systems.

Keywords: Bio-agents, Fungicides, Incidence, Intensity, Plant extracts, *Phaseolus vulgaris*

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is a pulse crop grown for dry seeds as well as tender pods and taxonomically finds its position in the family Fabaceae (Romero-Arenas *et al.*, 2013). From the enormous and oceanic literature available on common bean production constraints, diseases always catch our eye. Among various diseases reported which affect the common bean crop Anthracnose leads the list in terms of devastating and catastrophic yield limiting threat. Anthracnose of common bean was first reported in

India in Nilgiri Hills in 1915 by Hutchinson and Ayer. Common bean is taken as a *kharif* crop in general, so the humid and cool environmental conditions predispose the pathogenic attack (Tu, 1988; Kumar *et al.*, 1999). Infection can occur at any phenological stage provided the interaction quadrangle is satisfied. The pathogen results in loss of yield qualitatively as well as quantitatively in both green as well as dry beans (Pastor-Corrales and Tu, 1989). Common bean anthracnose is primarily a seed borne disease (Tu, 1983; Kumar *et al.*, 1999). Primary inoculum source is the infected seed or

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infected crop debris. *Colletotrichum lindemuthianum* survives inside the seed coat as dormant mycelium and can endure the temperature of -15 to -20 °C for a shorter span of time (Mordue, 1971a, 1971b). So, for the effective management of the said disease we need to use healthy seeds and fungicide treated seeds for sowing (Tu, 1992). The continuous dependence on chemical fungicides poses threat to agricultural systems and disturbs ecological balance (Maloney, 1995). Yield losses vary from cultivar to cultivar due to varying resistance responses, maximum yield loss in highly susceptible and susceptible bean cultivars and highest yield reduction (70.59%) recorded in jawala bean cultivar and least yield reduction (2.81%) in moderately resistant cultivar (Him-1) due to seed infection (Sharma *et al.*, 2008). Drastic yield reduction was reported in anthracnose susceptible cultivars ranging from 38 to 100 per cent under varying situations (Mukunya and Keya, 1979; Shao and Teri, 1985; Makini and Danial, 1995; Sartorato *et al.*, 1998). Taking into account the prominence and irreplaceable role which common beans play in our lives and the prevalence of the major disease (Anthracnose) that limits the yield of our crop of interest, present investigation was undertaken to tackle the threat by developing a suitable and sustainable strategy to combat this disease by validating the impact of different treatment combinations under *in vivo* conditions for the proposal of a best possible integrated disease management capsule.

MATERIALS AND METHODS

The current study entitled as “Integrated management of anthracnose of commons beans (*Phaseolus vulgaris* L.) amidst temperate conditions of Kashmir Valley” was carried out during *kharif* 2020 under *in vivo* conditions in the Division of Plant Pathology, Faculty of Agriculture, SKUAST-K Wadura Sopore, which finds the coordinates on globe as 34°-20' north latitude and 74°-24' east longitude with an elevation of 1590 meters above mean sea level. The materials and methodologies concerning the research problem are described under following headings and sub-headings:

Etiology of the disease

Isolation of the pathogen: Above ground aerial parts like leaves and pods showing characteristic symptoms of anthracnose caused by *Colletotrichum lindemuthianum* were collected and microscopy was done

to confirm the presence of pathogen in the diseased tissue. After collecting infected samples from the field, isolation of pathogen was done by tissue bit transfer method (Sicard *et al.*, 1997). Infected samples of leaf and pod were cut in to minute pieces followed by surface sterilization with 0.1% mercuric chloride for a time period of 30 seconds (Jhonston and Booth, 1983). After surface sterilization, tissue bits were washed three times in the sterile distilled water serially. To remove the moisture, tissue bits were placed on sterilised filter paper under laminar-air-flow cabinet. Now dry sterilized tissue bits were transferred/ inoculated in Petri plates and test tubes containing solidified cold potato dextrose agar under aseptic conditions i.e., under laminar-air-flow cabinet. Inoculated plates and slants were kept in incubator to maintain temperature at around 25°C for the promotion of test fungus growth.

Purification and maintenance of the pure culture:

Purification of fungal culture was done by employing single spore method (Jhonston and Booth, 1983). Spore suspension of *C. lindemuthianum* was prepared followed by dilution with sterilised distilled water to get 8 to 10 spores per microscopic field at low power. The pure culture of test fungus was maintained for subsequent use by sub-culturing at 30 days interval. Storage of culture was done in PDA slants stored at 4-5°C. For each experiment fresh culture of *C. lindemuthianum* was used to nullify the effects of vigor loss which occurs due to storage and sub-culturing.

Pathogenicity test

Test for pathogenicity of isolated fungal pathogen was done on common bean cultivar KDB-17 which is susceptible to anthracnose. The plants of said cultivar were raised from healthy and infection free seeds in plastic pots containing inoculum free soil, sand and farmyard manure in proportion of 2:1:1 by weight. Inoculum free growing media for plants was made possible by autoclaving it. Fresh culture of test fungus was prepared on PDA in Petri plates mixed with 10 ml distilled water. Conidia production occurred while mixing culture mass of said fungal pathogen in water. The resulted suspension was subjected to filtration through cheese cloth having four fold thicknesses. The concentration of conidia in the suspension was adjusted to about $1 \times 10^6 \text{ ml}^{-1}$ by making use of haemocytometer. Inoculation with the spore suspension was done to

foliage of 20 days old plant in the evening time with atomizer. Un-inoculated plants were also given the foliar spray of sterilized distilled water to mask the effect of humidity difference which arises due to foliar spray of spore suspension in inoculated plants. Un-inoculated plants served as control and both inoculated and un-inoculated plants were kept under humid chamber (glass house) for two days. The observations were recorded periodically concerning the disease development. After observation of diagnostic symptoms and confirmations from microscopic examinations, the pathogenicity of test fungus was confirmed as it qualified the postulates of Robert Koch.

To develop integrated management capsule for the disease

The treatments selected for *in vivo* study concerning the management of anthracnose of common beans include:

- (1) Non-systemic fungicide = Mancozeb 63% + Carbendazim 12%
- (2) Systemic fungicide = Carbendazim 50 WP
- (3) Bio-agent = *Trichoderma viride*
- (4) Botanical = *Allium sativum*

For devising an integrated management capsule against the anthracnose of common beans a field trial was laid during *kharif* 2020 in the farm belonging to Division of Plant Pathology, FoA, SKUAST-K Wadura Sopore. The adopted experimental design for field trial was randomized block design with 2m × 1m block size. One block contained as many as 60 plants approximately as per the spacing guidelines mentioned in package and practices of *kharif* vegetables by SKUAST-K. The selected common bean cultivar for *in vivo* management of anthracnose was KDB-17, which is a susceptible cultivar. The seeds of said cultivar were given treatments with fungicides and bio-agents separately and foliar application of botanicals and fungicides was also done. First foliar spray was given at the first trifoliate stage and second at 15 days after the first spray. Control plots were sprayed with water to nullify the effect of water used in fungicide spray.

Observations to be recorded

Disease incidence: For calculating disease incidence, symptoms on leaves and pods play a key role. It was calculated by a formula which is quoted below:

Seed treatments- 04

- S₀ No seed treatment (Control)
 S₁ Systemic fungicide
 S₂ Non-systemic fungicide
 S₃ Bio-agent

Foliar sprays- 04

- F₀ No foliar spray (Control)
 F₁ 1st spray with systemic fungicide and 2nd spray with non-systemic fungicide
 F₂ 1st spray with systemic fungicide and 2nd spray with plant extract
 F₃ Two successive sprays with plant extracts

$$\text{Per cent disease incidence} = \frac{\text{No. of infected leaves}}{\text{Total no. of leaves examined}} \times 100$$

Disease intensity: This attribute was estimated by selecting ten random plants and employing the rating scale of 0-9 which was given by Mayee and Dattar, 1986. Six categories were made on the basis of percent infected area of leaves and pods and these include:

Scale	Symptoms
0	Disease free leaves and pods
1	Minute round spots with leaf area < 1% and tiny flecks on pods
3	Spots with brown colour and sunken appearance occupying 1-10% foliage and 1% pod
5	Brown coloured spots with foliage area as 11-25% and pod area of 1-10%
7	Round, brownish spots with sunken appearance with foliage area coverage of 26-50% and pod area of 11-25%
9	Round to irregular spots covering > 50% foliage area and > 25% pod area

Per cent disease intensity was calculated by the formula given as:

$$\text{Per cent disease intensity} = \frac{\sum(n \times v)}{N \times G} \times 100$$

Where, n: Number of infected leaves in each category
 V: Category value

N: Total number of leaves examined Total number of leaves examined

G: Maximum category value Maximum category value

Table 1: Details of the treatment combinations

Treat- ment No.	Treatment Code	Details of treatment combinations	
		Seed treatment	Foliar spray
T ₁	S ₀ F ₀	No seed treatment	No foliar spray
T ₂	S ₀ F ₁	No seed treatment	First foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%.
T ₃	S ₀ F ₂	No seed treatment	First foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with clove extract of garlic @ 10%
T ₄	S ₀ F ₃	No seed treatment	Two successive foliar sprays with clove extract of garlic @ 10%
T ₅	S ₁ F ₀	Seed treatment with Carbendazim 50 WP @ 0.1%	No foliar spray
T ₆	S ₁ F ₁	Seed treatment with Carbendazim 50 WP @ 0.1%	First foliar spray with the Carbendazim 50 WP @ 0.1% and second foliar spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%
T ₇	S ₁ F ₂	Seed treatment with Carbendazim 50 WP @ 0.1%	1 st spray with Carbendazim 50 WP @ 0.1% and 2 nd spray with clove extract of garlic @ 10%
T ₈	S ₁ F ₃	Seed treatment with Carbendazim 50 WP @ 0.1%	Two successive foliar sprays with clove extract of garlic @ 10%
T ₉	S ₂ F ₀	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	No foliar spray
T ₁₀	S ₂ F ₁	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	1 st spray with Carbendazim 50 WP @ 0.1% and 2 nd spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%
T ₁₁	S ₂ F ₂	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	1 st spray with Carbendazim 50 WP @ 0.1% and 2 nd spray Clove extract of Garlic @ 10%
T ₁₂	S ₂ F ₃	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	Two successive sprays with clove extract of garlic @ 10%
T ₁₃	S ₃ F ₀	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹	No foliar spray
T ₁₄	S ₃ F ₁	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹	1 st spray with Carbendazim 50 WP @ 0.1% and 2 nd spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%
T ₁₅	S ₃ F ₂	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹	1 st spray with Carbendazim 50 WP @ 0.1% and 2 nd spray with clove extract of garlic @ 10%.
T ₁₆	S ₃ F ₃	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹	Two successive sprays with garlic clove extract @ 10%

Pod yield: After harvesting the crop yield of pods was recorded.

Statistical analysis

The data collected during the present study was analyzed by using OPSTAT software & Gomez & Gomez (1984).

RESULT AND DISCUSSION

Experimental findings of the investigation entitled “Integrated management of anthracnose of commons

beans (*Phaseolus vulgaris* L.) amidst temperate conditions of Kashmir Valley” conducted at FoA SKUAST-K Wadura Sopore are presented under various headings:

Etiology of the disease

Isolation of the pathogen: The incitant of anthracnose of common bean i.e., *Colletotrichum lindemuthianum* was isolated on potato dextrose agar from the disease specimen following the standard phytopathological techniques. The test fungus formed

Plate 1: Disease intensity scale on leaves (0-9) for assessment of Common bean anthracnose

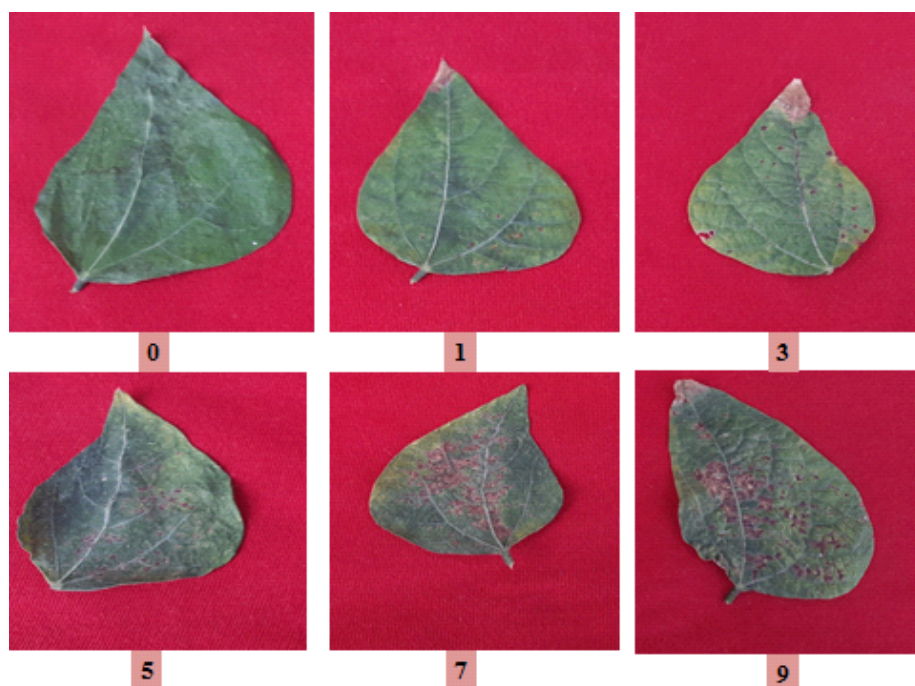


Plate 2: Disease intensity scale on pods (0-9) for assessment of Common bean anthracnose



greyish colony during juvenile phase and dark black colony with compact mycelial growth at maturity. The 90 mm Petriplates were fully occupied by the test fungus within 8 to 12 days of incubation period.

Purification and maintenance of pure culture of pathogen: Purification of fungal culture was done by employing single spore method. The pure culture of test fungus was maintained for subsequent use by subculturing at 30 days interval. Storage of culture was done in PDA slants kept in refrigerator having temperature of 4-5°C (Plate 3).

Pathogenicity test: Test for pathogenicity of isolated fungal pathogen was done by inoculating it on healthy Common bean potted plants kept under controlled conditions. Post inoculation symptoms were recorded and these were found to be the replica of symptoms of Anthracnose of common bean. The characteristic anthracnose symptoms were recorded after 7-8 days of inoculation (Plate 4). The fungus isolated from the symptoms of potted plants was identical to that of fungus isolated from diseased specimen collected from the field hence confirmation of pathogenicity of test fungus was observed by following Koch's postulates.

Plate 3: Isolation, Purification and Maintenance of the Pathogen

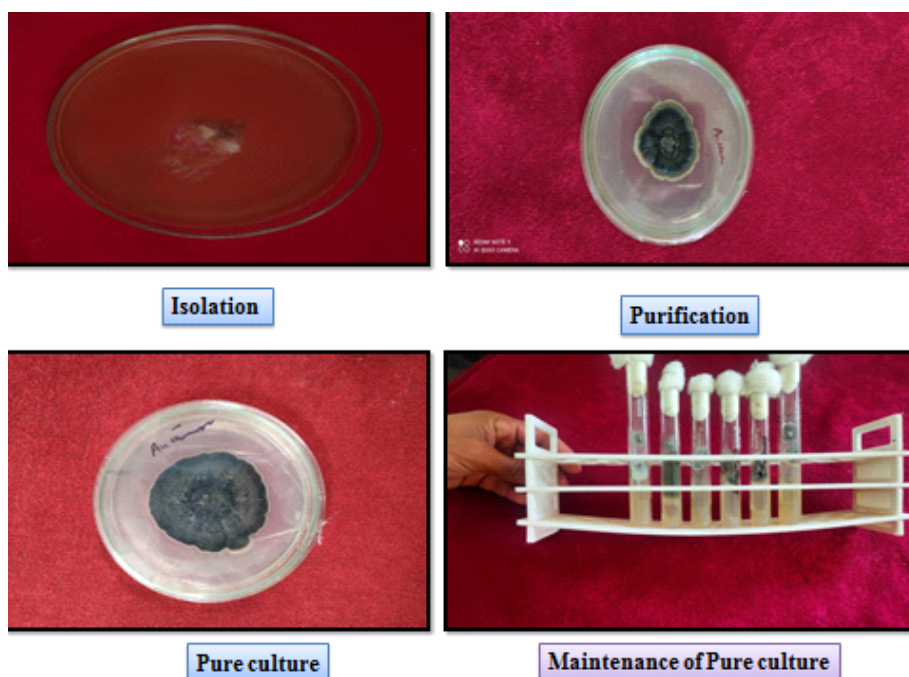
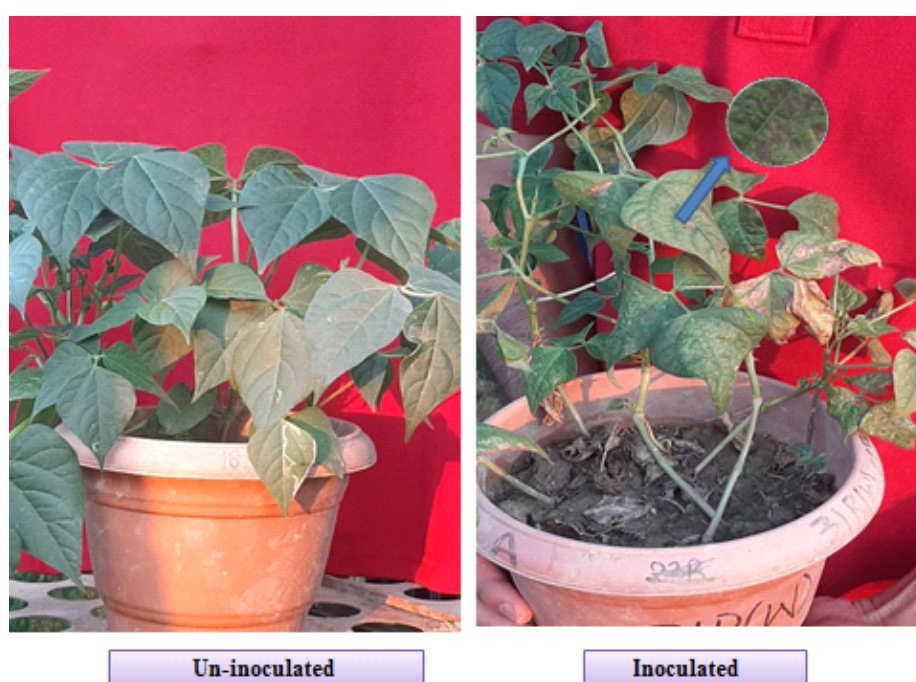


Plate 4: Pathogenicity test of *Colletotrichum lindemuthianum* on bean plant



Integrated management of the disease

For devising an integrated management capsule against the anthracnose of common beans a field trial was laid during *kharif* 2020 in the farm belonging to Division of Plant Pathology, FoA, SKUAST-K, Wadura Sopore. The adopted experimental design for field trial was randomized block design (Plate 5). The experiment evaluated the combined effect of different seed

treatments and foliar sprays. Seed treatment was given with combo fungicide (carbendazim 12% + mancozeb 63% @ 0.3%), systemic fungicide (carbendazim 50 WP @ 0.1%) and bio-agent (*Trichoderma viride* @ 1×10^{-8} conidia ml⁻¹) which performed best from the tested categories under *in vitro*. Foliar sprays comprised of combo fungicide (carbendazim 12% + mancozeb 63% @ 0.3%), systemic fungicide (carbendazim 50 WP @ 0.1%) and plant extract (Clove extract of garlic @ 10%)

which performed best from the tested categories under *in vitro*. The observations concerning disease incidence, disease intensity and pod yield recorded on the KDB-17 cultivar of Common bean are presented as under:

Statistical analysis of data concerning the above parameters inferred that all the treatment combinations limited the occurrence of anthracnose significantly over control on the common bean cultivar under study. Best results were recorded when seed treatment was given with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% which recorded with least disease incidence (3.19%) while as control recorded maximum disease incidence (46.51%). Control was treated with standard distilled water during seed treatment as well as during foliar sprays. Other treatment combinations which were seen to be effective in managing the disease are presented in increasing order of disease incidence as seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar sprays with extract of garlic @ 10% (4.14%), seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray with the same fungicide and second foliar sprays with carbendazim (12%) + mancozeb (63%) @ 0.3% (6.43%), seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray with the same fungicide and second foliar sprays with extract of garlic @ 10% (9.11%), seed treatment with *Trichoderma viride* @ 10^{-8} conidia ml⁻¹ followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% (12.34%) and seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by two successive foliar sprays with extract of garlic (15.33%). The rest of the treatment combination effects are better represented in Table 2.

The data presented in Table 2 reveals the effect of different treatment combinations upon disease intensity over control. Best results were recorded when seed treatment was given with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% which recorded with least disease intensity (1.61%) while as control recorded maximum disease intensity

(23.29%). Other treatment combinations which were seen to be effective in managing the disease are presented in increasing order of disease intensity as seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar sprays with extract of garlic @ 10% (2.06%), seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray with the same fungicide and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% (3.10%), seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray with the same fungicide and second foliar spray with extract of garlic @ 10% (4.51%), seed treatment with *Trichoderma viride* @ 10^{-8} conidia ml⁻¹ followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% (6.01%) and seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by two successive foliar sprays with extract of garlic (7.67%). The rest of the treatment combination effects are better represented in Table 2.

The data presented in Table 2 reveals that anthracnose of common beans was managed variably by the different treatment combinations and different values for pod yield were recorded. Best results were recorded when the seed treatment was given with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% which recorded maximum pod yield (82.37 q ha⁻¹) while as control recorded least pod yield (51.40 q ha⁻¹). Other treatment combinations which were seen to be effective in managing the disease are presented in decreasing order of pod yield as, seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with extract of garlic @ 10% (79.41 q ha⁻¹), seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray with the same fungicide and second foliar sprays with carbendazim (12%) + mancozeb (63%) @ 0.3% (77.41 q ha⁻¹), seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray with the same fungicide and second foliar spray with extract of garlic @ 10% (75.12 q ha⁻¹), seed treatment with *Trichoderma viride* @ 10^{-8} conidia ml⁻¹ followed by first foliar spray with Carbendazim

Table 2: Integrated management of Anthracnose of Common beans (*Phaseolus vulgaris* L.) during kharif2020

Treat- ment code	Treatment details	Disease incidence (%)	Disease intensity (%)	Pod yield (q ha ⁻¹)
T1	No seed treatment and no foliar spray (Control)	46.51	23.29	51.40
T2	No seed treatment, 1 st foliar spray with Carbendazim 50 WP @ 0.1% and 2 nd foliar spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	27.55	13.49	66.11
T3	No seed treatment, 1 st foliar spray with Carbendazim 50 WP @ 0.1% and 2 nd foliar spray with clove extract of garlic @ 10%	29.20	14.53	65.13
T4	No seed treatment, two successive foliar sprays with clove extract of garlic @ 10%	34.25	17.03	61.88
T5	Seed treatment with Carbendazim 50 WP @ 0.1% with no foliar spray	30.21	15.08	64.72
T6	Seed treatment with Carbendazim 50 WP @ 0.1% followed by 1 st foliar spray with the same fungicide and 2 nd foliar spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	6.43	3.10	77.41
T7	Seed treatment with Carbendazim 50 WP @ 0.1% followed by 1 st foliar spray with the same fungicide and 2 nd foliar sprays with clove extract of garlic @ 10%	9.11	4.51	75.12
T8	Seed treatment with Carbendazim 50 WP @ 0.1% followed by two successive foliar sprays with clove extract of garlic @ 10%	24.11	11.99	68.34
T9	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3% with no foliar spray	26.98	13.19	67.47
T10	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3%, 1 st foliar sprays with Carbendazim 50 WP @ 0.1% and 2 nd foliar spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	3.19	1.61	82.37
T11	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3%, 1 st foliar sprays with Carbendazim 50 WP @ 0.1% and 2 nd foliar spray with Clove extract of Garlic @ 10%	4.14	2.06	79.41
T12	Seed treatment with Carbendazim (12%) + Mancozeb (63%) @ 0.3% followed by two successive foliar sprays with clove extract of garlic @ 10%	15.33	7.67	71.93
T13	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹ with no foliar spray	35.24	17.67	60.44
T14	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹ followed by 1 st foliar spray with Carbendazim 50 WP @ 0.1% and 2 nd foliar spray with Carbendazim (12%) + Mancozeb (63%) @ 0.3%	12.34	6.01	73.41
T15	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹ followed by 1 st foliar spray with Carbendazim 50 WP @ 0.1% and 2 nd foliar spray with clove extract of garlic @ 10%	20.21	10.06	70.04
T16	Seed treatment with <i>Trichoderma viride</i> @ 10 ⁻⁸ conidia ml ⁻¹ followed by two successive foliar sprays with garlic clove extract @ 10%	31.08	15.44	63.13
C.D. (p ≤ 0.05)		4.02	2.11	5.07

50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3% (73.41q ha⁻¹) and seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by two successive foliar sprays with extract of garlic (71.93 q ha⁻¹). The rest of the treatment combination effects are better represented in Table 2.

All the treatment combinations were superior over control in limiting the outbreak of Anthracnose of

common bean. Different integrated management strategies can be used to control the pathogen damage sustainably by reducing the use of chemicals and employing the eco-friendly management strategies.

DISCUSSION

To propose an integrated management capsule against Anthracnose of common beans, present study was undertaken to evaluate the effectiveness of fungicides,

Plate 5: Field trial on integrated management of anthracnose of Common bean (*Phaseolus vulgaris* L.) during kharif 2020



botanicals and bio control agents, declared superior from the list of *in vitro* evaluates. These fungicides, botanicals and bio-agents were applied in two ways viz., seed treatments and foliar sprays. Seed treatments were given with carbendazim 12% + mancozeb 63% @ 0.3%, Carbendazim 50 WP @ 0.1% and *Trichoderma viride* @ 10^{-8} conidia ml⁻¹. Two foliar sprays were given with carbendazim (12%) + mancozeb (63%) @ 0.3%, Carbendazim 50 WP @ 0.1% and clove extract of garlic @ 10% individually as well as in combinations. In control plot no seed treatment or foliar spray was given, instead distilled water was sprayed, hence considered as a treatment. The seed treatments and foliar sprays along with control formed 16 treatment combinations. Observations were recorded and inference made was that every treatment combination reduced the disease incidence and disease intensity significantly than control. Best results were recorded when seed treatment was given with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3%, with least disease incidence (3.19%) and disease intensity (1.61%) over control which recorded maximum disease incidence (46.51) and disease intensity (23.29%). Control was treated with standard distilled water during seed treatment as well as during foliar sprays. Pod yield was recorded

maximum (82.37 q ha⁻¹) and minimum (51.40 q ha⁻¹) in the best plot and control plot, respectively. Other treatment combinations maintaining profitability include seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with clove extract of garlic @ 10%, seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray of the same fungicide and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3%, seed treatment with Carbendazim 50 WP @ 0.1% followed by first foliar spray the same fungicide and second foliar sprays with clove extract of garlic @ 10%, seed treatment with *Trichoderma viride* @ 10^{-8} conidia ml⁻¹ followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3%, seed treatment with carbendazim (12%) + mancozeb (63%) @ 0.3% followed by two successive foliar sprays with clove extract of garlic. The above findings are in consonance with the preceding findings of Amin *et al.* (2013); Rajesha *et al.* (2010); Manjunath *et al.* (2013); Misal *et al.* (2019); Jayaram *et al.* (2016); Padder and Sharma (2011) and Subedi *et al.* (2015).

CONCLUSION

The integrated management capsule for anthracnose of common beans is based on seed treatment with

carbendazim (12%) + mancozeb (63%) @ 0.3% followed by first foliar spray with Carbendazim 50 WP @ 0.1% and second foliar spray with carbendazim (12%) + mancozeb (63%) @ 0.3%. Foliar sprays are to be given in first trifoliate stage and 15-20 days after first spray. Timing of foliar sprays is weather based also.

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Conflict of Interest: The authors declare that they have no conflicts of interest relevant to this research.

REFERENCES

- Amin, M.; A. Amare and D. Nugussie. 2013. Effect of Integrated Management of Bean Anthracnose (*Colletotrichum lindemuthianum* Sacc. and Magn.) through soil solarization and fungicide applications on epidemics of the disease and seed health in Hararghe Highlands, Ethiopia. *Journal of Plant Pathology and Microbiology Corob.*, 4: 6.
- Demelash, B.B. 2018. Common Bean Improvement Status (*Phaseolus vulgaris* L.) in Ethiopia. *Advances in Crop Science and Technology*, 6(2): 1-6.
- Gomez, K.A. and A.A. Gomez. 1984. Statistical procedures for Agricultural research. 2nd Edition, John Wiley and Sons, New York. pp. 316-356.
- Jayaram, N.; B. Manjunath; N. Malikarjuna; G.K. Sudarshan; B.M. Ravikumara and M. Byregowda. 2016. Integrated management of anthracnose of field bean caused by *Colletotrichum lindemuthianum*. *Environment and Ecology*, 34(3): 1013-1017.
- Jhonston, A. and C. Booth. 1983. Plant Pathological Pocket Book. Common Wealth Mycological Institute, Kew Surrey, England 439.
- Kelly, J.D.; L. Afanador and L.S. Cameron. 1997. New races of *Colletotrichum lindemuthianum* in Michigan and implications in dry bean resistance breeding. *Plant Disease*, 78: 892-894.
- Kumar, A.; P.N. Sharma; O.P. Sharma and P.D. Tyagi. 1999. Epidemiology of bean anthracnose under sub-humid mid hills zone of Himachal Pradesh. *Indian Phytopathology*, 52: 393-397.
- Makini, F.W. and D.L. Danial. 1995. Bean production and constraints in Kenya with emphasis on diseases, breeding for disease resistance with emphasis on durability. Proceedings of a regional workshop for eastern, central and South Africa, held at Njoro, Kenya. pp 104-109.
- Maloney, A. 1995. Three sources of Non-chemical Management of plant disease: towards An Ecological Framework. *Advances in Plant Pathology*, 11: 103-129.
- Manjunath, B.; N. Jayaram; Nagaraju and H.K. Ramappa. 2013. In vitro evaluation of fungicides and bioagents against anthracnose disease of dolichos bean caused by *Colletotrichum lindemuthianum* (Sacc. & Magnus) Lams. Scri. *Journal of Mycopathology Research*, 51(2): 327-330.
- Mayee, C.D. and V.V. Datar. 1986. Phytopathometry. Technical bulletin-I. Marathwada Agricultural University, Parbani. pp 23-25.
- Misal, D.M.; P.B. Khair; M.R. Misal and D.G. Hingole. 2019. Integrated evaluation of fungicides, botanicals and bioagents against anthracnose of mungbean on natural field condition. *International Journal of Chemical Studies*, 7(2): 1975-1978.
- Mordue, J.E.M. 1971a. *Glomerella cingulata*. CM Descriptions of pathogenic Wallingford, UK: Centre for Agriculture and Bioscience International Fungi & Bacteria 315.
- Mordue, J.E.M. 1971b. *Colletotrichum lindemuthianum*. Descriptions of Pathogenic Fungi and Bacteria Set 32, Sheet No. 316. Wallingford, UK: Centre for Agriculture and Bioscience International.
- Mukunya, D.M. and S.O. Keya. 1979. The influence of seed borne anthracnose and halo blight inoculate on yield and disease development in a Canadian Wonder bean Selection at Kabete. Symposium on grain legume improvement in East Africa, University of Nairobi, Kenya, pp 20-24.
- Padder, B.A. and P.N. Sharma. 2011. *In-vitro* and *in-vivo* antagonism of biocontrol agents against *Colletotrichum lindemuthianum* causing bean anthracnose. Archives of Phytopathology and Plant Protection. 44(10): 961-969.
- Pastor-Corrales, M.A. and J.C. Tu. 1989. Anthracnose in bean production problems in the tropics. H.F. Schwartz and M.A. Pastor-Corrales. eds. (International Centre for Tropical Agriculture, California, Colombia) pp 77-104.
- Rajesh, G.; S.G. Mantur; M.R. Shankar; M.B. Boranayaka and T.V. Shadakshari. 2010. *In vitro* evaluation of fungicides and biocontrol agents against *Colletotrichum lindemuthianum* causing anthracnose of dolichos bean. *International Journal of Plant Protection*, 3(1): 114-116.
- Romero-Arenas, O.; D.M. Huato; R.J.A. Tapia; B.A. Simón; H.M. Lara and C.E. Huerta. 2013. The Nutritional value of Beans (*Phaseolus vulgaris* L.) and its importance for Feeding of Rural communities in Puebla-Mexico.

- International Research Journal of Biological Sciences*, 2(8): 59-65.
- Sartorato, A.; M.J. Zimmermann; M. Rocha and T. Yamada. 1998. Anthracnose cultura-defeijoeiro. Fatores-que-afetam-a-productividade. pp 457-477.
- Shao, F.M. and J.M. Teri. 1985. Yield losses in Phaseolus beans induced by Anthracnose in Tanzania, *Tropical Pest Management*, 31: 60-62.
- Sharma, P.N.; O.P. Sharma; B.A. Padder and R. Kapil. 2008. Yield loss assessment in common bean due to anthracnose (*Colletotrichum lindemuthianum*) under sub temperate conditions of North-Western Himalayas. *Indian Phytopathology*, 61(3): 323-330.
- Sicard, D.; Y. Michalakos; M. Dron and C. Neema. 1997. Genetic diversity and pathogenic variation of *Colletotrichum lindemuthianum* in three centres of diversity of its host, Phaseolus vulgaris. *Phytopathology*, 87: 807-813.
- Subedi, S.; D.B. Gharti; S. Neupane and T. Ghimire. 2015. Management of Anthracnose in Soybean using Fungicide. *Journal of Nepal Agricultural Research Council*, 1: 29-32.
- Tu, J.C. 1983. Epidemiology of anthracnose caused by *Colletotrichum lindemuthianum* on white bean (*Phaseolus vulgaris*) in southern Ontario: Survival of the pathogen. *Plant Disease*, 67: 402-404.
- Tu, J.C. 1988. Control of bean anthracnose caused by *Colletotrichum lindemuthianum* in Canada. *Plant Disease*, 72: 5-8.
- Tu, J.C. 1992. Bean anthracnose. Plant diseases of international importance, diseases of vegetables and oilseed crops by chaube, H. S., Kumar, J., Mukhopadhyay, A.N. and Singh, U.S., (Eds.). 2: 1-17.

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Research Article

Comparative Analysis of Information Seeking Behaviour of Extension Scientists

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ABSTRACT

The present study aimed to assess the information-seeking behavior of 150 extension scientists in Punjab and Odisha. Respondents were selected following probability proportionate to the number of extension scientists in each university, resulting in 73 from Punjab Agricultural University (PAU) and 77 from Odisha University of Agriculture and Technology (OUAT). Most of the respondents referred e-sources, kisan melas, and digital apps to seek information. Significant differences between both the universities were observed in terms of reference sources, including manuals, KVK scientists, university research scientists, subject matter extension specialists etc. Overall, Majority of respondents had medium level of information-seeking behavior. SAUs should schedule biannual events for extension scientists to attend seminars, symposiums, and conferences and refer to reports and e-modules for updates.

Keywords: Information seeking behaviour, Extension scientists, PAU, OUAT

INTRODUCTION

From the generations, every human being seeks information to satisfy their various types of needs. It is human nature that he/she always searches different ways to resolve the problems and try to satisfy them. "Information seeking is thus a natural and necessary mechanism of human existence" (Marchionini, 1995). The importance of information for general academic as well as agricultural research fraternity plays a major role in agricultural educational and research institutions particularly in Indian scenario (Neogi, 2021). An improved information and knowledge flow to, from, and within the agricultural sector is a key component in improving small-scale agricultural production and linking increased production to remunerative markets, thus leading to improved rural livelihoods, improving quality and yield, food security and national economies (Asaba *et al.*, 2006). Appreciating the importance of studying information seeking behavior, Anyaogu (2014) brought forward that adequate knowledge about the

information needs and seeking behavior of users is vital for developing library resources, services and facilities to meet their information needs effectively. Information needs and seeking activity differs from one profession to another. Thus, adequate knowledge of the information needs and seeking behavior of agricultural researchers was imperative for research institutes to support their research activity. Such an understanding will help Agricultural Research Institutes to develop information systems and services that are more likely to satisfy users' information needs. Researchers and extension workers operate as facilitators and communicators helping farmers in their decision making and ensuring that appropriate knowledge is implemented to obtain the best results in terms of sustainable production and general rural development and the private sector (support and input services, traders) to harness knowledge and information from various sources for better farming and improved livelihoods (FAO, 2005).

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MATERIALS AND METHODS

The present study was conducted in Punjab and Odisha state during the year 2021 to 2023. The Extension Scientists from Punjab Agricultural University (PAU) & Odisha University of Agriculture and Technology (OUAT) were taken as the respondents for the present study. A total of 150 extension scientists, including 73 from PAU and 77 from OUAT, were selected following probability proportionate to the number of extension scientists employed by each university as well as the number of extension scientists employed at both their headquarters and outposts. The data was collected through mailed structured questionnaire. The necessary care was taken to collect the un-biased and correct data. The questionnaire consisted major four sections like printed/online sources, interaction with different sources, attending different information sources and listening/watching to information sources. It was measured on a three-point continuum i.e., frequently, occasionally, and never and scores of two, one and zero were assigned, respectively. Mean score was calculated for each source and significant difference between both the universities for each source was checked using Mann-Whitney U test. Scores of different sources were summed for each respondent.

Information Seeking Behaviour was categorized into three categories by using cumulative cube root method.

RESULTS AND DISCUSSION

It is evident from Table 1 that e-sources received highest mean score 1.69 and 1.74 in PAU and OUAT respectively. In PAU, books were used by the respondents frequently (60.30%) and in OUAT, books were used by the respondents occasionally (55.80%) with mean score 1.50 and 1.38 respectively. More than half of the respondents of PAU (64.40%) and OUAT (57.10%) were using extension bulletins frequently to seek information with mean score 1.64 and 1.50 respectively. Nearly 50 percent of the respondents were using magazines frequently and occasionally in case of PAU and OUAT with mean scores 1.38 and 1.40 respectively. Nearly 54 per cent of the respondents of both the universities were using reports occasionally with mean score 1.12 of PAU and 1.29 of OUAT. In PAU, 60.30 per cent of the respondents were using booklet occasionally with mean score 1.28 and in OUAT, about half of the respondents were using booklets frequently with mean score 1.44. More than two-third of the respondents of PAU (71.20%) and OUAT (74%) were using e-sources frequently to seek

Table 1: Distribution of respondents according to frequency of seeking information from print/online sources (n=150)

Sources	Respondents								Z test #
	PAU (n ₁ = 73)				OUAT (n ₂ = 77)				
	F f (%)	O f (%)	N f (%)	Mean Score	F f (%)	O f (%)	N f (%)	Mean Score	
Books	44 (60.30)	22 (30.10)	7 (9.60)	1.50	32 (41.50)	43 (55.80)	2 (2.70)	1.38	-1.683
Extension bulletins	47 (64.40)	26 (35.60)	-	1.64	44 (57.10)	28 (36.30)	5 (6.60)	1.50	-1.182
Magazines	36 (49.30)	28 (38.30)	9 (12.40)	1.38	35 (45.40)	38 (49.30)	4 (5.30)	1.40	-0.126
Manuals	30 (41.10)	37 (50.70)	6 (8.20)	1.32	48 (62.30)	21 (27.20)	8 (10.50)	1.51	-2.151*
Reports	21 (28.80)	40 (54.80)	12 (16.60)	1.12	29 (37.60)	42 (54.5)	6 (7.90)	1.29	-1.608
Booklets	25 (34.20)	44 (60.30)	4 (5.50)	1.28	38 (49.30)	35 (45.40)	4 (5.30)	1.44	-1.731
E-sources	52 (71.20)	20 (27.40)	1 (1.40)	1.69	57 (74.00)	20 (26.00)	-	1.74	-0.431

*Significant at 0.05 level; F- Frequently; O-Occasionally; N-Never; #- Mann-Whitney U test

* Figures in parenthesis are the percentage to their respondents total

information. In case of manuals, there is a significant difference between both universities. Although from the data it seems that more difference exists in the mean scores of both universities with respect to referring booklets, reports, books, and extension bulletins but differences are not significant. It is clearly observed from the Table that respondents preferring more e-sources/ online sources over printed sources to seek information. It might be because the online sources can be accessed at any point of time when required which is not in case of printed sources. These findings are in line with those of Kaur (2003); Pezerski *et al.* (2005) and Gudeta *et al.* (2021) who reported that books, manuals, bulletins and magazines were most commonly used sources for seeking information.

The data set in Table 2 relates to interaction sources used by the respondents. The data reveals that in case of PAU, 64.38 percent of the respondents frequently interact with university research scientists with mean score 1.64 to seek information but in case of OUAT, 66.30 percent of the respondents were occasionally interacting with university research scientists with mean score 1.31. More than half of the respondents were frequently and occasionally interacting with subject matter extension specialists of university in PAU (54.70%) and OUAT (57.14%) with mean scores 1.53 and 1.35 respectively. More than half of the respondents of OUAT (54.50%) and 45.20 percent respondents of PAU were interacting with progressive

farmers to seek information with mean score 1.24 and 1.51 respectively. More than half of the respondents of PAU (60.20%) and OUAT (70.12%) were occasionally interacting with ICAR scientists to seek information with mean scores 1.17 and 1.19 respectively. In OUAT, highest mean score 1.88 was obtained in case of KVK scientists and in PAU, highest mean score 1.64 was obtained in case of university research scientists. There is a significant difference between both universities in case of KVK scientists, university research scientists, Subject matter extension specialists of university and progressive farmers. Majority of the respondents' interaction with ICAR scientists were occasional or never. The probable reason might be that as most of the respondents were attending the seminars/conferences/symposia at state level (Table 2) so, they were not getting exposure platform to interact with ICAR scientists. These findings are in line with those of Kaur (2003) and Gudeta *et al.* (2021) who reported that interacting with Subject matter specialists was the most common sources used to seek information.

The data set in Table 3 relates to sources attended by the respondents to seek information. The data reveals that all the respondents of both the universities had attended training to seek information. Almost more than half of the respondents of PAU (54.79%) and OUAT (70%) were frequently attending trainings to seek information. More than half of the respondents

Table 2: Distribution of respondents according to frequency of interaction with different information sources (n=150)

Sources	Respondents								Z test #
	PAU (n ₁ = 73)				OUAT (n ₂ = 77)				
	F f (%)	O f (%)	N f (%)	Mean Score	F f (%)	O f (%)	N f (%)	Mean Score	
KVK Scientists	38 (52.05)	35 (47.95)	-	1.52	68 (88.31)	9 (11.69)	-	1.88	-4.859 **
Subject matter extension specialists of university	40 (54.70)	32 (43.80)	1 (1.50)	1.53	30 (38.96)	44 (57.14)	3 (3.90)	1.35	-2.020 *
University research scientists	47 (64.38)	26 (35.62)	-	1.64	25 (32.40)	51 (66.30)	1 (1.30)	1.31	-3.940 **
Progressive farmers	33 (45.20)	25 (34.20)	15 (20.60)	1.24	42 (54.50)	33 (42.80)	2 (2.60)	1.51	-2.019 *
ICAR Scientists	21 (28.80)	44 (60.20)	8 (11.00)	1.17	19 (24.67)	54 (70.12)	4 (5.21)	1.19	-0.058

*Significant at 0.05 level; **Significant at 0.01 level; F- Frequently, O-Occasionally, N-Never; #- Mann-Whitney U test

*Figures in parenthesis are the percentage to their respondents total

Table 3: Distribution of respondents according to frequency of attending information sources (n=150)

Sources	Respondents								Z test #
	PAU (n ₁ = 73)				OUAT (n ₂ = 77)				
	F f (%)	O f (%)	N f (%)	Mean Score	F f (%)	O f (%)	N f (%)	Mean Score	
Training	40 (54.79)	33 (45.21)	-	1.54	54 (70.10)	23 (29.90)	-	1.70	-1.934
Workshops	45 (61.65)	28 (38.35)	-	1.61	40 (51.94)	36 (46.75)	1 (1.31)	1.50	-1.561
Seminars, symposium and conferences	27 (37.00)	46 (63.00)	-	1.36	23 (29.90)	48 (62.30)	6 (7.80)	1.22	-1.501
Refresher course/orientation	8 (11.00)	38 (52.00)	27 (37.00)	0.73	22 (28.50)	38 (49.30)	17 (22.20)	1.06	-2.816 **
Webinars	40 (54.79)	31 (42.46)	2 (2.75)	1.52	48 (62.30)	27 (35.10)	2 (2.60)	1.59	-0.909

**Significant at 0.01 level; F- Frequently; O-Occasionally; N-Never; #- Mann-Whitney U test

* Figures in parenthesis are the percentage to their respondents total

of PAU (61.65%) and OUAT (51.94%) had frequently attended workshops to seek information with mean score 1.61 and 1.50 respectively. More than half of the respondents of PAU (63%) and OUAT (62.30%) had occasionally attended seminars, symposium & conferences with mean score 1.36 and 1.22 respectively. Almost half of the respondents of PAU (52%) and OUAT (49.30%) had occasionally attended refresher course/orientation with mean scores 0.73 and 1.06 respectively. In PAU and OUAT, 54.79 and 62.30 per cent of the respondents had frequently attended webinars with mean score 1.52 and 1.59 respectively. In PAU, highest mean score 1.61 was obtained in case of workshop where as in OUAT, highest mean score 1.70 was obtained in case of training. There is a significant difference between both universities in case of refresher course. Although it seems that differences exist between both the universities with respect to training, seminar/symposium and workshop but these differences were not significant. Majority of the respondents of both the universities had either attended the refresher course/orientation occasionally or never, this might be because the service experience of most of the respondents were between 11-30 years and few respondents lies in the category of 2-11 years. These findings are in line with those of Kaur (2003) and Pezershki *et al.* (2005) who reported that workshops and trainings were the most common sources used to seek information.

The data put forth in Table 4 reveals that in PAU and OUAT, YouTube is mostly preferred by extension scientists to seek information having highest mean score 1.84 and 1.70 respectively. More than two-third respondents of PAU (70%) and more than half of the respondents of OUAT (57.10%) watched TV to seek information with mean scores 1.10 and 1.22 respectively. Nearly half of the respondents of PAU (50.60%) listened to radio occasionally and 49.30 per cent respondents of OUAT never listened to radio to seek information. Majority of the respondents of PAU (84.93%) and OUAT (76.62%) watched YouTube to seek information. More than half of the respondents of PAU (64.40%) and 48 per cent respondents of OUAT preferred video/audio conference call occasionally and frequently with mean scores 1.13 and 1.33 respectively. More than two-third respondents of PAU (69.86%) and more than half of the respondents of OUAT (52%) watched videos available on WhatsApp platform frequently to seek information. More than half of the respondents of PAU (60.30%) and OUAT (65%) were using e-modules occasionally to seek information. Majority of the respondents of PAU (82.19%) and more than half of the respondents of OUAT (61%) were using digital apps frequently to seek information with mean scores 1.82 and 1.59 respectively. More than two-third of the respondents of PAU (78.08%) and OUAT (70.12%) were seeking information by participating in kisan melas/exhibitions. There is a significant difference between both the

Table 4: Distribution of respondents according to frequency of listening/watching to information sources (n=150)

Sources	Respondents								Z test #
	PAU (n ₁ = 73)				OUAT (n ₂ = 77)				
	F f (%)	O f (%)	N f (%)	Mean Score	F f (%)	O f (%)	N f (%)	Mean Score	
TV	15 (20.50)	51 (70.00)	7 (9.50)	1.10	25 (32.40)	44 (57.10)	8 (10.50)	1.22	-1.258
Radio	27 (37.00)	37 (50.60)	9 (12.40)	1.21	14 (18.20)	25 (32.50)	38 (49.30)	0.68	-4.360 **
YouTube	62 (84.93)	11 (15.07)	-	1.84	59 (76.62)	18 (23.38)	-	1.76	-1.284
Facebook Videos	43 (59.00)	26 (35.60)	4 (5.40)	1.53	32 (41.50)	38 (49.40)	7 (9.10)	1.32	-2.116 *
Video/Audio conference call	18 (24.60)	47 (64.40)	8 (11.00)	1.13	37 (48.00)	29 (37.70)	11 (14.30)	1.33	-2.077 *
Videos available on WhatsApp platform	51 (69.86)	22 (30.14)	-	1.69	40 (52.00)	35 (45.40)	2 (2.60)	1.49	-2.326 *
E- modules	21 (28.70)	44 (60.30)	8 (11.00)	1.17	24 (31.10)	50 (65.00)	3 (3.90)	1.27	-0.889
Digital apps	60 (82.19)	13 (17.81)	-	1.82	47 (61.00)	29 (37.70)	1 (1.30)	1.59	-2.881 **
Participation in kisan melas/ exhibitions	57 (78.08)	16 (22.92)	-	1.78	54 (70.12)	23 (29.88)	-	1.70	-1.106

*Significant at 0.05 level; **Significant at 0.01 level; F- Frequently; O-Occasionally; N-Never; #- Mann-Whitney U test

*Figures in parenthesis are the percentage to their respondents total

universities in case of radio, digital apps, Facebook videos, video/audio conference calls and WhatsApp videos. From the above results it can be observed that respondents were using digital media/apps more frequently over traditional media. These findings are in line with those of Kaur (2003) and Meena *et al* (2013) who reported that social media and digital apps were the most common sources used to seek information whereas modules were least used for this purpose.

The data pertaining to level of Information Seeking Behavior of the respondents has been placed in Table 5. Information Seeking Behavior ranged from 26-46.

More than one-third of the respondents of PAU (46.50%) and OUAT (42.80%) were having medium level of information seeking behaviour (34.43-38.69). Overall, 44.45 percent of the respondents of both the universities belonged to medium information seeking behaviour category (34.43-38.69). It is clear from the data in Table 4.9 that more than one-third of the respondents of PAU (37%) and OUAT (33.80%) were having high level of information seeking behaviour (38.69-46). Overall, 35.40 percent of the respondents of both the universities were having higher information seeking behaviour (38.69-46). The data further reveals

Table 5: Distribution of the respondents according to their level of information seeking behaviour (n=150)

Level of information seeking behaviour	Respondents				Overallf (%)
	PAU (n ₁ = 73)		OUAT (n ₂ = 77)		
	Frequency	Percentage	Frequency	Percentage	
Low (26 – 34.43)	12	16.50	18	23.40	30 (19.95)
Medium (34.43 – 38.69)	34	46.50	33	42.80	67 (44.65)
High (38.69 – 46)	27	37.00	26	33.80	53 (35.40)

* Figures in parenthesis are the percentage to their respondents total

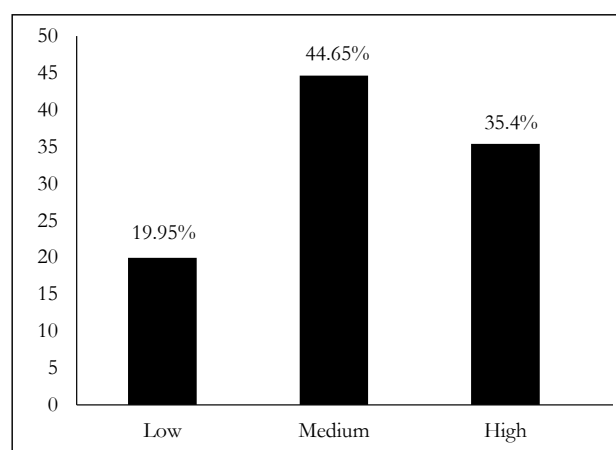


Figure 1: Information Seeking Behavior of Extension Scientists

that 16.50 and 23.40 per cent of the respondents of PAU and OUAT were having low (26-34.43) information seeking behaviour respectively. Overall, 19.95 percent of the respondents of both the universities were having low information seeking behaviour (26-34.43). A graphical representation of overall universities is given in Figure 1. These findings are in line with those of Mishra (2007) and Rani *et al.* (2012).

CONCLUSION

From the above findings, it can be concluded that majority of the respondents were using e-sources, extension bulletins, interaction with KVK scientists, attending training and webinars, watching YouTube, digital apps, and participation in kisan melas frequently to seek information. In PAU and OUAT, less than half per cent of the total respondents were having medium level of information seeking behavior followed by high. As less number of respondents have attended the seminars, symposium & conferences outside the state, respective universities should sort out and prepare appropriate strategies to provide seminars, symposium and conference exposures to extension scientists nationally and internationally to widen their professional horizon and knowledge update.

REFERENCES

Anyagou. 2014. Postgraduate Law students' information needs seeking behavior: Implication for improved provision of resources and services in Nigerian Institute

of advanced Legal studies Library in Lagos State. *Library Philosophy and Practice*.

- Asaba, J.F.; R. Musebe; M. Kimani; R. Day; M. Nkonu; A. Mukhebi; A. Wesonga; A. Mbula; P. Balaba and A. Nakagwa. 2006. Bridging the information and knowledge gap between urban and rural communities through rural knowledge centers: case studies from Kenya and Uganda. *International Association of Agricultural Information Specialists (IAALD) Quarterly Bulletin*, 51(6): 3-4.
- FAO. 2005. Improved agricultural marketing information empowers farmers: Bangladesh. http://www.fao.org/tc/tcp/pdf/Factsheet_clearedfinal_ENGLISH.pdf
- Gudeta, A.; L. Tesfaye and N. Eric. 2021. Information needs and information seeking behavior of agricultural researchers of Fadis and Mechara agricultural research centres, Ethiopia. *International Journal of Agricultural Extension and Rural Development Studies*, 8(3): 1-14.
- Kaur, K. 2003. *Communication pattern of home scientists regarding development and dissemination of scientific information*. Ph.D. Dissertation, Punjab Agricultural University, Ludhiana, India.
- Marchionini, G. 1995. Information seeking in electronic environment. Cambridge: Cambridge University Press. London. p.29.
- Meena, K.C.; S. Chand and N.R. Meena. 2013. Impact of social media in sharing information on issues related to agriculture among researchers and extension professionals. *Advances in Applied Research*, 5(2): 166-169.
- Mishra, D.; D.M. Chandargi and L.V. Hirevenkanagoudar. 2007. A comparative study on performance and job satisfaction of men and women extension officers. *Karnataka Journal of Agricultural Sciences*, 20: 432-434.
- Neogi, P. and B. Partap. 2021. Information Needs and Information Seeking Behaviour of Agricultural Research Fraternity of West Bengal, India: An Evaluative Study. *Library Philosophy and Practice* (e-journal). 5817. <https://digitalcommons.unl.edu/libphilprac/5817>.
- Pezeshki, R.G. and N. Zamani. 2005. Information-seeking behaviour of Iranian extension managers and specialists. *Information Resources Management Journal*, 10: 229.
- Rani, V.S.; S. Kota and M.S. Reddy. 2012. Agricultural information acquisition behavior of agricultural scientists. *Journal of Communication Studies*, 31: 3-12.

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Research Article

A Study on Effectiveness of Pragmatic Learning of University Students in Uttarakhand

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ABSTRACT

The agricultural landscape in India has undergone a significant transformation from subsistence to commercial production, facilitated by advanced technology and knowledge. This shift has diversified the agricultural profession, involving not only farmers but also administrators, managers, and young entrepreneurs. The implementation of the WTO agreement has exposed Indian farmers to global competition, necessitating a focus not only on quantitative aspects but also on qualitative dimensions. Globalization and the commercialization of agriculture have led to the involvement of private organizations and industries in the sector. A notable change in agricultural education is the increasing enrolment of students with urban backgrounds in agricultural universities. Total 100 final year graduate students were selected from GBPUA&T, Pantnagar. The findings depicts that in orientation programme, majority of respondents reported that their skill was developed to explore the extension work and followed by Knowledge regarding farmers' practices. In field visit components, majority of respondents reported that their awareness level was enhanced about KVK activities followed by knowledge about to start enterprise. In village attachment components majority of the students expressed that the RAWE was helpful to improve the knowledge in conducting group discussion followed by understanding complete life style of villagers and credit utilization and distribution patterns of farmers from SHGs. In Agro-industrial attachment component, majority of respondents reported that their skill was developed in farm budgeting followed by Knowledge of procedure to purchase the inputs. In Plant clinic component, majority of respondents reported that Plant Clinic component of RAWE was helpful in identifying beneficial and harmful insect followed by knowledge regarding pesticide and agro-chemical and use of biological methods of pest and disease management.

Keywords: RAWE, Experiential, Learning, Village

INTRODUCTION

In agricultural colleges, agricultural demonstrations were deemed insufficiently practical by the Royal Commission on Agriculture in India's Report. Dr. Radhakrishnan highlighted that an overemphasis on theoretical knowledge limited the value of agricultural education. Consequently, there is a recognition that agricultural education should occur in a rural environment to promote hands-on involvement and familiarity with agricultural life and practice. Understanding the socio-economic practices of rural

farmers, with whom agriculture graduates will interact, is crucial (Kapri *et al.*, 2016).

In response to these developments, courses like Rural Agricultural Work Experience (RAWE) have become imperative to in still professionalism in agriculture (Mahadik *et al.*, 2011). Introduced in 1991 for final-year B.Sc. (Ag.) students, RAWE combines classroom teaching, laboratory practice, and a Practical Crop Production (PCP) course, the latter being a pioneering, field-oriented program initiated by the College of Agriculture, Pantnagar. This final phase of

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practical field training enables students to experience real-life situations in the agricultural profession. Therefore, RAWE plays a foundational role in developing graduate competence in agribusiness, encompassing roles as traders, researchers, and extension specialists, making it a mandatory component of the undergraduate curriculum (Kumar *et al.*, 2021).

The introduction of the RAWE Program during the fourth year of the undergraduate curriculum in agricultural universities in India was viewed as an optimal opportunity for students to develop essential potential and gain a comprehensive understanding of the rural environment (Ineme and Arikpo, 2013). The Andhra Pradesh Agricultural University in Hyderabad was the first state agricultural university to incorporate the RAWE program into its curriculum (Naveen *et al.*, 2019). Subsequently, other state agricultural universities adopted the “RAWE” program, requiring students to live in a village, collaborate with a host farmer, and implement new agricultural technologies (Sajeev *et al.*, 2013).

The fundamental core of agricultural education comprises three intra-curricular components: classroom instruction, experiential learning through supervised experiences, and leadership activities. Regardless of the students’ chosen fields, these elements, when integrated into a well-designed program, provide a context for learning essential content and life skills, preparing students for adulthood (Roberts, 2006). The key components of RAWE encompass general orientation, field visit, village attachment, Agro-Industrial Attachment and plant clinic. This study aims to strengthen RAWE with the following objectives: [i] To assess the feedback of students about various components of the RAWE Programme. [ii] To examine the suggestions of students to strengthen RAWE in the graduation curriculum.

MATERIALS AND METHODS

The RAWE Program was introduced for undergraduate agriculture students during their seventh semester, spanning a six-month period. Within this program, each student undertook different components as orientation, field visit, village attachment and plant clinic etc. Throughout the RAWE program, students had the chance to engage with farmers, study diverse farming techniques, and identify production,

protection, and marketing challenges. The core components of the program included crop production, plant protection, rural economics, extension programs, and agro-based business centres. Indian Council of Agricultural Research launched a one-year program aimed at fostering practical skills, entrepreneurial spirit, and employability among undergraduate students. This study focuses on gathering information about various components of the RAWE Program, entrepreneurial aspects, and related topics. Additionally, it aims to document implementations and offer recommendations. Present research was conducted in Uttarakhand during 2023, involving final-year B.Sc. (Hons) students at GBPUA&T, Pantnagar. An ex post facto research design was used. A random sample of 100 students was selected and interviewed using a pre-tested interview schedule. The collected data was tabulated and analyzed for frequency, percentage, and ranking purposes.

RESULTS AND DISCUSSION

The initial phase involves lectures and discussions wherein various faculties, agricultural entrepreneurs, and trainers share their experiences with students on campus. This is followed by field visits within and outside the campus, enabling students to study ongoing research, farmers’ practices, understand problems, and explore extension work.

Majority of respondents (95%) reported that their skill was developed to explore the extension work and followed by Knowledge regarding farmers’ practices (90%). Total 85 per cent respondents reported that their practical knowledge was enhanced and Develop entrepreneurship skill (85%). Most of the respondents reported that they understand the extension programme (81%) followed by Information on various problems of villagers (78%).

This component exposes students to diverse farming situations and processing units run by industrialists. Visits to National Laboratories, Central Research Institutes, private farms, etc., are conducted. Students collect information as per the provided proforma, maintain separate registers, and write reports based on the gathered information. Student progress is reviewed through presentations and discussions. Additionally, a group of 10-15 students is attached to

Table 1: Learning experience of respondents about RAWE

Learning experience	Frequency	Percentage
<i>Orientation programme</i>		
Improve Listening Skill	89	89
Knowledge regarding farmers' practices	90	90
Understanding the extension programme	81	81
Information on various problems of villagers	78	78
Develop entrepreneurship skill	85	85
Enhancing skill to explore the extension work	95	95
Enhance practical knowledge	85	85
<i>Field visit</i>		
Improve knowledge regarding processing of products	86	86
Enhancing awareness about KVK activities	97	97
Enhancing knowledge about to start enterprise	96	96
Case studies of progressive farmers	89	89
Enhance skill of presentation and discussion	98	98
Enhancing knowledge regarding input supply chain	79	79
Enhancing knowledge regarding Raw material procurement	76	76
Enhancing knowledge regarding dairy and poultry farm	85	85
<i>Village attachment</i>		
Understand rural settings	97	97
Familiarizing them with socio-economic conditions of farmers	80	80
Competence in solving agricultural problems	85	85
Building confidence	91	91
Improve listening skill	93	93
Improve presentation skill	87	87
Enhance the knowledge about extension activities	81	81
Improve the skill of report writing	83	83
Improve the knowledge in conducting group discussion	87	87
Help in building self confidence	95	95
Preparation of teaching aids	80	80
Understanding the adoption patterns and adoption gaps	85	85
Daily routine diagramme of villagers	80	80
Understanding how to use Participatory rural appraisal techniques	89	89
Help to know Government programmes	96	96
Understanding complete life style of villagers	93	93
Credit utilization and distribution patterns of farmers from SHGs	92	92
Competency to prepare farm plan	90	90
Knowledge of resource utilization patterns	87	87
<i>Agro-industrial attachment</i>		
Developing skill in farm budgeting	98	98
Developing skill in agro economic survey	89	89
Marketing of products	78	78

Table 1 contd...

Learning experience	Frequency	Percentage
Knowledge of procedure to purchase the inputs	91	91
Develop the skill on management practices	80	80
Knowledge about utilization of resources	78	78
Develop the self confidence	83	83
Imparting diagnostic and remedial knowledge through practical training	81	81
Plant clinic		
Improve diagnostic skill	86	86
Help in identifying beneficial and harmful insect	97	97
Knowledge regarding pesticide and agro-chemical	94	94
Use of biological methods of pest and disease management	91	91
Preparation of spray fluid and botanic pesticide	87	87
Importance of time, dose and method of pesticides	86	86

agro-industries/cottage industries for a one-month period to complete assigned tasks.

Majority of respondents (97%) reported that their awareness level was enhanced about KVK activities followed by knowledge about to start enterprise (96%). Total 89% respondents reported that their knowledge level was enhanced on Case studies of progressive farmers (89%) and enhancing knowledge regarding dairy and poultry farm (85%). Total 79% respondents reported that their knowledge level was enhanced regarding input supply chain followed by enhancing knowledge regarding raw material procurement.

Students are attached to villages to study farming practices and problem-solving at farmers' fields. This attachment helps students understand rural situations, adopt agricultural technologies, prioritize farmers' problems, and develop skills and attitudes for working with farm families. The main objectives include providing students an opportunity to understand rural settings, familiarizing them with socio-economic conditions of farmers, imparting diagnostic and remedial knowledge through practical training, developing communication skills, and building confidence and competence in solving agricultural problems.

The findings of Table 1 inferred that majority of the students (97%) expressed that the RAWE was helpful to improve the knowledge in conducting group discussion followed by understanding complete life

style of villagers (93%) and credit utilization and distribution patterns of farmers from SHGs (92%). Most of the respondents reported that RAWE was helpful to know Government programmes (96%) and their confidence was also build up (91%) followed by understanding how to use Participatory rural appraisal techniques (89%), Knowledge of resource utilization patterns (87%). Majority of them reported that their knowledge was enhanced about extension activities (81%) followed by Preparation of teaching aids (80%).

This training focuses on studying industrial problems and correlating theory with actual practices in industries. Students undergo short-term training in relevant industries to gain knowledge and experience of the work culture. Objectives include exposing students to an industrial environment, familiarizing them with materials, machines, processes, products, and shop management, understanding the psychology of workers, and learning about entrepreneurship. The students document their activities, and industry officials evaluate and rank them. Certificates are issued upon successful completion of the components.

Majority (98%) of respondents reported that their skill was developed in farm budgeting followed by Knowledge of procedure to purchase the inputs (91%). Majority of respondents (89%) reported that their skill was developed in agro economic survey followed by Develop the self confidence (83%). Total 78 per cent respondents reported that Marketing of products and Knowledge about utilization of resources.

This training covers clinical aspects of agricultural husbandry, including lectures, laboratory exercises, and field visits on seed, soil, and plant health. Students learn about plant pathology, entomology, soil health, and nutritional problems in crop, vegetable, and fruit production. This component helps students open plant clinics as a business.

Majority of respondents (97%) reported that Plant Clinic component of RAWE was helpful in identifying beneficial and harmful insect followed by knowledge regarding pesticide and agro-chemical (94%) and use of biological methods of pest and disease management (91%). Total 86 per cent respondents reported that their knowledge on importance of time, dose and method of pesticides was enhanced.

Suggestions of students to strengthen RAWE in the graduation curriculum

- **Cultivate self confidence:** It assists students in cultivating the essential self-confidence needed to comprehend the fundamentals of agriculture and navigate the intricacies of launching their own commercial farming or agribusiness ventures post-graduation.
- **Explore real life situation:** RAWE provides students with the opportunity to explore agriculture in real-life scenarios.
- **Innovative skill:** The program encourages the generation of fresh concepts and innovations in agricultural enterprise development.
- **Practical experience:** RAWE is helpful in understanding managerial elements, including production, product development, marketing, and value chains related to product flow.
- **Utilization of human resources:** It facilitates the efficient utilization of human resources in alignment with time, cost, and resource availability.
- **Group formation:** Group formation enhances enterprise operations by promoting teamwork, group cohesion, and conflict management.
- **Report writing skill:** Creating project reports aids in comprehending the techno-economic, socioeconomic, and political context of the enterprise's location.
- **Job opportunities:** Students believe that RAWE programme enhances employment opportunities in specific agro-based businesses.
- **Learning experience:** Attachment to a contact farmer or progressive farmer in the village enriches the learning process and imparts knowledge about the challenges faced in applying technology within rural life conditions and institutions.
- **ITK:** RAWE facilitates the acquisition of knowledge regarding farmers' indigenous traditional practices.
- **PRA:** Participatory Rural Appraisal (PRA) with local farmers contributes to the development of community action plans for the efficient utilization of regional resources.
- **Farmers' circumstances:** Socioeconomic surveys are conducted to better understand farmers' circumstances and issues related to agricultural development.
- **Helpful in career:** Training sessions, demonstrations, observations, practice sessions, and participation in rural development programs prepare graduates for their desired career roles after graduation.
- **Ground-level knowledge:** First-hand knowledge of ground-level realities in farmers' holdings provides a comprehensive understanding of the rural ecosystem.
- **Insights into the rural environment:** Beneficial insights into the rural environment, cropping patterns, farming systems, soil types, irrigation sources, cultivation techniques, farming issues, produce marketing, processing, and value addition are gained.
- **Interaction with line department:** Interaction with line department officials provides information on the State Department of Agriculture's activities, organizational structure, implemented programs, subsidies, trainings, ATMA, NFSM, RKVY, and Social Forestry activities.
- **Village survey:** General village surveys include information on population, agrarian families, crops grown, and socio-economic factors.

- **Knowledge acquisition about farming technique:** Interaction with marginal, small, and large farmers facilitates practical knowledge acquisition about farming techniques, production limitations, marketing, and other issues, including polyhouse cultivation, indigenous methods, and integrated farming systems.
- **Cultivates a variety of skills:** RAWE cultivates a variety of skills, including practical subject knowledge, observation, analytical thinking, interactive problem-solving, questioning, planning extension activities, and report writing, fostering confidence in handling various farm issues.
- **Field-specific knowledge and skills:** RAWE provides students with field-specific knowledge and skills relevant to the workplace, as well as management and communication skills for sharing ideas and innovations with the farming community.
- **Improvement in leadership quality:** Highly beneficial for developing students' leadership and communication abilities, RAWE offers hands-on experience with crop production at the field level and introduces ongoing Transfer of Technologies (TOT) programs. RAWE assists in developing leadership and communication abilities during the execution of extension programs.
- **Rural orientation:** For students from rural backgrounds with limited familiarity with rural areas, the program should provide better general rural orientation and exposure to live agricultural circumstances.
- **Self-assurance and professional capacity:** Through RAWE, students gain self-assurance and professional capacity to address issues in the field.

CONCLUSION

The experiential learning opportunities provided by the RAWE in the two graduate programs prove highly beneficial for students, aiding their understanding of

the financial, legal, and practical aspects of farming operations. Demonstrations of new technology in farmers' fields, skill improvement, and entrepreneurial knowledge acquisition under work experience programs contribute to students developing and managing their businesses. The initiative also focuses on enhancing infrastructure by establishing centers of excellence in various agriculture-related skills and technologies in relevant universities, addressing both theoretical and practical aspects of instruction.

REFERENCES

- Ineme, A.E. and A. Arikpo. 2013. University undergraduate students' perception of arts course content, behavioural outcomes and entrepreneurial skills in cross river state, Nigeria. *Global Journal of Human Social Science Interdisciplinary*, 13(1): 13-15.
- Kapri, A.; N.C. Kurbetta and U.S. Hiremath. 2016. Perception of RAWE Programme by Students of UAS, Dharwad (Karnataka). *Journal of Agroecology and Natural Resource Management*, 15(1): 5-9.
- Kumar, A.K.; S.G. Nain; M.S. Singh; R. Kumbhare; R. Parsad and S. Shiv Kumar. 2021. Training Effectiveness of Skill Development Training Programmes among the Aspirational Districts of Karnataka. *Indian Journal of Extension Education*, 57(4): 67-70.
- Mahadik, R.P.; P.G. Mehta and P.A. Sawant. 2011. Attitude of students towards rural work experience programme. *Rajasthan Journal of Extension Education*, 19: 148-151.
- Naveen, B.; T. Gopikrishna; R.B. Mukunda and R. CH. Pulla. 2019. Constraints and suggestions of the RAWEP students for effective implementation of RAWEP. *International Journal of Chemical Studies*, 7(3): 810-812.
- Roberts, T.G. 2006. A philosophical examination of experiential learning theory for agricultural educators. *Journal of Agriculture Education*, 47(1): 17-29.
- Sajeev, M.V. and K.N. Gowda. 2013. Perceptions on Experiential Learning: A Study of Agriculture Students. *Indian Research Journal of Extension Education*, 13(1): 48-55.

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Research Article

Influence of Pruning Time on Growth Parameters and Yield of Guava (*Psidium guajava* L.) Genotypes

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ABSTRACT

The present investigations were conducted at the Instructional-cum-Research Farm, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri on seven different genotypes namely RHR-Guv-58, RHR-Guv-60, RHR-Guv-14, RHR-Guv-16, RHR-Guv-3, RHR-Guv-6 and Sardar with five pruning time i.e. 15th May, 15th June, 15th July, 15th August, 15th Sept. and no pruning (control). The experiment was laid out in Factorial Randomized Block Design with forty two treatments and was replicated two times. The experiment was conducted for two seasons, and results indicated that the maximum height of plant (2.42 m), number of shoots per plant (140.29), length of shoot (82.17 cm), girth of shoot (1.86 cm), number of fruits (214.08) and yield per plant (34.81 kg) was recorded in G₁ (Sardar). The significantly minimum time required for initiation of new shoots (24.00 days) was observed in Sardar with 15th May pruning time.

Keywords: Guava genotypes, Pruning time, Growth, Sprouting shoot, Yield

INTRODUCTION

Guava (*Psidium guajava* L.) is the most valuable cultivated species of the Myrtaceae family popularly known as “poor man’s fruit” or “apple of tropics” (Singh, 2013). It is native to tropical America stretching from Mexico to Peru and was introduced in India by the Portuguese during 17th century (Dinesh and Vasugi, 2010). Guava fruit is commercially important in India, China, Indonesia, South Africa, Florida, Hawaii, Egypt, Yemen, Brazil, Mexico, Colombia, West Indies, Cuba, Venezuela, New Zealand, Philippines, Vietnam and Thailand and also has good level of the dietary minerals, potassium, magnesium, and generally a broad, low-calorie profile of essential nutrients (Nimisha *et al.*, 2013). Guava is the fourth most important fruit crop in India after Mango, Banana and Citrus (Nagar *et al.*, 2017). The area under guava in India during 2018-19 was 270.0 thousand ha producing 4107.0 thousand MT with the productivity of 15.21 MT/ha. Guava

contributes 4.0 per cent area of total fruit and 4.1 per cent of total fruit production in India (Anonymous, 2019). Pruning technique is used to minimize the disease and insect pest attack, mostly fruit fly infestation. Maximum fruit fly infestation occurs in rainy season crop as compared to winter season crop at maturity stage of fruit. Pruning is very important horticultural operation leads to regulate the crop with season. It increases the yield and quality of fruit it evades the flowering and fruiting of crop and gives the better canopy structure. Guava trees bear terminally, that’s why pruning influences more sprouting of shoots, flowering, fruiting and consequently increase in the yield of guava. The yield of winter season crop is less than rainy season crop. To overcome the problem of low yield during winter season pruning has been taken to regulate summer season flowering to minimize rainy season crop and increase that during the winter season (Dubey *et al.*, 2012). Considering the above factors, the present experiment was undertaken with the

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following objective to study the effect of pruning time on growth parameters and yield of guava.

MATERIALS AND METHODS

An experiment was carried out with an objective to study growth and yield of guava genotypes at the Instructional-cum-Research Farm, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. The present investigations were conducted on seven different genotypes namely Sardar (G_1), RHR-Guv-58 (G_2), RHR-Guv-60 (G_3), RHR-Guv-14 (G_4), RHR-Guv-16 (G_5), RHR-Guv-3 (G_6) and RHR-Guv-6 (G_7) with five pruning time i.e. 15th May (P_1), 15th June (P_2), 15th July (P_3), 15th August (P_4), 15th Sept (P_5) and no pruning (control) (P_6). The genotypes were pruned 75 per cent of current season growth of guava plants. The experiment was laid out in Factorial Randomized Block Design with forty two treatments and was replicated two times. Observations on growth parameters and yield were recorded. The statistical analysis of the data was done as per the standard procedure (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Height of plant (m): The data on height of plant after the pruning operation are presented in Table 1, 2 and 3. The significantly highest height of plant (2.28 and 2.41 m) was recorded in P_6 (Control) treatment, which was superior over rest of treatments, whereas lowest (2.03 and 2.10 m) in P_5 treatment during both the season, respectively. In case of pooled data, significantly maximum height of plant (2.34 m) was observed in P_6 (Control) treatment and minimum (2.06 m) in P_5 treatment. The G_1 genotype was recorded significantly highest height of plant (2.36 and 2.47 m), while the lowest (1.97 and 2.06 m) in G_4 genotype during both the season, respectively. The pooled data indicated that, significantly maximum height of plant (2.42 m) was noticed in G_1 genotype, which was followed by G_3 genotype (2.24 m), whereas the minimum height (2.01 m) in G_4 genotype. The results indicated that the maximum height of plant was recorded in the G_1 (Sardar) as compared to other genotypes. It might be due to the independent growth rate and habit of variety because Sardar plant having vigorous growth compare to other genotypes. It was also observed increases in height of plant in the pruned plants. Since guava is highly responsive to pruning. It

might be due to pruning removes carbon-starved, fruiting exhausted shoots and promotes new leaf growth to build up carbohydrates reserves for the next flowering and allows the sprouting of lateral buds, which ultimately influence the plant height, plant spread, plant volume and other vegetative characters of plants during active growth phase of plant. Minimum plant height was recorded in 15th September pruning time treatment might be due to non-disturbance of metabolites with apical dominance in plant by continues growth of active period in rainy season. The results of present studies are confirmed with Kumar and Rattanpal (2010); Pilania *et al.* (2010); Sah *et al.* (2017) and Hiremath *et al.* (2017) reported significant increase in guava plant height after pruning of plants.

East-west plant spread (m): Data presented in Table 1, 2 and 3 showed that, the P_6 treatment was observed significantly highest East-West plant spread (4.28 and 4.45 m), which was followed by P_1 treatment (4.03 and 4.16 m), while the lowest (3.79 and 3.90 m) in P_2 treatment during both the season, respectively. In case of pooled data, maximum East-West plant spread (4.36 m) was noted in P_6 (Control) treatment and lowest (3.84 m) in P_2 treatment. In case of genotypes, highest East-West plant spread (5.75 and 5.98 m) was recorded by G_1 genotype, which was superior over rest of genotypes, while the minimum (3.43 and 3.55 m) in G_7 genotype during both the season. In pooled data similar trend was observed that, maximum in G_1 genotype (5.86 m) and minimum in G_7 genotype (3.49 m).

North-South plant spread (m): Data presented in Table 1, 2 and 3 showed that, the maximum North-South plant spread (4.24 m) was noticed in P_6 (Control) treatment and minimum (3.90 m) in P_2 treatment in pooled data. The G_1 genotype was recorded significantly maximum North-South plant spread (5.63 and 5.85 m), which was superior over rest of genotypes and least (3.28 and 3.40 m) in G_7 genotype during both the season, respectively. Similar trend was also observed in pooled data, i.e. maximum (5.74 m) in G_1 and minimum (3.34 m) in G_7 genotype. The results indicated that the increase in plant spread (EW and NS) was observed in all pruning treatments and genotypes in pruned plants. This might be due to high growth rate of new emerged shoots after the pruning which leads to increase in plant spread. Pruning removes

carbon- starved, fruiting exhausted shoots and promotes new leaf growth to build up carbohydrates reserves for the next flowering and allows the sprouting of lateral buds, which ultimately influence the plant spread, plant volume and other vegetative characters of plants during active growth phase of plant. The results of present studies are confirmed with Pilania *et al.* (2010) and Hiremath *et al.* (2017) reported significant increase in plant spread after pruning of guava plants.

Weight of pruned material (kg): The data on weight of pruned material are presented in Table 1, 2 and 3 the significantly maximum weight of pruned material (10.14 kg) was observed in P₂ treatment, which was at par with P₅ (9.90 kg) and P₁ (9.77 kg), while the minimum weight of pruned material was observed in P₄ (9.10 kg) treatment during season 1. The same trend was recorded during the season 2. Regarding pooled data, the significantly maximum weight of pruned material (10.66 kg) was recorded in P₂ treatment, which was at par with P₅ (10.48 kg) and P₁ (10.23 kg), whereas minimum (9.57 kg) in P₄ treatment. As regarding genotypes, the G₁ genotype was recorded significantly maximum weight of pruned material (14.44 and 16.16 kg), which was superior over rest of genotypes, while the minimum (6.49 and 7.19 kg) in G₇ genotype during both the season, respectively. In the pooled data same trend was observed, i.e. highest (15.30 kg) in G₁ genotype and minimum (6.84 kg) in G₇ genotype. The results indicated from the data that, the maximum weight of pruned material was recorded in P₂ (15th June pruning time) treatment. The congenial climatic conditions during rainy season might have led to luxurious vegetative growth and resulted in higher pruning weight. With respect to genotypes, it was observed that genotype G₁ showed maximum weight of pruned material than the rest of genotypes. This might be due to the independent growth rate and habit of genotype which leads to increase in organic matter in plant due to which high initial pruned weight was obtained by pruning operation. These results are in accordance with the findings of Raut *et al.* (2016); Nikumbhe (2017) and Hiremath *et al.* (2017) in guava.

Time required for initiation of new shoots (days): The data on time required for initiation of new shoots are presented in Table 1, 2 and 3. The P₁ treatment was recorded minimum time required for initiation of new shoots (28.29 days), which was superior over

rest of treatments and maximum (45.29 days) in P₅ treatment during the season 1. The similar trend was noticed during the season 2. Pooled results indicated that, minimum time required for initiation of new shoots (27.86 days) was observed in P₁ treatment, while the maximum (44.79 days) in P₅ treatment. During the season 1, data regarding effect of genotypes on time required for initiation of new shoot was noted minimum in G₁ genotype (31.83 days) and maximum (38.00 days) in G₃ and G₇ genotypes. During the season 2, the minimum time required for initiation of new shoot (31.00 days) was recorded in G₁ genotype and maximum (36.92 days) in G₃ and G₆ genotype. Regarding pooled data indicated that, minimum in G₁ genotype (31.42 days) and maximum (37.46 days) in G₃ genotype. The results of conducted experiments revealed that the minimum days required for initiation of new shoots was noted in the pruning time of 15th May (P₁) but later it was increased in number of days from June to September pruning time and also more or less in control treatments. The late commencement of initiation of new shoots in plant are subjected to time of pruning and active growth phase on the basis that such trees put forth new vegetative growth immediately after pruning and carbohydrates favour the flower bud formation or initiation, might have been utilized in the vegetative growth, thereby delaying in new shoots formation. In the present investigation delayed in sprouting was observed as there was delay in pruning time. The time of pruning also plays an important role in sprouting of buds. The earlier pruned trees required less days as compared to late pruning. The maximum days were required in September pruning, when the shoots were exposed to unfavorable climatic condition, whereas May pruning time favorable with monsoon climatic condition with active growth phase of plant leads to require minimum days for sprouting shoots. These results are similar with the findings of Nikumbhe *et al.* (2017) and Sah *et al.* (2017) who has obtained minimum days required for initiation of new shoots was in the pruned plants of guava compare to un-pruned plants.

Number of sprouted shoots per plant: Significantly P₁ treatment was recorded maximum number of shoots per plant (90.14 and 109.93) during both the season (Table 1 and 2), whereas the minimum (77.86 and 88.29) in P₅ treatment and it was at par with P₂

Table 1: Effect of pruning time and genotypes on different growth parameters of fruit (Season 1)

Treatments	Height of plant (m)	East-West plant spread (m)	North-South plant spread (m)	Weight of pruned material (kg)	Time required for initiation of new shoots (days)	Number of shoots sprouted per plant	Length of sprouted shoot (cm)	Girth of sprouted shoot (cm)	Number of fruits	Yield per plant (kg)
P ₁ - 15 th May	2.14	4.03	3.87	9.77	28.29	90.14	52.57	1.33	168.64	38.76
P ₂ - 15 th June	2.10	3.79	3.84	10.14	31.29	88.36	50.71	1.38	157.07	37.84
P ₃ - 15 th May	2.11	3.83	3.89	9.41	35.29	85.79	47.71	1.39	151.00	34.65
P ₄ - 15 th May	2.10	3.89	3.85	9.10	40.29	85.64	46.21	1.40	114.64	25.18
P ₅ - 15 th May	2.03	3.99	3.96	9.90	45.29	77.86	42.64	1.32	83.00	17.61
P ₆ (Control)	2.28	4.28	4.15	0.00	41.50	86.57	82.00	2.08	153.29	34.16
S.E. ($\pm$)	0.05	0.09	0.10	0.25	0.03	1.92	1.21	0.02	2.55	0.23
CD at 5 %	0.15	0.24	NS	0.71	0.08	5.33	3.34	0.07	7.08	0.63
G ₁ - Sardar	2.36	5.75	5.63	14.44	31.83	132.92	83.25	1.86	211.08	34.84
G ₂ - RHR-Guv-58	2.13	3.70	3.71	7.12	37.67	83.17	51.75	1.38	125.50	30.36
G ₃ - RHR-Guv-60	2.20	3.79	3.73	6.73	38.00	72.50	48.75	1.45	129.17	32.02
G ₄ - RHR-Guv-14	1.97	3.79	3.80	7.63	37.67	80.58	46.08	1.50	133.25	34.05
G ₅ - RHR-Guv-16	2.01	3.49	3.55	6.79	37.83	77.33	46.50	1.41	122.58	29.29
G ₆ - RHR-Guv-3	2.09	3.82	3.79	7.16	37.92	78.17	48.08	1.42	126.33	31.25
G ₇ - RHR-Guv-6	2.14	3.43	3.28	6.49	38.00	75.42	51.08	1.39	117.67	27.75
S.E. ($\pm$)	0.06	0.09	0.10	0.28	0.03	2.08	1.30	0.03	2.76	0.25
CD at 5 %	0.16	0.26	0.29	0.76	0.09	5.75	3.61	0.07	7.64	0.68
Interaction (P×G)										
S.E. ($\pm$)	0.14	0.23	0.25	0.67	0.08	5.08	3.19	0.06	6.76	0.60
CD at 5 %	NS	NS	NS	1.87	0.21	NS	NS	NS	18.72	1.67

Table 2: Effect of pruning time and genotypes on different growth parameters of fruit (Season 2)

Treatments	Height of plant (m)	East-West plant spread (m)	North-South plant spread (m)	Weight of pruned material (kg)	Time required for initiation of new shoots (days)	Number of shoots sprouted per plant	Length of sprouted shoot (cm)	Girth of sprouted shoot (cm)	Number of fruits	Yield per plant (kg)
P ₁ - 15 th May	2.24	4.16	4.01	10.70	27.43	109.93	49.07	1.30	174.50	38.64
P ₂ - 15 th June	2.18	3.90	3.96	11.19	30.29	105.50	48.00	1.34	162.86	38.22
P ₃ - 15 th May	2.18	3.96	4.01	10.19	34.29	99.29	46.00	1.28	155.64	35.28
P ₄ - 15 th May	2.16	4.01	3.97	10.03	39.29	100.93	43.29	1.29	117.14	25.45
P ₅ - 15 th May	2.10	4.10	4.09	11.06	44.29	88.29	40.86	1.28	87.71	18.26
P ₆ (Control)	2.41	4.45	4.34	0.00	40.00	98.21	83.71	2.16	161.86	35.63
S.E. ($\pm$)	0.06	0.09	0.10	0.29	0.04	2.40	1.37	0.03	2.33	0.22
CD at 5 %	0.17	0.25	NS	0.80	0.11	6.65	3.81	0.09	6.47	0.61
G ₁ - Sardar	2.47	5.98	5.85	16.16	31.00	147.67	81.08	1.86	217.08	34.77
G ₂ - RHR-Guv-58	2.19	3.81	3.84	7.95	36.50	96.67	50.92	1.34	130.42	31.04
G ₃ - RHR-Guv-60	2.28	3.89	3.85	7.45	36.92	85.92	47.33	1.38	133.33	32.51
G ₄ - RHR-Guv-14	2.06	3.91	3.92	8.20	36.50	95.08	44.00	1.43	136.92	34.31
G ₅ - RHR-Guv-16	2.08	3.59	3.66	7.28	36.83	91.58	45.25	1.33	127.42	29.92
G ₆ - RHR-Guv-3	2.18	3.94	3.93	7.79	36.92	96.67	46.92	1.37	133.17	32.10
G ₇ - RHR-Guv-6	2.22	3.55	3.40	7.19	36.83	88.92	47.25	1.38	124.67	28.74
S.E. ($\pm$)	0.07	0.10	0.11	0.31	0.04	2.59	1.48	0.03	2.52	0.24
CD at 5 %	0.18	0.27	0.30	0.86	0.12	7.18	4.11	0.10	6.98	0.66
Interaction (P×G)										
S.E. ($\pm$)	0.16	0.24	0.27	0.76	0.11	6.35	3.63	0.09	6.17	0.58
CD at 5 %	NS	NS	NS	2.11	0.30	NS	NS	NS	17.11	1.61

Table 3: Effect of pruning time and genotypes on different growth parameters of fruit (Pooled)

Treatments	Height of plant (m)	East-West plant spread (m)	North-South plant spread (m)	Weight of pruned material (kg)	Time required for initiation of new shoots (days)	Number of shoots sprouted per plant	Length of sprouted shoot (cm)	Girth of sprouted shoot (cm)	Number of fruits	Yield per plant (kg)
P ₁ - 15 th May	2.19	4.09	3.94	10.23	27.86	100.04	50.82	1.32	171.57	38.70
P ₂ - 15 th June	2.14	3.84	3.90	10.66	30.79	96.93	49.36	1.36	159.96	38.03
P ₃ - 15 th May	2.15	3.90	3.95	9.80	34.79	92.54	46.86	1.33	153.32	34.96
P ₄ - 15 th May	2.13	3.95	3.91	9.57	39.79	93.29	44.75	1.34	115.89	25.31
P ₅ - 15 th May	2.06	4.05	4.02	10.48	44.79	83.07	41.75	1.30	85.36	17.93
P ₆ (Control)	2.34	4.36	4.24	0.00	40.75	92.39	82.86	2.12	157.57	34.89
S.E. (±)	0.06	0.09	0.10	0.27	0.04	2.17	1.29	0.03	2.45	0.22
CD at 5 %	0.16	0.24	NS	0.75	0.10	6.03	3.58	0.08	6.78	0.62
G ₁ - Sardar	2.42	5.86	5.74	15.30	31.42	140.29	82.17	1.86	214.08	34.81
G ₂ - RHR-Guv-58	2.16	3.76	3.77	7.53	37.08	89.92	51.33	1.36	127.96	30.70
G ₃ - RHR-Guv-60	2.24	3.84	3.79	7.09	37.46	79.21	48.04	1.41	131.25	32.27
G ₄ - RHR-Guv-14	2.01	3.85	3.86	7.91	37.08	87.83	45.04	1.46	135.08	34.18
G ₅ - RHR-Guv-16	2.04	3.54	3.60	7.03	37.33	84.46	45.88	1.37	125.00	29.60
G ₆ - RHR-Guv-3	2.13	3.88	3.86	7.48	37.42	87.42	47.50	1.40	129.75	31.67
G ₇ - RHR-Guv-6	2.18	3.49	3.34	6.84	37.42	82.17	49.17	1.38	121.17	28.24
S.E. (±)	0.06	0.09	0.11	0.29	0.04	2.35	1.40	0.03	2.64	0.24
CD at 5 %	0.17	0.26	0.29	0.81	0.11	6.51	3.87	0.09	7.32	0.67
Interaction (P×G)										
S.E. (±)	0.15	0.23	0.26	0.72	0.09	5.75	3.42	0.08	6.47	0.59
CD at 5 %	NS	NS	NS	1.99	0.26	NS	NS	NS	17.93	1.64

treatment (88.36 and 105.50). In pooled data, the maximum number of sprouted shoots per plant (100.04) was noticed in P_1 treatment, which was at par with P_2 treatment (96.93) and the minimum (83.07) in P_5 treatment (Table 3). The G_1 genotype was recorded significantly maximum number of sprouted shoots per plant (133.92 and 147.67), while the minimum (72.50 and 85.92) in G_3 genotype in both season, respectively (Table 1 and 2). In case of pooled data was noticed similar trend (Table 3), i.e. maximum in G_1 (140.29) and minimum in G_3 genotype (79.71). It might be due to the independent growth rate and habit of variety because Sardar plant having more sprouting habit compare to other genotypes. The results of present aspect are found in line with those of Singh *et al.* (2001); Thakre *et al.* (2016) and Lakpathi and Rajkumar *et al.* (2018) observed maximum number of sprouted shoots in pruned plants compared to un-pruned plants in guava.

Length of sprouted shoot (cm): The data related to the length of sprouted shoot are presented in the Table 1, 2 and 3. The P_6 treatment was recorded significantly maximum length of sprouted shoot (82.00 and 83.71 cm) during both the season, respectively, whereas the minimum (42.64 and 40.86 cm) in P_5 treatment. Similar trend was noticed in pooled data, i.e. maximum in P_6 (82.86 cm) and minimum in P_5 treatment (41.75 cm). Regarding effect of genotype indicated that, significantly maximum length of sprouted shoot (83.25 and 81.08 cm) was observed in G_1 genotype, which was superior over rest of genotypes and minimum (46.08 and 44.00 cm) in G_4 genotype during the both season, respectively. In case of pooled data, significantly maximum was noticed in G_1 genotype (82.17 cm) and minimum in G_4 genotype (45.04 cm). From the results, it is indicated that increases length of shoot was recorded in the pruned plants as compared to control ones. It might be due to the translocation of metabolites in new emerged shoot lead to increase in length of shoot of pruned plants during active growth phase of plant. The minimum length of shoot per plant might be due to non-disturbance in the apical dominance of the growing shoots. The results of present studies are found in line with those of Jadhav *et al.* (2002), Mehta *et al.* (2012) and Raut *et al.* (2016) observed maximum length of shoot in pruned plants compared to un-pruned plants in guava.

Girth of shoot (cm): Girth of shoot was found differed significantly due to various pruning time and genotypes (Table 1, 2 and 3). However, significantly the maximum girth of shoot (2.08 and 2.16 cm) was noted in P_6 treatment and minimum (1.32 and 1.28 cm) in P_5 treatment during the both season, respectively. Regarding pooled results, the significantly maximum girth of shoot (2.12 cm) was observed in P_6 treatment and minimum (1.30 cm) in P_5 treatment. P_6 treatment (Control) showed superiority for girth of shoot during the both season. Data on effect of genotypes revealed that, the G_1 genotype was significantly recorded maximum girth of shoot (1.86 and 1.86 cm), which was superior over rest of genotypes in the both season and minimum (1.38 and 1.34 cm) in G_2 genotype during the both the season, respectively. Similar trend was noticed in pooled data, i.e. maximum in G_1 genotype (1.86 cm) and minimum in G_2 genotype (1.36 cm). It might be due to availability of higher stored food material in pruned plants, which put forth fast and vigorous growth of sprouted shoots of pruned plants during active growth phase of plant. Sardar plant having luxurious growth habit compares to other genotypes consequently increases of girth of shoot. The results are conformity with findings of Raut *et al.* (2016) and Nikumbhe *et al.* (2017) had often reported that an increase in shoot girth of guava.

Number of fruit harvested per plant: The number of fruits per plant were significantly differed due to different pruning time for both the season and pooled results. In the season 1 and 2, the maximum number of fruits (168.64 and 174.50) were recorded in P_1 treatment, which was superior over rest of treatments and minimum (83.00 and 87.71) in P_5 treatment. The same trend was noticed in pooled data of pruning time, the maximum number of fruits (171.57) were noted in P_1 treatment and minimum (85.36) in P_5 treatment. In case genotypes, the highest number of fruits (211.08 and 217.08) were significantly observed in G_1 genotype, which was superior over rest of genotypes, whereas the lowest in G_7 genotype (117.67 and 124.67) during both the season, respectively. Same trend was noticed for pooled results, the highest number of fruits (214.08) were noted in G_1 genotype and minimum in G_7 genotype (121.17). The results revealed that the maximum number of fruits in the pruning time of 15th May (P_1) but later it was decreased

from June (P_2) to September (P_3) pruning treatments and control also. This might be due to change in the weather conditions and C: N ratio in plant. Congenial climatic condition and C: N ratio leads to the more sprouting and fruiting and consequently increases in number of fruits. It was also observed that the maximum number of fruits was observed in G_1 (Sardar) as compared to others and this could be attributed to the characteristics of the genotype. Though, the number of branches was found to be more in control. The higher number of fruits was recorded in pruning treatments (P_1) irrespective of genotype. Similarly response of genotypes to pruning time was also noticed. However, G_1 (Sardar) having more sprouting ability to produce more number of fruits per shoot was superior over the rest of the genotypes. The results of this investigation are similar with the Singh *et al.* (2001) reported that, plants pruned in May and June recorded significantly maximum number of fruit per plant than un-pruned plants in guava. These results are also similar with the findings of Prakash *et al.* (2012); Ali *et al.* (2014) and Mali *et al.* (2016), in guava.

Yield of fruit per plant: Data regarding on yield of fruit per plant with fruit fly infestation are presented in Table 1, 2 and 3. The significantly highest yield of fruit per plant (38.76 and 38.64 kg) was noted in P_1 treatment, which was followed by P_2 treatment (37.84 and 38.22 kg), whereas minimum in P_3 treatment (17.61 and 18.26 kg) during both the season, respectively. In the pooled results similar trend was observed i.e. Maximum in P_1 treatment (38.70 kg) and minimum in P_3 treatment (17.93 kg). Regarding genotypes effect indicated that, maximum yield of fruit per plant (34.84 kg) was recorded in G_1 genotype, which was followed by G_4 genotype (34.05 kg) and the minimum (27.75 kg) in G_7 genotype in season 1. During the season 2, maximum yield of fruit per plant (34.77 kg) was observed in G_1 genotype, which was at par with G_4 genotype (34.31 kg), while the minimum (28.74 kg) in G_7 genotype. In the pooled results indicated that, the highest fruit yield per plant (34.81 kg) was noted in G_1 genotype, which was at par with G_4 genotype (34.18 kg), whereas the lowest in G_7 genotype (28.24 kg). The results revealed that, maximum yield of fruit per plant with fruit fly infestation was recorded in pruning time of 15th May (P_1) treatment. This may be attributed to the proper

balance between the vegetative and reproductive growth of the plants and availability of stored food material in pruned plant as compared to other treatments. Since un-pruned plant got exhausted because of the heavy crop load during the previous season, they produced less number of flower buds for winter season. This might have exposed the plants for compensation point unit production of photosynthesis and subsequently lower yield in winter compare to pruned ones. Maximum yield and fruit fly infested fruits was observed early pruning due to favourable condition for fruit yield and infestation, while minimum fruit yield and fruit fly infested fruits in late pruning due to unfavourable condition for fruit fly infestation. These findings are in accordance with Basu *et al.* (2007); Nimbalkar *et al.* (2010); Pilonia *et al.* (2010) and Sah *et al.* (2017) as they obtained an increment in fruit yield per plant by pruning in guava during winter season. It also observed that, maximum yield of fruit per plant with fruit fly infestation was recorded in G_1 (Sardar) and G_4 (RHR-Guv-60) genotype. It might be attributed to the characteristics of the Sardar having more sprouting ability to produce more number of fruits per shoot and genotype G_4 (RHR-Guv-60) having more fruit weight consequently increases yield (Nikumbhe, 2014).

CONCLUSION

The results of present investigation, it is concluded that the maximum vegetative growth and yield was noticed in Sardar after pruning as compared to other genotypes.

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REFERENCES

- Ali, F.S. and A.A. Abdel-Hameed. 2014. Effect of pruning on yield and fruit quality of guava trees. *Journal of Agriculture and Veterinary Science*, 7(12): 41-44.
- Anonymous. 2019. National Horticulture Board, Ministry of Agriculture, Govt. of India.

- Basu, J.; B. Das; S. Sarkar; K.K. Mandal; B.C. Banik; S. Kundu; M.A. Hassan; S. Jha and S.K. Ray. 2007. Studies on the response of pruning for rejuvenation of old guava orchard. *Acta Horticulturae*, 735: 303-309.
- Dinesh, M.R. and C. Vasugi. 2010. Guava improvement in India and future needs. *Journal of Horticultural Sciences*, 5: 94-108.
- Dubey, A.K.; D.B. Singh; A. Barche; Singh and D. Meenakshi. 2002. Deblossoming in summer season flowering in guava. *Indian Horticulture*, 47(1): 35-36.
- Hiremath, S.; S.I. Athani; K.K. Das; P.R., Choudhury; D. Pujar; A.M. Shirol and J.B. Gopali. 2017. Evaluation of physical characters of fruit, yield and cost economics under different crop regulation practices in guava (*Psidium guajava* L.) variety Sardar. *International Journal of Chemical Studies*, 5(6): 289-293.
- Jadhav, B.J.; V.K. Mahurkar and V.S. Kale. 2002. Effect of time and severity of pruning on growth and yield of guava (*Psidium guajava* L.) cv. Sardar. *Orissa Journal of Horticulture*, 30(2): 83-86.
- Kumar, Y. and H.S. Rattanpal. 2010. Effect of pruning in guava planted at different spacing under Punjab conditions. *Indian Journal of Horticulture*, 67(Special issue): 115-119.
- Lakpathi, G. and M. Rajkumar. 2018. Effect of pruning intensities and fruit load on yield and quality of guava under high density planting system. *International Journal of Current Microbiology and Applied Sciences*, 7(5): 1853-1860.
- Mali, D.S.; S.A. Ranpise; S.S. Kulkarni and P.H. Nikumbhe. 2016. Influence of pruning techniques on yield and fruit quality attributes in high density planting of guava cv. Sardar. *Ecology, Environment and Conservation*, 22(April Suppl.): S411-S414.
- Mehta, S.; S.K. Singh; B. Das; B.R. Jana and S. Mali. 2012. Effect of pruning on guava cv. Sardar under ultra high density orcharding system. *Vegetos*, 25(2): 192-195.
- Nagar, P.K.; B.N. Satodiya; H.L. Dhaduk and D.G. Prajapati. 2017. Genetic variability and bio-chemical screening of guava (*Psidium guajava* L.) hybrids. *International Journal of Chemical Studies*, 5(6): 143-146.
- Nikumbhe, P.H.; A.M. Musmade; D.S. Mali and R.S. Patil. 2017. Impact of pruning time on shoot initiation, shoot sprouting, fruit yield and fruit fly incidence in guava. *International Journal of Pure & Applied Bioscience*, 5(2): 513-518.
- Nimbalkar, C.A.; G.M. Idarte; S.P. Gaikwad and U.T. Desai. 2010. Rejuvenation technology for rejuvenation of old guava (cv. *Sardar*) orchard. *Journal of Maharashtra Agricultural University*, 35(3): 486-487.
- Nimisha, S.; D. Kherwar; K.M. Ajay; B. Singh and K. Usha. 2013. Molecular breeding to improve guava (*Psidium guajava* L.): Current status and future prospective. *Scientia Horticulturae*, 164: 578-588.
- Panse, V.G. and P.V. Sukhatme. 1985. Statistical Methods of Agriculture Workers, 4th Ed. ICAR, New Delhi Publication, 347.
- Pilania, S.; A.K. Shukla; L.N. Mahaver; R. Sharma and H.L. Bairwa. 2010. Standardization of pruning intensity and integrated nutrient management in meadow orcharding of guava (*Psidium guajava* L.). *Indian Journal of Agricultural Sciences*, 80(8): 673-678.
- Prakash, S.; V. Kumar; P.L. Saroj and S.C. Sirohi. 2012. Response of yield and quality of winter guava to severity of summer pruning. *Indian Journal of Horticulture*, 69(2): 173-176.
- Raut, S.A.; S.M. Choudhary; U.M. Naglot and D.L. Chavan. 2016. Effect of time and intensity of pruning on yield and quality of guava (*Psidium guajava* L.) cv. Sardar. *Advances in Life Sciences*, 5(22): 10750-10752.
- Sah, H.; S. Lal and S.S. Negi. 2017. Effect of pruning on growth, flowering and yield in high density planting of guava. *Indian Journal of Pure & Applied Biosciences*, 5(1): 285-292.
- Singh, D. 2013. Morphological and molecular characterization of guava (*Psidium guajava* L.) germplasm and F₁ hybrids. Ph.D. dissertation. Punjab Agricultural University, Ludhiana, India.
- Singh, G.; S. Rajan and A.K. Singh 2001. Influence of pruning date on fruit yield of guava under subtropics. *Journal of Applied Horticulture*, 3(1): 37-40.
- Singh, N.K.; D.C. Shivastava and A.P. Bhandarkar. 2012. Growth, yield and quality of guava as influenced by varying rejuvenation periods. *Indian Journal of Horticulture*, 69(2): 181-184.
- Thakre, M.; S. Lal; S. Uniyal; A.K. Goswami and P. Prakash. 2016. Pruning for crop regulation in high density guava plantation. *Spanish Journal of Agricultural Research*, 14(2): e0905.



Research Article

Knowledge of Farm Women about Recommended Technologies Related to Improved Cauliflower Cultivation in Udaipur District, Rajasthan

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ABSTRACT

Vegetables are beneficial for the maintenance of human health which deliver nutritive and balanced diet. This work considers the cauliflower, it is a popular rabi season vegetable crop that grown in whole the country. Curd, the edible part of cauliflower, is composed of a stalk system with small internodes, apices, bracts, and branches. It is enriched with a high-quality vitamins, proteins and variety of minerals such as potassium, sodium, iron, phosphorus, calcium, and magnesium. This research study was conducted in four panchayat samities of Udaipur district of Rajasthan purposively selected based on the highest area and production. This work is experimented through a sample of 89 cauliflower growers that was selected from sixteen villages using a proportionate random sampling technique. Data were collecting using structured interview schedule. It was found that 91.50 per cent respondents were categorized with average knowledge while 5 percent of respondents had poor knowledge and 3.5 percent of respondents had good knowledge about recommended technologies related to cauliflower cultivation.

Keywords: Vegetables, Farm women, Recommended practices, Knowledge and Improve Cauliflower cultivation

INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis*) is a widely produced winter vegetable crop across the country. Cauliflower is the major vegetable crop cultivated in India, covering 463 mha and producing 9038 MT in (2020-2021). Cauliflower cultivation is practiced in diverse agro-climatic regions (summer to subtropical climate) but this vegetable thrives best in cool (winter) as well as the moist condition. This adaptable vegetable can be grown in a variety of soil types, fertile, well-drained, and rich in organic matter. With proper management and attention to key agronomic practices, cauliflower cultivation can yield high-quality produce that meets the demands of both domestic and international markets. It is widely grown in Rajasthan, especially in Udaipur district, cauliflower cultivation

covers 85 acres and produces 52 metric tonnes. The cultivation of cauliflower typically involves several stages, starting from seed selection and nursery raising to transplanting, field management, and finally, harvesting. Farmers employ various agronomic practices such as soil preparation, irrigation, fertilization, pest, and disease management, and weed control to optimize cauliflower growth and productivity while minimizing crop losses. An attempt has been made in the present paper to study knowledge of farm women about recommended technologies related to improved cauliflower cultivation in Udaipur district, Rajasthan

MATERIALS AND METHODS

This research work was conducted in Udaipur district of Rajasthan. The cauliflower crop is the most

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prominent in this area. The study was conducted in four Panchayat samities namely Badgaon, Gogunda, Girwa, and Vallabhagar. The sample was selected by proportionate random sampling and consisted of 89 farm women. The data were collected through personal interview technique using structured interview schedule. Percentage and Mean percent scores were used to assess the overall knowledge of the respondents regarding improved cauliflower cultivation. Based on their mean percent scores, the respondents were divided into three equidistant categories.

RESULTS AND DISCUSSION

Knowledge of the respondents regarding recommended technologies related to cauliflower cultivation was assessed using nine components as recommended in package of practices *i.e.* improve varieties, nursery preparation, soil, field preparation, transplanting, manure and fertilizer. It also considers irrigation management, weed management, plant protection measures and harvesting.

An effort was made to categorize the respondents based on knowledge possessed by them regarding recommended technologies related to cauliflower cultivation. It is depicted in the given Table 1 that shows most of the respondents possessed average knowledge of cauliflower (91.50%) followed by 5.50 per cent of the respondents having poor knowledge and rest (3%) had good knowledge regarding improved cauliflower cultivation. Similar findings were reported by (Kumar *et al.*, 2018) that the majority of respondents (61.66%) stated that they had a medium level of knowledge, followed by poor knowledge (22.50%) and high knowledge (15.84%). Data in Table 2 depicts the knowledge of the respondents about improved cauliflower cultivation. Mean per scores were calculated to have uniformity in scores obtained by the respondents in different items in the improved practices.

Table 1: Categorization of the respondents based on their overall knowledge about recommended technologies related to improved cauliflower cultivation

Knowledge categories	Percentage
Good (Above 66.66)	3.00
Average (33.33-66.66)	91.50
Poor (Below 33.33)	5.50

Table 2: Knowledge of the respondents about improved cauliflower cultivation

Practices	Mean Percent Score	Rank
Improved varieties	73.37	IV
Soil and field preparation	89.30	I
Nursery preparation	39.64	VII
Transplanting	45.10	VI
Manure and fertilizer application	82.35	II
Weed management	28.73	IX
Irrigation management	70.67	V
Plant protection measures	32.26	VIII
Harvesting	80.07	III

Data in Table 2 reveal that the respondents had good knowledge about improved varieties of cauliflower with 73.37 MPS. They were aware of the improved varieties like Pusa Snow Ball, Pusa Deepali, Pusa Katki, Pusa Early Synthetic, Pusa hybrid-2, Pusa him Jyoti and Early Kunwari. Sandy soil is perfect for growing cauliflower. Medium to high land should be preferred and 3-4 ploughings followed by plunking should be given to get a fine tilth. Data presented in the table depict that the respondents had very good knowledge about the field preparation of cauliflower cultivation with 89.30 MPS. Seedlings are grown in a raised nursery bed. Nursery beds for healthy seedlings should be 3-5 meters long, 1 meter wide, and 10-15 cm tall. Cauliflower Planting one hectare of early crop requires 500-600 g of seeds. Seeds should be treated with Captan or Thiram at the rate of 2 to 3 grams per kg seeds. Data presented in the table depict that the respondents had average knowledge about the nursery preparation of cauliflower cultivation with 39.64 MPS. Healthy seedlings with four to six weeks old and four to six leaves should be transplanted. The seedlings are planted at the spacing of 45 X 45 for improved variety. According to the data shown in Table 2, reveal that the respondents had average knowledge about transplanting of cauliflower with 45.10 MPS. Application of 20-25 t/ha FYM and basal dose of NPK at the rate 120:60:60 kg/ha is applied for cauliflower cultivation. The entire dose of potash and phosphorous as well as half of the nitrogen is applied during the transplanting of the crop. Here, remaining nitrogen should be utilised as a top dressing 30 and 45 days after transplantation. It can be observed from the Table 2 that the respondents

had good knowledge about manure and fertilizer application with 82.35 MPS.

Weeds should be removed from the field on a regular basis through two times hoeing, weeding, and earthing up after four weeks of transplanting. Application of Pendimethalin at the rate of 4-6 liter/ha and Fluchloralin at the rate of 2-3 kg/ha is effective to prevent the weed. Regarding the knowledge of weed management, respondents had poor knowledge about weed management in cauliflower with 28.73 MPS. Two to three irrigations are sufficient for growing cauliflower. First irrigation is required after transplanting and thereafter 6-7 days intervals. It can be observed from the Table 2 that the respondents had good knowledge about irrigation management for cauliflower with 70.67 MPS. Common insect-pests in cauliflower are Diamond back moth, Mites and Leaf minor. NSKE 4%, Phosphamide (0.05%), Quinalphos and Chlorpyrifos at the rate of 2 ml/liter are recommend to prevent these insect pests. Common diseases in cauliflower are Black rot, Coller rot, Leaf scorching and Downey mildew which can be controlled by different chemicals such as Thiram, Captan and. The data available in Table 2 indicates that respondents possessed poor level of knowledge regarding plant protection measures with 32.26 MPS. As soon as the curds reach the right age they should be harvested. Delayed harvesting causes the curds to overripen loose, fuzzy, richy, leafy and losing the quality. The data presented in the Table 2 indicates that respondents possessed good knowledge regarding harvesting with 80.07 MPS.

According to the considered data, the respondents possessed highest knowledge with 89.30 MPS (I-Rank) closely followed by manure and fertilizer application (II-Rank), harvesting (III-Rank), improved varieties (IV-Rank), irrigation management (V-Rank), transplanting (VI-Rank), nursery preparation (VII-Rank). Regarding plant protection measures and weed

management in cauliflower cultivation, respondents had poor knowledge with MPS of 32.26, 28.73 and (VIII-Rank), (IX-Rank). This could be due to the respondents' inability to recall the names of the chemicals, as well as their low literacy level.

CONCLUSION

Cauliflower cultivation offers considerable potential for farmers to enhance their livelihoods and contribute to food security while meeting the growing demand for nutritious vegetables. Most of the respondents possessed average knowledge of cauliflower 91.50 per cent. it is suggested that an organized training programmes on cauliflower production, demonstrations, and frequent field visits should be taken up by the concerned extension agencies to enhance the knowledge of improved cauliflower cultivation among cauliflower growers. So that they can adopt the improved cauliflower cultivation practices and maximize yields, minimize risks, and sustainably produce high-quality cauliflower for local and global markets.

REFERENCES

- Chaturvedi, D.; K.L. Dangi and F.L. Sharma. 2010. Technological knowledge of cauliflower growers in Udaipur district of Rajasthan. *Rajasthan Journal of Extension Education*, 17(1): 124-127.
- Ramdhan Ghaswa, R.G.; N.K. Sharma; B.S. Badhala; S.K. Bana and S.K. Sunita Kumari. 2015. Knowledge Level of Cauliflower Growers about Recommended Cauliflower Production Technology, 8&4: 648-650.
- Kumar, M. 2018. Adoption of farmers regarding recommended cultivation practices of cauliflower crop in Khagaria district of Bihar. *Journal of Pharmacognosy and Phytochemistry*, 7(3), pp.2216-2218.
- Sasane, M.S.; V.V. Tayde and P.R. Deshmukh. 2013. Extent of Knowledge of Farmers on Cauliflower Production Technology. *International Journal of Agricultural Sciences*, 9(1): 267-269.

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Research Article

Constructions of Balanced Semi-Latin Rectangles with Block Size Three

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ABSTRACT

Semi-Latin rectangles (SLR) are row-column designs where each intersection contains the same number of experimental units, denoted as $k > 1$. Moreover, each treatment appears an equal number of times in each row (n_r , say) and in each column (n_c , say) ($n_r > 1$ and $n_c > 1$ may or may not be equal). Balanced Semi-Latin rectangles (BSLR) form a subset of SLR, extending the concepts of Latin squares and Semi-Latin squares (SLS). These designs are applicable in various agricultural and industrial experiments, particularly in scenarios where one effect is considered a column effect and the other a row effect, with each intersection accommodating exactly 3 units. This article proposed two methods for constructing BSLR designs with a block size of 3. Additionally, an R package has been developed for generating these designs.

Keywords: Semi latin rectangle, Balanced Semi-latin rectangles, Canonical efficiency factor, Average efficiency factor

INTRODUCTION

Bailey and Monod (2001) defined a semi-Latin rectangle (SLR) as a row-column design in which each row-column intersection has the same size, say k , where $k > 1$, every treatment occurs the same number of times in each row and every treatment occurs the same number of times in each column. Uto and Bailey (2020) introduced balanced SLR, which form a subclass of SLR, exhibit an additional property of balance where no two distinct pairs of treatments differ in their concurrences and also proposed algorithmic approach to construct such class of design for cell/block size two. The conditions for the existence and construction of a BSLR are specified by parameters v, k, b, p, n_r, n_c and λ , satisfying the following equations:

$$\begin{aligned} vbn_r &= vp n_c = kbp \\ \lambda(v-1) &= bn_r(k-1) = pn_c(k-1) \end{aligned} \quad \dots (1)$$

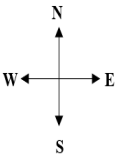
Further, Uto and Bailey (2022) proposed regular-

graph Semi-Latin rectangles which having an additional property that the treatment concurrences between any two pairs of distinct treatments differ by at most one. Yadav *et al.* (2024) developed an algorithmic approach for constructing BSLR with block size four.

BSLR designs are useful in various types of experiments, including agricultural studies such as plant disease experiments, food sensory experiments, glasshouse experiments, and consumer testing experiments. For example, considering trials on glasshouse crops there are usually pronounced row and column effects. The glasshouse is typically rectangular, say b plots by p plots. Its long axis is East-West. Because North-South variation is usually greater per distance than East-West variation, it is reasonable to divide the glasshouse into b rows and p columns, where each row is an East-West line of plots and each column consists of k contiguous North-South lines of plots. Let there are v treatments such as varieties of lettuce, or sowing

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Table 1: Semi-Latin rectangle for 5 treatments in glasshouse experiment

Column→	Plot1	Plot2	Plot3	Plot4	Plot5	Plot6	Plot7	Plot8	Plot9	Plot10	
Row↓											
Plot1	1,2,5	2,3,1	3,4,2	4,5,3	5,1,4	1,3,4	2,4,5	3,5,1	4,1,2	5,2,3	
Plot2	2,3,1	3,4,2	4,5,3	5,1,4	1,2,5	2,4,5	3,5,1	4,1,2	5,2,3	1,3,4	
Plot3	3,4,2	4,5,3	5,1,4	1,2,5	2,3,1	3,5,1	4,1,2	5,2,3	1,3,4	2,4,5	
Plot4	4,5,3	5,1,4	1,2,5	2,3,1	3,4,2	4,1,2	5,2,3	1,3,4	2,4,5	3,5,1	
Plot5	5,1,4	1,2,5	2,3,1	3,4,2	4,5,3	5,2,3	1,3,4	2,4,5	3,5,1	4,1,2	

dates for celery or factorial treatments on tomatoes. These treatments can be applied according to the symbols of a Semi-Latin rectangle. An experiment conducted for comparison of 5 ($v = h\bar{k}$) treatments in a glasshouse with 5 ($= h$) plots in rows and 10 ($= p$) plots in columns with block/cell size 3 ($= \bar{k}$) i.e. 3 treatments per cell (intersection of rows and columns) can be designed $(5 \times 10)/3$ SLR with five rows and ten columns of block/cell size three as given in Table 1.

A little work related to Semi-Latin rectangles are available in literature and those are of block size two, with a noticeable absence of work for block size $k = 3$. Looking the importance of BSLR we have developed two different construction methods for generating the BSLR designs with block/cell size 3. These methods of construction are simple and easy to use for generation of these classes of semi-Latin rectangles. Further, an R package named *slr* Yadav *et al.* (2023) is developed in which the proposed methods are implemented and users can generate balanced semi-Latin rectangles by providing only the number of treatments.

PRELIMINARIES

In the context of assuming the additive effect, the model for the present study is expressed as:

$$y = \mu 1 + \Delta' \tau + \phi' \rho + \Psi' \gamma + D' \beta + \varepsilon \quad \dots (2)$$

where,

$y = hp\bar{k} \times 1$ vector of observations,

$1 = hp\bar{k} \times 1$ vector of 1,

$\Delta' = hp\bar{k} \times v$ incidence matrix of observations versus treatments,

$\tau = v \times 1$ vector of treatment effects,

$\phi' = hp\bar{k} \times b$ incidence matrix of observations versus rows,

$\rho = b \times 1$ vector of row effects,

$\Psi' = hp\bar{k} \times p$ incidence matrix of observations versus columns,

$\gamma = p \times 1$ vector of column effects,

$D' = hp\bar{k} \times hp$ incidence matrix of observations versus blocks/cells,

$\beta = hp \times 1$ vector of block effects,

$\varepsilon = hp\bar{k} \times 1$ vector of random errors with Expectation $(\varepsilon) = 0$ and Dispersion $(\varepsilon) = \sigma^2 I$,

$(\cdot)'$ = Transpose of a matrix

The incidence matrices Δ' , ϕ' , Ψ' and D' are defined in the usual manner. For instance, if $\Delta' = (\xi_{ui})$, then

$\xi_{ui} = \{1, \text{ if the } u^{\text{th}} \text{ observation corresponds to the } i^{\text{th}} \text{ treatment @ } 0, \text{ otherwise}\}$

The matrices ϕ' , Ψ' and D' are defined similarly.

Under model (2), the information matrix for estimating the linear functions of treatment effects is given by

$$C_d = R_o - (N_1 A_{11} N_1' + N_2 A_{21} N_1' + N_3 A_{31} N_1' + N_1 A_{12} N_2' + N_2 A_{22} N_2' + N_3 A_{32} N_2' + N_1 A_{13} N_3' + N_2 A_{23} N_3' + N_3 A_{33} N_3')$$

Where,

$$A_{11} = \frac{1_{h \times h}}{pk} + \frac{1}{p^2} [J_{h \times p} A_{22} J_{p \times h} + J_{h \times hp} A_{32} J_{p \times h} + J_{h \times p} A_{23} J_{hp \times h} + J_{h \times hp} A_{33} J_{hp \times h}],$$

$$A_{12} = -\frac{1}{p} [J_{h \times p} A_{22} + J_{h \times hp} A_{32}], A_{21} = A_{12}',$$

$$A_{13} = \left(\frac{1}{p} - \frac{1}{h}\right) J_{h \times hp} A_{33}, A_{31} = A_{13}', A_{22} = \frac{1}{kh} [I_{p \times p} + (pk^2 - p^3 k^2) J_{p \times p}],$$

$$A_{23} = -\frac{1}{h} J_{p \times hp} A_{33}, A_{32} = A_{23}', A_{33} = \left(k I_{hp \times hp} - \frac{pk}{h} J_{hp \times hp}\right)^{-},$$

$$R_t = h n_r I_{(v \times v)}$$

N_1 = incidence matrix of treatments versus rows,

N_2 = incidence matrix of treatments versus columns,

N_3 = incidence matrix of treatments versus blocks / cells.

$(\cdot)^{-}$ = Generalized inverse of a matrix

$(\cdot)'$ = Transpose of a matrix

As we know that connected designs (i.e., $\text{Rank}(C_d) = v - 1$) is necessary to estimate all treatment contrast. For a connected designs with v treatments a matrix M_d can be defined as

$$M_d = R_{\tau}^{-1/2} C_d R_{\tau}^{-1/2}$$

Then the positive eigenvalues of the matrix M_d say q_i , $1 \leq i \leq v - 1$ are known as the canonical efficiency factor of the designs. Consider an equireplicate designs where $r_i = r$, the canonical efficiency factors are $1/r$ times the positive eigenvalues of C_d .

METHODS OF CONSTRUCTION

In the present investigations, construction methods for generation of BSLR designs for block/cell size three, is being developed. Two different construction methods are developed for generating BSLR designs which are based on two different situations i.e. for v is even and odd. The detailed construction methods are described in sequel.

Method 1: Construction of balanced SLR (when v is even)

The present approach for construction of BSLR design is based on the concept of generation of design from initial row. Once the initial row has been developed then the whole design can be generated from the initial

row using some procedure. Step 1 provides the method to get the initial row and step 2 provide the procedure of generating whole design from initial row as describe in sequel.

Step 1: Find the initial row with block size three as (i, j, l) , where $i < j < l$, $i = 1, 2, \dots, (v - 2)$; $j = 2, 3, \dots, (v - 1)$; $l = 3, 4, \dots, v$, $v = 2n + 2$, where n is any positive integer.

For example, if $v = 6$, we have $i = 1, 2, 3, 4$; $j = 2, 3, 4, 5$; $l = 3, 4, 5, 6$; the initial row will be: (1,2,3), (1,2,4), (1,2,5), (1,2,6), (1,3,4), (1,3,5), (1,3,6), (1,4,5), (1,4,6), (1,5,6), (2,3,4), (2,3,5), (2,3,6), (2,4,5), (2,4,6), (2,5,6), (3,4,5), (3,4,6), (3,5,6), (4,5,6).

Step 2: Add 1 to each element of the initial row with modulo v to obtain another $(v - 1)$ rows. The resultant design is $\{(v \times (v(v-1)(v-2)) / 6)\} / 3$ balanced Semi-Latin rectangles of block size three.

By following these steps, we can construct a balanced Semi-Latin rectangle of block size three for parameters

$$v = 2n + 2, h = 2n + 2, p = \frac{v(v-1)(v-2)}{6},$$

$$k = 3, n_r = \frac{(v-1)(v-2)}{2}, n_c = 3,$$

$$\lambda = v(v-2)$$

Example: For $v = 6$, $h = 6$, $p = 20$, $k = 3$, $n_r = 10$, $n_c = 3$, $\lambda = 24$ we obtained a $(6 \times 20)/3$ balanced semi-Latin rectangle as shown below

Row/col	1	2	3	4	5	6	7	8	9	10
1	1,2,3	1,2,4	1,2,5	1,2,6	1,3,4	1,3,5	1,3,6	1,4,5	1,4,6	1,5,6
2	2,3,4	2,3,5	2,3,6	2,3,1	2,4,5	2,4,6	2,4,1	2,5,6	2,5,1	2,6,1
3	3,4,5	3,4,6	3,4,1	3,4,2	3,5,6	3,5,1	3,5,2	3,6,1	3,6,2	3,1,2
4	4,5,6	4,5,1	4,5,2	4,5,3	4,6,1	4,6,2	4,6,3	4,1,2	4,1,3	4,2,3
5	5,6,1	5,6,2	5,6,3	5,6,4	5,1,2	5,1,3	5,1,4	5,2,3	5,2,4	5,3,4
6	6,1,2	6,1,3	6,1,4	6,1,5	6,2,3	6,2,4	6,2,5	6,3,4	6,3,5	6,4,5
Row/col	11	12	13	14	15	16	17	18	19	20
1	2,3,4	2,3,5	2,3,6	2,4,5	2,4,6	2,5,6	3,4,5	3,4,6	3,5,6	4,5,6
2	3,4,5	3,4,6	3,4,1	3,5,6	3,5,1	3,6,1	4,5,6	4,5,1	4,6,1	5,6,1
3	4,5,6	4,5,1	4,5,2	4,6,1	4,6,2	4,1,2	5,6,1	5,6,2	5,1,2	6,1,2
4	5,6,1	5,6,2	5,6,3	5,1,2	5,1,3	5,2,3	6,1,2	6,1,3	6,2,3	1,2,3
5	6,1,2	6,1,3	6,1,4	6,2,3	6,2,4	6,3,4	1,2,3	1,2,4	1,3,4	2,3,4
6	1,2,3	1,2,4	1,2,5	1,3,4	1,3,5	1,4,5	2,3,4	2,3,5	2,4,5	3,4,5

$(6 \times 20)/3$

Method 2: Construction of balanced SLR (when v is odd)

To construct balanced Semi-Latin rectangles of block size three, when v is odd, follow the following steps:

Step-1: First, create a matrix of order $(v-1)/2 \times 3$, where the elements in the first column are all 1's. Here, $v = 2n + 3$, where n is any positive integer. To populate the second column, arrange the numbers from 2 to $(v + 1)/2$ from top to bottom. For the third column, arrange the numbers from $(v + 1) / 2 + 1$ to v from bottom to top.

For example; for $v = 7$; matrix of order 3×3 will be

$$\begin{pmatrix} 1 & 2 & 7 \\ 1 & 3 & 6 \\ 1 & 4 & 5 \end{pmatrix}$$

Step-2: Consider each row of the matrix obtained in Step-1 as a block and add 1 to each element of the blocks with modulo v to obtain blocks of size three. Arrange these sets of blocks in a row and consider it as initial row.

For above example, initial row for $v = 7$ will be

(1,2,7), (2,3,1), (3,4,2), (5,6,4), (6,7,5), (7,1,6), (1,3,6), (2,4,7), (3,5,1), (4,6,2), (5,7,3), (6,1,4), (7,2,5), (1,4,5), (2,5,6), (3,6,7), (5,1,2), (6,2,3), (7,3,4).

Step-3: Add 1 to each element of the initial row with modulo to obtain another $(v - 1)$ rows. The resultant design is $\{v \times (v(v-1)) / 2\} / 3$ balanced Semi-Latin rectangles of block size three.

By following these steps, we can construct a balanced Semi-Latin rectangle of block size three for parameters

$$v = 2n + 3, b = 2n + 3, p = (n + 1)(2n + 3), k = 3, n_r = 3(n + 1), n_c = 3, \lambda = 6n + 9$$

Example: For $v = 7, b = 7, p = 21, k = 3, n_r = 9, n_c = 3, \lambda = 21$ we obtained a $(7 \times 21)/3$ balanced semi-Latin rectangle as shown below

Remark 1: As per the definition of BSLR, every treatment occurs an equal number of times in each row, an equal number of times in each column, and at most once in a block. Consequently, BSLR exists only when $v > k$, as if $v < k$, treatments would appear in a block at least once. Similarly, if $v = k$, each block, row, and column would have identical content, lacking meaningful interpretation in the context of BSLR. So, the proposed method for constructing BSLR is limited to $4 \leq v \leq 20$.

Remark 2: An R package *slr* has been developed to implement the proposed methods of constructions of balanced semi-Latin rectangles. The package is

Row/col	1	2	3	5	6	7	8	9	10	11
1	1,2,7	2,3,1	3,4,2	5,6,4	6,7,5	7,1,6	1,3,6	2,4,7	3,5,1	4,6,2
2	7,1,6	1,2,7	2,3,1	4,5,3	5,6,4	6,7,5	7,2,5	1,3,6	2,4,7	3,5,1
3	6,7,5	7,1,6	1,2,7	3,4,2	4,5,3	5,6,4	6,1,4	7,2,5	1,3,6	2,4,7
4	5,6,4	6,7,5	7,1,6	2,3,1	3,4,2	4,5,3	5,7,3	6,1,4	7,2,5	1,3,6
5	4,5,3	5,6,4	6,7,5	1,2,7	2,3,1	3,4,2	4,6,2	5,7,3	6,1,4	7,2,5
6	3,4,2	4,5,3	5,6,4	7,1,6	1,2,7	2,3,1	3,5,1	4,6,2	5,7,3	6,1,4
7	2,3,1	3,4,2	4,5,3	6,7,5	7,1,6	1,2,7	2,4,7	3,5,1	4,6,2	5,7,3
Row/col	12	13	14	15	16	17	19	20	21	
1	5,7,3	6,1,4	7,2,5	1,4,5	2,5,6	3,6,7	5,1,2	6,2,3	7,3,4	
2	4,6,2	5,7,3	6,1,4	7,3,4	1,4,5	2,5,6	4,7,1	5,1,2	6,2,3	
3	3,5,1	4,6,2	5,7,3	6,2,3	7,3,4	1,4,5	3,6,7	4,7,1	5,1,2	
4	2,4,7	3,5,1	4,6,2	5,1,2	6,2,3	7,3,4	2,5,6	3,6,7	4,7,1	
5	1,3,6	2,4,7	3,5,1	4,7,1	5,1,2	6,2,3	1,4,5	2,5,6	3,6,7	
6	7,2,5	1,3,6	2,4,7	3,6,7	4,7,1	5,1,2	7,3,4	1,4,5	2,5,6	
7	6,1,4	7,2,5	1,3,6	2,5,6	3,6,7	4,7,1	6,2,3	7,3,4	1,4,5	

$(7 \times 21)/3$

Table 2: Efficiency of balanced semi-Latin rectangles with $4 \leq v \leq 20$

v	h	p	n_r	n_c	λ	$\bar{E}$	Methods
4	4	4	3	3	8	0.8889	Method1
5	5	10	6	3	15	0.8333	Method2
6	6	20	10	3	24	0.8000	Method1
7	7	21	9	3	21	0.7778	Method2
8	8	56	21	3	48	0.7619	Method1
9	9	36	12	3	27	0.7500	Method2
10	10	120	36	3	80	0.7407	Method1
11	11	55	15	3	33	0.7333	Method2
12	12	220	55	3	120	0.7273	Method1
13	13	78	18	3	39	0.7222	Method2
14	14	364	78	3	168	0.7179	Method1
15	15	105	21	3	45	0.7143	Method2
16	16	560	105	3	224	0.7111	Method1
17	17	136	24	3	51	0.7083	Method2
18	18	816	136	3	288	0.7064	Method1
19	19	171	27	3	57	0.7037	Method2
20	20	1140	171	3	360	0.7012	Method1

available on CRAN in the webpage <https://cran.r-project.org/web/packages/slr/index.html>. It contains a function named as *bslr* (v, k) which can be used to construction of a balanced SLR for given number of treatments v and putting $k = 3$.

EFFICIENCY OF SEMI-LATIN RECTANGLES

In this Section, we provide the average efficiency factor of SLR designs generated using the developed methods of constructions. The average efficiency factor John (1992) of a design is determined by taking the harmonic mean of the canonical efficiency factors, which are obtained by multiplying the nonzero eigenvalues of its information matrix by . Here, the list of BSLR designs for $v \leq 20$ are given in Table 2. Average efficiency factor ($\bar{E}$) was computed for each parametric combination of designs obtained based on balanced semi-Latin rectangles and given in Table 2.

CONCLUDING REMARKS

In this paper we proposed construction methods for obtaining balanced SLR designs for any possible parametric combinations. Two methods of construction of balanced semi-Latin rectangles are developed. The methods enable construction of

balanced semi-Latin rectangles for all permissible number of treatments. We also have provided the average efficiency factor of designs generated using the proposed methods of constructions for the number of treatments up to 20. Further, we have developed an R package called *slr* which implements the proposed methods of constructions.

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REFERENCES

- Bailey, R.A. and H. Monod. 2001. Efficient Semi Latin Rectangles: Designs for Plant Disease Experiments. *Scandinavian Journal of Statistics*, 28(2): 257-270.
- John, J.A. 1992. Bounds for the efficiency factor of row-column designs. *Biometrika*, 79(3): 658-661.
- Uto, N.P. and R.A. Bailey. 2020. Balanced Semi-Latin rectangles: properties, existence and constructions for block size two. *Journal of Statistical Theory & Practice*, 14(3): 1-11.

- Uto, N.P. and Bailey, R.A. 2022. Constructions for regular-graph Semi-Latin rectangles with block size two. *Journal of Statistical Planning and Inference*, 221: 81-89.
- Yadav, K.K.; S. Dash; B.N. Mandal and R. Parsad. 2023. slr: Semi-Latin Rectangles. R package version 1.3.0, <https://CRAN.R-project.org/package=slr>.
- Yadav, K.K.; S. Dash; B.N. Mandal and R. Parsad. 2024. Construction of Balanced Semi-Latin Rectangles in block size four: An Algorithmic Approach. *Journal of Statistical Theory and Practice*, 18: 29. <https://doi.org/10.1007/s42519-024-00380-9>.
- Yadav, K.K.; S. Dash; B.N. Mandal and R. Parsad; A. Kumar and M. Kumar. 2024. Construction of Partially Balanced Semi-Latin Rectangles with block size 4. *Journal of The Indian Society of Agricultural Statistics*, 78(2): 115-124.

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Research Article

Assessing Farmers' Knowledge level and Adoption Behavior on Improved Ginger (*Zingiber officinale* Rosc.) Cultivation: Evidence from Nagaland, Northeastern Region (NER), India

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ABSTRACT

Adoption of advance scientific technologies in agriculture-based livelihood activities has direct influence to maintain sustainable livelihood, and ginger (*Zingiber officinale* Rosc.)-based livelihood is not an exception. Adoption of technology or innovation is depended on the individual's knowledge and perception about the technology or innovation. This research aimed to investigate the knowledge level of ginger growers on recommended cultivation practices and the level of adoption of technologies in ginger cultivation. Accordingly, present study was conducted in two districts, namely, Mon and Zunheboto of Nagaland, India. The study employed a purposive sampling method and descriptive research design. A total of 270 ginger growers were included in the study, and data were collected through direct interview by using structured interviews schedule. Statistical tools, namely, frequency, percentage, mean, standard deviation and correlation were used to develop indices (Knowledge Index and Adoption Index) and to bring the valid conclusions. The results indicated that the respondents had possessed an average knowledge index of 51.19 per cent with a range of 44.26 - 54.09 per cent. They had a mean adoption index of 26.92 per cent with a range of 22.95 – 33.60 per cent. Further, various socio-economic factors, namely, age, Annual income, Income from ginger cultivation, Training and Extension contact had established a positively significant relationship with knowledge and adoption indices. It can be recommended that the ginger growers had a less adoption of recommended technologies in ginger cultivation and concerned authorities may take the initiative to up-scale the level of adoption of technologies.

Keywords: Adoption, Adoption index, Ginger cultivation, Knowledge, Knowledge index, Nagaland

INTRODUCTION

India is famous for production, consumption and export of various spices. Ginger (*Zingiber officinale* Rosc.) is most commonly grown and used spice in all the regions in India. It is also a commonly growing crop in all the States of Northeastern region of India. It has a significant importance in income and livelihood of growers in Nagaland, Northeastern region of India (Patra and Benjongtoshi, 2023). In Nagaland, total area under ginger cultivation spans 4,694 hectares, with a production of 34,848 metric tonnes in 2021. While

ginger is grown across all the districts, but the primary ginger-producing districts include Peren, Zunheboto, Kohima, and Mon. (Govt. of Nagaland 2021). Various ginger varieties are cultivated in the state, each having a specific local name associated with the regions where they are grown. Among the cultivated varieties in Nagaland, *Nadia* is particularly popular due to its low fiber content (4.20%) and high yield potential.

Between 2007-08 and 2014-15, the area under ginger cultivation in Nagaland increased from 2,600 to 5,300 hectares. However, during the same period,

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the production of ginger only saw a modest increase from 23,000 to 36,000 MT (Spice Board of India, 2015). This mere 56% (13,000 MT) of increase in production, despite a quantum expansion of cultivation's area of 103 per cent, highlights the need for improvement in productivity and to ensure a remunerative income for farmers. In this regard Govt. of India (2006) reported that 60.00 per cent of farmers are interested to discontinue farming as occupation; and Burman *et al.* (2023) viewed about non-attraction of youth to agriculture. In spite of, crop-based activities are playing significant role in livelihood of rural communities and farmers in Nagaland (Gamlin and Patra, 2020; Benjongtoshi and Patra, 2021; Patra and Benjongtoshi, 2023) and not an exception for the farmers of Jammu, India (Abrol *et al.*, 2023).

However, various factors may be the responsible for less productivity of ginger in the study area. It may be due to the imperfect agro-ecological and climatic condition, improper management of crop cultivation, and non-adoption of technologies. Concerning the compatibility of crop with agro-ecological and climatic conditions, it is widely adopted in the State of Nagaland and almost all districts' farmers are growing ginger since time immemorial (Govt. of Nagaland, 2021). Issues of crop cultivation and management are depended on the farmers' knowledge level, acquired skills, and the status of adoption of improved/recommended technologies in the cultivation process. Based on previous works on different crops grown in the study area, inadequate knowledge of growers on scientific cultivation and non-adoption of improved technologies are the well-recognized problems for less productivity (Patra *et al.*, 2024). Knowledge about improved technologies has significant influence on adoption of technologies (Patra and Kense, 2020). Lalthamawii *et al.* (2022) reported that training exposure, extension contact and education have direct and significant influence on knowledge level, where education and experience have direct impact on adoption of technologies in rice cultivation. They also observed and reported about the knowledge and adoption/practice gap among the rice growers.

Concerning earlier discussion, present study aims to assess the ginger growers' knowledge level in respect of improved ginger cultivation and their status of adoption of improved practices in ginger cultivation.

Regarding the measurement of knowledge and adoption level, we adopted knowledge index and adoption index. Also, we included various issues from all the aspects under ginger cultivation for knowledge and adoption indices. Further, we interacted between the socio-economic variables versus knowledge and adoption indices. However, the outcome from this study may be used in the policymaking on technology transfer and extension programme planning. This paper may also be a valuable document for ginger cultivation related policymaking and research initiatives. This paper has two objectives: i) to assess and map the knowledge level of ginger growers on improved ginger cultivation practices, and ii) to delineate the adoption behavior of ginger growers on improved ginger cultivation practices. The paper is organized as follows. The methodology including the hypotheses for testing is presented in the next section. Section 3 presents the results and discussion. The concluding remarks form the last section.

MATERIALS AND METHODS

The research methodology section deals with the depiction of the study area, study community and research methods adopted to complete the study.

Profile of the study area: Present study was purposively conducted within the state of Nagaland, India. The geographic location of Nagaland is 25°6'N - 27°4'N, and 93°20'E - 95°15'E and it is under Northeaster Region (NER) of India (Figure 1). It has geographical area of 16,527 km² and the state is subdivided into 16 administrative districts. The state has population of about 1980,602, and above 90% are from indigenous tribal community (Govt. of Nagaland, 2012). Nagaland is a mountainous state with altitudes from 194 meters to 3,840 meters above from the MSL (Govt. of Nagaland, 2017). In Nagaland, agriculture or farming-based activities are playing a crucial role in rural livelihood (Benjongtoshi and Patra, 2021, Patra and Benjongtoshi, 2023), encompassing crops like rice, maize, ginger, chilli, banana, orange, Chow-chow, French beans, pineapple, kiwi, and cardamom (Patra and Babu, 2020; Patra and Lianzami, 2021; Patra and Benjongtoshi, 2023). Ginger holds a particular significance in the state and is cultivated across all its districts. However, the leading ginger-producing districts within the state are Mon, Zunheboto, and Peren (Govt. of Nagaland, 2016).

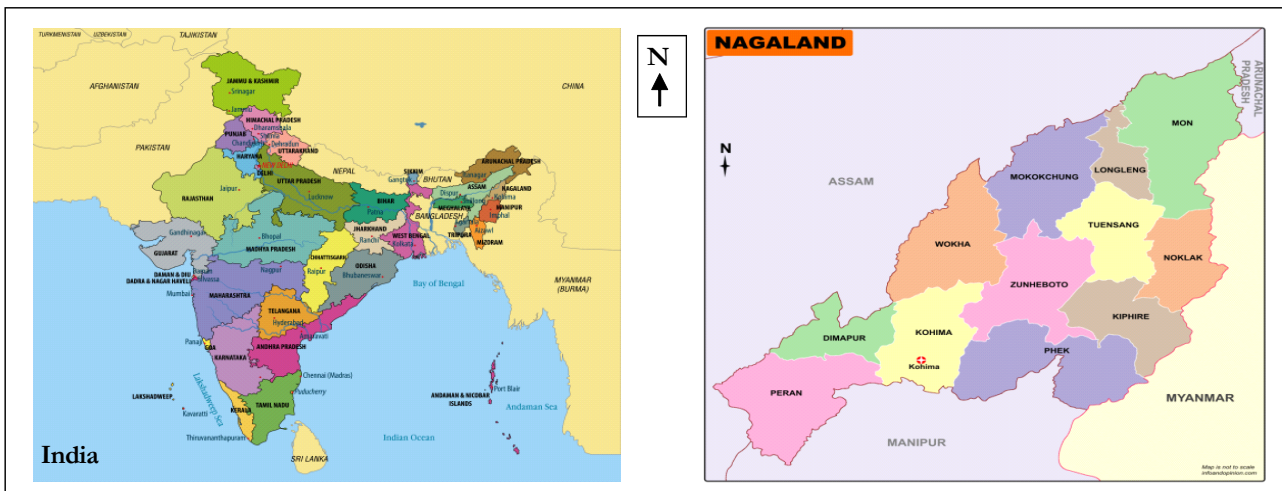


Figure 1: Location map of the study (Source of maps: www.indiagrowing.com/www.brainly.com)

For this study, two of Nagaland's prominent ginger-producing districts, namely Mon and Zunheboto, were selected due to their notable ginger production (Govt. of Nagaland, 2022). Selection criteria for the study areas were determined in consultation with reliable officials from the state's agriculture department. Specific blocks were chosen within these districts by ensuring the presence of a significant number of ginger growers as respondents. Altogether, six blocks (three from each district) and eighteen villages (three villages from each of the selected blocks) were selected for the study. Finally, study included a sample of 270 ginger growers (fifteen from each village) as respondents.

Knowledge index and adoption index: Knowledge test may bring the way for planning on capacity development (Singh *et al.*, 2023) It is essential to assess the respondents' knowledge levels to gauge their adoption of improved ginger cultivation practices. Knowledge is defined as the facts, information, and skills acquired through experience or education. Adoption refers to the decision to fully implement an innovation as the most effective method available. In this study, respondents' knowledge and adoption levels were evaluated across 16 categories related to ginger cultivation, including climatic conditions, soil management, land preparation, seed treatment, seed rate, spacing, planting time, propagation, cultivars, manure and fertilizer, importance of fertilizers, mulching, plant protection, disease management, water management, harvesting, and post-harvest management.

Respondents were assigned scores based on their awareness: a score of '2' for full awareness, '1' for partial awareness, and '0' for lack of knowledge. The subsequent table outlines the various parameters used to measure the respondents' knowledge levels. The extent of adoption of specific ginger cultivation practices by farmers was categorized into three response categories: fully adopted, partially adopted and not adopted. Farmers who adhered to a recommended practice were classified as fully adopted and assigned a score of 2. Those who deviated from the recommended practice were categorized as partially adopted and assigned a score of 1. Farmers who did not follow the recommended practice at all were considered not adopted and assigned a score of 0. The formulae adopted for calculation of knowledge index and adoption index is given below:

$$\text{Knowledge Index} = (\text{Total score obtained}) / (\text{Maximum possible score}) \times 100$$

$$\text{Adoption Index} = (\text{Total score obtained}) / (\text{Maximum possible score}) \times 100$$

Based on the mean and Standard Deviation (S.D.) of the obtained indices, respondents were sub-categorized into four as follows:

Category	Method of categorization
Low	$< \mu - \sigma$
Medium	$> \mu - \sigma$ to μ
High	$> \mu$ to $\mu + \sigma$
Very High	$> \mu + \sigma$

Hypothesis testing: Following two null hypotheses were formulated for due testing under the present research investigation.

H₀1: There is no association between the respondents' various socio-economic conditions and the knowledge level on recommendation practices.

H₀2: There is no association between the respondents' various socio-economic conditions and the adoption of recommendation practices.

Statistical tools and analysis: The data collected with the help of interview schedule from the respondents were tabulated, scored and analyzed using appropriate statistical tools and techniques. Statistical tools, namely, frequency, percentage, mean, standard deviation, range and correlation were used to bring the valid conclusions.

RESULTS AND DISCUSSION

In this section research findings are presented and discussed, following the objectives of the study. Favorable climatic condition is prerequisite for crop cultivation and climatic variation have severe negative affect on the climate sensitive crops (Gorai *et al.*, 2024; Patra *et al.*, 2024a). Present study's findings indicated that all respondents (100%) understood that ginger requires warm climate conditions, but they were unaware of its preference for humid conditions (Table 1). In terms of soil management, 67.78 per cent of respondents had full knowledge that ginger thrives in rich, well-draining soil, while 32.22 per cent were only partially aware. Additionally, 70.00 per cent were fully informed about the significance of aeration of soil, and 72.22 per cent knew that sandy loam soil is ideal for ginger cultivation. Regarding land preparation, all the respondents (100%) recognized the need for ploughing before planting and a significant majority (83.70%) was fully aware of recommended land preparation practices, while 16.30 per cent had partial awareness. Furthermore, 100 per cent of the respondents understood that ginger should not consecutively be planted in the same field. The knowledge level of the study community about land preparation are likely aligned with the findings of Sundresha *et al.* (2020).

Notably, all the respondents were unaware of treating rhizomes with cow urine for enhanced growth, and the importance of seed treatment for disease

control. This lack of knowledge maybe due to limited training opportunities and the regional scarcity of cattle. With regard to seed rates, 56.67 per cent of respondents were partially aware of the recommended planting rate of 1,200-1,500 kg of seed/ha, while 26.66 per cent were unaware and 16.67 per cent were fully aware (Table 1). However, all respondents were fully informed about seed weight, size, the use of true-to-type rhizomes, and the necessity for seeds to be disease and pest-free. The study also found that 94.07% were fully aware of the requirement for 30 cm spacing between rows, with only 5.93% unaware. Additionally, 92.22 per cent knew that 25 cm spacing is needed between plants for optimal growth, while 7.78 per cent were unaware. All respondents understood that rhizomes should be planted at a depth of 4-5 cm in furrows. Overall, respondents demonstrated good awareness of spacing and planting depth, which aligning with the findings on knowledge levels among ginger growers from Sundresha *et al.* (2020).

The study further reveals that 83.33 per cent of the respondents were unaware that April to May is the optimal time for sowing ginger, while only 16.67 per cent were fully aware of this timing (Table 1). This lack of awareness may be due to traditional practices, as ginger is commonly sown between January and February in the region, which is considered ideal. Additionally, the harsh climatic conditions during April-May may further discourage planting during this period. These findings are consistent with Odyuo *et al.* (2022), as reported that only 0.83 per cent of respondents were knowledgeable about the recommended planting time for ginger.

It was also seen that all respondents (100%) were fully aware of using 4-5 cm long sprouted buds as planting material and also recognized the Nadia variety (Table 1). However, they were completely unaware of other varieties, such as China, Maran, and Varada. On the other hand, 92.59 per cent of the respondents were fully aware of using manure to improve soil condition, while 7.41 per cent were partially aware. Additionally, 93.70 per cent recognized that manure boosts ginger production, and remaining 6.30 per cent were partially aware about manure's role on ginger production. However, all the respondents were unaware of the proper dosage and timing for application of farmyard manure (FYM).

All respondents were fully aware of FYM and pig manure as alternative nutrient sources, and 92.22 per cent were fully aware that poultry manure can also be used (Table 1). Conversely, 72.59 per cent were unaware of the importance of fertilizers for soil fertility management, with only 18.52 per cent fully aware and 8.89 per cent partially aware of their role in enhancing ginger production. Notably, none of the respondents knew the appropriate fertilizer dosage for optimal ginger yield. However, these findings highlight a gap in knowledge regarding the use of fertilizers, which impacting on low production level of ginger.

The study also indicates that 50.38 per cent of respondents were fully aware of mulching, while 34.81 per cent had partial awareness and 14.81 per cent were unaware (Table 1). Similarly, 50.38% understood the purpose of mulching, with 27.40 per cent partially aware and 22.22 per cent unaware. Regarding weed management, 50.38 per cent recognized mulching's role, while 26.66 per cent had partial awareness and 22.96 per cent were unaware. Notably, 80.00 per cent of respondents were unaware of using paddy straw as a mulching material, although 20.00 per cent did use it. While using paddy straw as mulch is a traditional practice and vital for controlling weeds, the low awareness may be due to some farmers not engaging in paddy cultivation. These results are consistent with Odyuo *et al.* (2022), they found that 53.16 per cent of respondents had knowledge about mulching.

The study found that all respondents (100%) were unaware of chemical weed control in ginger cultivation (Table 1). However, 74.44 per cent were fully aware of the harmful effects of insects, while 25.56 per cent had partial awareness. This reliance on traditional knowledge reflects limitations in economic capacity and may hinder profitable yields. Regarding diseases, 35.93 per cent of respondents were partially aware of soft rot disease, with 34.44 per cent unaware and 29.63 per cent fully aware. Notably, all respondents were unaware that soft rot is the most severe disease affecting ginger. Additionally, all were unaware of bacterial wilt and dry rot, and 55.19 per cent were unaware of leaf spot disease, whereas only 44.81 per cent were partially aware about both the diseases. Concerning disease management, none of the respondents knew about treating rhizomes with *trichoderma* to manage soft rot. Overall, these findings indicate a significant lack of

familiarity with plant pathogens, which contributes to poor yield outcomes and undermines the potential for large-scale ginger production.

Importance of soil and moisture conservation, and water resource management was well emphasized in the implementation of Integrated Watershed Management Programme (IWMP) in Nagaland (Ao and Patra, 2022). It was also found that 70.37 per cent of respondents were fully aware of water management in ginger cultivation, while 29.63 per cent had partial awareness. Furthermore, 85.19 per cent were fully aware that the first irrigation should be given immediately after planting, and the same percentage recognized the importance of irrigation in ginger cultivation, with 14.81 per cent unaware of its significance.

However, all respondents (100%) were unaware of the specific timing for irrigation in ginger cultivation (Table 1). This lack of knowledge about irrigation requirements can lead to inadequate application of irrigation, resulting in poor crop yields. The respondents' awareness of irrigation practices likely stems from general farming experience, yet their ignorance of timing could lead to neglect or overwatering. Additionally, challenging terrain and limited water supply may further complicate effective irrigation, contributing to the relegation of water management in their farming practices.

Harvesting is a critical agricultural activity that directly impacts income by influencing quality and market price. In ginger cultivation, harvesting immature rhizomes can negatively affect quality and profitability, whereas fully matured rhizomes ensure better keeping quality for long-term storage and fetch higher prices. This study (Table 1) found that all respondents (100%) were fully aware that the optimal time for harvesting ginger is 8-10 months after planting. These findings align with those of Odyuo *et al.* (2022), they also reported that most ginger growers had full knowledge of the appropriate harvesting time.

Regarding adoption (Table 2) of technologies in the farming sector, Patra and Babu (2020) reported about non-adoption and inadequate adoption in the region. Present study indicated that every single respondent (100%) partially embraced the practice of ensuring proper drainage in their ginger fields. Furthermore, the study revealed that 70.00 per cent

Table 1: Distribution of respondents based on knowledge level about recommended practices of ginger cultivation (N=270)

Particulars	Fully Aware		Partially Aware		Un-aware	
	F	P	F	P	F	P
<i>Climatic condition</i>						
Do you know that ginger grows well in warm climatic condition?	270	100	0	0	0	0
Do you know that ginger grows well in humid climatic condition?	0	0	0	0	270	100
<i>Soil management</i>						
Do you know that a rich soil with good drainage is good for ginger cultivation?	183	67.78	87	32.22	0	0
Do you know that soil aeration is ideal for ginger cultivation?	189	70.00	81	30.00	0	0
Do you know that sandy loam soil is the best type of soil for ginger cultivation?	195	72.22	75	27.78	0	0
<i>Land preparation</i>						
Do you plough your field before planting?	270	100	0	0	0	0
Do you know that it requires 3-4 pulverizing/ploughing to bring the soil to fine friable?	226	83.70	44	16.30	0	0
Do you know that Ginger should not be planted in the same field year after year?	270	100	0	0	0	0
<i>Seed treatment</i>						
Do you know that before sowing, rhizomes should be dipped in cow urine for half an hour?	0	0	0	0	270	100
Do you know that drenching the soil with Mancozeb @ 2g/l of water at 30 days interval is effective for control of diseases?	0	0	0	0	270	100
<i>Seed rate</i>						
Do you know that 1200 to 1500 kg is required for 1 ha of land?	45	16.67	153	56.67	72	26.66
Seed weight 15-25 gms	270	100	0	0	0	0
Seed size: 10-15 gms	270	100	0	0	0	0
Do you know that the rhizomes should be true to type?	270	100	0	0	0	0
Do you know that the seeds should be free from diseases and pests?	270	100	0	0	0	0
<i>Spacing</i>						
Do you know that Spacing of 30 cm between rows is ideal for growing ginger?	254	94.07	0	0	16	5.93
Do you know that 25 cm between plants is considered ideal for Ginger?	249	92.22	0	0	21	7.78
Do you know that the rhizomes are placed at a depth of 4-5 cm in furrows and covered with soils?	270	100	0	0	0	0
<i>Planting time</i>						
Do you know that April to May is the optimum time for sowing Ginger?	45	16.67	0	0	225	83.33
<i>Propagation material</i>						
Do you know that Four to five cm long sprouted buds are required?	251	92.96	19	7.04	0	0
<i>Cultivars</i>						
Nadia	270	100	0	0	0	0
China	0	0	0	0	270	100
Maran	0	0	0	0	270	100
Varada	0	0	0	0	270	100
<i>Manures and fertilizers</i>						
Are you aware that manure is good for soil health management	250	92.59	20	7.41	0	0
Are you aware that manure is good for higher production of ginger?	253	93.70	17	6.30	0	0
Do you know that, FYM 3-5 tonnes per ha is ideal for ginger cultivation?	0	0	0	0	270	100
Do you know that FYM should be applied at the time of field preparation?	0	0	0	0	270	100

Table 1 contd...

Particulars	Fully Aware		Partially Aware		Un-aware	
	F	P	F	P	F	P
Types of manures						
FYM	270	100	0	0	0	0
Poultry	249	92.22	21	7.78	0	0
Pig manure	270	100	0	0	0	0
Others	0	0	0	0	270	100
Fertilizers						
Are you aware that fertilizer is good for the soil health management?	50	18.52	24	8.89	196	72.59
Are you aware that fertilizer is good for higher ginger production?	50	18.52	24	8.89	196	72.59
Do you know that dose of NPK @ (100:90:90 kg/ha) should be applied in the form of chemical fertilizer?	0	0	0	0	270	100
Do you know that 1/3 Nitrogen should be applied as basal?	0	0	0	0	270	100
Do you know that full doses of phosphorus and potassium should be applied at the time of sowing?	0	0	0	0	270	100
Do you know that 1/3 of nitrogen should be applied at 45 DAP. Remaining 1/3 Nitrogen should be applied 90-95 DAP?	0	0	0	0	270	100
Mulching						
Are you aware about mulching practices?	136	50.38	94	34.81	40	14.81
Are you aware of the purpose of mulching?	136	50.38	74	27.40	60	22.22
Are you aware that purpose of mulching is for weed management?	136	50.38	72	26.66	62	22.96
Are you aware that paddy straw can be used as mulching material?	0	0	54	20	216	80
Plant protection measures						
Are you aware about the chemical control of weeds in ginger cultivation?	0	0	0	0	270	100
Are you aware of the harmful effects of insects?	201	74.44	69	25.56	0	0
Are you aware of the various diseases of ginger?	80	29.63	97	35.93	93	34.44
Soft rot	0	0	270	100	0	0
Bacterial wilt	0	0	0	0	270	100
Dry rot	0	0	0	0	270	100
Leaf spot	0	0	121	44.81	149	55.19
Do you know that soft rot is the most severe disease of ginger?	0	0	0	0	270	100
Disease management						
Do you know that rhizome treatment with trichoderma @ 8-10 gm/ litre water helps in managing soft rot?	0	0	0	0	270	100
Water management						
Are you aware about the water management in ginger cultivation?	190	70.37	80	29.63	0	0
Do you know that the first irrigation should be done immediately after planting?	230	85.19	40	14.81	270	100
Are you aware of the importance of irrigation in ginger cultivation?	230	85.19	0	0	40	14.81
Do you know the time of irrigation in ginger cultivation?	0	0	0	0	270	100
Harvesting						
Do you know that the optimum harvesting time of Ginger is 8 to 10 months after planting?	270	100	0	0	0	0

of the respondents followed optimal soil aeration for their ginger fields. Additionally, it was observed that 61.11 per cent of the respondents partially adopted the practice of planting ginger in sandy loam soil, while 11.11 per cent fully adhered to this practice. Conversely, 27.78 per cent of the respondents chose not to use sandy loam soil for ginger cultivation. In terms of field preparation, it was found that all respondents (100%) fully adhered to the practice of ploughing their fields before planting ginger rhizomes. The study also demonstrated that 51.85 per cent of respondents fully adopted the practice of performing 3-4 rounds of soil pulverization to attain a fine and crumbly soil texture, while 48.15 per cent partially adopted this practice.

It was observed that all the respondents did not use any form of seed treatment (Table 2). Additionally, the study revealed that 71.85 per cent of the respondents did not adhere to the recommended seed rate, while 28.15 per cent partially followed it. Furthermore, 88.89 per cent of the respondents partially adopted the recommended seed weight, and 11.11 per cent fully complied with it. In terms of seed size, 83.34 per cent partially followed the recommended size, and 11.11 per cent fully adhered to it. Only 5.55 per cent of the respondents did not use the recommended seed size.

Moreover, it was observed that all respondents fully embraced the practice of using insect and disease-free true-to-type rhizomes. Additionally, it was found that 99.26 per cent of the respondents partially adopted the recommended seed rate for ginger cultivation, while 0.74 per cent fully adhered to it. Furthermore, a significant majority (97.78%) of the respondents had fully complied with the recommended spacing for ginger cultivation. Moreover, it was noted that 60.74 per cent of the respondents had partially followed the recommended depth of rhizome placement, and 39.26 per cent fully adhered to it. These responses indicated that the farmers generally possessed a good understanding of the crops they were cultivating. Whether through extension support or practical farming experience, they demonstrated a reasonable level of adherence to recommended agricultural practices. This aligns with the findings of a study conducted by Jakkawad *et al.* (2017).

Regarding the timing of planting, it was observed that 83.33 per cent of the respondents did not follow the recommended planting schedule, while 16.67 per cent fully adhered to it (Table 2). Additionally, 92.96 per cent of the respondents partially followed the recommended practice of using a specific number of sprouted bits to enhance ginger production, while 7.04

Table 2: Distribution of respondents based on degree of adoption of recommended practices in ginger cultivation (N=270)

Particulars	Fully Adopted		Partially Adopted		Not adopted	
	F	P	F	P	F	P
Climatic condition						
Growing in warm climatic condition	270	100	0	0	0	0
Soil management						
Growing in rich soil with good drainage facility	0	0	270	100	0	0
Soil aeration is ideal for ginger cultivation	0	0	189	70	81	30
Sandy loam soil is the best type of soil for ginger cultivation	30	11.11	165	61.11	75	27.78
Land preparation						
Plough of field before planting	270	100	0	0	0	0
It requires 3-4 pulverizing/ploughing to bring the soil to fine friable	140	51.85	130	48.15	0	0
It should not repeatedly be planted in the same field	270	100	0	0	0	0
Seed treatment						
Before sowing, rhizomes should be dipped in cow urine for half an hour	0	0	0	0	270	100
Drenching of soil with Dithane Z-78 @ 2g/l of water at 30 days interval is effective for control of diseases	0	0	0	0	270	100

Table 2 contd...

Particulars	Fully Adopted		Partially Adopted		Not adopted	
	F	P	F	P	F	P
Seed rate						
Around 1200 to 1500 kg of seed is required for 1 ha of land	0	0	76	28.15	194	71.85
Seed weight is 15-25 gms	30	11.11	240	88.89	0	0
Seed size: 10-15 cms	30	11.11	225	83.34	15	5.55
Rhizomes should be true to type	270	100	0	0	0	0
Seeds should be free from diseases and pests	270	100	0	0	0	0
Spacing						
Spacing of 30 cm between rows is ideal for growing ginger	2	0.74	268	99.26	0	0
25 cm between plants is considered ideal for Ginger	0	0	264	97.78	6	2.22
Rhizomes are placed at a depth of 4-5 cm in furrows and covered with soils	106	39.26	164	60.74	0	0
Planting time						
April to May is the optimum time for sowing Ginger	45	16.67	0	0	225	83.33
Propagation material						
Need to use 4-5 cm long sprouted buds	251	92.96	19	7.04	0	0
Cultivars						
Nadia	270	100	0	0	0	0
China	0	0	0	0	270	100
Maran	0	0	0	0	270	100
Varada	0	0	0	0	270	100
Manures						
FYM @ 3-5 tonnes per ha is ideal for ginger cultivation	270	100	0	0	0	0
FYM should be applied at the time of field preparation	270	100	0	0	0	0
Fertilizers						
Using fertilizer	0	0	0	0	270	100
Application of NPK @ 100:90:90 kg/ha in the form of chemical fertilizer	0	0	0	0	270	100
$\frac{1}{3}$ of Nitrogen should be applied as basal	0	0	0	0	270	100
Full doses of phosphorus & potassium should be applied at the time of sowing	0	0	0	0	270	100
Application of $\frac{1}{3}$ of nitrogen at 45 DAP and remaining $\frac{1}{3}$ of nitrogen at 90-95 DAP	0	0	0	0	270	100
Mulching						
Use of mulching practices	0	0	54	20	216	80
Use of mulching for weed management	0	0	54	20	216	80
Use of paddy straw as mulching material	0	0	54	20	216	80
Plant protection measures						
Use of chemical control for weeds management	0	0	0	0	270	100
Disease management						
Treatment of rhizome with trichoderma @ 8-10 gm/ litre water for soft rot disease management	0	0	0	0	270	100
Water management						
Application of irrigation in ginger cultivation	0	0	0	0	270	100
Harvesting						
Harvesting of ginger is done 8 to 10 months after planting.	270	100	0	0	0	0

per cent fully embraced this recommendation. All of the respondents, exclusively opted for the Nadia variety, showing a complete absence of other ginger varieties in the study area. While it is commendable that ginger growers chose a high yielding variety, this also raises concerns about the vulnerability of the ginger cultivation to potential outbreaks of insects or diseases due to giving the strong preference for a single variety. This situation indicates a significant monoculture tendency in ginger cultivation, which is a risk factor for potential crop epidemics, as noted in the study by Kharjana *et al.* (2017).

The data revealed that all respondents in the study area did not utilize any form of manure or farmyard manure (FYM) to enhance soil health in their ginger fields and promote higher ginger yields. It was observed that none of the respondents in the study area followed the recommended fertilizer dosage for their ginger fields. This finding corresponds with the research conducted by Kharjana *et al.* (2017), where it was reported that none of the respondents adopted fertilizer application as a practice for ginger cultivation.

Moreover, 80.00 per cent of the respondents did not adopt mulching, and 20.00 per cent only partially embraced straw mulching practices. Notably, none of the respondents used chemical methods to control weeds in their ginger cultivation, and none followed the recommended treatment for disease control in ginger. The study conducted by Kharjana *et al.* (2017)

aligns with the current findings, as they reported that all respondents (100%), did not adhere to the recommended set of practices for protecting ginger plants during cultivation. The research findings indicated that none of the respondents in the study area adhered to the recommended irrigation schedule for ginger cultivation, as they exclusively relied on rainfall for their water management in ginger fields. In terms of the timing for harvesting ginger, it was observed that all respondents had fully embraced the recommended harvest time. This finding is consistent with a study conducted by Jakkawad *et al.* (2017), which reported that the majority (87.50%) of ginger growers followed the recommended harvesting guidelines.

Concerning the indices on knowledge and adoption, Table 3 indicates that the mean knowledge level was 51.15 with a standard deviation of 2.701 and ranged from 44.26 to 54.09 per cent. Further, majority (61.00%) of the respondents had exhibited a high or very high level of knowledge index, and remaining 38.88 per cent had a low to medium level of knowledge index. It can be concluded that ginger growers had a medium level of knowledge and these finding are aligned with the findings of Patra *et al.* (2024); and Patra and Kense (2020) and Patra *et al.* (2019). When it came to adoption of improved practices in ginger cultivation, the mean adoption index was 26.92 with a standard deviation value of 2.67 and a range of 22.95 to 33.60 per cent. Subsequently, 75.00

Table 3: Distribution of the respondents based on knowledge and adoption level (N=270)

Categorization	Frequency	Percentage	Mean	SD	Range	
					Achievable	Achieved
<i>Knowledge Level</i>						
Low	36	13.33				
Medium	69	25.55				
High	120	44.44	51.159	2.701	0.00 -100	44.26 - 54.09
Very High	45	16.66				
Total	270	100.00				
<i>Adoption Level</i>						
Low	8	2.96				
Medium	197	72.96				
High	20	7.40	26.921	2.676	0.00 -100	22.95 – 33.60
Very high	45	16.66				
Total	270	100.00				

Table 4: Relationship between ginger growers' various socio-economic factors and their knowledge and adoption indices

Variables	Knowledge r value	Adoption r value
Age	0.228**	0.227**
Educational qualification	0.089	0.079
Occupation	-0.205**	-0.270**
Land holding	-0.296**	-0.207**
Operational land holding	-0.210**	-0.180**
Land under ginger cultivation	-0.210**	-0.097
Annual income	0.237**	0.350**
Income from ginger	0.328**	0.296**
Training	0.665**	0.767**
Extension contact	0.252**	0.182**
Information source	0.259**	0.328**
Marketing	0.309**	0.273**

*Significant at 5 per cent, table value: 0.119; **Significant at 1 per cent level, table value: 0.158

per cent of the respondents had a low to medium level of adoption and remaining 25.00% of the respondents had a high to very high level of adoption. In respect of adoption, Manisha *et al.* (2023) also found that 14.20 per cent of the respondents were under high adopter category. Therefore, it can be concluded that the respondents had a moderate level of knowledge level on improved ginger cultivation but adoption of improved cultivation practices in ginger cultivation is in pitiful state.

The relationship study shows (Table 4) that the socio-economic variables, namely, age, annual income, income from ginger, training, extension contact, sources of information, and marketing have a significant correlation with the knowledge index, as reflected by their correlation values of 0.228, 0.237, 0.328, 0.665, 0.252, 0.259, and 0.309, respectively. Therefore, study transpire that the H_01 is rejected. On the other hand, occupation, land holding, operational land holding, and land under ginger cultivation was found to have a significant but negative correlation with the knowledge index with a correlation value of -0.205, -0.296, -0.210, and -0.210, respectively. Further, results on relationship study have an agreement with the finding of Patra *et al.* (2023).

Table 4.40 reveals that age, annual income, income from ginger, training, extension contact, information source and marketing had a positive correlation with adoption index, with a correlation value of 0.227, 0.350, 0.296, 0.797, 0.182, 0.328 and 0.273, respectively. Accordingly, it can be inferred that the H_02 is also rejected. On the contrary, occupation, land holding, occupational land holding and land under ginger cultivation had a negative correlation with the adoption level. Findings on relationship have a agreement with the findings of Patra *et al.* (2021).

CONCLUSION

Regarding the knowledge level of ginger growers about the improved and recommended cultivation practices, respondents are relatively knowledge rich with average knowledge index of 51.15 per cent. However, they have huge inadequacy of knowledge in respect of seed treatment, disease management, irrigation, manures and fertilizers use, important cultivars of ginger, mulching materials and different diseases of ginger crop. On the other hand, ginger growers are lagged behind in respect of adoption of recommended practices in cultivation of ginger. The average adoption index was 26.92 per cent, i.e., near to $\frac{1}{4}^{\text{th}}$ of the maximum achievable adoption index with a range of 22.95 to 33.60 per cent. Therefore, the study community had an average adopted of only $\frac{1}{4}^{\text{th}}$ of the recommended practices, which extended up to the $\frac{1}{3}^{\text{rd}}$ of the recommended practices. So, it is also clear from the study that there is a knowledge, attitude and adoption or practice discrepancies are common scenario in rural farming community and with reference to Nagaland's ginger growers.

As a result, farmers are getting less production from per unit area of cultivation and earning less income from ginger cultivation, which ultimately impacting on their livelihood. However, findings from the present study are not the exceptional trend of discrepancy and alternatives to mitigate the problem is also the requirement to explore. Rigorous extension works with advance extension approaches for capacity strengthening with positive attitude formation initiatives may be the alternative to up-scale the knowledge level and complete the adoption of innovation and continuous use of the same. Thus, it suggests that there is a huge opportunity for the Nagaland's extension

functionaries to improve knowledge level and adoption rate of recommended techniques among the farming community. This effort should encompass various strategies, including training programs, awareness campaigns, ICT-based information sharing and knowledge-sharing initiatives. In essence, the continuous focus on and support for the adoption of these recommended practices can contribute significantly to the sustainable growth and prosperity of ginger cultivation in the region.

REFERENCES

- Abrol P., P. Choudhary, P. Kumar and R. Gupta. 2023. Assessment of farmers' knowledge and practices adopted for the safe use of pesticides in Jammu. *Journal of Community Mobilization and Sustainable Development*, 18(4): 1298-1304. [https://DOI:10.5958/2231-6736.2023.00095.9](https://doi.org/10.5958/2231-6736.2023.00095.9)
- Ao Sashilila and N.K. Patra. 2022. Performance of integrated watershed management programme (IWMP): A study from Nagaland, India. *Journal of Community Mobilization and Sustainable Development*, 17(2): 685-693.
- Benjongtoshi and N.K. Patra. 2021. Socio-economic and livelihood features of French bean growers: Evidence from Kiphire District, Nagaland. *Indian Research Journal of Extn Education*, 21(1): 24-29.
- Burman, R.R.; R.N. Padaria; G.S. Mahra; S. Mallick; S. Mukherjee; S.K. Jha; P. Sheoran and S.K. Roy. 2023. Perception, attitude and knowledge of farmers towards agri-drones: Case Study on influence of *Mann Ki Baat* program. *Journal of Community Mobilization and Sustainable Development*, 18(1): 79-88.
- Gamlin, M. and N.K. Patra. 2020. Crop based livelihood activities of pineapple growers and constraints in its cultivation: A study in North Eastern Himalayan Region, India. *Journal of Community Mobilization and Sustainable Development*, 15(2): 471-478.
- Gorai, S.K.; R.N. Padaria; R.R. Burman; S. Sarkar; Md Yeasin; B. Ghosh; S.N. Kumar and A. Lama. 2024. Institutional network analysis for adaptation to climate change and natural disasters in agricultural sector: Evidences from Odisha. *Journal of Community Mobilization and Sustainable Development*, 19(2): 381-386. [https://DOI:10.5958/2277-8934.2024.00113.X](https://doi.org/10.5958/2277-8934.2024.00113.X)
- Govt. of India (2006) NCF (National Commission on Farmers), Serving Farmers and Saving Farmers. Jai Kisan: Revised Draft National Policy for Farmers, Fifth and final report, October 2006, Ministry of Agriculture, Government of India, New Delhi.
- Govt. of Nagaland (2012) Nagaland Statistical handbook. Published by Directorate of Economics and Statistics. Govt. of Nagaland, Kohima, Nagaland.
- Govt. of Nagaland (2016) Nagaland Statistical handbook. Published by Directorate of Economics and Statistics. Govt. of Nagaland, Kohima, Nagaland.
- Govt. of Nagaland (2017) Nagaland Statistical handbook. Published by Directorate of Economics and Statistics. Govt. of Nagaland, Kohima, Nagaland.
- Govt. of Nagaland (2021) Nagaland Statistical handbook. Published by Directorate of Economics and Statistics. Govt. of Nagaland, Kohima, Nagaland. *Journal of Community Mobilization and Sustainable Development*, 14(1): 97-103.
- Jakkawad, S.R.; R.C. Sawant and S.B. Pawar. 2017. Knowledge and adoption of ginger production technology in Aurungabad district. *Trends in Bioscience*, 10(24): 5111-5114.
- Kharjana, V.; Nisha; N. Bordoloi and S. Sharma. 2017. A study on the extent of the adoption of improved ginger cultivation practices by the farmers of Ri-Bhoi District of Meghalaya. *International Journal of Agricultural Science*, 7(4): 89-96.
- Lalthamawii, N.K. Patra and Zohmingmawii Sailo. 2022. Knowledge and adoption status of recommended practices of rice by farmers in Mizoram, India. *Indian Research Journal of Extension Education*, 22(3): 91-98. https://doi.org/10.54986/irjee/2022/apr_jun/19-98
- Manisha; B. Kaur; R. Mukteshwar and S. Boora. 2023. Extent of adoption among farmers practicing organic farming in Haryana. *Journal of Community Mobilization and Sustainable Development*, 18(4): 1220-1228. [https://DOI:10.5958/2231-6736.2023.00083.2](https://doi.org/10.5958/2231-6736.2023.00083.2)
- Odyuo, M.N.; T.A. Jongbo and J. Longkumer. 2022. Knowledge level of ginger growers on improved cultivation practices of ginger (*Zingiber officinale* L.) in Tuensang District, Nagaland. *Indian Journal of Hill Farming*, 35: 169-173.
- Odyuo, M.N.; T.A. Jongbo and J. Longkumer. 2023. Adoption of improved cultivation practices of ginger (*Zingiber officinale* L.) in Tuensang District, Nagaland, India. *Journals of Soils and Crops*, 33(1): 174-177.
- Patra, N.K. and B.S. Chandra. 2020. Scope and strategic intervention for climate smart agriculture in North Eastern India. In: V. Venkatramanan, Shachi Shah, Ram Prasad (eds.), *Global Climate Change: Resilient and Smart Agriculture*. Springer. pp-155-186. https://doi.org/10.1007/978-981-32-9856-9_8
- Patra, N.K. and Benjongtoshi. 2023. Sustainable performance of French bean (*Phaseolus vulgaris* L.) cultivation, a

- livelihood component in Eastern Himalayan Region. *International Journal of Agricultural Sustainability*, 21(1): 2247784.
- Patra, N.K. and L. Lianzami. 2021. Socio-economic status and constraints faced by Chow-chow [*Sechium edule* (Jacq.) Sw.]. *Journal of Community Mobilization and Sustainable Development*, 16(2): 343-350.
- Patra, N.K. and Pelebei-u Kense. 2020. Study on knowledge and adoption of improved cultivation practices of Mandarin (*Citrus reticulata* Blanco) growers in Nagaland, India. *Indian Journal of Extension Education*, 56(4): 126-133. <https://DOI:10.5958/2454-552X.2020.00061.4>
- Patra, N.K. and Pelebei-u Kense. 2021. Socio-economic features of mandarin (*Citrus reticulata* Blanco) growers: A case study in Nagaland, India. *Indian Journal of Extension Education*, 57(2): 87-93.
- Patra, N.K. and T. Rilung; L. Das and P. Kumar. 2024a. Assessing climate change and its impact on Kiwi (*Actinidia deliciosa* Chev.) production in the Eastern Himalayan Region of India through a combined approach of people perception and meteorological data. *Theoretical and Applied Climatology*. Springer Nature. <https://doi:10.1007/s00704-023-04793-7>
- Patra, N.K. and V.S. Choppi. 2023. Knowledge level and adoption behaviour of maize growers in selected Districts of Nagaland, India. *Indian Journal of Extension Education*, 59(4): 1-7. <https://doi.org/10.48165/IJEE.2023.59406>
- Patra, N.K.; M. Pongener; Marensangla; S. Ao and S. Das. 2024. Status of adoption of improved technologies in farming sector in Nagaland, India. *Journal of Community Mobilization and Sustainable Development*, 19(Special Issue): 166-174. <https://DOI.10.5958/2231-6736.2024.00067.X>
- Patra, N.K.; S. Konyak; S. Das, S. Ao; M. Gamlin and A.K. Sahu. 2021. Assessing socio-economic and modernization status of king chilli (*Capsicum* spp.) growers: Evidence from Nagaland, North East India. *Journal of Community Mobilization and Sustainable Development*, 14(1): 97-103.
- Singh, S.R.K.; D. Bardhan; V. Shrivastava; A.A. Raut; R.R. Burman; R. Singh; A.K. Singh and U.S. Gautam. 2023. Psychometric Validation of knowledge test developed on nutrition and nutri-rich foods. *Journal of Community Mobilization and Sustainable Development*, 18(4): 1171-1176. <https://DOI:10.5958/2231-6736.2023.00076.5>
- Sudreshah, B.R.; D. Nanjappa; R.V. Kumar and M.T.L. Narayan. 2020. A study on knowledge level of ginger growers on improved cultivation practices in Hassan District, India, *International Journal of Current Microbiology and Applied Sciences*, 9(7): 2319-7706.



Research Article

Analyzing the Relationship between Farm Waste Production and Demographic Profile of Dairy Farmers of Punjab[#]

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ABSTRACT

An exploratory study was conducted in two districts *viz*; Ludhiana and Pathankot of Punjab to understand relationship between farm waste production and demographic profile of respondents. Sample size was 160 dairy farmers (80 from Ludhiana and 80 from Pathankot district) were selected through multistage random sampling. Education and family size were having significant ($p < 0.05$) with farm waste production and Land holding, Type of dairy farm, Livestock holding as livestock equivalent were highly significant ($p < 0.01$) with the production of farm waste at dairy farms. So, that as land holding increases, education status improves, large family size and greater herd size leading to more farm waste production at their dairy farms which tends towards commercial dairying.

Keywords: Adoption, Dairy farmers, Demographic profile, Farm waste

INTRODUCTION

Waste is anything that is not used in its current form and needs to be discarded or managed. Similarly, farm waste includes items that are generated at dairy or livestock farms, such as solid, semisolid, and liquid waste, which are of no use in their current form. Farm waste includes animal dung, urine, feed, and fodder residues, bedding materials, parturition waste such as placenta, dead animal carcass, abortion waste such as aborted fetus including placenta and biomedical waste such as needles, syringes, vials, gloves, and so on. The quantum of per capita waste generated globally is 0.74 kg per day, which ranges from 0.11 kilograms to 4.54 kilograms countrywide (Kaza *et al.*, 2018). India has currently 193.46 million cattle and 109.85 million buffaloes (BAHS, 2019) and Punjab has 40.16 lakh buffaloes and 25.31 lakh cattle (Statistical Abstract of Punjab, 2020). On a wet weight basis, manure

production can reach up to 5.27 kg/day/1000 kg live weight of the animal (Bharadwaj *et al.*, 2019). In India farm wastes are managed with different methods *viz*; Animal dung by dung cake preparation, vermicomposting, preparing farm yard manure and establishment of bio-gas plant; animal urine as liquid manure, direct application in fields; feed and fodder residues as dung cake preparation, vermicomposting, preparing farm yard manure and establishment of bio-gas plant; Bedding materials as dung cake preparation, vermicomposting and preparing farm yard manure, other wastes were managed as deep burial and burning methods.

Looking at such a huge potential in rural areas for waste generation, there is a strong need to understand the demographic profile of the farmers living in rural set-ups and how demographic profile is affecting the farm waste production so that various interventions

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can be designed and made on demographic variables. Keeping the above principles in mind the present study was conducted.

MATERIALS AND METHODS

The present exploratory research was carried out on dairy farms in Punjab state of India. Two districts namely Ludhiana and Pathankot were selected purposively, based on their maximum number of dairy animals in Ludhiana and minimum in Pathankot district (BAHS, 2019). For the present study, dairy farmer was operationally defined as farmer who practices dairying as business and had at least 5 dairy animals at his farm with minimum 05 or more years of experience in dairying. Dairy farmers were divided into two categories i.e., small farmers having 5-25 animals and large farmers having more than 25 dairy animals respectively. From district Ludhiana; total 80 respondents were identified by multistage random sampling for the study purpose. Similarly, from district Pathankot; 80 dairy farmers were selected by multistage random sampling. Therefore, total sample size for study was 160 respondents. The conclusions were achieved using descriptive analysis, z-test, Mann-Whitney U-test, Chi – square test, Correlation analysis, and Regression analysis using SPSS.

RESULTS

The demographic profile and its relationship with farm waste production was analyzed and presented as follows:

Age: The age of the respondents in the present study ranged between 18 to 75 years and the average age of respondents was 42.18 years. The average age of small and large farmers was 42.11 and 42.25 years respectively. It is evident from Table 1 that majority (40.62%) of total farmers were in middle age group,

followed by young age group (34.38%) and 25.00 percent farmers were in old age group. Most of the small farmers (46.25%) were in middle age group, followed by young (33.75%). Large farmers were equally distributed in middle and young age groups i.e., 35.00 percent. The results of z-test indicated that the difference between the age of small farmers and large farmers of the study was non-significant.

Education: Education leads to improve knowledge and skills, as well as improved understanding of new techniques and personality development. It helps to improve the socioeconomic status of an individual. As seen in Table 2; majority of farmers (25.62%) were educated up to high school followed by senior secondary school (21.88%), graduates (19.38%), and the middle school (10.62%). Among small farmers majority of farmers were educated up to high school (25.00%), similarly in large farmers maximum number of farmers (26.25%) were high school passed. The result of the Chi-square test indicated that no significant difference between the education of small and large farmers of study.

Family size: It could be seen in Table 3; that the mean family size of respondents was 5.35 members. In small farmers, average family size was 5.44 members and in large farmers average family size was 5.26 members. Most of the dairy farmers (48.12%) were in medium family size category, followed by small family size (38.75%), and 13.13 percent of farmers had large family size. Most of the small farmers (51.25%) as well as large farmers (45.00%) fell under the medium category of family size i.e., 5 to 7 members followed by small family size, and large family size. The result of z-test indicated that the difference between the family size of small farmers and large farmers of the study was non-significant.

Table 1: Distribution of respondents with respect to age

Age (years)	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Young (Up to 35)	27 (33.75)	28 (35.00)	55 (34.38)
Middle (36 to 50)	37 (46.25)	28 (35.00)	65 (40.62)
Old (51 and above)	16 (20.00)	24 (30.00)	40 (25.00)
Mean $\pm$ SE	42.11 $\pm$ 1.27	42.25 $\pm$ 1.45	42.18 $\pm$ 0.96
z-test value = 0.071 ^{NS}			

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error; *: Significant

Table 2: Distribution of respondents with respect to their education status

Education	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Illiterate	07 (08.75)	08 (10.00)	15 (09.38)
Can read only	02 (02.50)	00 (00.00)	02 (01.25)
Can read and write	03 (03.75)	01 (01.25)	04 (02.50)
Primary school	03 (03.75)	09 (11.25)	12 (07.50)
Middle school	09 (11.25)	08 (10.00)	17 (10.62)
High school	20 (25.00)	21 (26.25)	41 (25.62)
Senior Secondary school	17 (21.25)	18 (22.50)	35 (21.88)
Graduate	17 (21.25)	14 (17.50)	31 (19.38)
Above graduate	02 (02.50)	01 (01.25)	03 (01.88)
Chi-square Test Value = 6.80^{NS}			

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error, *: Significant

Table 3: Distribution of respondents with respect to their family size

Family size	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Small (2–4 members)	30 (30.50)	32 (40.00)	62 (38.75)
Medium (5–7 members)	41 (51.25)	36 (45.00)	77 (48.12)
Large (8–10 members)	09 (11.25)	12 (15.00)	21 (13.13)
Mean $\pm$ SE	5.44 $\pm$ 0.176	5.26 $\pm$ 0.215	5.35 $\pm$ 0.139
z-test value = 0.629^{NS}			

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error, *: Significant

Social Participation: The results were seen in Table 4; indicated that majority of respondents (59.38%) had low social participation, followed by no participation (28.12%), medium (09.37%), and high (03.13%) level of social participation. Among small farmers, majority of farmers (58.75%) were having a low level of social participation, as against, no participation (32.50%), medium (07.50%), and high (01.25%) level of participation. In the case of large farmers, majority of respondents (60.00%) were having low social participation followed by no social participation (23.75%), 11.25 per cent farmers with medium, and 05.00 per cent with a high level of participation. There is a significant difference at 5% level ($P < 0.05$) in the Mann-Whitney U test value among the social participation of small farmers and large farmers.

Dairy farming experience: Data presented in Table 5; indicated that the range of dairy farming experience was 05–50 years. The average experience was 18.69 years for pooled respondents, for small farmers (19.35

years), and 18.02 years for large farmers. Majority of farmers (45.63%) had a low level of dairy farming experience, followed by medium (36.87%), high (11.87%), and very high (05.63%). Among small farmers, majority of farmers (45.00%) fell under a low level of dairy farming experience, as against medium (36.25%), high (11.25%), and 07.50 percent with very high dairy farming experience. In the case of large farmers, maximum farmers (46.25%) had a low level of dairy farming experience, as against medium (37.50%), high (12.50%), and very high (03.75%). The result of z-test indicated that the difference between the dairy farming experience of small farmers and the large farmers of the study was non-significant.

Land-holding: Land-holding of respondents as mentioned in Table 6; average land holding of pooled farmers was 08.08 acres, 09.87 acres for small farmers, and 6.30 acres for large farmers. Majority of respondents (37.50%) were falls under the category

Table 4: Distribution of respondents with respect to their social participation

Social Participation	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
No participation (0)	26 (32.50)	19 (23.75)	45 (28.12)
Low (1 – 3)	47 (58.75)	48 (60.00)	95 (59.38)
Medium (4 – 6)	06 (07.50)	09 (11.25)	15 (09.37)
High (7 – 10)	01 (01.25)	04 (05.00)	05 (03.13)

Mann-Whitney U Test Value = 2678.50*

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error, *: Significant

Table 5: Distribution of respondents with respect to their experience in dairy farming

Experience (years)	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Low (5 – 15)	36 (45.00)	37 (46.25)	73 (45.63)
Medium (16 – 26)	29 (36.25)	30 (37.50)	59 (36.87)
High (27 – 37)	09 (11.25)	10 (12.50)	19 (11.87)
Very high (38 – 50)	06 (07.50)	03 (03.75)	09 (05.63)
Range	5 – 50	5 – 50	5 – 50
Mean $\pm$ SE	19.35 $\pm$ 1.18	18.02 $\pm$ 0.97	18.69 $\pm$ 0.76

z-test value = 0.862^{NS}

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error, *: Significant

Table 6: Distribution of respondents with respect to land-holding

Land-holding (acres)	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Landless (0)	04 (05.00)	02 (02.50)	06 (03.75)
Marginal (0.1 – 2.5)	09 (11.25)	08 (10.00)	17 (10.62)
Small (2.6 – 5.0)	27 (33.75)	33 (41.25)	60 (37.50)
Semi-medium (5.1 – 10.0)	23 (28.75)	30 (37.50)	53 (33.12)
Medium (10.1 – 25.0 acres)	11 (13.75)	04 (05.00)	15 (09.38)
Large (more than 25.0 acres)	06 (07.50)	03 (03.75)	09 (05.62)
Mean $\pm$ SE	9.87 $\pm$ 1.982	6.30 $\pm$ 0.614	8.08 $\pm$ 1.044

z-test value = 1.720^{NS}

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error, *: Significant

of small land holding, followed by semi-medium (33.12%), marginal (10.62%), medium (09.38%), large (05.62%), landless (03.75%). Majority of small farmers (33.75%) had small land holding as against semi – medium, and medium land holding, similarly in the case of large farmers most of them (41.25%) were in the small land holding category followed by semi-medium, marginal land holding. The result of z-test indicated that the difference between the land holding

of small farmers and large farmers of the study was non-significant.

Type of dairy farm: Results presented in Table 7 indicated that majority of farmers (55.63%) were having cattle dairy farms, followed by mixed farms (28.12%), and buffalo farms (16.25%). In the case of small farmers, majority (71.25%) of farmers had cattle farm, followed by (17.50%) mixed farm, and (11.25%) buffalo farm. Among large farmers, 40.00 percent had

Table 7: Distribution of respondents with respect to type of dairy farm

Type of dairy farm	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Cattle	57 (71.25)	32 (40.00)	89 (55.63)
Buffalo	09 (11.25)	17 (21.25)	26 (16.25)
Mixed(Cattle and buffalo both)	14 (17.50)	31 (38.75)	45 (28.12)

Figures in parenthesis indicate percentage of the respondents

Table 8: Distribution of respondents with respect to herd size (cattle equivalent)

Livestock holding (Per cattle equivalent)	Small farmers (n = 80)	Large farmers (n = 80)	Pooled farmers (N = 160)
Small (03.85 – 14.63)	80 (100.00)	0 (0.00)	80 (50.00)
Medium (14.64 – 25.42)	0 (0.00)	65 (81.25)	65 (40.62)
Large (25.43 – 36.21)	0 (0.00)	10 (12.50)	10 (06.25)
Very large (36.22 – 47.00)	0 (0.00)	05 (06.25)	05 (03.13)
Range	03.85 – 14.20	18.65 – 47.00	03.85 – 47.00
Mean $\pm$ SE	5.57 $\pm$ 0.16	23.96 $\pm$ 0.67	14.76 $\pm$ 0.81
Total cattle equivalent	445.85	1917	2362.85

z-test value = 26.514**

Figures in parenthesis indicate percentage of the respondents, NS: Non-significant; SE: Standard Error, *: Significant

cattle farm, 38.75 per cent had mixed farm, and 21.25 per cent was with buffalo farm.

Livestock holding: Results mentioned in Table 8; indicated that the average adult cattle equivalent reared by small farmers was 5.57 ACU, in large farmers was 23.96 ACU and 14.76 ACU for pooled farmers. Among pooled farmers majority (50.00%) of them were in small category of livestock holding (per cattle equivalent), followed by medium (40.62%), large (06.25%), and very large (03.13%). In the case of small farmers, all of them (100%) were having small livestock holding. Among large farmers most (81.25%) of them had medium livestock holding, followed by (12.50%) large livestock holding, and (06.25%) with very large herd size. The total adult cattle equivalent was 445.85 in the case of small farmers, 1917 ACU in large farmers, then the sum of adult cattle equivalent was 2362.85. There is a highly significant difference at 1% level ($P < 0.01$) in z-test value among livestock holding as per cattle equivalent of small farmers and large farmers of study.

Relational analysis between production of farm waste and demographic profile of dairy farmers

Results presented in Table 9; gives the relational analysis

of dependent variables like production of farm waste with various independent demographic profile variables. Education and family size were having significant ($p < 0.05$) and positive correlation with farm waste production and regression coefficient of both education and family size were also found to be significant ($p < 0.05$) with it. Land holding, Type of dairy farm, Livestock holding as livestock equivalent were highly significant ($p < 0.01$) and positively correlated with

Table 9: Relational Analysis between farm waste produced and other independent variables

Independent Variables	Production of Farm Waste	
	r	B
Age	0.01	00.41
Education	0.04*	09.06*
Family Size	0.03*	11.12*
Social Participation	0.04	08.42
Land Holding	0.10**	00.09**
Dairy Farm Type	0.25**	01.73**
Livestock Holding (In Cattle Equivalent)	0.99**	67.17**
Experience in Dairy Farming	0.12	00.30

farm waste production. Further regression coefficient of Land holding, Type of dairy farm, Livestock holding as livestock equivalent were found to be highly significant ($p < 0.01$) with production of farm waste at dairy farms.

DISCUSSION

Large farmers and small farmers were having no significant difference in age with majority of farmers were in middle age group category. Similar results are reported by (Chauhan and Kansal 2014; Rathod and Chander 2016; Hundal *et al.*, 2016 and Thakur *et al.*, 2018); that majority of farmers in the middle age group category, followed by the younger than the old age group. The education of small and large farmers is not significantly different in which majority of farmers were studied up to high school. The observations of study are similar with results of previous researchers like (Chauhan and Kansal, 2014; Hundal *et al.*, 2016; Rathod and Chander, 2016; Kaur *et al.*, 2017 and Singh *et al.*, 2020) in which majority of farmers studied up to high school. Difference in family size of small farmers and large farmers of the study was non-significant. These results are similar with other researchers like (Chauhan and Kansal, 2014 and Chander and Chand, 2020); majority of respondents were having medium family.

The social participation of small farmers and large farmers were significantly different. It may be due to commercial farmers had more contacts with various social organizations, that would become helpful in management of farm waste. The results of the study in line with other past researchers (Singh, 2019 and Brar, 2020) majority of farmers were having a low level of social participation. The dairy farming experience of small farmers and the large farmers of the study was almost similar. The results of the study are in line with a past researcher like (Singh, 2011). There is no significant difference between the land holding of small farmers and large farmers of the study with smaller size of land holding. The findings are in line with the study of (Lokhande, 2009; Khin Mar Do, 2005; Patel, 2005); studied that maximum number of farmers belong to the small land holding category, but not similar to (Rathod and Chander, 2016).

In present study cattle rearing at farms was much more frequent in the case of small as well as large

farmers. The findings are not in line with (Gangil, 2019; Jadoun, 2014), revealed that majority (87.33%) of farmers had buffalo. There is a highly significant difference at 1% level ($P < 0.01$) in z-test value among livestock holding as per cattle equivalent of small farmers and large farmers of study. The findings are in line with previous researchers like (Lokhande, 2009; Tak, 2010; Hundal *et al.*, 2016; Singh *et al.*, 2016; Rathod and Chander, 2016). Farm waste production was correlated with education, family size and highly correlated with land holding, herd size and dairy farm type.

As education level of farmers increase, they move towards commercial dairy farming with greater number of livestock at their dairy farms, so production of farm waste increased as dung, urine but with the use of scientific management practices with the use of knowledge gain through education per animal feed and fodder residues production reduces. Large family size also promotes large herd size, so, farm waste production increases. Farmers with large land holding solve the problem of land requirement for rearing and fodder production for animal at dairy farms, so they kept large herd size at farms produces more farm waste. Farmers with large land holding solve the problem of land requirement for rearing and fodder production for animal at dairy farms, so they kept large herd size at farms produces more farm waste.

CONCLUSION

Here, we can conclude that as social participation increased by participating in Kisan melas, Dairy farmer's associations, Pashu-Palan melas and Fairs which is responsible for improving knowledge level regarding scientific farm waste management practices and lesser production of farm waste at their livestock farms as compare to similar herd size farms. Production of farm waste was significantly correlated with Education, Family Size, Land Holding, Dairy Farm Type, Livestock Holding because these variables were responsible for commercial dairy farming and solve the problem of limiting factors of dairy farming in the form of land requirement, labor etc., so, there is a need of more training facilities, scientific demonstration units at village, block and district level for farmers with respect to farm waste management practices. Especially for women farmers some technical and technological facilities are also provided for easy dung cake preparation. So, there is a need to prepare such rules,

policies and researches that quantity of farm waste at dairy farms can minimize comparative to similar herd size farms with traditional practices of management at farms.

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REFERENCES

- BAHS. 2019. Government of India. Ministry of Fisheries, Animal Husbandry and Dairying. Department of Animal Husbandry and Dairying, Krishi Bhavan, New Delhi.
- Bharadwaj, A.; S. Kashyap and D. Methwani. 2019. Remediation of agricultural waste into wealth. *Vinechan International Journal of Research*, 10(2): 32-37.
- Brar, T.S. 2020. A study on entrepreneurial behavior among the dairy farmers of Punjab. M.V.Sc. Thesis, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India.
- Chand, S. 2011. Analysis of reproductive disorders in dairy animals in Alwar district of Rajasthan. M. Sc Thesis, NDRI Deemed University, Karnal, India.
- Chander, R.K. and R. Chand. 2020. Socio-cultural effect of training and dairy extension services on milk producers of Rural Punjab. *Journal of Krishi Vigyan*, 9(1): 306-310.
- Chauhan, M. and S.K. Kansal. 2014. Most preferred animal husbandry information sources and channel among dairy farmers of Punjab. *Indian Research Journal of Extension Education*, 14(4): 33-36.
- Gangil, D. 2019. Assessment of short message advisory service developed for the dairy farmers of Punjab (Doctoral dissertation, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana).
- Hundal, J.S.; U. Singh; N. Singh; S.K. Kansal and J.S. Bhatti. 2016. Impact of training on knowledge level of goat farmers in Punjab. *Haryana Vet*, 55(1): 47-49.
- Jadoun, Y.S. 2020. Integrated Murrah Development Scheme (IMDS) in Haryana; Acritical Appraisal. Ph.D. Thesis, NDRI Deemed University, Karnal, India.
- Kaur, S.; H.K. Verma; J. Singh; S.K. Dash and S.K. Kansal. 2017. Knowledge level of women dairy farmers about various farming practices in border area of Punjab. *Journal of Animal Research*, 7(6): 1051-1059.
- Kaza, S.; L. Yao; P. Bhada-Tata and F. Van Woerden. 2018. What a waste 2.0: a global snapshot of solid waste management to 2050. World Bank Publications.
- Khin Mar, O.O. 2005. Knowledge and adoption of improved dairy management practices by women dairy farmers in Dharwad district (Doctoral dissertation, University of Agricultural Science, Dharwad).
- Lokhande, J.P. 2009. A comprehensive study of scientific temperament among dairy farmers of Karnal district (Haryana) (Doctoral dissertation, NDRI, Karnal).
- Patel, B.S. 2005. A study of Peasantry Modernization in Integrated Tribal Development Project Area of Dahod district of Gujarat State. Ph.D. Thesis, Anand Agricultural University, Anand, India.
- Rathod, P. and M. Chander. 2016. Perception of dairy farmers towards attributes of dairy innovations in North India. *Indian Journal of Veterinary Sciences and Biotechnology*, 11(3): 29-33.
- Singh, A. 2019. Development of a Need-based and Effective Mobile App for Promoting Organic Waste Management among Dairy Farmers. M.V.Sc. Thesis. ICAR-Indian Veterinary Research Institute, Bareilly, India.
- Singh, A.; R. Tiwari; P. Joshi and T. Dutt. 2020. Insights into organic waste management practices followed by dairy farmers of Ludhiana District, Punjab: Policy challenges and solutions. *Waste Management & Research*, 38(3): 291-299.
- Singh, H.; J. Singh; H.K. Verma and S.K. Kansal. 2020. Milk quality and safety issues inside the farm gate of dairy farmers of Punjab (India). *Indian Journal of Dairy Science*, 73(6): 614-624.
- Singh, R. 2011. Human Resource Management, 1st Edition Excel Printers, New Delhi.
- Statistical abstract of Punjab. 2020. Various issues & livestock census, Department of Animal Husbandry, Dairying & Fisheries Ministry of Agriculture.
- Tak, A.M. 2010. Udder Health-Care Practices followed by Dairy Farmers: An Exploratory Study in N.D.R.I Adopted Villages. M. Sc. Thesis, N.D.R.I Deemed University, Karnal, India.
- Thakur, N.; P. Singh; B. Deshmukh and R. Kastrija. 2018. Relationship of demographic profile of dairy farmers with transitional diseases in Punjab. *International Journal of Current Microbiology and Applied Science*, 7(8): 3032-3037.



Research Article

Study of Knowledge and Adoption of FMD Vaccination Among Livestock Owners

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ABSTRACT

The Gross Value Added (GVA) of the livestock sector is about Rs. 11,14,249 crores at current prices during FY 2020-21 which is about 30.87 per cent of agricultural and Allied Sector GVA and 6.17 per cent of the Total GVA. At constant prices (2011-12), the GVA of the livestock sector is about Rs. 6,17,117 Cr (DAHD Annual Report, 2022-2023). India's livestock sector is one of the largest in the world. An estimated 20.5 million people are dependent on livestock for their livelihood. Livestock in India contributes to two-thirds of the livelihood of the rural communities. India ranks first in the world in total milk production with an estimated milk production of 187.7 million tons (2019-20). Among several diseases, FMD (Foot and mouth disease) is considered one of the most important diseases that cause direct and indirect losses. An ex-post facto research design was suitable to study and survey 160 dairy farmers regarding the objective. It explored demographics, farming practices, FMD control measures, susceptibility of crossbred livestock, knowledge levels, and the adoption of FMD vaccination. The research reveals that a majority of sampled dairy farmers, mainly middle-aged with primary school education, practice dairy farming as a secondary occupation. They maintain lower-medium-sized herds and fair shelter types, earning a lower-medium level of income. Crossbreds exhibit higher susceptibility to diseases than Nondescript breeds. Despite medium-level knowledge about FMD and FMD vaccination, 40 per cent of respondents have not employed measures to control the disease's spread. Overall, 61.88 per cent of respondents demonstrate a medium level of adoption of FMD vaccination. This research highlights the need for targeted interventions, emphasizing the vulnerabilities of crossbred livestock and the existing gaps in FMD control measures. Policymakers should focus on enhancing awareness and promoting FMD vaccination to fortify the livestock sector, sustaining its significant contribution to the national economy.

Keywords: Adoption, Farmer, FMD, Knowledge, Vaccination

INTRODUCTION

Foot-and-mouth disease (FMD) stands as one of the most persistent threats to the global livestock industry. With its highly contagious nature and potential for severe economic repercussions, FMD is a disease of significant concern for livestock owners, agricultural policymakers, and animal health experts. The successful management of FMD largely depends on preventative measures, with vaccination being a primary strategy.

This research article delves into the crucial domain of FMD vaccination, focusing on the knowledge and adoption levels among livestock owners. Understanding the factors influencing livestock owners' decisions regarding FMD vaccination is paramount for enhancing disease control and prevention strategies. Furthermore, as FMD often transcends national borders, it is essential to appreciate the global implications of FMD management.

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Foot-and-mouth disease is a highly contagious viral infection that affects cloven-hoofed animals, including cattle, swine, and sheep. The disease not only causes severe suffering in infected animals but also has dire economic consequences, including trade restrictions and production losses. As a result, FMD remains a key concern in both developed and developing nations. (FMDCP) stands for Foot-and-mouth Disease Control Programme is an intense vaccination program in India, it is carried out by implementing a series of measures ranging from clinical diagnosis of the disease under field conditions field, to diagnosing clinical samples in the laboratory and eventually Vaccinating the animals, Vaccines are used to cover all the susceptible livestock population. FMDCP started in phases in 2003–2004 and by 2017–2018; it has covered all the districts of India. The FMDCP is initiated with the intention to vaccinate all the susceptible livestock populations of the country, species such as White Cattle, Buffalo, and Small Ruminants like sheep, goats, and also pigs. That exercise was adopted to free the country of disease until 2025–2030. The directorate on FMD is functioning untiringly in this regard and the international center on FMD has been set up to serve the SAARC region-South Asian Association for Regional Cooperation. Vaccination is proven to be one of the potent tools in mitigating and controlling the spread of FMD. However, the efficacy of vaccination strategies heavily relies on the knowledge and willingness of livestock owners to participate. Understanding this group's awareness and adoption of FMD vaccination is pivotal to designing effective disease management programs.

MATERIALS AND METHODS

Keeping in view the objectives of the study, the type of variables, and the nature of the problem, an *ex-post facto* research design was used for the present investigation. The state of Tamil Nadu has been divided into seven major agro-climatic zones (Northeastern, Northwestern, Cauvery Delta zone, High rainfall zone, Hill zone, Western and South zone) by the Tamil Nadu Agricultural University and Environmental Information System. Out of the seven agro-climatic zones, north northeastern zone was selected purposively on the basis of the highest cattle population under the present study. It comprises six districts, namely Cuddalore, Villupuram, Tiruvallur, Tiruvannamalai, Kanchipuram, and Vellore.

Out of the selected agro-climatic zone, further two districts namely Villupuram (812035) and Tiruvannamalai (676639) were selected purposively on the basis of the highest cattle population (19th livestock census, GOI, 2012). Multistage random sampling was done to select the dairy farmers. One block was selected randomly from both the plain and hill regions separately from Villupuram district. Likewise, one block was selected randomly from both plain and hill regions separately from Tiruvannamalai district, thus making a total of 4 blocks from 2 districts. From each selected block, randomly 2 villages were selected. From each selected village, 20 dairy farmers were selected, thus making a total sample size of 160.

H_0 : There is no statistically significant correlation between the knowledge levels of dairy farmers regarding FMD and FMD vaccination, and no significant correlation exists between knowledge levels and the adoption of FMD vaccination, suggesting observed associations result from random variation.

H_1 : There is a statistically significant correlation between the knowledge levels of dairy farmers regarding FMD and FMD vaccination. And, there is a significant correlation between the extent of knowledge and the adoption level of FMD vaccination among dairy farmers, suggesting observed associations are not due to random variation but indicate meaningful relationships.

RESULT AND DISCUSSION

It is indicated in Table 1 that the average age of plain and hill region farmers was 44.90 and 44.43 years respectively followed by the old age group (16.30%) and the young age group (11.30%). Independent sample t-test analysis shows that a significant difference was not observed between the ages of plain and hilly region dairy farmers. These findings were contrary to the findings of Singh (2004) who reported that the majority (76.25%) of respondents represented the middle age group followed by the old age group (17.08%).

Majority of the respondents had education up to primary school (23.13%) followed by middle school (21.88%), high school (13.75%), higher secondary (1.88%), and graduate (3.13%). There were only 3.13 per cent of respondents who were graduates and above. significant difference was not observed between

Table 1: Based on Age distribution of the respondents

Age (years)	Hilly farmers (n=80)	Plain Farmers (n=80)	Pooled (N=160)
Young (26-35)	11 (13.75)	7 (8.75)	18 (11.30)
Middle (36-53)	55 (68.75)	61 (76.25)	116 (72.50)
Old (54-65)	14 (17.50)	12 (15.00)	26 (16.30)
Mean $\pm$ SE	44.43 $\pm$ 0.97	44.90 $\pm$ 0.88	44.66 $\pm$ 0.65
t-test value = -0.364 ^{NS}			

Figures in parenthesis indicate percentage; NS: Non-significant; SE: Standard Error

Table 2: Based on the Education distribution of respondent

Education	Hilly farmers (n=80)	Plain farmers (n=80)	Pooled (N=160)
Illiterate	12 (15.00)	7 (8.75)	19 (11.88)
Can read-only	1 (1.25)	1 (1.25)	2 (1.25)
Can read and write	25 (31.25)	12 (15.00)	37 (23.13)
Primary	21 (26.25)	16 (20.00)	37 (23.13)
Middle School	14 (17.50)	21 (26.25)	35 (21.88)
High School	5 (6.25)	17 (21.25)	22 (13.75)
Higher Secondary	0 (0.00)	3 (3.75)	3 (1.88)
Graduate and above	2 (2.50)	3 (3.75)	5 (3.13)
Mann-Whitney U Test = 2123 ^{NS}			

Figures in parenthesis indicate percentage; NS: Non-significant

hill and plain farmers with regard to education. The results are in concurrence with Akila and Chander (2009) (Table 2).

It is revealed from Table 3 that the majority of the sample had nuclear in both hill and plain regions, as is the trend in the present rural social dynamics all over the country. Overall, 58.75 per cent of respondents had nuclear and 41.25 per cent of respondents had joint family. The results are in accordance with those of Sathisha (2017) who reported that the majority (67.40%) of respondents belonged to a nuclear family, followed by a joint family (32.60%).

Herd size maintained by the respondents was categorized into five categories viz. small herd (1.5-2.92 cattle equivalent), lower medium (2.93-4.34 cattle equivalent), medium (4.35-5.76 cattle equivalent), upper

medium (5.77-7.18 cattle equivalent) and large (7.19-8.60 cattle equivalent). The majority (30.63%) of the overall respondents had lower medium herd size, and so were hilly (30.00%) and plain (31.25%) regions, followed by herd sizes of small (27.50%), medium (26.25%), upper medium (11.25%) and large (4.38%). significant difference was not observed between hill and plain regional farmers regarding herd size. Similar results were found by Meena *et al.* (2017) in their study area.

Table 5 revealed that the majority (68.13%) of the respondents expressed that cattle were affected most commonly by the FMD followed by small ruminants (29.37%) and buffalo (2.50%). Among hilly farmers, the majority (71.25%) expressed that cattle were affected commonly, it was followed by small ruminants

Table 3: Distribution of respondents based on family type

Family type	Hilly farmers (n=80)	Plain Farmers (n=80)	Pooled (N=160)
Nuclear	50 (62.50)	44 (55.00)	94 (58.75)
Joint	30 (37.50)	36 (45.00)	66 (41.25)

Figures in parenthesis indicate the percentage

Table 4: Based on Herd size distribution of respondents

Herd size (cattle equivalent)	Hilly farmers (n=80)	Plain Farmers (n=80)	Pooled (N=160)
Small (1.5-2.92)	20 (25.00)	24 (30.00)	44 (27.50)
Lower medium (2.93-4.34)	24 (30.00)	25 (31.25)	49 (30.63)
Medium (4.35-5.76)	23 (28.75)	19 (23.75)	42 (26.25)
Upper medium (5.77-7.18)	11 (13.75)	7 (8.75)	18 (11.25)
Large (7.19-8.60)	2 (2.50)	5 (6.25)	7 (4.38)
Mean $\pm$ SE	4.161 $\pm$ 0.17	4.023 $\pm$ 0.19	4.10 $\pm$ 0.13

t-test value = 0.529^{NS}

Figures in parenthesis indicate percentage; NS: Non-significant; SE: Standard Error

Table 5: Species of animals affected by FMD

Species	Hilly farmers (n=80)	Plain Farmers (n=80)	Pooled (N=160)
Cattle	57 (71.25)	52 (65.00)	109 (68.13)
Buffalo	3 (3.75)	1 (1.25)	4 (2.50)
Small ruminants	20 (25.00)	27 (33.75)	47 (29.37)

Figures in parenthesis indicate the percentage

(25.00%) and buffalo (3.75%). Among plain region farmers, 65.00% reported that cattle were affected commonly followed by small ruminants (33.75%) and buffalo (1.25%).

Table 6 reveals that the majority (59.38%) of overall respondents had a medium (7-10) level of knowledge about FMD and FMD vaccination followed by high (20.62%) and low (20.00%). The majority (60.00%) of respondents in the hill and (58.75%) of respondents in the plain region had a medium level of knowledge and 25.00 per cent of respondents in the plain region

had a high level of knowledge whereas only 16.25 per cent of respondents in hill region had a high level of knowledge about FMD and FMD vaccination. The mean knowledge score for overall respondents was 8.59 and so was in the hill (8.33) and in the plain (8.86) region. A significant difference was not observed in the knowledge level of FMD and FMD vaccination between hill and plain regional farmers. The results are in concurrence with Kakoty and Sharma (1998) who reported that the majority of farmers had medium to high-level knowledge of disease control practices and it was further supported by Singh (2004) who stated

Table 6: Respondents distribution based on the level of knowledge regarding FMD and FMD vaccination

Knowledge level (Scores)	Hilly Farmers (n=80)	Plain Farmers (n=80)	Pooled (N=160)
Low (3-6)	19 (23.75)	13 (16.25)	32 (20.00)
Medium (7-10)	48 (60.00)	47 (58.75)	95 (59.38)
High (11-14)	13 (16.25)	20 (25.00)	33 (20.62)
Mean $\pm$ SE	8.33 $\pm$ 0.25	8.86 $\pm$ 0.27	8.59 $\pm$ 0.19

t-test = -1.451^{NS}

Figures in parenthesis indicate percentage; NS: Non-significant; SE: Standard Error

Table 7: Adoption Index of FMD Vaccination

Parameter	Hilly region (n=80)	Plain region (n=80)	Pooled (N=160)
Total adoption score	794	836	1630
Adoption Index	0.50	0.52	0.51
Percent adoption	50.25	52.25	51.37

that 98.33 per cent of farmers had knowledge about vaccination against FMD and 33.33% farmers had knowledge about vaccination schedule for FMD.

Table 7 shows the total adoption score, adoption index, and percent adoption level of FMD vaccination. The total adoption score for the pooled sample was 1630 and so was in the hill (794) and in the plain (836) region. The adoption index for the pooled sample was 0.51 and so was in the hill, it was 0.50, and in the plain region, it was 0.52.

CONCLUSION

The Indian livestock sector is an epitome being one of the largest in the world, contributing significantly to the nation's agricultural and overall GDP. With over 512 million livestock heads, this sector is not only a pillar of economic strength it also stands as a source of livelihood for a substantial portion of the rural population. Among the various challenges faced by the livestock industry like FMD remains a prominent concern, because of the substantial direct and indirect losses it causes. This ex-post facto research study, conducted with 160 respondents, provides valuable insights into the knowledge and adoption levels regarding FMD vaccination among dairy farmers in India. The demographic profile of the respondents indicates that the majority are middle-aged, educated up to the primary school level, primarily engaged in agriculture, and involved in dairy farming as a secondary occupation. They typically maintain medium-sized herds and basic shelter facilities, possess moderate experience in dairy farming, and earn incomes at the lower-medium level, with dairy income contributing significantly. The findings reveal that FMD is indeed a contagious and infectious disease, highlighting its potential for rapid spread within the livestock population. Unfortunately, a considerable portion of the respondents (40.00%) reported not employing any preventive measures to control the spread of the disease, underscoring the need for enhanced awareness and intervention. The study also identifies that crossbred livestock are more susceptible to FMD compared to indigenous Deshi breeds, emphasizing the importance of breed selection and management strategies to mitigate disease risks. Crucially, the research reveals that there is room for a lot of improvement, The research respondent majority exhibit a moderate level of FMD

and FMD vaccination knowledge. light Furthermore, a significant proportion (61.88%) display a moderate level of adoption of FMD vaccination, indicating that there is some awareness and acceptance of vaccination as a disease management strategy among dairy farmers. With the research findings, it is clear that there is an opportunity to enhance awareness and education regarding FMD prevention and control, particularly among livestock owners who have not yet adopted vaccination measures. Moreover, the study underscores the importance of targeted efforts to promote vaccination and improve the overall health and resilience of India's livestock sector. This research contributes valuable insights into the state of FMD knowledge and vaccination adoption with regard to India's livestock industry, it has the potential to inform future policy and outreach initiatives aimed at reducing the burden of FMD and its associated economic and livelihood impacts.

REFERENCES

- 20th livestock census, DAHD GOI, 2019-2020.
- Akila, N. and M. Chander. 2009. Utilization pattern of draught bullocks by different categories of farmers in Tamil Nadu. *Indian Journal of Animal Science*, 79: 1061-1065.
- DAHD Annual Report 2022-23 https://dahd.nic.in/document/annual_report retrieved 6.10.2023
- Kakoty, H.N. and P.N. Sharma. 1998. A study on the knowledge concerning improved dairy farming practices. *Dairy Guide*, 10: 55-56.
- Meena, N.C.; S.K. Badodiya and P.B. Kamni. 2017. Extent of adoption of improved animal husbandry practices by dairy farmers of Morar block of Gwalior district. *Asian Journal of Agricultural Extension*, 16(4): 1-8.
- Sandhiya, M. 2020. Study of knowledge and adoption of FMD vaccination among the livestock owners: A case of North-eastern zone of Tamil Nadu. *M.V.Sc. Thesis*, Indian Veterinary & Research Institute, Uttar Pradesh.
- Sathisha M.C. 2017. Knowledge and adoption of good dairy farming practices by commercial dairy farmers of Karnataka. *M.V.Sc. Thesis*, Indian Veterinary & Research Institute, Uttar Pradesh.
- Singh, R.R. 2004. Status of vaccination against Foot and Mouth Disease (FMD) : An exploratory study in Bareilly district of Uttar Pradesh. *M.V.Sc. Thesis*, Indian Veterinary & Research Institute, Uttar Pradesh.



Research Article

Attitude of Working and Non-working Women Towards Time Saving Devices: A Study of Ludhiana City

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ABSTRACT

Time is an intangible force that influences people's interaction patterns, and it is the only resource that is evenly distributed to all. According to estimates, women spend three times as much time as men do performing unpaid tasks like housework and child care. Women's workforce participation rates have increased dramatically in recent years, this is especially true among married women. Lack of access to time-saving technologies as well as insufficient physical infrastructure for home energy, water, and sanitization contribute to women's unpaid workload. This scenario prevents or severely restricts many women's opportunities to engage in revenue activities. In recent decades, a number of contemporary household appliances have been released and extensively embraced, along with improvements to previously produced technologies. The present study was, therefore, undertaken to study the difference in the attitude of working and non-working women towards time saving devices. The study was conducted in Ludhiana city of Punjab state with 80 working and 80 non-working women selected randomly from four zones of Ludhiana. The results revealed that more working women found time saving devices favorable as compared to non-working women.

Keywords: Household appliances, Household chores, Labor saving devices, Time saving devices, Time management

INTRODUCTION

Time is an intangible force that influences people's interaction patterns, and it is the only resource that is evenly distributed to all. "Time use" is the process of humans selecting activities to indulge in, and these activities are arranged into patterns that are special to each individual (Erlandsson and Eklund, 2006). "Time use patterns" can be defined as patterns of task output in terms of frequency, length, and order of everyday tasks. Occupational therapists have long been concerned about these trends, which have been found to help in disease prevention and health promotion (Christiansen and Baum, 2005).

There is evidence that women work much more hours than males do worldwide (Anonymous, 2016).

According to estimates, women spend three times as much time as men do performing unpaid tasks like housework and child care. Women's workforce participation rates have increased dramatically in recent years, this is especially true among married women. In 1950, just around 25 per cent of married women worked; by 2000, about 60 per cent of married women were working. Women did not mention household chores as uplifting instead work experiences were reported as uplifting despite having the stress of managing a variety of roles (Erlandsson and Eklund, 2003). Working women were found to have better well-being than homemakers, which may be due to social interaction, social support, and financial independence (Oakley, 2005). There was no significant difference in the amount of time spent on household

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tasks by working and non-working women. Working women, on the other hand, sacrificed their leisure time, child care time, and personal time to get things done (Muthusamy, 2006). Lack of access to time-saving technologies as well as insufficient physical infrastructure for home energy, water, and sanitization contribute to women's unpaid workload. This scenario prevents or severely restricts many women's opportunities to engage in revenue activities. Due to "time poverty" and the physical demands of much unpaid work as well as the abundance of low-skilled paid employment opportunities available to women in resource-poor settings, women's participation in political, educational, social, leisure, and well-being activities is restricted. This maintains economic poverty, gender inequality and a protracted drudgery (Chopra and Zambelli, 2017). The UN's call for action includes investments on infrastructure and time-saving technologies, particularly in the areas of water and sanitation and renewable energy and safe roads. Clean energy is a global concern because 40 per cent of the world's population still cooks with polluting fires and uses environmentally harmful fuels like charcoal, kerosene and wood for other household needs (Bonjour *et al.*, 2013). Most of the weight of this antiquated energy system falls on women. The cost of poor health is now extensively acknowledged and well-documented.

In recent decades, a number of contemporary household appliances have been released and extensively embraced, along with improvements to previously produced technologies. Greenwood, Seshadri, and Yorukoglu (2005) [hence referred to as GSY] claim that the popularity of home appliances such as washers, coolers, and other such goods had a crucial part in freeing women from housework and encouraging them to enter the workforce. According to GSY, the rise in the rate of mechanical progress in the home durable goods industry prompted the use of time-saving technology. Two of the most crucial inputs in the production of household goods and services are time and energy. As time-saving technologies are introduced, households may modify their activity patterns and reallocate their time between competing tasks. The market adoption of time-saving technology for typical household use is therefore predicted to have a double impact on domestic energy use. Secondly, since many time-saving technologies use more energy than those

that demand longer time commitments, increased use of these technologies for routine home tasks (such as cleaning and cooking) may have a direct impact on energy use. Second, more effective time-saving technology encourages family members to engage in the activity more frequently (for instance, since cooking takes less time, more meals can be prepared at home) or to spend more time engaging in other household chores or leisure activities (reading, exercising and watching TV), which may or may not be energy-draining. The present study was, therefore, undertaken to study the difference in the attitude of working and non-working women towards time saving devices.

MATERIALS AND METHODS

The present study was conducted in Ludhiana city of Punjab state. The target population was a set of working and non-working women from Ludhiana city. Four zones i.e., Zone A, B, C and D of Ludhiana city and two localities out of each of the four zones i.e. Zone A- *Gandhi Nagar* and *Mata Rani Chowk*; Zone B- *Partap Colony* and *Bhagat Singh colony*; Zone C- *Janta Nagar* and *Pritam Nagar*; Zone D- *Sarabha Nagar* and *Model Town Extension* were selected for the study. Random sampling technique was used for the current study. Eighty working women who were working for 6-8 hours and eighty non-working women were randomly selected the four zones with 10 working and 10 non-working women from each locality. Thus, a total of 160 respondents were selected for the study. A self-developed interview schedule containing statements regarding the attitude towards time saving devices was prepared for the collection of data. The approach of direct personal interview was utilized to collect the data, both working and non-working women were primarily reached at their homes.

For measuring the attitude of working and non-working women, an attitude scale with 15 statements was developed. Among the scales available, the Likert scale of summated rating (1932) by Rensis Likert was used. The attitude measurement was done by using *3 points Likert Scale* (strongly agree, somewhat agree and strongly disagree) on 15 statements with scores of 3, 2 and 1 respectively for positive statements and 1, 2 and 3 respectively for negative statements. The total attitude score for each respondent was obtained by adding the weights of her responses made to the individual item.

The scale was administered to all working and non-working women, who were asked to express their reaction in terms of their agreement or disagreement with each item by selecting any one of three response categories. The total score of each respondents on the attitude test was calculated out of the maximum score of 45. Based on the scores gained by the respondents, the attitude level was categorized into favourable attitude and unfavourable attitude using category interval method:

$$\text{Level of Attitude} = (\text{Maximum score} - \text{Minimum score}) / (\text{Number of categories to be formed})$$

Level of Attitude	Score Range
Favourable	1-22.5
Unfavourable	22.6-45

RESULTS AND DISCUSSION

The attitude of respondents towards time-saving devices refers to their opinions, beliefs, and perceptions about the use of technology and devices that can help save time. It involves understanding how respondents view the use of such devices and whether they perceive them as helpful or not. Attitudes can be positive or negative, and they can impact a respondent's behavior and decision-making. The distribution of working and non-working women according to their attitude towards time saving devices is given in Table 1. The findings inferred that majority (88.75%) of working women agreed to the statement ($\bar{x} = 2.88$) that household devices/appliances saves time, while just over half of the non-working women (52.5%) somewhat agreed to this statement ($\bar{x} = 2.40$). Four-fifths (80.00%) of working women ($\bar{x} = 2.03$) and over two-fifths (41.25%) of non-working women ($\bar{x} = 2.04$) somewhat agreed that their possession and utilization of time-saving devices is influenced by friend circle. Most of working women (73.75%) agreed ($\bar{x} = 2.68$) that they are curious to learn more about current trends in time-saving technologies and are always eager to try out new gadgets and devices, whereas, slightly more than half (53.75%) of non-working women somewhat agreed to this statement ($\bar{x} = 1.86$). Half of working women fully agreed to the statement that they have more time for their hobbies and official works since they started using time-saving devices ($\bar{x} = 2.43$),

whereas, more than half (56.25%) of non-working women fully agreed that they have more time for their hobbies after using time-saving devices ($\bar{x} = 2.31$). Just over three-fifths (61.25%) of working women disagreed to the statement that time-saving devices are costly ($\bar{x} = 2.38$), while more than two-fifths (47.50%) of non-working women also disagreed to this statement ($\bar{x} = 2.20$). Most of working women (60.00%) fully agreed that they always share the performance of the time-saving devices they possessed with their friends and family ($\bar{x} = 2.49$), whereas, over three-fifths (62.50%) of non-working women disagreed to this assertion ($\bar{x} = 1.51$). Most of working women (71.25%) disagreed to the statement that they do not want to upgrade their time saving devices whenever new products and models are released ($\bar{x} = 2.63$), while the opinions of non-working women towards this statement were split (28.75% each) between fully agree and disagree ($\bar{x} = 2.00$). Approximately three-quarters (76.25%) of working women believed that every household must possess time-saving devices ($\bar{x} = 2.74$), whereas, equal halves (36.25% each) of non-working women somewhat agreed and disagreed to this statement ($\bar{x} = 1.91$). Two-thirds (65.00%) of working women somewhat agreed to the statement that time-saving devices consume too much electricity ($\bar{x} = 2.28$), whereas, more than half (56.25%) of non-working women also somewhat agreed to this statement ($\bar{x} = 1.96$). Less than three-quarters (73.75%) of working women disagreed to the statement that time-saving devices are not a good investment ($\bar{x} = 2.66$), however, more than a half (53.75%) of non-working women somewhat agreed that time-saving devices are not a good investment ($\bar{x} = 2.29$). Most of working women (72.50%) disagreed to the statement that time-saving devices are not innovative ($\bar{x} = 2.63$), whereas, slightly more than two-fifths (41.25%) of non-working women somewhat agreed that time-saving devices are not innovative ($\bar{x} = 2.16$). More than a half (51.25%) of working women ($\bar{x} = 2.41$) and more than one third (38.75%) of non-working women ($\bar{x} = 1.94$) somewhat agreed to the statement that they are not satisfied with the performance of the time-saving devices they own. It is observed that there was no significant difference between the attitudes of the two groups with respect to this statement. A significant proportion (86.25%) of working women fully agreed to the statement that

Table 1: Attitude of respondents towards time saving devices (n=160)

Statements	Working women (n _w =80)				Non-working women (n _{nw} =80)				t test
	Fully Agree	Somewhat Agree	Disagree	Mean Score	Fully Agree	Somewhat Agree	Disagree	Mean Score	
I believe household devices/appliances really save time.	71(88.75)	8(10.00)	1(1.25)	2.88	35(43.75)	42(52.5)	3(3.75)	2.40	6.06*
My possession and utilization of time-saving devices is influenced by friend circle	9(11.25)	64(80.00)	7(8.75)	2.03	25(31.25)	33(41.25)	22(27.5)	2.04	1.01**
I'm curious to learn more about current trends in time-saving technologies and always eager to try out new gadgets and devices.	59(73.75)	16(20.00)	5(6.25)	2.68	13(16.25)	43(53.75)	24(30.00)	1.86	13.25*
I have more time for my hobbies/official works since I have started using time-saving devices.	40(50.00)	34(42.5)	6(7.5)	2.43	45(56.25)	15(18.75)	20(25.00)	2.31	6.89*
Time-saving devices are costly.	19(23.75)	12(15.00)	49(61.25)	2.38	22(27.5)	20(25.00)	38(47.5)	2.20	1.74**
I always share the performance of the time-saving devices with my friends and family.	48(60.00)	23(28.75)	9(11.25)	2.49	11(13.75)	19(23.75)	50(62.5)	1.51	9.27*
I do not want to upgrade my devices whenever new products and models are released.	7(8.75)	16(20.00)	57(71.25)	2.63	23(28.75)	34(42.5)	23(28.75)	2.00	4.23*
Every household must possess time-saving devices.	61(76.25)	17(21.25)	2(2.5)	2.74	22(27.5)	29(36.25)	29(36.25)	1.91	8.25*
Time-saving devices consume too much electricity.	3(3.75)	52(65.00)	25(31.25)	2.28	19(23.75)	45(56.25)	16(20.00)	1.96	7.78*
Time-saving devices are not a good investment.	6(7.5)	15(18.75)	59(73.75)	2.66	7(8.75)	43(53.75)	30(37.5)	2.29	7.94*
Time-saving devices are not innovative.	8(10.00)	14(17.5)	58(72.5)	2.63	17(21.25)	33(41.25)	30(37.5)	2.16	2.68*
I'm not satisfied with the performance of the time-saving devices I own.	3(3.75)	41(51.25)	36(45.00)	2.41	27(33.75)	31(38.75)	22(27.5)	1.94	0.62
I'm able to do a large number of chores in a short amount of time by utilizing time-saving devices.	69(86.25)	10(12.5)	1(1.25)	2.85	29(36.25)	32(40.00)	19(23.75)	2.13	13.18*
I don't like time-saving devices because they are complicated for me to use.	7(8.75)	31(38.75)	42(52.5)	2.44	38(47.5)	33(41.25)	9(11.25)	1.64	10.92*
Because of time-saving devices, I'm able to perform chores without much help from family members or a helper.	66(82.5)	13(16.25)	1(1.25)	2.81	18(22.5)	53(66.25)	9(11.25)	2.11	15.18*

(Figures in parentheses indicates percentages)

*Significant at 1% level; ** Significant at 5% level; Mean score range (1-3)

Table 2: Attitude level of respondents towards time saving devices

Level of Attitude	Working Women (n=80)	Non-Working Women (n=80)	z test
Favorable (1-22.5)	59(73.75)	41(51.25)	2.94*
Unfavorable (22.6-45)	21(26.25)	39(48.75)	2.94*

(Figures in parentheses indicates percentages); *Significant at 1% level

they were able to perform a large number of chores in a short amount of time by utilizing time-saving devices ($\bar{x} = 2.85$), whereas, only two fifths (40.00%) of non-working women somewhat agreed to this statement ($\bar{x} = 2.13$). More than a half (52.50%) of working women disagreed to the statement that they do not like to use time-saving devices because they are complicated for them to operate ($\bar{x} = 2.44$), meanwhile, more than two-fifths (47.50%) of non-working women found time saving devices complicated to use ($\bar{x} = 1.64$). Majority (82.50%) of working women full agreed that because of time-saving devices, they are able to perform chores without much help from family members or helpers ($\bar{x} = 2.81$), however, more than two-thirds (66.25%) of non-working women somewhat agreed to this statement ($\bar{x} = 2.11$).

The attitude that respondents had regarding time-saving technologies is depicted in Table 2 and Figure 1. It can be discerned from these findings that time-saving technologies are viewed favorably by most (73.75%) of working women, whereas, half (51.25%) of non-working women also had favorable attitude towards time saving devices. This difference in attitude may be because working women often have more responsibilities both at work and at home, which can lead to time constraints and a higher demand for efficiency. Time-saving technology, such as automation

and productivity tools, can help alleviate some of these demands and provide more free time, leading to a more favorable attitude towards it. Non-working women may not feel the same urgency to save time, leading to a lesser preference for such technology, moreover, non-working women may believe that some time-saving gadgets, like dishwashers, really require more time than hand washing because all the utensils must be pre-rinsed before loading the dishwasher, and the loading-unloading process itself may be considered tedious or a burden by some.

Studies and researches have consistently shown that working women have a more favorable attitude towards household technologies than non-working women. One of the key reasons behind this trend is the need for time and energy management. Working women often have a lot of responsibilities and obligations, both at work and at home, which can lead to stress and burnout. Household technologies such as dishwashers, washing machines, and vacuum cleaners can help reduce the time and energy spent on household chores, giving working women more time to focus on other important tasks. A study by Nakamura and Okada (2017) also revealed that working women had a more favorable attitude towards household technologies because of the time and energy savings they offer. The authors also noted that working women were more likely to adopt household technologies that were technologically advanced and automated. Another study by Phillips and McVeigh (2005) also found that working women were more likely to embrace household technologies, such as dishwashers, compared to non-working women. The authors noted that working women valued the convenience and efficiency offered by such technologies, and were more willing to invest in them.

CONCLUSION

In conclusion, the majority of working women had a favorable attitude towards household technologies because they help manage their time and energy more

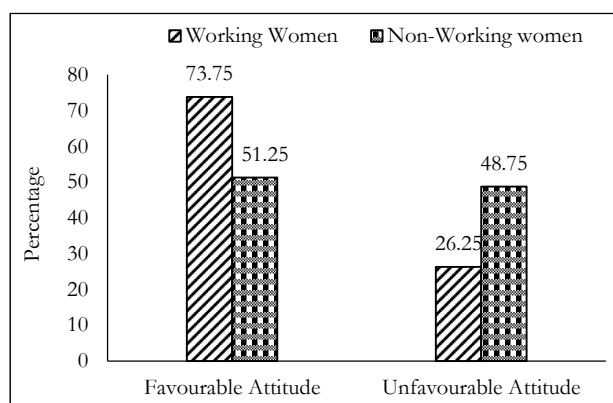


Figure 1: Attitude level of respondents towards time saving devices

effectively, and provide convenience and efficiency. These findings are consistent across a range of studies and research conducted in the field.

REFERENCES

- Anonymous. 2016. Progress of the World's Women: Transforming Economies, Realizing Rights. Retrieved from United Nations Entity for Gender Equality and the Empowerment of Women. <http://progress.unwomen.org/2015/pdf/UNWprogressreport.pdf>.
- Bonjour, S.; R.H. Adair; J. Wolf; N.G. Bruce; S. Mehta; A. Prüss-Ustün and K.R. Smith. 2013. Solid fuel use for household cooking: country and regional estimates for 1980–2010. *Environmental Health Perspectives*, 121(7): 784–90.
- Chopra, D. and E. Zambelli. 2017. No time to rest: Women's lived experiences of balancing paid work and unpaid care work. *Gender Work Organization*, 24(1): 1–16.
- Christiansen, C. and C.M. Baum. 2005. The complexity of human occupation. In: Christiansen C and Baum C M (ed) *Occupational Therapy: Performance, Participation, and Well-Being*. pp. 2–22. Bethesda, MD: American Occupational Therapy Association. Thorofare, New Jersey, USA.
- Erlandsson, L.K. and M. Eklund. 2003. Women's experiences of hassles and uplifts in their everyday patterns of occupations. *Occupational Therapy International*, 10: 95–114.
- Erlandsson, L.K. and M. Eklund. 2006. Levels of complexity in patterns of daily occupations: Relationship to women's well-being. *Journal of Occupational Science*, 13: 27–36.
- Greenwood, J.; Seshadri and M. Yorukoglu. 2005. Engines of Liberation. *Review of Economic Studies*, 72(1): 109–33.
- Muthusamy, S. 2006. Are working mothers in India investing less time in the next generation? Paper presented at: The Population Association of America (PAA) Annual Meeting held at Westin Bonaventure Hotel, Los Angeles, California, USA from 30th March – 1st April, 2006. <https://paa2006.princeton.edu/papers/60451>
- Nakamura, M. and A. Okada. 2017. Working women have a more favourable attitude towards household technologies. *Journal of Consumer Marketing*, 34(6): 516–524.
- Oakley, A. 2005. *The Ann Oakley Reader: Gender, Women and Social Science*. pp. 60–64. Policy Press, Bristol University, England.
- Phillips, K.E. and J.J. McVeigh. 2005. Working women and household technology: Adoption and attitudes. *Journal of Consumer Marketing*, 22(4): 181–88.

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Research Article

Work Related Stress Analysis for Bank Employees

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ABSTRACT

The present study was undertaken to study the causes and symptoms of work-related stress among bank employees in Ludhiana city of Punjab state, India during February-March, 2023. Snowball technique was used for selecting nationalized banks. Bank employees, of the rank of Probationary officer and above, from all the selected banks were contacted for data collection. A questionnaire was prepared on Google form and was circulated and a total of 280 responses were received. Results revealed that all the respondents shared cordial relationship with their co-workers but were suffering from some level of work related stress. More than 90 per cent of the respondents considered extra working hours and frequent system error as major stress causing factors and 76.78 per cent respondents agreed that there is blaming culture in their bank. Majority of the respondents “sometimes” encountered various stress causing incidents like conflict with customers/clients, conflict with colleagues, conflict with higher officials/management, confusion at work, personal life problems bothering at work, feeling isolated at workplace, fear of loss of job, work issues bothering at home. Headache, fatigue, poor concentration, digestive disorder and low blood pressure were some of the symptoms which were “often” experienced by most of the respondents due to work related stress.

Keywords: Bank workers, Job dissatisfaction, Workplace problems, Work stress

INTRODUCTION

Banking is one of the vital pillars of Indian economy. It caters to the financial needs of all the sections of the country (Yadav, 2017). The technological growth has revolutionized the way banking sector works. High salaries and social status associated with the banking sector has attracted people to take up these jobs, but many suffer on account of various factors like late working hours, job-related pressures, physical discomfort while meeting deadlines and mental tension. Banking is one of the most stressful jobs because it plays a vital role in ensuring public security (Reb *et al.*, 2019). Work overload, unattractive working environment, poor relations with coworkers, fear of dismissal, unrealistic targets, and emotional intelligence have all been demonstrated to be stressful factors for bank employees (Verma, 2022). Stress Management is

getting more and more consideration now-a-days, particularly in the financial sectors. There is no such thing like stress-free job (Dhankar, 2015). Shukla and Garg (2013) in a study revealed that the employees feel pressure due to overload of work, target achievements, etc. Most of the time is spent by the employees in their organization leaving less time to take care of their personal and family needs (Dev and Raj, 2017). Bank employees cannot afford the time to relax and they are faced with work variety, discrimination, favoritism, delegation, and conflicting tasks (Kumar and Sundaram, 2014). Job stress refers to an individual's response to the characteristics of the work environment, which appears to be threatening and is caused by the individual's perceptions of the imbalance between work demands and their abilities to cope with those demands (Gupta and Agarwal, 2022). Work stress is considered as an important phenomenon affecting the

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organizational health and the health of its employee. Stress at the workplace becomes a threat to the health conditions of all workers which can affect their performance (Ramli, 2019). It affects the behavior of employees and have far reaching impact on the job satisfaction. Job related dissatisfaction may then lead to lesser motivation of employees. Higher level of stress with no managerial concern for solution consequently lowers the employee performance, staking organizational reputation and loss of skilled employees, these situations call for immediate concern from organization management for employing effective stress management practices to increase employee satisfaction and overall employee performance (Subha and Shakeel, 2009). Veen *et al.*, (2023) in a study also reported that adverse psychosocial working conditions are widely recognized to play an important role for workers' mental health, which in turn has consequences for individuals, organizations, and society as a whole. The level of stress faced by the employees in banking sector is growing rapidly. There is a need for interventions aimed at mitigating the occupational stress among employees of the banking sector (Malamardi *et al.*, 2015). The present study was therefore undertaken to study the causes and symptoms of work related stress among bank employees.

MATERIALS AND METHODS

The study was conducted in Ludhiana city of Punjab state, India during February-March, 2023. Snowball technique was used for selecting nationalized banks. Bank employees, of the rank of Probationary officer and above, from all the selected banks were contacted for data collection. Consent of the bank employees to participate in the study was taken and those employees who were willing to provide data for the study were selected as sample for the study. A questionnaire was structured and a Google form was prepared to collect the required data from the respondents, which was then circulated via WhatsApp and email to the respondents. A total of 280 responses were received.

A 3-point scale (Scoring: Never=1, Sometimes=2 and Often=3) was used to analyse the frequency of episodes of stress causing incidents as experienced by respondents. To study the symptoms of work related stress among respondents a 5-point scale (Scoring:

Never=1, Rarely=2, Sometimes=3, Often=4, Always=5) was used. Simple frequencies, percentages and mean scores were worked out for statistical analysis of data.

RESULTS AND DISCUSSION

Table 1 reveals the general information about the respondents. Majority of the respondents were in the age group of 30-35 years (44.64%) and were male (75%). About 62 per cent of the respondents had 5-10 years of experience and majority of the respondents were married (76.78%) and living in nuclear families (78.57%). On an average, majority of the respondents were working for 9.25 hours day⁻¹ and were travelling about 23 km daily to reach their respective workplaces.

All the respondents shared cordial relationship with their co-workers as evident from Figure 1 that 71.42 per cent respondents had good and 28.57 per cent respondents had very good relation with their co-workers.

Table 1: General information about respondents

Parameters	Number of respondents
Age (years)	
25-30	25 (8.92)
30-35	125 (44.64)
35-40	110 (39.28)
Above 40	20 (7.14)
Gender	
Female	70 (25)
Male	210 (75)
Experience (Years)	
0-5	25 (8.92)
5-10	175 (62.50)
10-15	65 (23.21)
More than 15	15 (5.35)
Marital status	
Married	215 (76.78)
Unmarried	55 (19.64)
Divorced	10 (3.57)
Family type	
Joint	60 (21.42)
Nuclear	220 (78.57)
Working hours per day	9.25±1.12 (mean value)
Distance to place of work	23.69±31.99 (mean value)

*Figures in parentheses indicate percentage

Figure 2 unveils that all the respondents were suffering from work related stress. Very high work stress was experienced by 55.35 per cent respondents, high stress by 33.92 per cent respondents and moderate stress by 10.71 per cent respondents. Kumar and Sundaram (2014) in a study reported similar findings that majority of the bank employees had high and very high stress levels.

Table 2 shows that majority (92.85%) of the respondents considered extra working hours and frequent system error as major stress causing factors. For 89.28% of the respondents, need to meet target / deadlines and inability to spend time with family were factors responsible for causing stress. Work overload and non-cooperation from fellow workers caused stress in 87.50% respondents. Frequent transfer was also reported by 83.92 per cent respondents as stress causing factor. Other reasons for work related stress as reported by respondents were lack of proper description of roles and task assignment (76.78%), complaints or problems not heard and responded by superiors (75%), anger due to things outside respondent's control at workplace (73.21%), lack of open communication among staff (73.21%), problem in getting leave approved (71.42%), lack of support

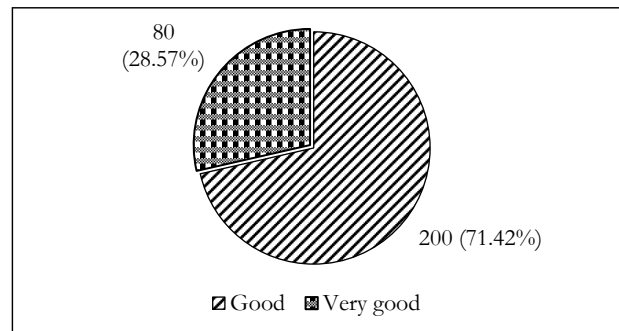


Figure 1: Respondents' relation with the co-workers

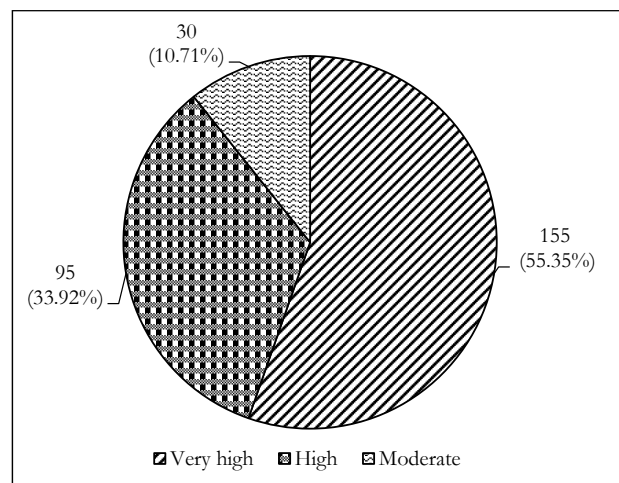


Figure 2: Level of work stress experienced by respondents

Table 2: Work related factors responsible for causing stress among respondents

Factors	Number of respondents
Extra working hours	260 (92.85)
Frequent system error	260 (92.85)
Pressure to meet target/deadlines	250 (89.28)
Inability to give time to family	250 (89.28)
Work overload	245 (87.50)
Non co-operation from fellow workers	245 (87.50)
Frequent transfers	235 (83.92)
Lack of proper description of roles and task assignments at workplace.	215 (76.78)
Complaints or problems not heard and responded on time by the superiors.	210 (75.00)
Anger because of things that are outside your control at workplace.	205 (73.21)
Lack of open communication among the staff.	205 (73.21)
Problem in getting leave approved.	200 (71.42)
Lack of support and understanding of family members about job and work timings	190 (67.85)
Yearly appraisal system	170 (60.71)
Inability to cope with all the things that need to be done at workplace.	165 (58.92)
Daily unmanageable count of customers at branch	145 (51.78)

*Figures in parentheses indicate percentage

and understanding of family members about job and work timings (67.85%), yearly appraisal system (60.71%), inability to cope with all the things that need to be done at workplace (58.92%) and unmanageable customers (51.78%). Tilottama (2014) also reported that long working hours, organizational culture, role conflict, and lack of management support, etc. are the main causes of stress felt by the bank employees.

Table 3 unveils that 76.78 per cent respondents agreed that there is blaming culture in their bank. More than 70 per cent respondents enjoyed working with their colleagues and refrained from taking promotions. More than 60 per cent of the respondents hesitated to discuss work issues with their seniors and were clear about their work profile. Thoughts of changing or quitting job were experienced by 58.92 per cent respondents and 53.57 per cent respondents found their job boring. Only 41.07 per cent respondents reported that they get required training from time to time and have enough authority to carry out the assigned responsibility. Job stress is a real phenomenon and it is associated with job satisfaction level of employees in any place (Sheopuri, 2019). Job satisfaction was reported by only 37.50 per cent respondents and only

32.14 per cent respondents got regular motivation from their seniors. Offices of 30.35 per cent respondents were well equipped, 28.57 per cent respondents got sufficient time to complete the assigned task and only 23.21 per cent respondent's office had sufficient staff. Very few, only 16.07 per cent respondents were of the view that their financial incentives are sufficient and only 10.71 per cent agreed that their non-financial incentives were sufficient.

Table 4 depicts that majority of the respondents sometimes encountered various stress causing incidents like conflict with customers/clients (mean score: 2.12), conflict with colleagues (mean score: 1.83), conflict with higher officials/management (mean score: 1.96), confusion at work (mean score: 1.96), personal life problems bothering at work (mean score 2.03), feeling isolated at workplace (mean score: 1.80), fear of loss of job (mean score: 1.80), work issues bothering at home (mean score: 2.25).

Stress and its effects is an important health issue among bank professionals. Effects of excessive stress prove to be harmful for an individual. It ultimately leads to compromised health and loss of productivity

Table 3: Respondents' opinion about their work in bank

Statements	Number of respondents who agreed with the statement
Is there a blaming culture in your organisation?	215 (76.78)
Do you enjoy working with your colleagues?	205 (73.21)
Do you refrain from taking promotion?	200 (71.42)
Do you hesitate to discuss your issues with your seniors?	185 (66.07)
Are you clear about your work profile?	170 (60.71)
Do you constantly think to change or quit your job?	165 (58.92)
Do you find your work boring?	150 (53.57)
Do you get required training from time to time?	115 (41.07)
Do you have enough authority to carry out the assigned responsibility?	115 (41.07)
Are you satisfied with your job?	105 (37.50)
Do you get regular motivation from your seniors?	90 (32.14)
Is your office well equipped?	85 (30.35)
Do you get sufficient time to complete the assigned task?	80 (28.57)
Does your office have sufficient staff?	65 (23.21)
Do you think that Financial Incentives are sufficient?	45 (16.07)
Do you think that Non -Financial Incentives are sufficient?	30 (10.71)

*Figures in parentheses indicate percentage

Table 4: Frequency of episodes of stress causing incidences

Statements	Often	Sometimes	Never	Mean score
How often do you face conflicts with customers/clients?	70 (25)	175 (62.50)	35 (12.50)	2.12
How often do you face conflicts with colleagues?	10 (3.57)	215 (76.78)	55 (19.64)	1.83
How often do you face conflicts with Management?	50 (17.85)	170 (60.71)	60 (21.42)	1.96
How often do you remain confused at the work?	55 (19.64)	160 (57.14)	65 (23.21)	1.96
How often do your personal life problems bother you at work?	60 (21.42)	170 (60.71)	50 (17.85)	2.03
How often do you feel isolated at the work?	85 (30.35)	165 (58.92)	30 (10.71)	1.80
How often do you feel the fear of loss of your job?	60 (21.42)	105 (37.50)	115 (41.07)	1.80
How often do the work related issues bother you at home?	100 (35.71)	150 (53.57)	30 (10.71)	2.25

*Figures in parentheses indicate percentage, **Scoring: Never=1, Sometimes=2, Often=3**

Table 5: Symptoms of work related stress among respondents

Symptoms	Always	Often	Sometimes	Rarely	Never	Mean score
Headache	10(3.57)	90 (32.14)	80 (28.57)	70 (25)	30 (10.71)	2.92
Insomnia	50 (17.85)	40 (14.28)	80 (28.57)	55 (19.64)	55 (19.64)	2.91
Frustration	85 (30.35)	65 (23.21)	100 (35.71)	25 (8.92)	5 (1.78)	3.71
Fatigue	70(25)	95 (33.92)	55 (19.64)	25 (8.92)	35 (12.50)	3.50
Negative thoughts	80 (28.57)	60 (21.42)	85 (30.35)	40 (14.28)	15 (5.35)	3.53
Anger	50 (17.85)	80 (28.57)	100 (35.71)	45 (16.07)	5 (1.78)	3.44
Restlessness	65 (23.21)	80 (28.57)	90 (32.14)	20 (7.14)	25 (8.92)	3.50
Mood swings	50 (17.85)	75 (26.78)	95 (33.92)	45 (16.07)	15 (5.35)	3.35
Overthinking	95 (33.92)	85 (30.35)	65 (23.21)	35 (12.50)	00	3.85
Poor Concentration	60 (21.42)	80 (28.57)	65 (23.21)	35 (12.50)	40 (14.28)	3.30
Digestive Disorder	50 (17.85)	95 (33.92)	50 (17.85)	40 (14.28)	45 (16.07)	3.23
Neck pain	60 (21.42)	60 (21.42)	85 (30.35)	35 (12.50)	40 (14.28)	3.23
Back pain	70 (25)	75 (26.78)	80 (28.57)	30 (10.71)	25 (8.92)	3.48
Shoulder pain	55 (19.64)	50 (17.85)	70 (25)	55 (19.64)	50 (17.85)	3.01
Depression	55 (19.64)	35 (12.50)	80 (28.57)	55 (19.64)	55 (19.64)	2.92
Nervousness	50 (17.85)	55 (19.64)	75 (26.78)	50 (17.85)	50 (17.85)	3.01
Loss of short term memory	30 (10.71)	60 (21.42)	70 (25)	60 (21.42)	60 (21.42)	2.78
Breathing problem	45 (16.07)	25 (8.92)	55 (19.64)	50 (17.85)	105 (37.50)	2.48
Loss of appetite	30 (10.71)	60 (21.42)	80 (28.57)	55 (19.64)	55 (19.64)	2.83
High Blood Pressure	25 (8.92)	50 (17.85)	70 (25)	15 (5.35)	120 (42.85)	2.44
Low blood pressure	5 (1.78)	95 (33.92)	50 (17.85)	65 (23.21)	65 (23.21)	2.67

*Figures in parentheses indicate percentage, **Scoring: Never=1, Rarely=2, Sometimes=3, Often=4, Always=5**

(Sheopuri, 2019). Table 5 gives an insight into the symptoms experienced by respondents due to work related stress among them. Headache, fatigue, poor concentration, digestive disorder and low blood pressure were some of the symptoms which were “often” experienced by most of the respondents. Insomnia, frustration, negative thoughts, anger,

restlessness, mood swings, neck pain, back pain, shoulder pain, depression, nervousness, loss of short term memory and loss of appetite were experienced by majority of respondents “sometimes”. Most of the respondents reported that they “always” overthink and “never” faced breathing problem and high blood pressure due to work related stress.

CONCLUSION

Bank employees were working in a highly stressful work environment due to the nature of their job, work culture in banks, non-cooperation from co-workers and superiors, lack of support from family members, etc. Employees should try to make a work-life balance and work culture in the banks needs to be improved. Efforts from senior officials should be made to make the work environment stress free by being supportive and encouraging to the employees.

REFERENCES

- Dev, S.S. and S.J.M. Raj. 2017. Work life balance of employees and its effect on work related factors in nationalized banks. *Shanlax International Journal of Management*, 4(4): 29-35.
- Dhankar, S. 2015. Occupational stress in banking sector. *International Journal of Applied Research*, 1(8): 132-135.
- Gupta, R. and M. Agarwal. 2022. Work demands and perceived job stress of bank employees: Implications for public and private sector banks during Covid19 Pandemic. *Humanities and Social Science Studies*, 11(1): 10-21.
- Kumar, S.G. and N.D. Sundaram. 2014. Prevalence of stress level among Bank employees in urban Puducherry, India. *Industrial Psychiatry Journal*, 23(1): 15-17.
- Malamardi, S.N.; R. Kamath; R. Tiwari; B.V.S. Nair; V. Chandrasekaran and S. Phadnis. 2015. Occupational Stress and health related quality of life among public sector bank employees: A cross-sectional study in Mysore, Karnataka, India. *Indian Journal of Occupational and Environmental Medicine*, 19(3): 134-37.
- Ramli, A.H. 2019. Manage of job stress and measure employee performance in Health Services. *Business and Entrepreneurial Review*, 18(1): 53-64.
- Reb, J.; S. Chaturvedi; J. Narayanan and R.S. Kudesia. 2019. Leader mindfulness and employee performance: a sequential mediation model of LMX quality, interpersonal justice, and employee stress. *Journal of Business Ethics*, 160(3): 745-763.
- Sheopuri, A. 2019. Occupational stress among public sector banks employees. *Indian Journal of Applied Research*, 9(6): 44-46.
- Shukla, H. and Garg, R. 2013. A study on stress management among the employees of nationalized banks. *Voice of Research*, 2(3): 72-75.
- Subha, I. and A. Shakil. 2009. Impact of stress on employee productivity, performance and turnover; an Important Managerial Issue. *International Review of Business*, 5: 468-477.
- Tilottama, A. 2014. Managing stress among Banking sector employees in Bhopal. *International Journal of Multidisciplinary Research in Social & Management Sciences*, 2(2): 44-48.
- Veen, M.V.; K.M.O. Hengel; R.M.C. Schelvis; P.M.C. Bongers; J.C.F. Ket; A.J. Beek and C.R.L. Boot. 2023. Psychosocial work factors affecting mental health of young workers: A systematic review. *International Archives of Occupational and Environmental Health*, 96: 57-75. <https://doi.org/10.1007/s00420-022-01907-y>
- Verma, 2022. An empirical study of factors affecting Occupational stress among Bank employees during COVID-19. <http://dx.doi.org/10.2139/ssrn.4072142>
- Yadav, R. 2017. A study on stress among employees in Banking Industry. *International Journal of Research in Humanities & Social Sciences*, 5(7): 8-13.

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Research Article

Biorational Management of Ginger Rhizome Rot in North-Western Himalaya

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ABSTRACT

Rhizome rot of ginger (*Zingiber officinale*), an economically important disease is a fungal complex comprising species of *Pythium* and *Fusarium*. To manage this disease bio-rationally, field experiment was carried out at the Research farm of the Regional Research Station (Punjab Agricultural University), Ballawal Saunkhri, Punjab for two consecutive years in 2022 and 2023. Hot water, bioagents (*Trichoderma harzianum* and *Pseudomonas fluorescens*), a chemical as a standard check were used to treat the seed rhizomes before sowing including an untreated control. Results of two years study revealed that T7 (rhizome treatment in hot water at 51°C for 10 min followed by treatment with *Trichoderma harzianum* @ 15 g/kg seed) was found most effective in both years to check rhizome rot as least disease incidence (40.0% & 50.0%) as compare to untreated control with highest germination (83.3% & 80.0%) and yield (20.3 t/ha & 18.6 t/ha) was recorded in this treatment. However, the chemical treatment T14 (Ridomil Gold (64% w/w mancozeb + 4% w/w metalaxyl-M) @ 2 g/l water) as a standard chemical check exhibited lowest disease incidence (20.0 %, & 43.3%), highest germination (98.3 % & 93.3 %) and yield (25.3 t/ha 21.1 t/ha).

Keywords: Biocontrol, *Pseudomonas* spp., *Trichoderma* spp., *Pythium* spp., *Zingiber officinale*

INTRODUCTION

Ginger (*Zingiber officinale*) of family Zingiberaceae is cultivated globally in organically rich and well-drained loamy soils under tropical areas. The knotty and fleshy rhizome of ginger with aromatic and pungent properties is well known as a popular spice and traditional medicine. India is a leading country with 40 per cent share in global ginger production, which is followed by Nigeria (13.84%), China (11.8%), and Indonesia (5.53%) in the year 2020-21 (FAO, 2021). The ginger is extensively cultivated in the Sirmour district of Himachal Pradesh adjoining sub-mountainous region (kandi) area of Punjab. One of the major problem in kandi region is crop damage by wild animals and kandi region of Punjab has 18.88 thousand ha area under agro-forestry plantation. Since ginger is a shade-loving crop and is not preferred by animals,

hence it can be successfully grown in an agroforestry system. Here, ginger cultivation can help in crop diversification and increase the farmers' income. Furthermore, ginger crop is ravaged by variety of biotic stresses triggered by fungi, bacteria and nematodes (Kumar *et al.*, 2008; Stirling *et al.*, 2009; Stirling *et al.*, 2013; Apet *et al.*, 2018; Avinash *et al.*, 2018a; Hosain *et al.*, 2018). However, rhizome rot is a major disease among above-mentioned causes which significantly affects the ginger cultivation in this region. The commonly distributed fungus, *Pythium aphanidermatum* causes rhizome rot, which may affect entire fields (Cui *et al.*, 2019). The combination of warm and humid weather favour rapid spread of pathogen causing yellowing, water soaking and wilting of plants rendering them soft rot of rhizomes and unpleasant odors (Dohroo, 2005; Dohroo *et al.*, 2012a). Diseased plants generally show stunted growth and may finally

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die if management practice is not applied. The significant annual yield losses, which may around 80–90 per cent has been reported from some parts of the world (Stirling *et al.*, 2009; Cui *et al.*, 2019).

The seed as well as soil borne nature and broad-host range of the disease it is very difficult to manage. Whereas an effective management method is essentially required to get good economic yield of ginger. The chemicals are deleterious to the environment and expensive also which affect the quality of the ginger (Tarafdar and Saha, 2007). In the past, several studies have been carried out to manage the rhizome rot of ginger using various chemical, botanical and biological methods (Ram and Thakur, 2009; Subba, 2009; Bandyopadhyay and Bhattacharya, 2012; Dohroo *et al.*, 2012b; Singh *et al.*, 2012; Parveen and Sharma, 2014; Rai *et al.*, 2018; Goswami and Syiem, 2021). In spite of this, ongoing research is also important to develop more effective non-chemical and ecofriendly management strategy against rhizome rot. Considering the aforementioned facts and economic importance of the disease, field trials were carried out in 2022–23 to assess the effectiveness of biological treatments to manage rhizome rot.

MATERIALS AND METHODS

The experiment was conducted at the research farm of Regional Research Station of Punjab Agricultural University, Ballawal Saunkhri, Balachaur, SBS Nagar, Punjab during two ginger growing seasons from 2022–2023. The experiment was led out in randomized block design with 15 treatments (seed rhizome treatment with T1- Hot water treatment at 51°C for 10 min, T2- Seed treatment with *Trichoderma harzianum* @ 10 g/kg seed, T3- Seed treatment with *Trichoderma harzianum* @ 15 g/kg seed, T4- Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed, T5- Seed treatment with *Pseudomonas fluorescens* @ 15 g/kg seed, T6- T1+ Seed treatment with *T. harzianum* @ 10 g/kg seed, T7- T1 + Seed treatment with *T. harzianum* @ 15 g/kg seed, T8- T1+ Seed treatment with *P. fluorescens* @ 10 g/kg seed, T9- T1+ Seed treatment with *P. fluorescens* @ 15 g/kg seed, T10- ST with *T. harzianum* @ 10 g/kg seed + foliar spray of the same, T11- ST with *T. harzianum* @ 15 g/kg seed + foliar spray of the same, T12- ST with *P. fluorescens* @ 10 g/kg seed + foliar spray of the same, T13- ST with *P. fluorescens* @ 15 g/kg seed +

foliar spray of the same, T14- Standard Control (Ridomil Gold) @ 2 g/l water, T15-Control) and three replications. The pre-sowing treated seed rhizomes of ginger cultivar Himigiri were sown in raised beds of 2m × 2m with spacing of 30cm x 20cm for row to row and plant to plant respectively. The N: P: K fertilizers were applied at the rate of 60: 40: 20. The FYM was applied @ 15 t/ha in the beds before planting. One third N and full dose of P and K were applied at sowing and remaining N is top dressed in 2 split doses 45 and 90 DAS at the time of earthing up. The beds were covered with vegetative mulch material @ 10 t/ha immediately after sowing. The crop was provided shade by using 50% shade net. Two intercultural operations (earthing up) were done 45 and 90 DAS to pulverize the soil and control weeds. Crop was irrigated 2-3 times before the onset of monsoon and stopped during monsoon season (July to September) followed by irrigation at 15 days interval from October to November. Crop was harvested in the month of December.

Thirty days after planting, germination data was collected in order to calculate the percentage of germination. At 90, 120 and 150 days following planting, the plants were routinely observed for the appearance of signs consistent with rhizome rot, as documented in the literature (Dohroo 2005). The number of infected plants per plot were counted and percentage of infection was computed. The percent disease control was also calculated.

RESULTS AND DISCUSSION

The results of present study on ginger to know the effectiveness of 15 treatments (T1-T15) on germination, incidence of rhizome rot, per cent disease control and fresh rhizome yield across two growing seasons of the years 2022 and 2023 are compiled in Table 1. The pooled data provides a broad understanding about effectiveness of each treatment. The germination was varied significantly among the treatments. The T14 (Ridomil Gold (64% w/w mancozeb + 4% w/w metalaxyl-M) @ 2 g/l water) used as a standard chemical control, constantly exhibited the highest germination rates (98.3% in 2022, 93.3% in 2023, pooled 95.8%) which shows the great efficacy of this treatment to improve viability of seed and its establishment. Irrespective of T14, another

treatments including T7 (81.7%) and T6 (75.0%) were the next which showed better germination than the others. On the other hand, T4 (Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed) exhibited the lowest rate of germination (60.0%), suggesting in pooled analysis depicting its restricted efficacy to improve germination. Results of two years study from 2022-2023 revealed that disease incidence for two years of study was at lowest levels in T14, the standard chemical treatment (Ridomil Gold (64% w/w mancozeb + 4% w/w metalaxyl-M) @ 2 g/l water) which ranged from 20.0-43.3 per cent with 21.1-25.3 t/ha of yield. Treatment T7 (rhizome treatment in hot

water at 51°C for 10 min followed by treatment with *Trichoderma harzianum* @ 15 g/kg seed) was also found next to show superiority in reducing rhizome rot as lower disease incidence after T14 was recorded as compare to rest of treatments which was ranged from 40.0-50.0 per cent from 2022-2023. The T7 was second best treatment which also gave highest range of germination (80.0-83.3%), maximum disease control (31.5-39.7%) and maximum yield (18.6-20.3 t/ha) during 2022-2023 (Table 1).

The pooled analysis of data showed that T14 (Ridomil Gold (64% w/w mancozeb + 4% w/w

Table 1: Effect of various seed treatments on rhizome rot incidence, germination and yield of ginger during 2022 and 2023

Treatment*	**Germination (%)			**Rhizome rot incidence (%)			**Disease reduction (%)			**Fresh rhizome yield (t/ha)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T1	66.7	60.0	63.3	53.3	66.7	60.0	19.8	8.9	14.4	14.7	13.9	14.3
T2	70.0	73.3	71.7	50.0	63.3	56.7	24.6	13.1	18.9	15.0	14.5	14.733
T3	76.7	76.7	76.7	46.7	60.0	53.3	30.2	17.9	24.0	15.3	14.8	15.1
T4	63.3	56.7	60.0	60.0	66.7	63.3	10.3	8.3	9.7	13.0	11.6	12.
T5	66.7	60.0	63.3	56.7	66.7	61.7	15.1	8.3	12.1	13.0	12.0	12.5
T6	76.7	73.3	75.0	43.3	53.3	48.3	34.1	27.4	30.8	18.3	17.3	17.8
T7	83.3	80.0	81.7	40.0	50.0	45.0	39.7	31.5	35.2	20.3	18.6	19.5
T8	70.0	60.0	65.0	56.7	66.7	61.7	15.1	8.3	12.1	13.7	12.8	13.3
T9	73.3	66.7	70.0	53.3	60.0	56.7	20.6	17.9	19.3	14.7	14.1	14.4
T10	70.0	70.0	70.0	50.0	56.7	53.3	24.6	22.0	23.3	16.0	15.9	16.0
T11	70.0	76.7	73.3	46.7	53.3	50.0	29.4	27.4	28.0	17.0	16.9	16.9
T12	66.7	56.7	61.7	56.7	66.7	61.7	14.3	8.3	11.3	13.3	12.3	12.8
T13	70.0	63.3	66.7	56.7	66.7	61.7	15.1	8.9	12.0	14.3	13.2	13.8
T14	98.3	93.3	95.8	20.0	43.3	31.7	69.8	39.9	54.5	25.3	21.1	23.2
T15	66.7	63.3	65.0	66.7	73.3	70.0	0.00	0.0	0.0	14.0	12.0	13.0
CD for Years		4.8			4.8			13.1			2.5	
CD for Treatments		8.9			8.2			13.6			1.9	
CD for Years × Treatments		13.6			14.8			20.7			3.3	

T1- Hot water treatment at 51°C for 10 min, T2- Seed treatment with *Trichoderma harzianum* @ 10 g/kg seed, T3- Seed treatment with *Trichoderma harzianum* @ 15 g/kg seed, T4- Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed, T5- Seed treatment with *Pseudomonas fluorescens* @ 15 g/kg seed, T6- T1+ Seed treatment with *T. harzianum* @ 10 g/kg seed, T7- T1 + Seed treatment with *T. harzianum* @ 15 g/kg seed, T8- T1+ Seed treatment with *P. fluorescens* @ 10 g/kg seed, T9- T1+ Seed treatment with *P. fluorescens* @ 15 g/kg seed, T10- ST with *T. harzianum* @ 10 g/kg seed + foliar spray of the same, T11- ST with *T. harzianum* @ 15 g/kg seed + foliar spray of the same, T12- ST with *P. fluorescens* @ 10 g/kg seed + foliar spray of the same, T13- ST with *P. fluorescens* @ 15 g/kg seed + foliar spray of the same, T14- Standard Control (Ridomil Gold) @ 2 g/l water, T15-Control

** Values within a column represent the mean of three replications.

metalaxyl-M) @ 2 g/l water) as a standard chemical treatment exhibited lowest disease incidence (31.7%). It indicates its superiority in promoting seedling emergence, preventing the losses by decreasing the incidence and severity of rhizome rot which finally increase the yield. The T7 (rhizome treatment in hot water at 51°C for 10 min followed by treatment with *Trichoderma harzianum* @ 15 g/kg seed) and T6 (T1+ Seed treatment with *T. harzianum* @ 10 g/kg seed) also showed reduced rhizome rot incidence (45.0% and 48.3%, respectively) as compare to untreated control, proving their efficiency to control the disease. On the other hand, T15 had the highest rhizome rot incidence (70.0%), reflecting poor disease suppression. The ability of treatments to reduce disease incidence varied greatly. Among all treatments, greatest pooled disease control (54.5%), with notable reductions in both years (69.8% in 2022 and 39.9% in 2023) was achieved in T14 (as a standard chemical treatment). Additionally, T7 and T6 were next to reduce disease incidence significantly amounting of 35.2 per cent and 30.8 per cent respectively.

Yield is a decisive factor while assessing the efficacy of treatments. With the consistent performance, T14 showed the highest pooled yield (23.2 t/ha), in both years (25.3 t/ha in 2022, 21.1 t/ha in 2023) as well. The next utmost results for yield were achieved in T7 (19.5 t/ha) and T6 (17.8 t/ha) as compare to untreated control. Interestingly the lowest yield (12.0, 12.5 & 12.8 t/ha) was recorded in T4 (Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed), T5 (Seed treatment with *Pseudomonas fluorescens* @ 15 g/kg seed) and T12 (ST with *P. fluorescens* @ 10 g/kg seed + foliar spray of the same) treatments respectively which was lower than untreated control (13.0 t/ha). This indicates the restricted efficacy of above said treatments to improve productivity.

The critical difference (CD) values revealed significant differences between treatments, years, and their interactions. For germination, disease incidence, and yield, the variations between treatments were statistically significant, as indicated by CD values. T14 was found most effective treatment as it performed better than other treatments in terms of germination, rhizome rot incidence, disease reduction and yield showing its potential to be a most successful among

all treatments. This could be ascribed by its unique ability to improve crop establishment and productivity. In areas where disease is common, as far as biological method to manage rhizome rot, T7 and T6 performed better than other non-chemical treatments in terms of germination, rhizome rot incidence, disease reduction and yield which make them possible viable alternatives in disease-prone regions. On the other hand, treatments like T15 and T4 consistently underperformed. Strong negative correlation (-0.945 in 2022 & -0.965 in 2023) is worked out for two years of study between disease incidence and yields in T14, T7, and T6 that means yield will be highest when incidence of rhizome rot will be least. It revealed that suitable management of rhizome rot is key factor to enhance the yield of ginger, Future studies could explore the mechanisms underlying the success of these treatments to refine their application further.

The results of current study are in line with the findings of Sasikumar *et al.* (2009); BARI (2010); Singh (2011); Mishra and Pandey (2014); Nath *et al.* (2014); Tripathi (2014); Chavan *et al.* (2017); Avinash *et al.* (2018b); Trivedi *et al.* (2021) who found that treating ginger rhizomes with Ridomil alone and metalaxyl 8% + mancozeb 64% efficiently increased the ginger germination and reduced the rhizome rot incidence. The potential of biocontrol agents in reducing the rhizome rot of ginger was also worked out by several workers (Subba, 2009; Muthukumar *et al.*, 2011; Dohroo *et al.*, 2012b; Singh *et al.*, 2012; Khasto and Tiameren, 2013). Studies also revealed that isolates of *Trichoderma* showed their potential to manage of rhizome rot of turmeric (Anoop and Bhai, 2014; Chavan *et al.*, 2017).

The our findings also are in accordance with Gopi *et al.* (2016) who recorded maximum germination (91.3 and 90.3%) and yield (158 and 126 q/ha) of ginger with lowest disease incidence (16.7% and 15.0%), respectively for the year 2011-12 and 2012-13 under field conditions, when hot water treatment @ 47°C for 30 min + *T. harzianum* followed by drenching of COC @ 0.3 % were applied thrice periodically. In an earlier study HWT @ 50°C for 30 min followed by seed and soil treatment with *Trichoderma* was found effective to manage soft rot of ginger (Basistha and Homan, 2015). The efficacy result of combination of

HWT and biological treatment of our study are in line with the results of earlier study where HWT of seed rhizome at 47°C for 30 min coupled with *T. barzianum* followed by three drenching of Mancozeb effectively reduce the disease incidence (Dohroo *et al.*, 2015). In our study, it was observed that the individual effect of *T. barzianum*, or hot water treatment was lesser than the combined effect. The our finding also is agreement with Dohroo *et al.* (2015) who reported that rhizome seed treatment alone with hot water was ineffective in limiting rhizome rot in ginger.

Singh *et al.* (2023) recorded the pooled maximum ginger yield (186.24 q/ha), greatest rhizome germination (84.43%) and minimum disease incidence (17.13%) with field application of *T. barzianum* at 2.5 kg + 50 kg FYM followed by drenching with Metalaxil MZ @ 0.1 per cent thrice at 20 days of interval. Sharma (1998) reported the effectiveness of *T. barzianum*, *T. viride* in reducing hyphal growth of *P. aphanidermatum* causing rhizome rot of ginger. Rajan *et al.* (2002) found that *T. barzianum* was the most effective in reducing the growth of *Pythium aphanidermatum*. Rani and Satheesh (2007) observed that *T. viride* effectively inhibited mycelial growth of *P. aphanidermatum* causing damping off of tomato. Apet *et al.* (2018) conducted an *in-vitro* study where they reported highest and least inhibition in hyphal growth of *Pythium aphanidermatum* respectively by *T. viride* and *Pseudomonas fluorescens* which support our findings. *In-vitro* efficacy of Trichoderma species like *T. koningii*, *T. virens*, *T. barzianum* and *T. viride* against *Pythium aphanidermatum* was stated by Kannahi *et al.* (2016).

CONCLUSION

The integrated treatments may be studied on a broader scale. Moreover, use of bio control agents (BCAs) of indigenous origin are encouraged since they are well adapted to the prevalent agro-climatic conditions, allowing for quicker establishment and proliferation in the rhizosphere.

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REFERENCES

- Anoop, K. and R. Bhai. 2014. Evaluation of antagonistic potential of indigenous Trichoderma isolates against *Pythium aphanidermatum* (Edson) Fitzp. causing rhizome rot in turmeric (*Curcuma longa* L.). *Journal of Science*, 4(2): 99–105.
- Apet, K.T.; A.G. Patil; R.C. Agale and A.P. Sasane. 2018. *In vitro* efficacy of fungicides and bio fungicides against *Pythium aphanidermatum* (Edson.) Fitzp. causing rhizome rot of ginger. *International Journal of Current Microbiology and Applied Sciences*, 6(Special Issue): 1910–1917.
- Avinash; K. Bijendra and Shivani. 2018a. Identification and characterization of the pathogens associated with rhizome rot complex of ginger in Kumaon region of Uttarakhand. *Journal of Pharmacognosy and Phytochemistry*, 7(5): 2675–2681.
- Avinash; K. Bijendra and Shivani. 2018b. *In vitro* and glass house evaluation of fungicides against the pathogens associated with rhizome rot complex of ginger in Kumaon region of Uttarakhand. *International Journal of Chemical Studies*, 6(5): 1364–1372.
- Bandyopadhyay, S. and P.M. Bhattacharya. 2012. Management of rhizome rot of ginger using physical, chemical and biological methods. *Journal of Mycology and Plant Pathology*, 42(3): 314–316.
- BARI. 2010. Annual Report 2006–2007. Bangladesh Agril. Res. Inst. Joydebpur, Gazipur. 2007; 159–160. 15. Bangladesh Agricultural Research Institute (BARI). Annual Report 2009–2010. Bangladesh Agril. Res. Inst. Joydebpur, Gazipur; 172.
- Basistha, A. and R. Homan. 2015. Evaluation and selection of appropriate management package of ginger rhizome rot disease in field condition. *IOSR –JAVS*, 8(6): 53–56.
- Chavan, P.G.; K.T. Apet and R.S. Borade. 2017. Efficacy of fungicides and bioagents against *Pythium aphanidermatum* causing rhizome rot of turmeric. *International Journal of Current Microbiology and Applied Sciences*, 6(11): 4312–4320.
- Cui, W.; P. He; S. Munir; P. He; Y. He; X. Li; L. Yang; B. Wang; Y. Wu and P. He. 2019. Biocontrol of soft rot of chinese cabbage using an endophytic bacterial strain. *Frontiers in Microbiology*, 10: 1471.
- Dohroo, N.P. 2005. Diseases of ginger. In: Ravindran, P.N., Babu, K.N. (Eds.), *Ginger, the Genus Zingiber*. CRC Press, Boca Raton, 2005, 305–340.
- Dohroo, N.P.; S. Kansal and N. Ahluwalia. 2012a. Status of soft rot of ginger (*Zingiber officinale* Roscoe). Department of Vegetable Science Dr Y S Parmar

- University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh.
- Dohroo, N.P.; S. Kansal and N. Ahluwalia. 2015. Studies on eco-farmer-friendly practices for management of soft rot of ginger (*Zingiber officinale*). *Indian Phytopathology*, 68(1): 93–96.
- Dohroo, N.P.; S. Kansal; P. Mehta and N. Ahluwalia. 2012b. Evaluation of eco-friendly disease management practices against soft rot of ginger caused by *Pythium aphanidermatum*. *Plant Disease Research*, 27(1): 1-5.
- FAO (Food and Agriculture Organization). 2021. <https://www.fao.org/faostat/en/#data/QCL>.
- Gopi, R.; H. Kalita and R.K. Avasthe. 2016. Organic management of soft rot of ginger (*Zingiber officinale*) in Sikkim Himalayan region. *Indian Journal of Agricultural Sciences*, 86(12): 1586–1590.
- Goswami, D. and M.B. Syiem. 2021. Biocontrol of *Pythium aphanidermatum* causing soft rot in ginger with bio surfactant produced by a rhizospheric *Bacillus* species. *JOSAC*, 30(1): 69-80.
- Hosain, M.K.; S.M.M. Hossain; Z. Abedin; M.M. Islam; M.A. Rahman; M.S. Rahman and M.A. Zafor. 2018. Control of rhizome rot disease of ginger through application of fungicides. *Asian Research Journal of Agriculture*, 8(3): 1-9.
- Kannahi, M.U.; Dhivya and R.S. Kumar. 2016. Biocontrol efficacy of *Trichoderma* spp. against rhizome rot disease of *Zingiber officinale* Rosc. *International Journal of Pharmaceutical Sciences Review and Research*, 36(1): 63–66.
- Khatso, K. and A. Tiameren. 2013. Biocontrol of rhizome rot disease of ginger (*Zingiber officinale* Rosc.). *International Journal of Bio-resource and Stress Management*, 4(2): 317–322.
- Kumar, A.; S.T. Reeja; R.S. Bhai and K.N. Shiva. 2008. Distribution of *Pythium myriotylum* Drechsler causing soft rot of ginger. *Journal of Spices and Aromatic Crops*, 17(1): 5-10.
- Mishra, R.S. and V.P. Pandey. 2014. Management of soft rot of ginger through bio-fumigation, fungicides and bio-agents. *Journal of Plant Disease Sciences*, 9(1): 128-130.
- Muthukumar, A.; A. Eswaran and S. Kumar. 2011. Exploitation of *Trichoderma* species on the growth of *Pythium aphanidermatum* in chilli. *Brazilian Journal of Microbiology*, 42(4): 25-30.
- Nath, B.C.; L.C. Bora; S. Srisvastava and J.P. Singh. 2014. Integrated disease management of *Zingiber officinale* Rosc. Rhizome rot. *The Bioscan*, 9(1): 265-269.
- Parveen, T. and K. Sharma. 2014. Management of “Soft Rot” of ginger by botanicals. *International Journal of Pharmacy and Life Sciences*, 5(4): 3478–3484.
- Rai, M.; A.P. Ingle; P. Paralikar; N. Anasane; R. Gade and P. Ingle. 2018. Effective management of soft rot of ginger caused by *Pythium* spp. and *Fusarium* spp.: emerging role of nanotechnology. *Applied Microbiology and Biotechnology*, 102: 6827–6839.
- Rajan, P.P.; S.K. Gupta; Y.R. Sharma and G.V.H. Jackson. 2002. Diseases of ginger and their control with *Trichoderma harzianum*. *Indian Phytopathology*, 55(2): 173–177.
- Ram, J. and B.B.L. Thakur. 2009. Loss of ginger rhizome during storage and its management by fungicides. *Journal of Mycology and Plant Pathology*, 39: 432-435.
- Rani, S.U. and G. Satheesh. 2007. Management of damping off of tomato caused by *P. aphanidermatum* (Edson) Fitz. Through biocontrol agents, organic amendments and soil solarization, *Plant Disease Research*, 22(1): 27-29.
- Sasikumar, B.; C.K. Thankamani; V. Srinivasan; S. Devasahayam; J. Santhosh; K.A. Eapen and J.T. Zacharia. 2009. Ginger (Extension Pamphlet).
- Sharma, B.K. 1998. Antifungal properties of biocontrol agents from plant extracts against causal fungi of yellows and rhizome rot of ginger. *Journal of Biological Control*, 12: 77-80.
- Singh, A.K. 2011. Management of rhizome rot caused by *Pythium*, *Fusarium* and *Ralstonia* sp. in ginger (*Zingiber officinale*) under natural field conditions. *Indian Journal of Agricultural Sciences*, 81(3): 268-270.
- Singh, H.K.; N. Prakash; P.K. Ray; P. Singh; B.N. Saha; R. Singh; M.K. Roy; A. Kumar and A. Kumar. 2023. Yield maximization in ginger through management of ginger (*Zingiber officinale* Roscoe) rhizome rot. *The Pharma Innovation Journal*, 12(8): 1230-1232.
- Singh, H.K.; R.C. Shakywar; S. Singh and A.K. Singh. 2012. Evolution of comparative efficacy of native isolate of *T. viride* against rhizome rots diseases of ginger. *Journal of Plant Disease Sciences*, 7(1): 22-24.
- Stirling, G.R.; U. Turaganivalu and M.K. Smith. 2013. Burrowing nematode (*Radopholus similis*): a severe pathogen of ginger in Fiji. *Australas. Plant Pathology*, 42(4): 431-436.
- Stirling, G.R.; U. Turaganivalu; A.M. Stirling; M.F. Lomavatu and M.K. Smith. 2009. Rhizome rot of ginger (*Zingiber officinale*) caused by *Pythium myriotylum* in Fiji and Australia. *Australas. Plant Pathology*, 38: 453-460.
- Subba, J.R. 2009. Indigenous knowledge on bio-resources management for livelihood of the people of Sikkim. *Indian Journal of Traditional Knowledge*, 8(1): 56–64.
- Tarafdar, J. and N. Saha. 2007. Correlation study on population dynamics of ginger soft rot inciting

pathogens under different organic amendments, disease incidence and its survival in Darjeeling hill soils. Proceedings of the 13th ISTRC Symposium, 2007, pp 165–169.

Tripathi, A.K. 2014. Management of rhizome rot disease of ginger in Bundelkhand region of Madhya Pradesh. *International Journal of Current Research*, 6(4): 6435-6436.

Trivedi, A.; R.K. Fagodiya; B.L. Fagodia and S. Kumar. 2021. Metalaxyl and Mancozeb - An efficient combination to control soft rot in ginger. *Annals of Agricultural Research, New Series*, 42(4): 439-444.

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Research Article

Drivers and Pattern of Indebtedness among Agricultural Households in India: Insights from A Largescale Survey

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ABSTRACT

Agricultural credit has an important role in meeting the financial needs of households for farm investment, consumption smoothing and risk mitigation. This study employs the unit level data from a large-scale survey of the NSS 77th round for exploring the determinants and patten of indebtedness among the agricultural households in India. It was found that 50 percent of the agricultural households in India were indebted. Rural financial inclusion programs seem to have been successful in extending the households' access to institutional banking facilities in terms of access to a bank account. Institutional agencies were a major source of credit for the agricultural households especially, for meeting their farm investment needs. Non-farm financial needs such as medical expenditure, expenditure on housing, education and social ceremonies were also one of the major reasons for which the agricultural households borrowed funds, thus, leading to indebtedness. However, informal credit sources, like professional money lenders, friends and relatives played an important role in addressing these needs. Socially disadvantaged groups, households that are resource poor, those with an incidence of casual labour, experience of crop loss, and households having larger family size were more likely to be indebted. Social safety nets and risk reduction programs appeared to work in tandem with financial inclusion programs in reducing the extent of indebtedness and mitigating financial risks. The study recommends strengthening the outreach of KCC and extending institutional finance programmes for meeting consumption credit needs of the agricultural households.

Keywords: Indebtedness, Agricultural credit, Loan outstanding, Institutional credit source, PM-Jan Dhan Yojana (PMJDY), Kisan Credit Card (KCC), Financial inclusion, Crop Insurance (PMFBY)

INTRODUCTION

Credit is an important component of rural development programmes. Rural households substitute owned and borrowed resources for meeting their various investment and expenditure needs. Credit enables households to meet their consumption demands when there is a divergence in regular income flows (Ahuja, 1976). Therefore, institutional credit programmes often focus on catering to the credit needs of households at affordable interest rates. The expansion of rural financial institutions also strengthens the liquidity of its non-farm sector (Binswanger *et al.*, 1995). Households also need finance for meeting their

non-consumption requirements such as medical expenses, expenditure on education and social ceremonies etc. Households' demand for credit may not always be pre-planned often, unexpected requirements for liquid money do arise. Under such circumstances, non-institutional sources play a key role in meeting the immediate credit needs of the rural households though at a higher cost as they are made available in a shorter span of time with no or limited procedures being followed. Thus, both formal and informal sources of credit play an important role in meeting the credit needs of households. Therefore, rural households in general and agricultural households

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in particular rely on varied sources of finance. Existing studies have pointed towards limited access of institutional credit to resource poor rural households such as the small and tenant farmers (Reddy *et al.*, 2019). Besides there are regional disparities in the access to institutional credit (Sidhu and Gill, 2006). Recognising the role of timely, affordable credit availability for the development of agricultural sector, several policy initiatives such as the Interest Subvention Scheme, Kisan Credit Card (KCC) Scheme (1998) etc have been taken up by the government. Besides, the Pradhan Mantri Jan Dhan Yojana (PMJDY)-a financial inclusion program with an ambition to provide access to institutional banking to the marginalised and socio-economically backward classes was initiated in the year 2014 for delivery of financial services at an affordable cost, on timely basis to the vulnerable groups. Credit has a key role in enabling the agricultural households to meet their cash requirements, consumption smoothing as well as technology adoption. However, indebtedness which is a consequence of borrowing is one of the factors leading to distress of the households. It also has an important influence on household vulnerability besides the socio-ecological consequences (Ramprasad, 2019). Thus, rural indebtedness has also been identified as one of the reasons for distress among the farming community, leading to farmers' suicides (Dandekar and Bhattacharya, 2017). The present study attempts to explore the extent of indebtedness, sources of credit and reasons for borrowing as well as the determinants of indebtedness among agricultural households.

MATERIALS AND METHODS

This study is based on the data from the 77th round 'Survey on Land and Livestock Holdings of Households and Situation Assessment of Agricultural Households' (2019)-A large scale survey conducted by the National Sample Survey (NSS). Specifically, the information regarding the credit and outstanding amount of 45,719 agricultural households, compiled in the visit 1 of the survey conducted during July-December 2018 was used. The socio-economic distribution of the sample households is given in Table 1 and Table 2.

Extent of indebtedness was measured in terms of average amount of outstanding per household across the various states as well as socioeconomic

Table 1: Distribution of sample agricultural households across the social groups

Social Group	Number	Percent
Schedules Tribe (ST)	8,864	19.39
Scheduled Caste (SC)	6,419	14.04
Other Backward Caste (OBC)	18,734	40.98
Others	11,702	25.6
Total	45,719	100

Source: Authors' estimates based on NSS 77th round Unit level data

Table 2: Distribution of sample agricultural households across land holding categories

Land holding (ha)	Number	Percent
<0.01	329	0.72
0.01 - 0.40	13,195	28.86
0.40 - 1.00	13,213	28.90
1.01 - 2.00	11,672	25.53
2.01 - 4.00	5,827	12.75
4.01 - 10.00	1,312	2.87
10.00 and more	171	0.37
Total	45,719	100

Source: Authors' estimates based on NSS 77th round Unit level data

categories. Incidence of Indebtedness (IOI) was calculated as the percent of the indebted households as on the date of the survey. Loan outstanding was estimated as the average amount of cash dues as on the date of the survey. Determinants of indebtedness were estimated using a logistic model wherein the dependent variable Y_i was the incidence of indebtedness of a household. The dependent variable was binary in nature, taking the value 1 if a household was indebted, 0 otherwise. The logit model estimates the probability P_i that i^{th} agricultural household is indebted given a set of socio-economic variables (X_i). The probability of a household being indebted is a function of an index variable Z_i . The conditional probability of Y_i taking the value 1 or 0 is given by,

$$P_i = E(Y = 1|X_i) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}} \quad \dots (1)$$

$$P_i = \frac{1}{1 + e^{-Z_i}} = \frac{Z_i}{1 + e^{Z_i}} \quad \dots (2)$$

Equation (2) represents the cumulative logistic distribution function. Here, $Z_i = (\beta_1 + \beta_2 X_i)$. It ranges from -d to +d and P_i ranges from 0 to and 1. P_i is non linearly related to Z_i i.e., X_i .

Given, $P_i = \frac{1}{1+e^{Z_i}}$ we can write $(1 - P_i) = \frac{1}{1+e^{Z_i}} \dots(3)$.

Therefore,

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} \dots(4)$$

Here, $\frac{P_i}{1 - P_i}$ is the log odds ratio in favor of Y_i taking the value 1 or 0 i.e., a household being indebted or not. Taking logarithm, we can write equation 4 as, $L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = Z_i = (\beta_1 + \beta_2 X_i + u_i)$ where, u_i is the error term. Here, L is the logit (logs odd ratio) linear in X as well as parameters. The equation is estimated using maximum likelihood (ML) method (Gujarati, 2004).

RESULTS AND DISCUSSION

More than 93 per cent of the agricultural households across the different land holding categories were found to have a bank account. It is interesting to note that, such trend was evident irrespective of social group of the household or gender of the head. About 98 percent of the male headed, 96% of female headed and all the households headed by transgenders had a bank account. It reflects on the success of the PMJDY in providing inclusive access to banking facilities (Figure 1).

The trend across households of different social groups is provided in Figure 2. KCC scheme is an

important initiative to meet the financial requirements of farmers by providing adequate and timely credit support. It makes provision for timely purchase of agriculture inputs such as seeds, fertilizers, pesticides etc. and draw cash for their production needs.

In the year 2004, the coverage of the scheme was extended to meet the credit requirements of farmers for investments in farm and non-farm activities. Only 19.12 percent of the households reported having a KCC card. State wise percent of households with KCC is depicted in Figure 3. It is important to note that the survey covered only rural agricultural households and each household is counted only once if it reported access to a KCC. Hence, there might be differences in the extent of coverage as compared with the administrative data (GOI, 2021).

Further, more than 50 percent of agricultural households were indebted in Andhra Pradesh, Karnataka, Kerala, Maharashtra, Odisha, Punjab, Rajasthan, Telangana and West Bengal states. Of these, Andhra Pradesh and Telangana were the most indebted states with an incidence of indebtedness in more than 90 percent of the agricultural households. The share of indebted households at the all-India level was 59.19 percent (Table 3).

Institutional sources were the major contributors to agricultural finance across all the states. Across the states, 25.37 percent of the households sourced their financial needs exclusively through institutional sources,

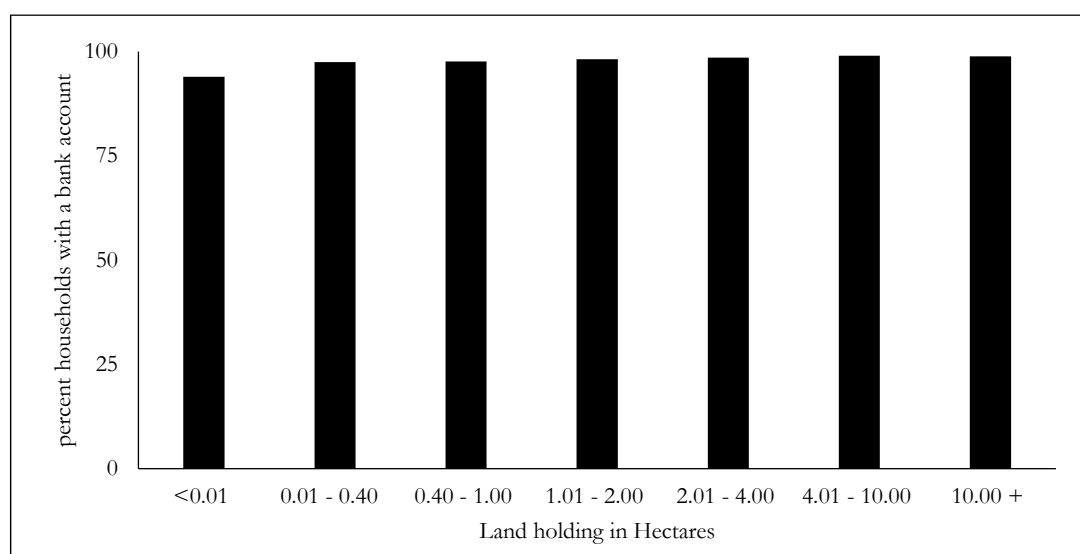


Figure 1: Access to bank account for households of different land holding categories

Source: Authors' estimates based on NSS 77th round Unit level data

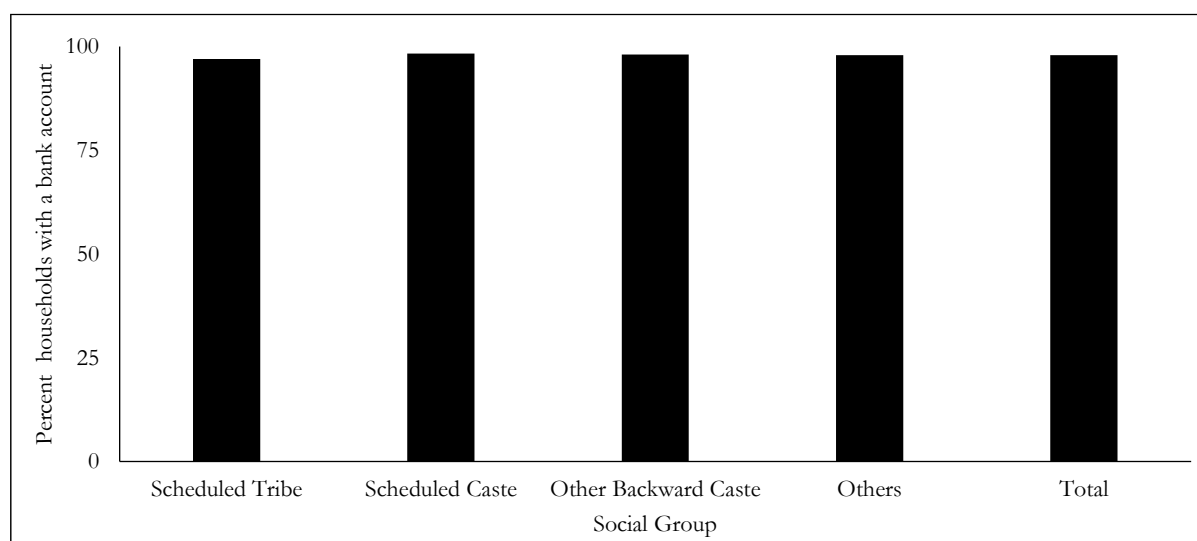


Figure 2: Access to bank account by households of different land holding categories

Source: Authors' estimates based on NSS 77th round Unit level data

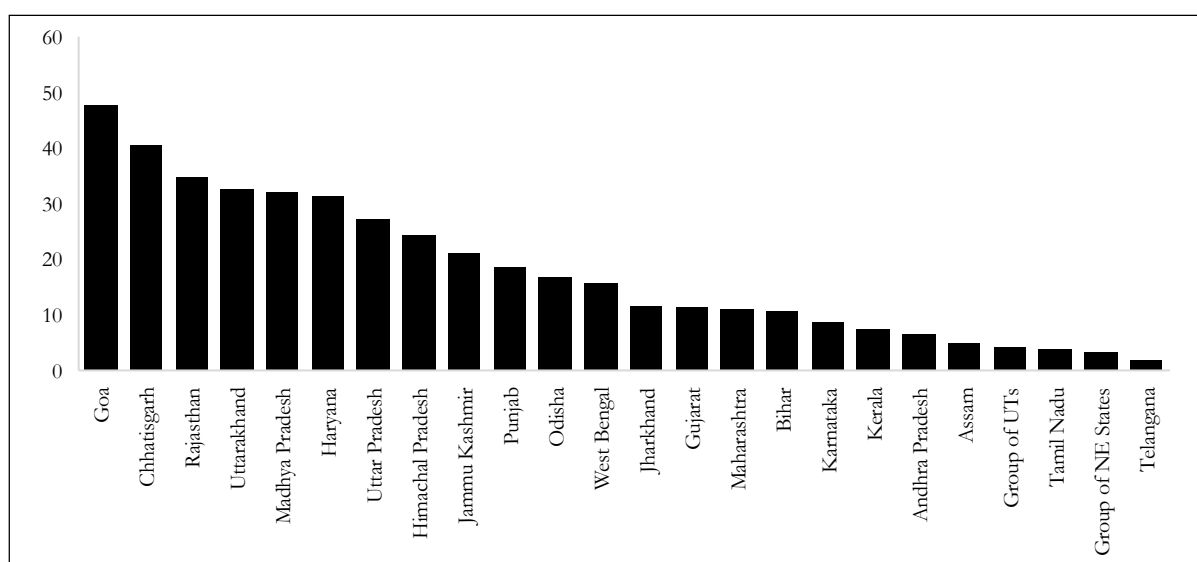


Figure 3: Percent households reporting access to KCC during the survey (2018)

Source: Authors' estimates based on NSS 77th round Unit level data

12.29 percent through exclusively non-institutional sources and 12.53 percent relied on both institutional and non-institutional sources. Across different states the share of households exclusively accessing non-institutional credit sources was higher in Rajasthan (22.47), Uttar Pradesh (15.93), Jammu Kashmir (15.88), Bihar (15.78), Jharkhand (13.87) and Madhya Pradesh (12.94) as compared to national level which was 12.29 percent. Distribution of indebted households per 1000 agricultural households is depicted in Figure 4.

Across the land categories, incidence of indebtedness was highest among the households with

a land holding of 4 ha and above and lowest among those with landholding of less than 0.01 ha (Figure 5).

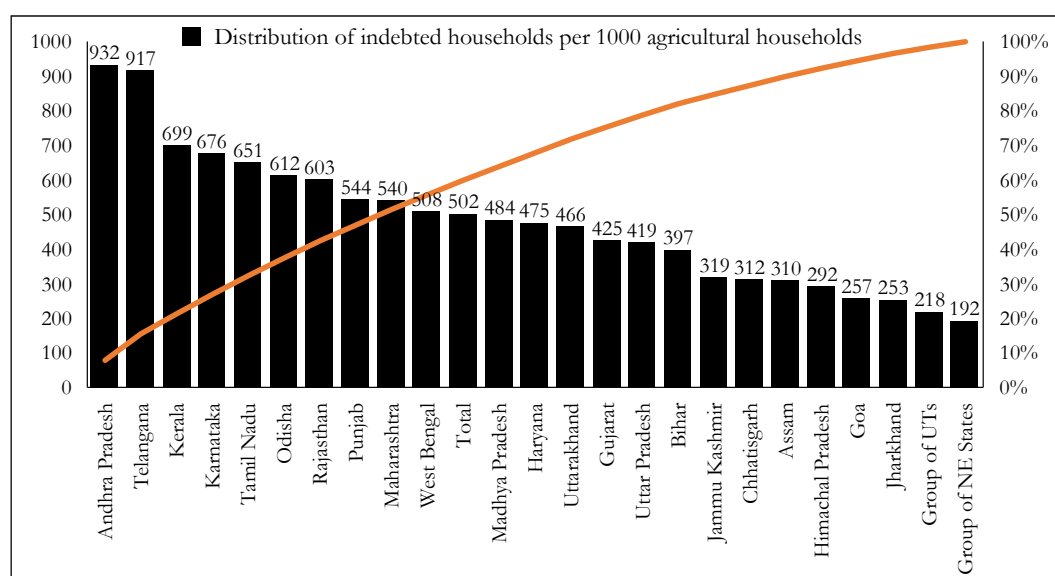
On an average, a agricultural household had a debt of Rs. 74,121, of which Rs. 51,387 was through institutional loans and Rs. 22,734 through non-institutional loans (Table 4). Highest outstanding loan amount per household was observed in Andhra Pradesh (Rs. 2,45,553), Kerala (Rs. 2,42,490) and Punjab (Rs. 2,03,255) states.

Extent of indebtedness and amount of institutional outstanding were both positively associated with land ownership. Thus, resource rich households borrowed

Table 3 State-wise Percent of agricultural households accessing different loan sources

State	Indebted	Institutional	Non-institutional	Both institutional & non-institutional	Total
Andhra Pradesh	93.17	25.41	8.61	59.15	100
Assam	31.02	26.38	4.09	0.55	100
Bihar	60.35	16.57	15.78	7.30	100
Chhattisgarh	31.18	19.48	6.02	5.68	100
Gujarat	42.48	27.7	9.54	5.25	100
Haryana	47.54	26.24	7.94	13.36	100
Himachal Pradesh	29.23	22.76	3.81	2.66	100
Jammu Kashmir	31.94	15.04	15.88	1.02	100
Jharkhand	25.34	9.05	13.87	2.43	100
Karnataka	67.64	38.72	10.75	18.17	100
Kerala	69.93	52.3	2.85	14.78	100
Madhya Pradesh	48.36	22.65	12.94	12.76	100
Maharashtra	54.00	39.18	6.06	8.76	100
Odisha	61.16	28.21	12.96	19.99	100
Punjab	54.36	25.98	11.99	16.4	100
Rajasthan	60.32	24.65	22.47	13.21	100
Tamil Nadu	65.11	34.29	8.44	22.38	100
Telangana	91.74	23.61	10.93	57.2	100
Uttar Pradesh	41.95	18.77	15.93	7.24	100
Uttarakhand	46.57	32.28	9.02	5.27	100
West Bengal	50.85	32.9	12.12	5.83	100
Group of NE States	19.17	12.69	6.08	0.40	100
Group of UTs	21.83	13.81	7.23	0.79	100
All India	50.19	25.37	12.29	12.53	100

Source: Authors' estimates based on NSS 77th round data Unit level data, Note: NE states-includes group of North-Eastern states

**Figure 4: State-wise distribution of indebted households per 1000 agricultural households**

Source: Authors' estimates based on NSS 77th round Unit level data

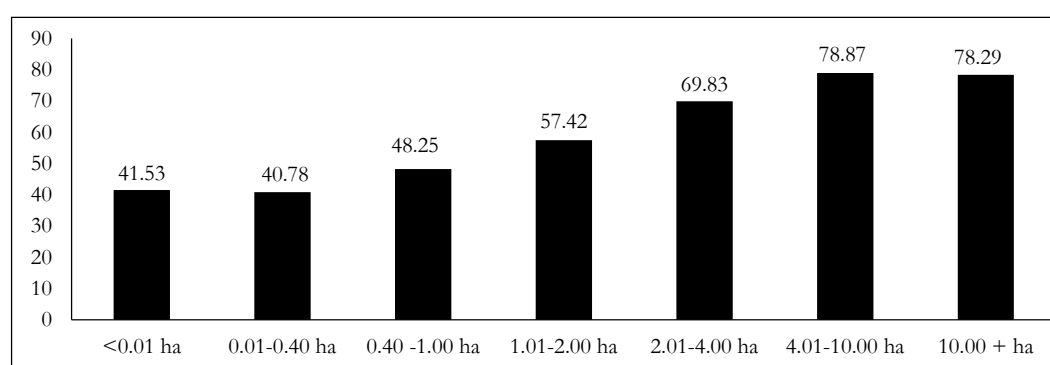


Figure 5: Indebtedness across agricultural households of different landholding groups

Table 4: State wise extent of indebtedness of agricultural households in India (2018-19)

State	Outstanding from Institutional loan (Rs.)	Outstanding from Non-institutional loan (Rs.)	Total Outstanding Amount (Rs.)
Andhra Pradesh	1,22,416	1,23,137	2,45,553
Kerala	2,20,527	21,962	2,42,490
Punjab	1,60,059	43,196	2,03,255
Haryana	1,24,199	58,722	1,82,921
Telangana	64,465	87,649	1,52,114
Karnataka	92,646	33,593	1,26,239
Rajasthan	74,259	39,606	1,13,865
Tamil Nadu	73,879	32,676	1,06,556
Himachal Pradesh	82,287	3,535	85,822
Maharashtra	69,809	12,277	82,086
Madhya Pradesh	52,360	22,060	74,419
Gujarat	48,079	8,489	56,568
Uttar Pradesh	35,748	15,360	51,108
Uttarakhand	44,068	4,271	48,338
Odisha	20,488	12,233	32,721
Jammu Kashmir	19,300	11,138	30,437
West Bengal	20,760	5,692	26,452
Bihar	13,928	9,607	23,535
Chhattisgarh	16,012	5,431	21,443
Assam	14,470	1,937	16,407
Jharkhand	3,733	4,683	8,415
Total	51,387	22,734	74,121

more and through formal financial institutions. Interestingly, for households with a land holding of more than 10 hectares, both institutional and non-institutional financial sources played an important role (Table 5). Rural households were found to depend on multiple sources of finance. Almost 67 percent of the loans were sourced through formal credit Institutions,

of which, major source was scheduled commercial banks (29%) while remaining 33 percent through non institutional sources (Figure 6). The role of informal sources such as professional moneylenders, friends and relatives cannot be undermined as they accounted for 24 percent of the total loans reported by the households. Together, these three sources accounted

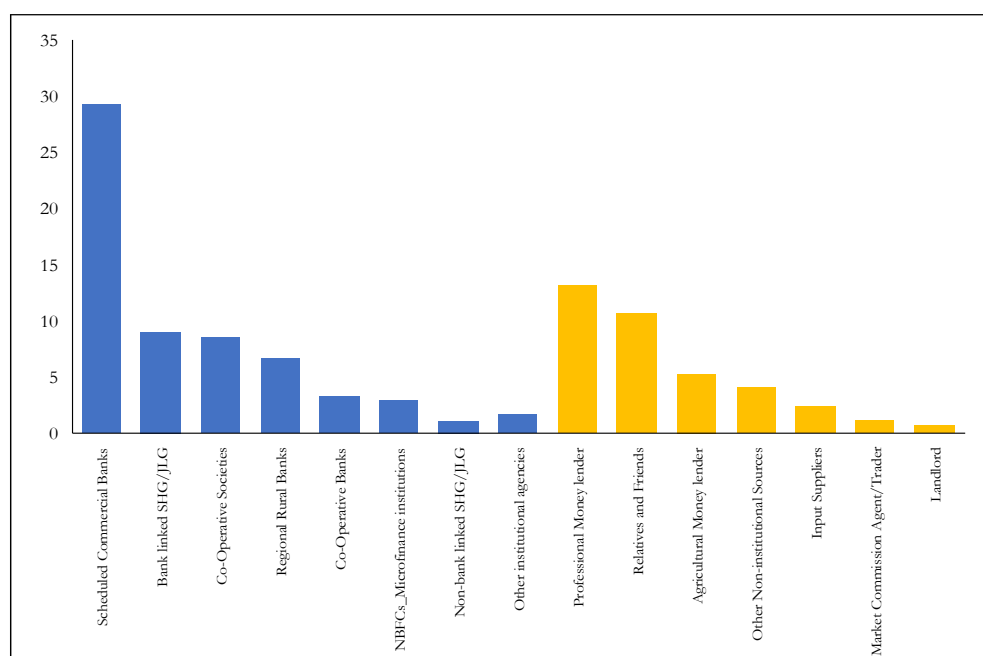
Table 5: Source-wise outstanding per agricultural household across the land categories

Land Category	Outstanding from institutional loan (Rs)	Outstanding from Non-institutional loan (Rs)	Total Outstanding (Rs)
<0.01 ha	22,578	15,523	38,102
0.01 - 0.40 ha	20,506	12,540	33,046
0.40 - 1.00 ha	32,932	18,393	51,325
1.01 - 2.00 ha	66,640	27,684	94,324
2.01 - 4.00 ha	1,28,080	47,139	1,75,219
4.01 - 10.00 ha	2,61,504	63,627	3,25,131
10.00 + ha	5,16,898	2,38,958	7,55,856
All classes	51,387	22,734	74,121

Source: Authors' estimates based on NSS 77th round Unit level data

Figure 6: Major sources of loan for agricultural households

Source: Authors' estimates based on NSS 77th round Unit level data

**Table 6: Purpose for which agricultural households' sought loan**

Purpose of Loan	Landholding (ha)							Total
	<0.01	0.01 - 0.40	0.40 - 1.00	1.01 - 2.00	2.01 - 4.00	4.01 - 10.00	10.00 & more	
Capital Expenditure in Farm Business	13.29	13.98	20.33	26.44	29.24	27.04	28.81	21.54
Revenue Expenditure in Farm Business	8.05	19.12	29.57	36.59	42.58	48.35	54.14	31.06
Non-farm Business	5.68	4.77	3.19	2.67	2.06	1.95	1.23	3.28
Housing	9.96	11.00	7.76	5.79	4.20	2.79	1.93	7.41
Marriages & Ceremonies	8.05	7.16	5.72	4.85	3.62	2.90	1.66	5.47
Education	0.45	1.29	1.78	1.49	0.87	0.58	1.38	1.39
Medical	11.11	9.78	5.30	3.37	2.80	1.67	0.00	5.53
Other Consumption Expenditure	34.36	23.87	18.70	13.71	10.27	11.09	9.51	17.56
Others	9.05	9.03	7.63	5.07	4.35	3.62	1.34	6.76
Total	100	100	100	100	100	100	100	100

Source: Authors' estimates based on NSS 77th round Unit level data

Table 7: Cost of credit for agricultural households

Purpose	Interest Rate (%)					
	Short term loan		Medium term loan		Long term loan	
	Institutional	Non-institutional	Institutional	Non-institutional	Institutional	Non-institutional
Capital Expenditure in Farm Business	7.11	28.20	9.33	27.53	9.02	26.59
Revenue Expenditure in Farm Business	7.02	27.98	9.18	27.85	8.68	27.77
Non-farm Business	9.63	27.71	12.69	30.09	11.11	27.40
Housing	10.46	26.68	12.83	28.77	10.79	28.15
Marriages & Ceremonies	10.42	33.70	12.45	31.66	12.35	30.39
Education	10.24	22.22	13.41	26.28	11.10	28.15
Medical	11.07	32.88	12.36	32.50	13.15	33.33
Other Consumption Expenditure	10.72	28.48	13.00	26.81	11.30	27.91
Others	10.08	25.88	12.49	31.58	11.01	31.25
Total	7.77	28.50	10.70	28.74	9.87	28.93

Source: Authors' estimates based on NSS 77th round Unit level data. *Note:* Average interest rate of the purpose wise loans reported by the households.

for more than 50 percent of the loans accessed by the agricultural households. Self-help groups (SHG), Cooperative societies and Regional Rural Banks (RRBs) are other important formal sources of credit for agricultural households.

Overall, the major reason for borrowing by the agricultural households was to meet capital and revenue expenditure of farm business. About 50 per cent of the loans were availed to meet such expenditure (Table 6). However, for households with a landholding of less than 0.40 hectare one of the major reasons for borrowing was to meet their consumption expenditure. It is noteworthy that, for these households medical, marriages and ceremonies, housing related expenditure were the drivers for borrowing, next only to their farm expenditure and consumption needs. For households with higher landholding meeting the expenditure in these categories seems to be of relatively lesser concern.

Institutional sources were the major contributors to the financial needs of rural households, also they were available at lower interest rates. Of all the loans that the households reported 33 percent loans were of short-term duration (less than 1 year), 45 percent medium duration (1-3 years) and 22 percent long duration loans (3 years or more). Regardless of the tenure of loan, the cost of finance was much higher

when borrowed through a non-institutional source as compared to institutional source (Table 7).

Estimates of logistic regression model suggests that the odds of a being indebted was high in case of male headed households (Table 8). Age is a proxy for the experience of household head. Our estimates show that older farmers are less likely to be indebted. This could be due to risk taking nature of the young household heads who borrow money for farm investments and technology adoption. Household size showed a negative association with the likelihood of being indebted. Households belonging to lower social stratum (SC/OBC), those that experienced a crop loss and households with an incidence of casual labour were more likely to be indebted. Households from lower social groups are generally resource poor, also incidence of crop loss and casual labour reflect on level of distress in the agricultural households leading to indebtedness. Within the lower social stratum, households belonging to the ST were found to be less likely to be indebted. Larger households and households with more diversified incomes had higher probability of being indebted as discussed earlier, households with large land holdings availed credit mainly for meeting farm business expenditure. However, share of non-farm income did not

Table 8: Determinants of indebtedness among the agricultural households in India

Variable	Description	Coefficient	Odds Ratio	p value
Age	Years	0.0407*** (0.0051)	1.042	0.001
Age square	Years	-0.0004*** (0.0000)	1.001	0.001
Household Size	Number	-0.0082* (0.0048)	0.992	0.090
Gender	1=Male, 0=Female/ Transgender	0.3199*** (0.0393)	1.377	0.001
MGNREG card	1=Yes, 0=No	-0.2787*** (0.0230)	0.757	0.003
PMFBY Card	1=Yes 0=No	-1.0109*** (0.0479)	0.364	0.003
Education up to primary	1=Yes 0=No	0.1243*** (0.0461)	1.132	0.007
Education up to secondary	1=Yes 0=No	0.0733 (0.0521)	1.076	0.160
Education up to higher secondary and above	1=Yes 0=No	0.0139 (0.0583)	1.014	0.811
HH belongs to ST	1=Yes 0=No	-1.0074*** (0.0347)	0.365	0.001
HH belongs to SC	1=Yes 0=No	0.1218*** (0.0361)	1.130	0.001
HH belongs to Other Backward Caste	1=Yes 0=No	0.1996*** (0.0268)	1.221	0.001
Experienced crop loss	1=Yes 0=No	0.2206*** (0.0216)	1.247	0.003
HH Self-employed in crop production	1=Yes 0=No	0.1193*** (0.0453)	1.127	0.008
HH has animal farming	1=Yes 0=No	0.5859*** (0.1030)	1.797	0.002
HH casual labour in agriculture	1=Yes 0=No	0.2287*** (0.0697)	1.257	0.001
HH casual labour in non-agriculture	1=Yes 0=No	0.2586*** (0.0639)	1.295	0.002
Land Owned	ha	0.2792*** (0.0138)	1.322	0.002
Diversification Index	Number	0.4921*** (0.0514)	1.636	0.001
Non-farm Income	Share	0.2116 (0.2230)	1.236	0.343
District fixed effects		Yes		

N=40721; Wald Chi2(90)=3698.82; R Square= 0.0841; Log pseudolikelihood= -25850.4

Source: Authors' estimates based on NSS 77th round Unit level data. #Robuts standard errors in parenthesis.

significantly affect the indebtedness status of agricultural households. It is pertinent to note that social safety net programs such as provision of wage employment under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), and risk coverage for crop loss under the Pradhan Mantri Fasal Bima Yojana (PMFBY) scheme reduced the odds of a household being indebted.

CONCLUSION

Institutional credit is an important component of rural development programmes. It not only promotes investments on adoption of improved technology, but also helps in meeting the consumption expenditure needs of the households. Almost half of the agricultural households in India were found to be indebted. Role of formal credit sources was found to be greater in financing the agricultural households. Scheduled commercial banks, self-help groups, cooperative societies, regional rural banks were the major institutional loan sources while informal credit was obtained mainly obtained through professional moneylenders, friends and relatives. Financial inclusion programmes have strengthened the access to banking for rural households. On the other hand, risk coverage through PMFBY and, employment provision under MGNREGA seemed to aid in mitigating financial risk and reduce the extent of indebtedness. Though, the KCC scheme has been modified to cater to the consumption needs of agriculture households through flexible and timely finance for input purchase, its coverage is yet to be strengthened. For resource poor households, meeting the consumption expenditure particularly, in immediate and unforeseen situations such as medical emergencies, education and social ceremonies appears to be a major challenge. In general, these needs were found to be met through informal credit sources at a higher cost leading to indebtedness. Rural financial programmes need to emphasise on strengthening credit facilities for consumption purposes. Social awareness could be a key to avoid conspicuous consumption on ceremonies owing to societal pressure so that, heavy indebtedness doesn't push the

households that are already resource poor into economic distress. Also, investments on quality, affordable education, health infrastructure, wide coverage of the existing health insurance schemes as well as affordable housing schemes for rural sector would be crucial as it eases the credit burden on rural households and could support productive use of credit by avoiding its diversion for consumption purposes. Thus, government's development programmes and schemes in these areas could complement the overall development of agricultural households.

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REFERENCES

- Ahuja, K. 1976. Rural Indebtedness: A Note. *Indian Journal of Industrial Relations*, 12(2): 227-235.
- Binswanger, H.P. and S.R. Khandker. 1995. The impact of formal finance on the rural economy of India. *The Journal of Development Studies*, 32(2): 234-262.
- Government of India. 2021. Survey on Land and Livestock Holdings of Households and Situation Assessment of Agricultural Households (2019), NSS 77th Round, Ministry of Statistics and Programme Implementation, National Statistical Office.
- Government of India. 2022. Ministry of Agriculture & Farmers' Welfare, Press Information Bureau <https://pib.gov.in/FactsheetDetails.aspx?Id=148600>
- Gujarati, D.N.; D.C. Porter and S. Gunasekar. 2012. Basic econometrics. Tata mcgraw-hill education.
- Pavithra, S. and K. Vatta. 2013. Role of Non-Farm Sector in Sustaining Rural Livelihoods in Punjab. *Agricultural Economics Research Review*, 26(2): 257-265.
- Reddy, A.A.; S.S. Raju and A. Bose. 2019. Farmers' Income, Indebtedness and Agrarian Distress in India. *Microfinance Review*, 12: 19-38.
- Sidhu, R.S. and S.S. Gill. 2006. Agricultural credit and indebtedness in India: Some issues. *Indian Journal of Agricultural Economics*, 61(902-2016-66794).



Research Article

A Time Series Analysis of Kinnow Market Arrivals and Prices in Kinnow Belt of Punjab

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ABSTRACT

South-western Punjab is suitable for the cultivation of kinnow on account of suitable soil and climatic conditions. Kinnow is popular among the south-western producers for its heavier bearings and high juice content. However, kinnow being a strongly seasonal commodity, even the heavier bearing, does not safeguard the producers against price fluctuations. As such, the current study examines the trends, instability and seasonal variation of kinnow prices and market arrivals in Punjab. The results revealed that kinnow prices and arrivals had a positive growth rate in Fazilka, Muktsar and Bathinda. High instability of Fazilka arrivals and prices, moderate instability for Muktsar arrivals and prices & low instability for arrivals and high instability for prices for Bathinda were observed. In Fazilka, kinnow arrivals were recorded from October to March, whereas in Muktsar and Bathinda, they were observed from November to April. An inverse relation existed between prices and arrivals. The study further highlights thrust areas for securing maximum profitability for kinnow farmers.

Keywords: Arrivals, Instability, Kinnow, Prices, Seasonality

INTRODUCTION

Fruits and vegetables have been a part and parcel of human beings' life since times immemorial. The popularity of vegetarian food not only in India but also in western countries makes the fruits and vegetables sector more important now-a-days. India is the second largest fruit producer in the world after China. In 2020-21, the country's area under fruit cultivation and production was 9.6 million hectares and 102.45 million metric tons respectively (APEDA, 2022a). With around 43 Geographical Indication tags for fruits, India has established a prominent position on the pomological map of the world (APEDA, 2022b). The major fruits grown in India are mangos, grapes, apples, apricots, oranges, fresh bananas, avocados, guava, litchi, papaya, sapota and watermelons (APEDA, 2022c). Nagpur oranges, nanjanagud and jalgaon bananas, allahabad surkha

guavas, tezpur and shahi litchis, fazli, gir kesar, banaganapalle, alphonso, and malihabadi dusseheri mango, mahabaleshwar strawberry, nashik grapes, and solapur pomegranate are some of the popular fruits registered under geographical indication tags (APEDA, 2022b). Today consumers are becoming increasingly health conscious and pay close attention to the nutritional values of the food they consume. Besides being a store of nutritional value, fruits are labour-intensive and help in the generation of income and employment. The increasing demand for high value agricultural commodities in domestic and international market has opened multiple avenues for producers, marketing agents and processors to develop and adopt high value adding processes for fruits to produce a diversified range of high value added products (Kumar and Sharma, 2016). Nevertheless, largely due to inadequate handling and marketing arrangements of the fresh fruits, ignorance of value addition processes,

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and the large quantum of physical and qualitative losses, the potential of fruit crops remains under-utilized (Anonymous, 2006).

The state of Punjab offers a vast agro-climatic and geographical conditions which are suitable for the cultivation of various varieties of fruits. In 2020-21, the area under the cultivation of fruits was 93.6 thousand hectares with a production of 2.03 million metric tonnes (Anonymous, 2022). The major fruit crops grown in Punjab are Citrus (Kinnow, Orange and Malta, Lemon), Mangoes, Litchi, Guava, Pear, Peach, Plum, Grapes, Ber, Amla, Banana, etc. Kinnow has recently gained exceeding popularity among producers and consumers alike because of its rich quality and economic significance. Kinnow is a high yield mandarin hybrid variety of two kinds of citrus cultivars i.e., King (*Citrus nobilis*) and Willow leaf (*Citrus deliciosa*) (Anonymous, 2020). Kinnow was introduced in Punjab from California in 1959. In 2020-21, kinnow was cultivated on an area of 44.75 thousand hectares with an annual production of 1.18 million metric tonnes (Anonymous, 2022). In 2020-21, Fazilka (34018 ha), Hoshiarpur (1995 ha), Muktsar (2410 ha) and Bathinda (1179 ha) accounted for the highest area under kinnow cultivation (Anonymous, 2021). The kinnow belt of south-western Punjab comprising of Fazilka, Ferozepur, Muktsar, Bathinda, Faridkot and Mansa accounts for 75 percent area under kinnow (Guleria *et al.*, 2022). However, kinnow being a strongly seasonal agricultural commodity, even the larger area under cultivation and heavier bearing, does not safeguard the orchardists against the associated price risk of seasonal fluctuations (Bhat *et al.*, 2014). As such, it becomes imperative to examine the trends, instability and seasonal variation of prices and market arrivals in Punjab.

MATERIALS AND METHODS

Monthly time series data from January 2006 to December 2021 pertaining to the market arrivals and prices of kinnow in Fazilka and Muktsar were collected from the www.agmarknet.gov.in portal of Ministry of Agriculture and Farmers Welfare, Government of India. The units of market arrivals and prices were in tonnes and rupees per quintal respectively. Similar to the study of Kaur and Guleria (2022), linear trend was used to estimate the trend in prices and arrivals of kinnow. t-statistic was used to test the significance of

the individual regression coefficients and F-statistic was used to test the significance of overall regression. r^2 provided the overall contribution of time variable. The slope of estimated regression equation 'b' was the average annual rate of growth. Breusch Godfrey's LM test for autocorrelation (Godfrey, 1978) and White's test for heteroscedasticity (White, 1980) was used. Similar to the study of Sanjay *et al.* (2018), the Cochrane Orcutt transformation procedure (Cochrane and Orcutt, 1949) for the resolving autocorrelation. Cuddy-Della-Valle index (Cuddy and Della Valle, 1978) was computed for analyzing the instability. Ratio to six-month moving averages based on multiplicative model was used for estimation of seasonal variations of kinnow market arrival and prices in the selected markets. Mean imputations were used for imputing any missing market arrivals and price data.

RESULTS AND DISCUSSION

The trend component was computed to ascertain the long-run movement of kinnow prices and arrivals in Fazilka, Sri Muktsar Sahib and Bathinda markets. Linear trend model was fitted to the market arrival and price data of selected markets. Table 1 represents results of statistical tests on the estimated linear trend models for the selected markets. The results of the statistical testing procedure revealed that the Muktsar arrivals, Bathinda arrivals, Fazilka arrivals and Fazilka prices had non-significant t-statistics at 5 percent level of significance either for the intercept or the slope. As such, the intercept term was dropped for them. The no intercept model for such markets yielded significant results. After the statistical testing of original linear fitted models for the market arrivals and prices for the selected markets, the models were scrutinized for econometric deficiencies.

Table 2 provides the results of econometric tests on the original models. The results revealed that the original estimated model for Fazilka market prices was plagued with significant autocorrelation and heteroscedasticity. The Bathinda market arrivals were also found to be under the influence of autocorrelation. Cochrane-Orcutt transformation of original model was performed with autocorrelation coefficient, ρ equal to 0.767 and 0.581 for Fazilka and Bathinda models respectively. Table 2 depicts the transformed model for the Fazilka prices and Bathinda market arrivals. It

Table 1: Statistical test for selection of model

Particulars	Models	t (intercept)	t (slope)	F	r ²
Model with intercept					
Fazilka arrivals	-934.89 + 382.167(t)	-0.74	2.92***	8.50***	0.378***
Fazilka prices	1122.651 – 0.701 (t)	10.70***	-0.06	0.00	0.0003
Muktsar arrivals	Y = 171.145 + 19.581(t)	2.06*	2.28**	5.18**	.270**
Muktsar prices	Y = 804.956 + 75.025(t)	5.92***	5.33***	28.44***	0.670***
Bathinda arrivals	Y = 15.348 + 6.650 (t)	0.50	2.08*	4.34*	0.237*
Bathinda prices	Y = 534.051 + 91.780(t)	3.63***	6.02***	36.30***	0.722***
Model without intercept					
Fazilka arrivals	Y = 297.177(t)	-	4.83***	23.32***	0.609***
Fazilka prices	Y = 101.359(t)	-	6.69***	44.82***	0.749***
Muktsar arrivals	Y = 35.139(t)	-	7.77***	60.41***	0.801***
Bathinda arrivals	Y = 8.046(t)	-	5.43***	29.45***	0.663***

Source: Authors' own computations from secondary data

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

Table 2: Econometric test for selection of model

Particulars	Models	R-squared	Breusch Godfrey LM statistic	White's statistic
Original models				
Fazilka arrivals	Y = 297.18(t)	0.609***	1.302	1.54
Fazilka prices	Y = 101.359(t)	0.75***	9.226***	10.88***
Muktsar arrivals	Y = 35.139(t)	0.801***	0.262	3.72
Muktsar prices	Y = 804.956 + 75.025(t)	0.670***	1.319	1.21
Bathinda arrivals	Y = 8.045(t)	0.663***	5.045**	2.09
Bathinda prices	Y = 534.051 + 91.780(t)	0.722***	0.368	3.66
Transformed models				
Fazilka prices	Y = 83.025(t)	0.421***	3.154*	4.82*
Bathinda arrivals	Y = 7.195(t)	0.338**	0.123	1.94

Source: Authors' own computations from secondary data

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

is clear that extent of autocorrelation and heteroscedasticity has been reduced.

There was an increasing yearly trend in the annual kinnow prices in the selected markets Table 3. Bathinda had the highest annual increase (Rs. 91.780/q), followed by Fazilka (Rs. 83.025/q) and Sri Muktsar Sahib (Rs. 75.025/q). The overall contribution of time variable to the changes in the prices of kinnow was 72 percent in Bathinda market, 67 percent in Muktsar market and 42 percent in Fazilka market.

Over time the arrivals of kinnow had an increasing yearly trend in the selected markets Table 4. The per

annum increase in the arrival of kinnow was highest in Fazilka (297.18 t/annum), followed by Muktsar (35.139 t/annum) and Bathinda (7.195 t/annum). Time played

Table 3: Trend of kinnow prices in Fazilka, Sri Muktsar Sahib and Bathinda

Market	Equation	r ²
Fazilka	Y = 83.025(t)	0.421***
Muktsar	Y = 804.956 + 75.025(t)	0.670***
Bathinda	Y = 534.051 + 91.780(t)	0.722***

Source: Authors' own computations from secondary data

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

Table 4: Trend of kinnow arrivals in Fazilka, Sri Muktsar Sahib and Bathinda

Market	Equation	r ²
Fazilka	Y = 297.18(t)	0.609***
Muktsar	Y = 35.139(t)	0.801***
Bathinda	Y = 7.195(t)	0.338**

Source: Authors' own computations from secondary data

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

a significant role in increase of kinnow arrivals in Fazilka, Muktsar and Bathinda market. The overall contribution of time variable to the changes in the arrivals of kinnow was 80.1 percent in Muktsar, 60.9 percent in Fazilka and 33.8 percent in Bathinda.

Table 5 illustrates the instability of kinnow market prices and arrivals for Fazilka, Muktsar and Bathinda. The results revealed that Fazilka market witnessed high instability of 79.42 percent and 77.51 percent in the

annual average prices and annual market arrivals respectively. The Muktsar market witnessed moderate instability of 16.82 percent and 22.94 percent for average annual prices and yearly market arrivals respectively. The Bathinda market witnessed low instability of 19.996 percent in annual prices and high instability of 71.327 percent in market arrivals.

The seasonal indices of prices and market arrivals in the Fazilka, Sri Muktsar Sahib and Bathinda market are depicted in Table 6. A simultaneous look at the market arrivals and price indices reveals an inverse relation between prices and market arrivals of the selected markets of Punjab. The market arrivals of kinnow begins from October and concludes in the month of March in Fazilka market. There were no new arrivals from April to September month. A lean period existed in the Fazilka market for November, January and March months. The glut period existed for October, December and February each year. The

Table 5: Instability of kinnow prices and market arrival in Fazilka, Muktsar and Bathinda

Particulars	Fazilka		Muktsar		Bathinda	
	Average prices (T)	Market arrival (O)	Average prices (O)	Market arrival (O)	Average prices (O)	Market arrivals (T)
Mean	268.730	2313.529	1442.668	337.582	1314.185	71.875
Standard deviation	280.444	2866.219	422.483	173.656	498.043	63.000
C.V.	104.359	123.889	29.285	51.441	37.898	87.652
r ²	0.421	0.609	0.670	0.801	0.722	0.338
CDVI	79.420	77.507	16.820	22.942	19.996	71.327
Range of instability	High instability	High instability	Medium instability	Medium instability	Low instability	High instability

Source: Authors' own computations from secondary data

(T) – Transformed model, (O) – Original model.

Table 6: Seasonal indices of market arrivals and prices of kinnow in Fazilka, Muktsar and Bathinda

Months	Fazilka		Shri Muktsar Sahib		Bathinda	
	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices
January	97.030	95.488	192.958	81.456	140.247	84.410
February	145.853	91.971	158.071	80.987	178.377	85.833
March	57.370	115.860	111.556	96.217	127.337	102.103
April	-	-	29.312	132.934	42.003	123.808
October	118.433	98.783	-	-	-	-
November	74.538	103.585	20.733	107.866	45.811	107.864
December	106.777	94.313	87.370	100.540	66.226	95.981

Source: Authors' own computations from secondary data

seasonal index of price was maximum in the month of March (115.859) when the market arrival index was at the lowest levels (57.369) whereas the lowest price index was observed during February (91.971) when the maximum arrival index (145.852) was prevailing in the market. In Sri Muktsar Sahib and Bathinda, market arrivals begin from November and concludes in the month of April. November, December and April were lean arrival months and January, February and March were periods of glut. For Muktsar market, the market arrival index was maximum during January (192.958) whereas the minimal arrival index was observed in November (20.733). Seasonal price index was highest in April (132.934) associated with lean arrival index of April (29.312). The lowest price index was observed in January (81.456) and February (80.987). For Bathinda market, Lowest arrival index was observed in April (42.003) in association with the highest price index (123.808). Maximum arrival index was in February (178.377) whereas lowest price index was observed in January (84.410). The stockists purchase the kinnow produce from market during glut when prices are low. They store it for one or two months and release into market as per market outlook. The stockists of Fazilka, released their stock of cold-stored kinnow in the months of March whereas the stockists of Muktsar and Bathinda released their lot in the month of April. In doing so, the stockists enjoyed higher prices for their kinnow.

CONCLUSION

Trend and Instability analysis revealed that over the years, the arrivals of kinnow in Fazilka, Muktsar and Bathinda have increased significantly. However, owing to the strong seasonal nature of kinnow, it become difficult for farmers to dispose the kinnow produce in a timely and cost-efficient manner. Fewer local ready markets for disposal, high costs of transportation and packing material, absence of support prices, lack of market information, drastically reduces the net price realization of the producers. The perishable nature of kinnow also poses as a threat, and the absence of value addition processes and infrastructures like packaging houses, processing houses and cold storage units in the value chains, results in a large quantum of spoilage. As a remedy to the problems, policy measures like fixation of kinnow price at a certain reasonable level such that it covers all the costs of cultivation and still be able to

yield a certain profit margin to farmers, development of better market infrastructure for the proper timely disposal and sale of kinnow, development of better road conditions and connectivity to disposal markets, provision of cheaper transportation services, reduction of wastage during transit, adoption of uniform grading standards and practices, development of cold storage and packaging houses, dissemination of technologies and development of market information service are some thrust areas that require attention.

REFERENCES

- Agmarknet. 2021. Agmarknet portal of Ministry of Agriculture and Farmers Welfare, Government of India. <https://agmarknet.gov.in/>
- Anonymous. 2022. Punjab Economic Survey 2021-22. Economic and Statistical Organization, Department of Planning, Government of Punjab.
- Anonymous. 2021. Statistical Abstract of Punjab 2021. Economic and Statistical Organization, Department of Planning, Government of Punjab.
- Anonymous. 2020. Kinnow a “king fruit” of Punjab – problems and its one stop crop solution. <https://www.dhanuka.com/blogs/kinnow-crop-problems-and-solution-conika>
- Anonymous. 2006. Awareness programme on value added products from fruits and vegetables. School of Agriculture, Indira Gandhi National Open University, New Delhi. <https://egyankosh.ac.in/handle/123456789/670>
- APEDA. 2022a. Fresh fruits and vegetables. https://www.apeda.gov.in/apedawebsite/six_head_product/FFV.htm
- APEDA. 2022b. Food and agri products registered as GI. https://apeda.gov.in/apedawebsite/about_apeda/Catalogue_GI_Products.pdf
- APEDA. 2022c. Other fresh fruits. https://apeda.gov.in/apedawebsite/SubHead_Products/Other_Fresh_Fruits.htm
- Bhat, A.; J. Kachroo and S. Singh. 2014. A study on behaviour of arrivals and prices of citrus in Narwal market of Jammu, India. *Indian Journal of Agricultural Research*, 48(1): 23-28.
- Cochrane, D. and G.H. Orcutt. (1949). Application of Least Squares Regression to Relationships Containing Autocorrelated Error Terms. *Journal of American Statistical Association*, 44(245): 32-61.
- Cuddy, J.D.A. and P.A. Della Valle. 1978. Measuring the Instability of Time Series Data. *Oxford Bulletin of*

- Economic Statistics*, 40(1): 79-85. <https://doi.org/10.1111/j.1468-0084.1978.mp40001006.x>
- Godfrey, L.G. 1978. Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. *Econometrica*, 1293-1301.
- Guleria, A.; S. Mouzam and A. Kamra. 2022. Punjab's kinnow value chain: problems and prospects. *Indian Horticulture*, 67(2): 43-45. <https://epubs.icar.org.in/index.php/IndHort/article/view/123787>
- Kaur, K. and A. Guleria. 2022. Analysis of instability and seasonality indices of kinnow market arrivals and prices in India. https://www.researchgate.net/profile/Amit-Guleria-2/publication/362291181_Analysis_of_Instability_and_Seasonality_Indices_of_Kinnow_Arrivals_and_Prices_in_India/links/62e159fc3c0ea8788761eb7a/Analysis-of-Instability-and-Seasonality-Indices-of-Kinnow-Arrivals-and-Prices-in-India.pdf
- Kumar, S. and A. Sharma. 2016. Agricultural value chains in India: prospects and challenges. *CUTS (Consumer Unity and Trust Society) International, Jaipur*. 1-19.
- Sanjay; M. Seidu and K. Kundu. 2018. Growth and instability in cotton cultivation in Northern India. *Economic Affairs*, 63(2): 433-440
- White, H. 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, 48(4): 817-838.

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Research Article

Learning Impact of Farmer Field Schools Extension Approach on Soybean Farmers through KVK-ATMA Convergence in Madhya Pradesh

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ABSTRACT

Farmer field school is an innovative and unique participatory extension education approach which deals with the farmers in a group focused for teaching learning and practical or skill development approach at their fields to provide them technical backstopping, problem solving for better production and sustainable income. Farmer field schools approach used as is one the field based group extension methods, by which farmers receives learning at prime importance and learning by doing and seeing is believing basic principles of extension get adopted. The main 10 soybean recommended technologies were taught to the farmer through farmer field school extension approach, the efforts were made for knowledge improvement and experiential learning opportunities for sustainable skills development to the farmer field school attending farmers group. The study was conducted on the farmer field school programme organized by KVK-ATMA convergence mode during the period of year 2018 to 2022 in Harda district of Madhya Pradesh. It was found that the mean average knowledge gain of the farmer field school attending farmers, mean value (53.45) which was 50.48 per cent more than the non attending farmers as mean value (35.72). The significant difference ($t = 9.354$) in calculated overall knowledge level of the farmer field school attending farmers and non-attending farmers was observed which means the improvement in farmer's knowledge level and skills regarding Soybean production technology through farmers field school extension approach including to training and field days activities. The collective efforts of KVK-ATMA convergence were found very effective and impacted on Soybean growing farmers to get higher yield and income from same piece of land in Harda district of MP.

Keywords: FFS, Impact, Knowledge gain, Production, Soybean, Productivity, Oilseeds

INTRODUCTION

Soybean is one of the very dynamic dual purpose crops (oilseed & pulse both) grown for getting soybean oil and many important value added products like soya chunks, very popularly used in houses as edible products. The many other products may also be prepared by soybean like soymilk, soy paneer, soy tofu, soy sticks as snacks, soy badi, soy biscuits, soy papad, soy chakli, soy laddo and soy nuts etc. are very famous and commonly available in markets in India. This soybean crop is very popularly known as golden bean

and due to highest area under soybean cultivation state Madhya Pradesh is being entitled as Soy State of India. The Asian country India has received ranks IVth in area with 11.34 million ha and ranks Vth in production with 11.22 million tones in the year 2019-20. The Soybean production of India was reported about 127.20 lakh tonnes in year 2021-22 (Soybean Outlook Report, 2022).

Among the all soybean growing states in kharif season Madhya Pradesh stood at first place with cultivated area as 53 lakh ha (2022) followed by

Maharashtra with 46.01 lakh ha cultivated area (Farmer Field School, 2023).

Farmer field school is a participatory education approach which brings together a group of small-scale food producers to solve production problems through sustainable agriculture. This approach generally provides freedom for experimental group learning to enhancing skills for crop problem self surveillance and significant study and develop decision making ability by farming communities at their level (<https://elearning.fao.org/course/view.php?id=724>).

The farmer field school scheme was begun in the year 1994 in India to train the farmer on specific field level problems at their villages to make farmers skilled and experienced in adopting new technology for better production and their strengthen livelihood in rural areas.

The farmer field school approach was developed by Food and Agriculture about 29 years ago in Southeast Asia as an alternative to the prevailing top-down extension method of the Green Revolution, to provide risk-free setting to discuss, modify and experiment with new agricultural based management ideas. The field day also organized at maturity stage of crop to showcase the technological effect on crop performance including local leaders, villagers, extension workers and scientists for publicity and assessment by famer (FAO Farmer Field School Approach, 2023).

The farmer field school extension approach is also can be defined as a season-long training for farmers involving participatory activities and interactive learning for economic viability, ecological reliability and social acceptability. May used as key strategy in strengthening agricultural extension services for promoting sustainable agriculture and farmer's income; Ahaman and Maharjan, 2022). Farmer field school is an extension training methodology used to educate farmers to adapt agricultural decisions making into diverse field conditions (Berg *et al.*, 2020).

It is clearly evident that the area sown under soybean in Harda district of Madhya Pradesh is covered about 175000 ha which is about 93.28 per cent of 187000 ha the total cultivated land of the district. The highest productivity was received in the year 2021-22 which is 1571 kg/ha reaped by farmers (Table 1). This productivity value is about 47.79 per cent more per

Table 1: Soybean Area, Production and Productivity Status of Harda district

Year	Area (ha)	Production (q)	Productivity (kg/ha)
2012-13	175000	1860250	1063
2013-14	175500	2636010	1502
2014-15	121000	1345520	1112
2015-16	166380	999943	601
2016-17	133000	1995000	1500
2017-18	84500	676000	800
2018-19	145000	2276500	1570
2019-20	164980	1031125	625
2020-21	167000	267200	160
2021-22	118560	1862578	1571

Source: Deputy Director Agriculture-District- Harda, Govt. of MP, Year 2022-23

hectare than to the base year 2012-13. The continuous increase in production and productivity of soybean crop in the district is reflects the sound role of KVK and ATMA convergence in implementation of extension activities. The importance of this crop was keeping in mind the farmer field school extension approach was planned to study its impact organized on Soybean crop for better production and income of the farming community in Harda district during 2018 to 2022 continuously.

MATERIALS AND METHODS

The study was conducted during 2018 to 2022 in Harda district of state Madhya Pradesh. The three intervention blocks namely Harda, Timarni and Khirkiya were selected and 12 farmer field school attending farmers groups as 4 groups from each block and 10 farmers in one group were studied. In this way the total numbers of respondent farmers (120) were interviewed randomly and their responses were noted down for further analysis that were voluntarily participated in the farmer field school on soybean crop organized by the KVK-ATMA convergence. A total of 240 farmers, 120 each from farmer field school attending and non attending farmers were selected randomly form Harda district. The scientists of ICAR-IISR Indore were also getting involved as facilitators for the farmer field school as per critical needs. In all the farmer field school training programmes, field visits was also conducted for making farmers convenience

to assess the given innovative technology. The technical curriculum for farmer field school was prepared as per the recommendations of all concerned KVK scientists and written advisory of ICSR-IISR scientists for Soybean crop during the kharif season. The responses of farmer field school attending farmers were collected through interview scheduled asked by KVK scientists with ATMA extension personnel and

the correct and incorrect answers were then tabulated and knowledge gain of beneficiary farmers was analyzed. The collected data were subjected to descriptive statistics such as percentage, mean, standard deviation and 't' test. The knowledge index was calculated for each farmer (attending and non-attending) by multiplying the actual knowledge score received by 100 and dividing with maximum possible

Table 2: The scientific recommendations of Soybean crop cultivation disseminated and knowledge gap perceived among farmers field school attending farmers and non attending farmers

SN	Technical knowledge Items	Recommendations approved by ICAR-IISR, Indore and KVK Scientists	Knowledge level of Farmers Field School attended farmers (%)	Knowledge level of non-attending farmers (%)	Knowledge Difference (%)
1	Sowing time	20 th June-5 th July or after receiving 4 inches rain	89.50	82.70	6.80
2	Varieties	JS 20-116, JS 20-94, JS 20-98, NRC 127, JS 20-34, RVS 2001-4, JS 20-29	78.80	55.50	23.30
3	Seed Rate	75 kg/ha	81.75	48.60	33.15
4	Seed treatment for Disease control (Collar rot, Aerial Blight, Yellow Mosaic Virus, Charcoal rot)	Thiophanate methyl 45% + Pyraclostrobin 5% FS (3 ml/kg seed) or Carboxin 37.5 + Thiram 37.5 (3g/kg seed) Carbendazim 25%+ Mencozeb 50% WS (3g/kgseed) or Trichoderma viride @ 8-10 g/kg seed. For Yellow Mosaic Virus and Stem fly seed treatment with insecticide Thiamethoxam 30 FS @10 ml/kg of seed or Imidacloprid 48 FS@ 1.25 ml/kg seed.	75.50	50.80	24.70
5	Farm Yard Manure	5-10 t/ha	82.75	67.50	15.25
6	Fertilizers	56 kg Urea+375 kg SSP+ 67 kg MoP/ha	83.00	51.80	31.20
7	Row to Row distance	40-45 cm	85.45	49.90	35.55
8	Weed control	1.Pendimethalin 38.7 CS 1.5-1.75 kg/ha Pre emergence 2. Imazethapyr 70% WG + Surfactant (100g/ha) at 15-20 DAS	78.50	50.95	27.55
9	Insect Control (Gram pod borer, Green Semilooper, Tobacco caterpillar)	Biological Control: Spray the crop with biological pesticides like NPV 250 LE/ha or Bacillus thuringiensis/Beauveria basiana@ 1l/ha. Chemical Control: If needed, spray Chlorantraniliprole 18.5 SC @ 0.15 l/ha or or Spinetoram 11.7 SC @ 450 ml/ha or Quinalphos 25 EC @ 1.5 l/ha or or Indoxacarb 14.5 SC @ 0.5 l/ha or Betacyfluthrin + Imidacloprid @ 350 ml/ha or Flubendiamide 39.35 SC @ 150 ml/ha) or or Flubendiamide 20 WG @ 250-300 g/ha) or Thiamethoxam + Lambda Cyhalothrin @ 125 ml/ha using 500 litre of water per hectare.	79.58	51.50	28.08
10		1. Broad Bed Furrow planting (BBF), 2. Ridges & Furrows planting	84.50	47.30	37.20
Mean average value			81.93	55.67	26.27

score for an individual. The total 10 technical knowledge items were selected and finalized and separate score for each technical knowledge items of Soybean crop cultivation was observed and noted for completing this study.

RESULTS AND DISCUSSION

The data placed in Table 2 reveals the knowledge level of farmers in percentage gain during the farmer field school training and other extension activities through KVK-ATMA convergence mode. It is very true that the farmer field school attended farmers possessed more knowledge on scientific production technology of Soybean as major oilseed and pulse crop depicted by mean average value 81.93 per cent, on the ground of these farmer field school attending farmers answered correctly during the interview after completing the programme. But the non attending farmers who could answer the same questions near to correct information by mean average 55.67 per cent, which is again reflects that the farmers of Harda district had good knowledge of Soybean production technology in general that is why they could answers 55.67 per cent correctly without involving in farmers field school training programmes. It may be due to role other para extension workers and extension efforts of line department and farmer to farmer extension system and social media exploitation in the district. The trainings and other extension activities done by KVK scientist and ATMA extension workers was found fruitful to improve the knowledge level of voluntarily participated farmers in farmer field school up to 26.27 per cent in the uncontrolled segment of farmers group. The results of this study found in line of as perceived by Anitha and Chandrika (2017) & Kumar *et al.* (2021).

The knowledge was analyzed in terms of the average knowledge score of the farmer field school

attending farmers and non attending farmers as well as in terms of the average knowledge score obtained for each of the technical knowledge items. Hence, it was quite rational to assess the impact on the knowledge improvement among farmer field school attending farmer's group and non attending farmers.

The data presented in Table 3 indicated that the calculated overall knowledge level of the farmer field school attending farmers group is higher than the non attending farmers. The mean of the average knowledge score of the farmer field school attending farmers was 53.45 and standard deviation of 17.86, whereas the mean of the non attending farmers was 35.72 with standard deviation of 13.67 indicative of the high knowledge level of farmer field school attending farmers. Total 50.48 per cent knowledge gap between farmer field school attending farmers and non attending farmers was found during statistical calculation. The categorization of the farmers based on the knowledge level also indicated that only 15.21 per cent of the non attending farmers were categorized in the high knowledge level compared to the scores of farmer field school attending farmers i.e. 24.79 per cent, with 55.21 per cent in medium and 20.00 per cent in low knowledge level category. The knowledge categories among the non attending farmers were found as 15.21 per cent in high, 43.75 per cent farmers in medium and 41.04 per cent in low respectively, which shows the knowledge up-gradation of farmer field school attending farmers was due to farmer field school extension methodology given to them for better yield gain by Soybean farmers. The Huluka and Negatu (2016); Anitha and Chandrika (2017) also reported the knowledge gain of farmer field school graduate farmers was higher than the non- farmer field school graduate farmers and this finding are statistically significant. Thus, it can be concluded that participation

Table 3: Statistics of overall knowledge level of farmers field school attended farmers and non attending farmers on improved Soybean production technology (n=120)

Knowledge level category	Farmers field school attending farmers (%)	Mean (Knowledge score)	SD Value	Non attending farmers (%)	Mean (Knowledge score)	SD Value
Low	20.00			41.04		
Medium	55.21	53.45	17.86	43.75	35.52	13.67
High	24.79			15.21		
Total	100			100		

Table 4: Calculating the knowledge level difference between farmers field school attending farmers and non-attending farmers (n=120)

Farmer's Category	Mean	SD	't' value
Farmer field school attending farmers	53.45	17.86	9.354**
Farmer field school non attending farmers	35.52	13.67	4.915 Non significant

Significant at probability <0.01 level of significance

in the farmer field school training significantly enhances agricultural knowledge of the participants.

Impact of the farmer field school on knowledge level of farmers on improved production technology of Soybean by knowing the accurate seed rate, sowing methods, sowing distance, seed treatment method, symptoms of the pest attack and use of right insecticides, integrated pest management and crop surveillance practices was brought out in terms of farmer's knowledge level improvement. This was presented in Table 2, as the difference in knowledge level between the farmer field schools attended farmers and non attending farmers in terms of average knowledge gain of individual farmers.

The data also revealed that the participation in farmer field school helped farmers in improving the overall knowledge gain on various Soybean production technologies based technical items. It could also be seen that the knowledge of farmer field school attending farmers of majority of item was 51 per cent and above then to non farmer field school attending farmers.

Table 4 The observations received and presented in the table may clearly show significant difference in overall knowledge level of the farmer field school attending farmers and non-attending farmers. It means the farmers could get valuable change in their knowledge level and skills regarding Soybean production technology through farmer field school extension and training approach. Dinpanah *et al.* (2010); Tripp *et al.* (2015); Anitha and Chandrika (2017) also have reported significant difference in knowledge on biological control of pests, between the participant and non participant rice farmers. Hence, the farmer field schools extension approach for knowledge and income enhancement through scientific technologies and backstopping of Soybean farmers through KVK-ATMA convergence was found worthwhile in Madhya Pradesh.

CONCLUSION

The present study was concluded in very potential pocket of central Narmada valley of Madhya Pradesh. The soybean found very suitable a sustainable crop in kharif season. The significant difference ($t = 9.354$) in calculated overall knowledge level of the farmer field school attending farmers and non attending farmers was observed which deals with the improvement in knowledge level and skills regarding Soybean production technology through farmers field school extension and training activities. The major ill effects on yield potential of this crop were seen as weather conditions like some time heavy continuous rain, flood, sometime delayed monsoon, long dry spell, insect and disease infestation etc. for improving the production and sustainability of this wonder crop a lot of efforts were made by KVK scientist through training and trials and other extension activities. Now farmers are getting very good yield and growing this crop with adoption of many innovative practices like raised bed planting, ridge & furrow sowing, integrated pest management, weed management practices, creating drainage facilities in fields at the time of sowing through ditcher implements as many more. The success of this crop cultivation was result of collective efforts of Krishi Vigyan Kendra and ATMA in convergence mode. The Farmer Field School were organized to improve farmer knowledge, skill of seed treatment and insect disease identification and their control measure likewise total ten technologies at their villages on their fields. The practical approach was used farmers were facilitated for learning by doing and seeing believing. The important inputs like improved seed, fertilizers, plant protection kits etc were also provided to from ATMA and technical backstopping was done by KVK scientist with valuable suggestion and feedback system to soybean research scientists round the season. The collective efforts of KVK scientist and ATMA were found very effective and impacted farmers to get higher

yield and income from same piece of land. The farmer to farmer extension was also observed as very effective tool of extension among farming community. The best farmers were motivated and honored by giving them best farmers awards at district level as per their yield received. The studied farmers were also added as participants of WhatsApp group, kisan sarthi portal, Facebook, KVK YouTube channel, messaging and social media platform for future attachment with KVK scientists and to receive continuous technical information to the farmers.

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REFERENCES

- Anitha, P. and M. Chandrika. 2017. Impact of Farmer Field Schools (FFS) in Coconut Crop in Kerala State: Gender Based Knowledge Analysis. *Indian Research Journal of Extension Education*, 17(4): 1-7.
- Berg, H.; S. Philips; M. Dicke and M. Fredric. 2020. Impacts of Farmer Field Schools in the Human, Social, Natural and Financial Domain: A Qualitative Review. *Food Security*, 12(1).
- Dinpanah, G.; M. Mirdamadi; A. Badragheh; J.M. Sinaki and F. Aboeye. 2010. Analysis of Effect of Farmer Field School Approach on Adoption of Biological Control of Rice Producers Characteristics in Iran; *American-Eurasian Journal of Agriculture and Environmental Science*, 7(3): 247-254.
- FAO farmer field school approach (2023). Retrieved from <https://www.fao.org/agriculture/ippm/programme/ffs-approach/en/>
- Farmer field school (2023). Retrieved from www.agricoop.gov.in
- <https://elearning.fao.org/course/view.php?id=724>
- https://www.academia.edu/25051935/farmer_field_school_ffs_an_extension_methodology, 2023
- <https://www.google.com/search?client=firefox-be&q=when+farmers+field+school+scheme+was+started+in+india>
- Huluka, A.T. and W. Negatu. 2016. The Impacts of Farmer Field School Training on Knowledge and Farm Technology Adoption: Evidence from Smallholder Maize Farmers in Oromia, Ethiopia. *Journal of Economics and Public Finance* (Online), 2(1): 1-21.
- Kumar, S.; M.K. Bankoliya; P. Jharia and R.C. Sharma. 2021. Evaluating priority index and knowledge gain of farmers participated in multimedia based Krish Mahotsav. *Journal of Community Mobilization and Sustainable Development*, 16(2): 319-324.
- Rahman, M.M. and K.L. Maharjan. 2022. Impact of Farmer Field School on Crop Income, Agroecology, and Farmer's Behavior in Farming: A Case Study on Cumilla District in Bangladesh. *Sustainability*, 14(7): 4190.
- Soybean Outlook Report (2022). Retrieved from <https://pjetsau.edu.in/files/AgriMkt/2022/January/Soyabean-January-2022.pdf>
- Tripp, R.; M. Wijertne and V.H. Piyadasa. 2005. What should we expect from Farmer Field Schools? A Sri Lanka Case Study, *World Development*, 33(10): 1705-1720.

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Research Article

Effectiveness of Extension Strategies for Changing Awareness Regarding Health Benefits of Jaggery Consumption among Farm Families

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ABSTRACT

Jaggery, a natural sweetener derived from sugarcane juice, has numerous health benefits due its rich mineral and vitamin content. Despite its numerous benefits, jaggery consumption is limited in many parts of India, with many farmers and rural communities being unaware of its advantages over refined sugar. So, extension strategies can be an effective medium in promoting the awareness regarding various health benefits of jaggery consumption among rural communities. Thus, the present study aimed to evaluate the effectiveness of extension strategies in increasing awareness about the benefits of jaggery consumption among farm families. The study used an experimental research design, with twelve villages divided into two groups: control and experimental group. Fifteen farm families from each village were selected, comprising a sample of 180 farm families. The results showed that all extension strategies significantly increased awareness about the health benefits of jaggery consumption compared to the control group. The data highlighted significant improvement in mean awareness scores for all the health benefits of jaggery consumption, including increase in immunity, relief from cough and cold, increase hemoglobin level, good for lungs and cures in indigestion and bloating at one and five per cent significance level. The comparison of extension strategies revealed that Strategy IV (recorded video and booklet distribution) was found to be most effective in increasing the awareness regarding health benefits of jaggery. The finding of the study provides valuable insights into the most effective extension strategy for promoting awareness about the health benefits of jaggery consumption among rural families. The study suggested that extension strategies can play a crucial role in disseminating information about the health benefits of jaggery consumption, ultimately leading to increased adoption and utilization of this healthier alternative to refined sugar.

Keywords: Extension strategies, Awareness, Effectiveness, Farm families, Health benefits, Jaggery

INTRODUCTION

Jaggery is a natural sweetener made from sugarcane juice simply by evaporation. According to Food Safety and Standards Authority of India (FSSAI), cane jaggery is a byproduct of boiling or processing sugarcane juice (*Saccharum officinarum*). Jaggery is also known as “medicinal sugar” due to its use in Ayurveda. It contains an enormous wealth of minerals, protein, and vitamins. It can be regarded as one of the healthiest sugars in

world because of its nutritional qualities. Jaggery contains substantial amounts of magnesium, potassium, sodium and iron, all of which have major health benefits (Quadri *et al.*, 2022). The nutritional composition of jaggery and its comparison with normal white sugar is presented in Table 1.

Jaggery is a rich mixture of minerals and vitamins, thus it is the healthiest from the group of sweeteners. It is made up of longer chain of sucrose, hence digested

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Table 1: Nutritive value of jaggery in comparison to sugar (per 100g)

Particulars	Jaggery	Sugar
Sucrose	65-85	99.5
Protein (g)	0.4	-
Fats (g)	0.1	-
Iron (mg)	10-13	-
Calcium (mg)	40-100	-
Potassium (mg)	1050	-
Manganese (mg)	0.2-0.5	-
Phosphorus (mg)	20-90	-
Sodium (mg)	19-30	-
Zinc (mg)	0.2-0.4	-
Copper (mg)	0.1-0.9	-
Chloride (mg)	5.3	-
Moisture (%)	3-10 %	0.2-0.4%
Energy (Kcal)	383	398

(Kashyap *et al.*, 2021 and Selvi, 2022)

slowly and supply energy for longer period. It is thus more beneficial for body as compared to white sugar which digests spontaneously. The mineral contents in jaggery are approximately 50 times greater than refined sugar and 5 times more than brown sugar by Gopalan *et al.* (1991). Jaggery is a good source of energy (383 kcal/100 g) and has various medicinal values (Ghosh *et al.*, 1998; Rao and Sreedevi, 2014). It is used as a sweetening agent in confectioneries and pharmaceutical formulations. The micronutrients present in the jaggery possess antitoxic and anti-carcinogenic properties (Nath *et al.*, 2015). The magnesium strengthens the nervous system, helps to relax our muscles, gives relief from fatigue and takes care of our blood vessels. The potassium and low amount of sodium present in jaggery maintain the acid balance in the body cells, and also combat acids and acetone and control our blood pressure. Jaggery contains iron which helps to prevent anaemia. It also helps to relieve tension and take care of asthma, due to its antiallergic properties. The moderate amount of calcium, phosphorous and zinc helps to maintain optimum health. In *Ayurveda*, it was known for its property to increase the health of bone marrow. Eating *shakkar* mixed with ghee serves as cleanser for lungs and intestine and acts as digestive aid. It cleanses the liver by flushing out harmful toxins, purify blood and boost the immune system to fight against harmful infections.

Despite its numerous benefits, jaggery consumption is largely limited to few areas in India, where it is often used in traditional medicine and as a natural sweetener. Therefore, there is a pressing need to promote awareness about the benefits of jaggery consumption among farm families. Extension strategies can play a crucial role in disseminating information about the health benefits of jaggery consumption among rural communities. Effective extension strategies can facilitate the transfer of information, leading to increased knowledge, understanding and ultimately, use of jaggery in food item. Thus, study aimed to evaluate the effectiveness of various extension strategies in changing awareness regarding the health benefits of jaggery consumption among farm families in Punjab.

MATERIALS AND METHODS

The study was conducted in Gurdaspur and Hoshiarpur, districts of Punjab state which had the largest area under sugarcane cultivation. The study used an experimental research design, with twelve villages, divided into two groups: experimental groups and a control group. The villages within the experimental group received extension strategies while the control group did not receive any intervention. A total of fifteen sugarcane growing families from each village were selected using snowball sampling technique, resulting in a sample of 180 farm families.

The study developed and implemented the five extension strategies: Strategy I (Lecture by expert), Strategy II (Lecture and interaction with successful entrepreneur), Strategy III (Recorded video only), Strategy IV (Recorded video and distribution of booklet) and Strategy V (WhatsApp messages). The data collection was done in two phases: Phase I: before the implementation of extension strategies and Phase II: one year after the implementation of extension strategies. The primary objective of this study was to assess the effectiveness of extension strategies in increasing awareness about benefits of jaggery consumption among farm families in Punjab. The finding of this study provides valuable insight into the most effective extension strategy for promoting the awareness regarding benefits of jaggery consumption among rural families.

The Table 2 illustrates the pre and post mean awareness scores concerning health benefits of jaggery

Table 2: Change in awareness about health benefits of jaggery consumption (n=180)

Jaggery	Control group (n _c =30)			Experimental group I (n ₁ =30)			Experimental group II (n ₂ =30)			Experimental group III (n ₃ =30)			Experimental group IV (n ₄ =30)			Experimental group V (n ₅ =30)		
	Pre ($\bar{x}$)	Post ($\bar{x}$)	t-value	Pre ($\bar{x}$)	Post ($\bar{x}$)	t-value	Pre ($\bar{x}$)	Post ($\bar{x}$)	t-value	Pre ($\bar{x}$)	Post ($\bar{x}$)	t-value	Pre ($\bar{x}$)	Post ($\bar{x}$)	t-value	Pre ($\bar{x}$)	Post ($\bar{x}$)	t-value
increases immunity	1.6	1.65	0.60 ^{NS}	1.26	2.53	10.85**	1.33	2.5	8.56**	1.4	2.4	7.88**	1.13	2.76	16.09**	1.36	2.7	12.04**
relief cough and cold	1.26	1.45	1.08*	1.33	2.6	10.85**	1.40	2.53	10.03**	1.43	2.5	9.11**	1.33	2.86	21.11**	1.43	2.73	11.95**
increases hemoglobin	1.26	1.30	0.56 ^{NS}	1.36	2.56	9.28**	1.46	2.43	7.37**	1.5	2.23	6.89**	1.56	2.8	9.95**	1.33	2.5	9.87**
good for lungs	1.16	1.36	1.76*	1.43	2.5	6.92**	1.53	2.4	6.55**	1.46	2.3	5.53**	1.58	2.9	8.85**	1.53	2.76	7.53**
cures indigestion	1.3	1.53	2.40*	1.63	2.63	5.17**	1.66	2.26	4.54**	1.8	2.13	1.62*	1.7	2.8	7.94**	1.83	2.6	7.37**
cures bloating	1.13	1.26	0.99 ^{NS}	1.56	2.5	6.60**	1.53	2.46	5.64**	1.4	2.36	5.44**	1.23	2.7	15.56**	1.29	2.7	13.81**
Total	1.28	1.42	2.05*	1.46	2.55	24.39**	1.45	2.43	14.99**	1.48	2.26	13.08**	1.38	2.82	26.86**	1.43	2.66	26.24**

Mean range (1 – 3), *Significant at 5% level of significance, **Significant at 1% level of significance, NS= Non-significant

across the experimental group and control group. To assess the significance of the difference in both pre and post mean awareness scores of the respondents, t-test was used at a one and five per cent level of significance.

Jaggery is known to be a rich source of zinc, an essential mineral that plays a crucial role in boosting the immune system and increasing the resistance to infections (Singh and Rao, 2021). The findings revealed that the mean awareness score of the respondents regarding this benefit increased significantly across all experimental groups, ranging from 1.26, 1.33, 1.4, 1.13 and 1.36 to 2.53, 2.50, 2.40, 2.76 and 2.7 respectively. The calculated 't' value showed a significant difference at a 0.01 level in the awareness of the respondents pre and post intervention in each group, indicating a clear improvement in their understanding of jaggery's ability to increase immunity. While, the control group, indicated a lack of significant change in awareness, with a t-value of 0.70^{NS}.

The study found that the awareness regarding jaggery's ability to relieve cough and cold showed substantial improvement, with mean awareness score of the respondents improved from 1.33 to 2.6, 1.40 to 2.53, 1.43 to 2.5, 1.33 to 2.86 and 1.43 to 2.73 in all experimental groups. Data from the control group, showed that mean awareness score of respondents in pre data was 1.26, which increased to 1.45 during post data. The difference between pre and post data mean awareness scores in all experimental groups and control group was statistically tested with t-test found significant at one and five per cent level.

Furthermore, jaggery contains considerable amount of iron, which is essential for individuals with anemia or iron deficiency, was well received by the respondents. The awareness about jaggery increases hemoglobin showed significant improvements across all experimental groups. In experimental group I mean awareness scores increased from 1.36 to 2.56, 9, in experimental group II scores improved from 1.46 to 2.43, in experimental group III scores rose from 1.5 to 2.23, in experimental group IV scores increased from 1.56 to 2.8, and experimental group V scores rose from 1.33 to 2.5. While the control group, showed a non-significant change in awareness.

The awareness about jaggery being good for lungs showed significant enhancement in all experimental

Table 3: Comparison of extension strategies for changing awareness about health benefits of jaggery (n=180)

Jaggery	Control group (n _c =30)	Experimental groups				
		Strategy I (n ₁ =30)	Strategy II (n ₂ =30)	Strategy III (n ₃ =30)	Strategy IV (n ₄ =30)	Strategy V (n ₅ =30)
Increases immunity	0.05 ^c	1.26 ^{ab}	1.16 ^{ab}	1.00 ^b	1.63 ^a	1.33 ^{ab}
Relief cough and cold	0.19 ^c	1.26 ^{ab}	1.13 ^{ab}	1.07 ^b	1.53 ^a	1.33 ^{ab}
Increases hemoglobin	0.04 ^c	1.23 ^a	0.96 ^{ab}	0.73 ^{ab}	1.23 ^a	1.13 ^a
Good for lungs	0.2 ^c	0.96 ^{ab}	0.96 ^{ab}	0.66 ^{bc}	1.33 ^a	1.23 ^{ab}
Cures indigestion	0.23 ^b	0.80 ^{ab}	0.60 ^{ab}	0.33 ^b	1.10 ^a	0.96 ^a
Cures bloating	0.13 ^d	1.00 ^{bc}	0.93 ^{bc}	0.80 ^{cd}	1.60 ^a	1.43 ^{ab}
Total	0.14 ^c	1.09 ^{bc}	0.98 ^{cd}	0.77 ^d	1.43 ^a	1.23 ^{ab}

Mean values followed with different superscripts are significantly different ($p \leq 0.05$) using Tukey's test

groups after post-intervention with the increase of mean awareness scores ranging from 1.43 to 2.5, 1.53 to 2.4, 1.46 to 2.30, 1.58 to 2.90 and 1.53 to 2.76 in experimental group I to V, respectively. In the control group, mean awareness scores was 1.16 before treatment and 1.36 after treatment, with a t-value of 1.76*, indicating a significant change in awareness.

The awareness regarding jaggery cures indigestion revealed significant improvements in all experimental groups and control group. In the experimental groups (I to V), mean awareness scores improved from 1.63 to 2.63, 1.66 to 2.26, 1.80 to 2.13, 1.7 to 2.8 and 1.83 to 2.60, respectively. In the control group, scores increased from 1.30 to 1.53, with the t-value of 2.40*, indicated a significant change in awareness.

The use of jaggery is effective in reducing bloating. The study revealed that the awareness regarding jaggery cures bloating showed significant improvements in the experimental groups ranging from I to V with mean scores 1.56, 1.53, 1.40, 1.23, 1.29 to 2.50, 2.46, 2.36, 2.70 and 2.70, respectively. This showed that there was a significant difference in the mean awareness scores before and after treatment in each experimental group (p -value ≤ 0.01).

Overall, data highlighted that the mean awareness scores for all the health benefits of jaggery significantly increased from pre to post treatment in all experimental groups, with t-values indicating significant differences at the one and five per cent level. These results demonstrated the effectiveness of the extension strategies in significantly increasing awareness about the health benefits of jaggery among respondents.

The change in awareness scores among respondents about various health benefits of jaggery, after exposing them to the intervention was calculated by subtracting their pre-intervention awareness scores from their post-intervention awareness scores. The mean change in awareness was worked out and presented in Table 3.

To determine if there was a significant difference in mean awareness change among respondents exposed to different extension strategies, a one-way ANOVA (analysis of variance) was calculated. These extension strategies were lecture by expert (Strategy I), lecture and interaction with successful entrepreneur (Strategy II), recorded video only (Strategy III), recorded video and distribution of booklet (Strategy IV) and Whatsapp messages (Strategy V). By comparing the differences in mean scores between different strategies, the effectiveness of the extension strategies was revealed.

For instance, "jaggery increases immunity" maximum change in awareness of the respondents (mean score = 1.63) was noted by strategy IV, followed by strategy V (mean = 1.33). The calculated 'F' value showed that these differences in the mean scores of change in awareness were significantly different at 0.05 level. Strategy IV was found to be most effective followed by strategy V. Strategy I and II emerged to be at par with strategy III for increasing the awareness of respondents.

Similarly, the change in awareness scores of the respondents for awareness regarding jaggery is helpful for giving relief in cough and cold was noticed as 1.53, 1.33, 1.26, 1.13 and 1.07 after exposure through strategy

IV, strategy V, strategy I, strategy II and strategy III, respectively. The differences in mean change in awareness achieved through different extension strategies were significant at 0.05 level of probability. Strategy IV was found to be most effective followed by strategy V. Strategy I and II emerged to be at par with strategy III for increasing the awareness of respondents regarding benefits of jaggery during cough and cold.

Awareness regarding “jaggery increases hemoglobin”, showed significant differences among the strategies. Strategy IV was found to be most effective followed by strategy V and strategy I with mean score of 1.23, 1.23 and 1.13. The least effective strategy was the exposure of recorded video only with a mean change in awareness score of 0.73.

There is a significant difference among the strategies, strategy IV (mean score = 1.33) emerged to be most effective as compared to other strategies in change in awareness related to benefits of jaggery for lungs. Furthermore, for use of jaggery to cure indigestion, the increase in awareness score of the respondents from the group strategy IV was 1.10 and strategy V was 0.96. The difference in mean change in awareness scores through different strategies was found to be statistically significant at 0.05 level. The findings revealed that the combination of exposure of video and receiving booklet (Strategy IV) was most effective than receiving Whatsapp messages (Strategy V) in changing respondents awareness.

Data related to “jaggery cures bloating”, highlighted the change in awareness of respondents (1.60 - 0.80) after exposure to different strategies. The analysis revealed that Strategy IV, which involved exposure of recorded video and receiving booklet was significantly more effective in changing respondents awareness compared to strategy III which relied solely on video. The difference in the mean change in awareness was significant at 0.05 level of probability.

The Tukey test depicted a significant difference in the mean scores of change in awareness among respondents at a 0.05 significance level. Strategy IV was identified to be the most effective in increasing awareness of jaggery health benefits, followed by strategy V and strategy I. Strategy II and III emerged to be at par with Strategy IV and V for changing the

awareness of respondents related to jaggery health benefits.

CONCLUSION

All extension strategies significantly increased awareness about health benefits of jaggery consumption as compared to control group. The data highlighted the significant improvements in mean awareness scores for all the health benefits at a one and five per cent significance level. The comparison of extension strategies revealed that Strategy IV (recorded video and booklet distribution) was found to be the most effective strategy in increasing the awareness because it provided a comprehensive visual and audio presentation along with written text regarding the benefits of jaggery consumption.

REFERENCES

- Fabregas, R.; M. Kremer; J. Robinson and F. Schilbach. 2017. The effectiveness of public agricultural extension: evidence from two approaches in Kenya. Retrieved from <https://pdfs.semanticscholar.org/df77/d7545d8c5f8eff49b6004e77d093b0276f32.pdf> on 20-07-2024
- Ghosh, K.; A.K. Shrivastava and V.P. Agnihotri. 1998. *Production technology of lump sugar gur/jaggery*. Pp. 271-78. Daya Publishing House, Delhi.
- Gopalan, C.; B.V.R. Shastri and S.C. Balasubramanian. 1991. *Nutritive value of Indian foods*. Pp. 14. National Institute of Nutrition Hyderabad, Indian Council of Medical Research, Hyderabad.
- Kashyap, L.; R. Bhatt and Anuradha. 2021. Sugarcane jaggery: An alternative of sugar for healthy living. *Indian Farming*, 72: 11-13.
- Kaur, C. 2003. *Developing module for imparting education in minimal processing of vegetables by women*. M.Sc. Thesis, Punjab Agricultural University, Ludhiana, India.
- Kaur, L. 2023. *Effectiveness of extension strategies for disseminating household water management practices*. Ph.D. Dissertation, Punjab Agricultural University, Ludhiana, India.
- Nath, A.; D. Dutta; P. Kumar and J.P. Singh. 2015. Review on recent advances in value addition of jaggery based products. *Journal of Food Processing & Technology*, 6: 1-4.
- Patel, D. 2018. *Development of extension strategy for managing reproductive problems in animals under different dairy production systems*. Ph.D. Dissertation. ICAR-National Dairy Research Institute (Deemed University), Karnal, Haryana.
- Quadri, H.; V. Madhavi; A. Navya; R. Jayaprakash and G. Rajender. 2022. Development of granular jaggery and

- jaggery based chocolates. *Journal of Pharmaceutical Innovation*, 11(5): 1951–1956.
- Rao, P.V.K. and Sreedevi. 2014. Jaggery quality – An option for non-traditional sugarcane growing areas. *Indian Farming*, 67: 41-44.
- Santhi, M.D. and Kokilavani. 2015. Effectiveness of video teaching programme on physical care of new born among Primigravida mothers admitted in urban health maternity centres, Coimbatore. *International Journal of Contemporary Microbiology*, 1: 114-119.
- Selvi, V.M.; M. Mathialagan and S. Mohan. 2021. The Art and Science of Jaggery Making: A Review. *Agricultural Revolution.*, 59: 23-27.
- Singh, S.R.K.; A. Mishra; V. Jallaph; A.A. Raut; R.R. Singh and S. Kumar. 2020. Measuring effectiveness of whatsapp messenger in dissemination of technological information among e-farmers in Madhya Pradesh. *Journal of Community Mobilization and Sustainable Development*, 15(1): 99-102.
- Van, C.B.; D.J. Spliman and E. Lecoutere. 2021. Information and communication technologies to provide agriculture advice to smallholder farmers: experimental evidence from Uganda. *American Journal of Agricultural Economics*, 103(1): 317-137.

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Research Article

Prevalence of Nutritional and Lifestyle Diseases among Farm Families

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ABSTRACT

The current research was conducted in the state of Punjab, focusing on examining the nutrient intake and prevalence of disease in farming families. A sample of 180 participants, consisting of 60 males, 60 females, and 60 children from farming families in Punjab, was collected through the use of an interview schedule. The purpose of this data collection was to gather information on the nutrient intake of these individuals and to assess the relationship of nutrient intake with prevalence of disease. From the study, it was found that the nutrient intake of the respondents showed that intake of energy, Vitamin C, iron and iodine was less than the estimated average requirements. The intake of fat and sodium was found to be high in all three categories of the respondents. Comparing the adequacy of nutrient intake, it was found that intake of fat was much higher in males and females as compared to children. Intake of iron was inadequate by female respondents. Whereas, fewer percentage of respondents were suffering from different dietary diseases and the prevalence of these diseases was more in females than males. Additionally, a significant correlation was found between intake of energy, protein, fat & sodium with the prevalence of dietary related diseases among the selected respondents.

Keywords: Nutrient intake, Nutrient adequacy, Lifestyle diseases, Farm families

INTRODUCTION

India, is the world's second-largest food producer, after China. It has the capacity to generate about 600 million tonnes of food every year. The demand for frozen, ready-to-cook, and ready-to-eat food is gradually expanding, particularly in India's major cities. Consumers have been more attracted to convenience foods as a result of lifestyle changes, increased purchasing power, and adapting to western culture, and overconsumption of convenience meals is one of the leading causes of obesity and other non-communicable diseases (Dhir and Singla, 2019).

Due to the rapidly fast-growing world, modernization has touched every corner of the world even the rural areas. It has been observed that even the food habits of the people living in rural areas have

also changed to a great level (Amoura *et al.*, 2020). Nowadays, people are suffering from nutrition-related problems which have never been occurred before. Many people face problems from over-nutrition to malnutrition. Such type of situation increases the risk of obesity, diabetes mellitus, cardiovascular disease, hypertension, arthritis, and several other diseases. In today's world, malnutrition, in the form of overweight and obesity is increasing and is seriously affecting health. It is also seen that a nutritional transition has occurred as many people seem to be shifting from high cereal and fiber diets to diets high in fats and sugars. The consumption of fast food has also increased causing different non-communicable diseases among the people. Thus, overall dietary habits, physical activities, daily routine, etc. together comprise the lifestyle of an individual, which determines the health of the individual.

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It's not only about what you eat when it comes to eating healthy; it's also about how you keep food secure from harmful bacteria and viruses, chemicals, and other toxins. Many incidents of the foodborne disease may be avoided if people handled their food with care: Separate raw, prepared, and ready-to-eat meals; keep food clean; cook it to safe internal temperatures; Perishable goods should be chilled as soon as possible, and frozen items should be defrosted appropriately (Duyff, 2006).

Food and meal preparation activities of families have also been linked to a variety of human health issues, including foodborne infections, from buying to consumption. Food purchase/transport should be viewed as the key determinant variables for healthy food consumption since consumers' incorrect behaviour from the first step of the food preparation affect the risk level at subsequent stages (e.g., food handling, cooking, and storage). The growth of viruses due to insufficient time-temperature control during food purchase and/or transport can indicate the possible dangers of consumers' food handling behaviour before meal preparation in the home. Foodborne infections are generally caused by microbiological risk factors associated with consumer actions in food purchasing till its storage (Cho *et al.*, 2020).

MATERIALS AND METHODS

The study was conducted in the three socio-cultural regions of Punjab, namely Malwa, Majha, and Doaba, with the aim of obtaining a representative sample of all farming families in Punjab. Twenty farming families were purposefully selected from each zone to ensure that the sample included one adult man, one adult woman, and one child aged between 9 and 12 years from each family. Therefore, a total of 180 participants were included in the study. The selected participants were personally interviewed using a structured interview schedule. Information regarding the dietary intake of the respondents was collected by using, the 24-hour recall method for three consecutive days. The food consumed by the respondents was converted into raw equivalents and the average daily nutrient intake was calculated. The nutrient intake was then compared with the suggested intake according to Estimated Average Requirements (ICMR, 2020). The following

formula was used to calculate the per cent nutritional adequacy:

$$\% \text{ Nutrient Adequacy} = \frac{\text{Intake of Nutrient}}{\text{Estimated Average Requirement}} \times 100$$

Then the total intake for the family for each nutrient was also calculated. ICMR (2014) established a consumption unit (CU) per day to express these intakes. The calorie consumption of an average adult man weighing 60 kg doing sedentary work is defined as one consumption unit. The other coefficients were calculated proportionally based on the calorie need. The total consumption units of each family were expressed in terms of adult consumption units for males, females, and children and the basis of consumption of the adult unit is given below:

Category	Adult Consumption unit coefficient
Adult Male (Sedentary)	1.0 A.U
Adult Female (Sedentary)	0.8 A.U
Children (9–12 years)	0.8 A.U

Source: ICMR (2014)

The nutrient intake of the family was then calculated as per the consumption unit as follows:

$$\text{Nutrient Intake of the family} = \frac{\text{Total amount of nutrient consumed by each family member}}{\text{Total consumption units of the family}}$$

Afterwards, Prevalence of diseases was studied in terms of the presence of common diseases that occurred due to dietary and lifestyle disorders in the family i.e., heart diseases, diabetes, hypertension, anaemia and scurvy. It was measured in yes or no response. The collected data were organized into tables and subjected to statistical analysis to interpret the findings. Statistical tests such as percentage, frequency, Arithmetic mean and Karl Pearson Coefficient of correlation were employed to analyze the data.

RESULTS AND DISCUSSION

In nutritional research, it is more common to consider food consumption in terms of nutrient intakes than in terms of food consumed. The data in Table 1 is distributed according to the nutrient intake of the respondents and is then compared to their estimated average requirement given by (ICMR, 2020). The data

Table 1: Distribution of the respondents according to their mean nutrient intake

Nutrients	Male EAR	Male (n ₁ =60)	Female EAR	Female (n ₂ =60)	Child EAR	Child (n ₃ =60)
Energy (Kcal)	2110	1747.17	1660	1800.44	2220	1972.07
Protein (g)	42.9	30.46	36.3	32.45	26.2	32.67
Fat (g)	25	39.00	20	29.90	35	44.40
Vitamin C (mg)	65	35.85	55	34.28	45	35.76
Calcium (mg)	800	627.86	800	638.07	650	689.28
Iron (mg)	11	10.31	15	10.27	12	11.38
Sodium (mg)	2000	2259.42	2000	2201.45	2000	2005.21
Iodine (µg)	95	92.46	95	92.38	100	92.89

EAR = Estimated Average Requirements

in Table 1 reveals the intake of the nutrients i.e., energy, protein, fat, Vitamin C, calcium, iron, sodium and iodine. The average daily intake of energy by the male respondents was 1747.17 Kcal which was less than the estimated average requirement i.e., 2110 Kcal, whereas, female respondents were having a high average daily intake of energy (1800.44 Kcal) than the estimated average requirement (1660 Kcal). The average daily intake of energy by child respondents (1972.07 Kcal) was found to be less than the estimated average requirement (2220 Kcal). The energy intake was found to be nearly adequate among both male and child respondents and energy intake was slightly high by female respondents. Mahajan (2011) also reported that nearly fifty per cent of the male respondents had adequate energy intake.

The results showed that the mean intake of protein in male respondents (30.46g) and female respondents (32.45g) was less than the estimated average requirement i.e., 42.9g and 36.3g for males and females, respectively. However, child respondents were having a high intake of protein (32.67g) as compared to the estimated average requirement (26.2g). The per cent adequacy was found to be 71 per cent, 89.39 per cent and 124.69 per cent for male, female and child respondents. It was observed that protein intake was low by male respondents and high by child respondents. Results are in line with those of Kaur *et al.* (2020) who observed that consumption of routine was higher in females than males.

It is shown in Table 1 that the average daily intake of total fat by male (39.00g), female (29.90g) and child (44.40g) respondents were high than the estimated

average requirement i.e., 25g, 20g and 35g for males, females and child, respectively. The adequacy of fat intake was noted as 156 per cent in male respondents, 149.5 per cent in female respondents and 126.86 per cent in child respondents. It can be concluded that fat intake of all the respondents was to be above the EAR.

Low intake of Vitamin C was observed in male (35.85 mg), child (35.76 mg) and female (34.28) respondents as compared to their estimated average requirement i.e., 65 mg, 45 mg and 55 mg, respectively. The adequacy of Vitamin C intake was observed as 55.15 per cent, 62.33 per cent and 79.47 per cent of EAR for male, female and child respondents respectively. The reason for low adequacy may be due to less intake of fruits by the respondents. Dapi (2010) also stated that the median intake of Vitamin C by all the respondents was low.

The data showed that the average daily calcium intake was low by male (627.86 mg) and female (638.07 mg) respondents as the estimated average requirement was 800 mg for both male and female, while, child respondents were having a high intake of calcium i.e., 689.22 mg than the estimated average requirement (650 mg). Adequacy of calcium intake was found to be slightly inadequate in males (78.48%) and females (79.76%). However, the calcium intake of child respondents was found to be adequate.

The data on nutrient intake revealed that the average daily intake of iron by male respondents was 10.31 mg and by child respondents was 11.38 mg. However, the average iron intake by female respondents was found to be low i.e., 10.27 mg as compared to the

estimated average requirement (15 mg). The adequacy of iron was 93.72 per cent in males and 94.83 per cent in children. Low adequacy of iron was found in female respondents (68.47) which can be due to low intake of iron rich foods and green leafy vegetables. Kumari *et al.* (2017) also studied iron deficiency in females and found that 50 per cent of them were consuming low intake of iron.

Intake of sodium was reported to be 2259.42 mg, 2201.45 mg and 2005.21 mg by male, female and child respondents respectively, which is higher than the estimated average requirement i.e., 2000mg. Sodium intake was found on the higher side in all the three categories of respondents i.e., males (112.97%), females (110.07%) and children.

A slightly low intake of iodine was observed in male (92.46 µg), female (92.38 µg), and child (92.89 µg) respondents. While the estimated average requirement of iodine was 95 µg for both male and female, and 100 µg for child. Adequate iodine intake was found in all the respondents.

Thus, it is evident from Table 1 & Figure 1 that intake of fat was much higher than EAR by all the respondents. Deficient intake of Vitamin C was found in male and female respondents. Intake of iron was found to be low in female respondents and intake of sodium was also high than the recommended amount in all the three categories of the respondents (Figure 1). Our food habits have a direct impact on our health.

Excessive or less intake of certain nutrients leads to various diseases such as heart diseases, diabetes, hypertension, anaemia and scurvy. The data in Table 2 reveals the prevalence of diet related diseases among the respondents. It was observed that 15 per cent of the total respondents suffered from anaemia followed by diabetes (13.33%), hypertension (12.78%), heart diseases (6.11%) and scurvy (5%). Further, the data reveals that the prevalence of heart disease was high in male (10%) than female (8.33%) respondents and the prevalence of diabetes was higher in females (20%) than males (18.33%) and children (1.6%). Prevalence of anaemia according to data was higher in females i.e., 20 per cent followed by children i.e., 18.33 per cent and males i.e., 6.67 per cent. No female respondent was suffering from scurvy whereas 5 per cent males and 10 per cent of children were suffering from it. Twenty per cent of the male respondents were suffering hypertension followed by 18.33 per cent of female respondents.

Table 2: Distribution of the respondents based on the prevalence of nutritional and lifestyle diseases (n=180)

Diseases	Male (n ₁ =60) f (%)	Female (n ₂ = 60) f (%)	Child (n ₃ =60) f (%)	Total (n=180) f (%)
Heart disease	6(10.00)	5(8.33)	-	11(6.11)
Diabetes	11(18.33)	12(20.00)	1(1.6)	24(13.33)
Hypertension	12(20)	11(18.33)	-	23(12.78)
Anaemia	4(6.67)	12(20.00)	11(18.33)	27(15.00)
Scurvy	3(5.00)	-	6(10.00)	9(5.00)

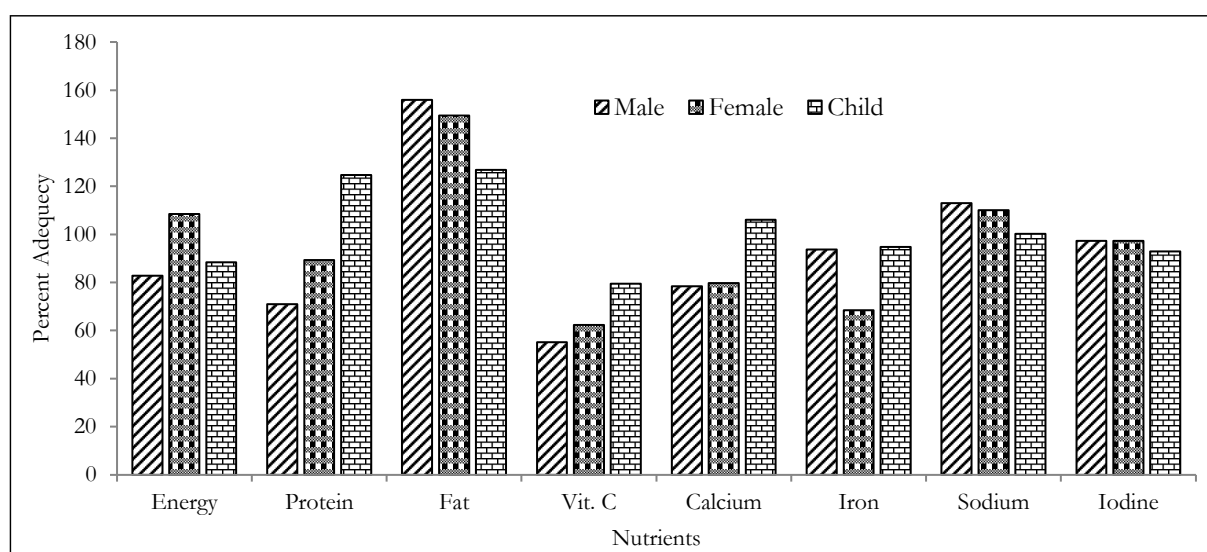


Figure 1: Percent adequacy of nutrient intake by the respondents

Table 3: Relationship between nutrient intake and prevalence of diseases (n=60)

Nutrient Intake	
Energy	0.293*
Protein	-0.268*
Fat	0.292*
Vitamin C	0.044
Calcium	0.072
Iron	-0.098
Sodium	0.271*
Iodine	0.003

*Significant at 5% level of significance

Overall, the data reveals that the prevalence of diet-related diseases were highest in females than in males and children.

Data in Table 3 indicates the relationship between food habits and the prevalence of diseases in the selected families. From the data, it was observed that frequency of consumption of energy intake ($r=0.293$), fat intake ($r=0.292$) and sodium intake ($r=0.271$) was positively and significantly correlated with the prevalence of the disease among the family members whereas protein intake is negatively and significantly correlated to the prevalence of the diseases in the families. It can be concluded that with the increased intake of energy, fat and sodium, the number of diseases increased in a family. Whereas intake of protein showed an inverse relationship which means that with high intake of protein number of diseases decreases. Similar findings were reported by Missra *et al.* (2011) and Missra *et al.* (2010) who found that consumption of energy intake was significantly associated with certain diseases.

CONCLUSION

It may be concluded for the research findings that the intake of some of the nutrients was on the higher end whereas the consumption of other nutrients was inadequate. This imbalance might be one of the reasons for the prevalence of certain diseases in the respondents. Therefore, community-based interventions through awareness campaigns, training camps, nutritional counselling, etc. should be planned to emphasize the role of a balanced diet in maintaining good health.

REFERENCES

- Amoura, C.B.; B. Pandeya; M. Reba; S. Ahmad; F. Creutzgib and K.C. Setoa. 2020. Urbanization, processed foods, and eating out in India. *Global Food Security*, 25: 100361.
- Cho, T.J.; S.E. Kim; H.W. Kim; S.M. Park and M.S. Rhee. 2020. Changes in consumers' food purchase and transport behaviors over a decade (2010 to 2019) following health and convenience food trends. *International Journal of Environmental Research and Public Health*, 17: 5448.
- Dapi, L.N. 2010. Socioeconomic and sex differences in adolescents' dietary intake, anthropometry and physical activity in Cameroon, Africa. *Journal of Epidemiol & Global Health*, 7: 783-795.
- Dhir, B. and N. Singla. 2019. Consumption pattern and health implications of convenience foods: A practical review. *CJAST*, 38(6): 1-9.
- Duyff, R.L. 2006. American Dietetic Association complete food and nutrition guide. John Wiley & Sons Inc, Hoboken, New Jersey.
- ICMR. 2020. Recommended Dietary Allowances and Estimated Average Requirements Nutrient Requirements for Indians-2020 National Institution of Nutrition, Indian Council of Medical Research, Hyderabad, India.
- Kaur, M.; R. Kaur and P. Walia. 2020. Exploring gender disparity in nutritional status and dietary intake of adolescents in Uttarkashi. *Indian Journal of Human Development*, 14: 115-127.
- Kumari, R.; R.K. Bharti; K. Singh; A. Sinha; S. Kumar; A. Saran and U. Kumar. 2017. Prevalence of iron deficiency and iron deficiency anaemia in adolescent girls in a tertiary care hospital. *Journal of Clinical and Diagnostic Research*, 11: BC04.
- Mahajan, N. 2011. *Food Consumption Pattern and Nutritional Status of Urban and Rural Adolescent Boys*. M.Sc. thesis, Punjab Agricultural University, Ludhiana.
- Misra, A.; N. Singhal and L. Khurana. 2010. Obesity, the metabolic syndrome, and type 2 diabetes in developing countries: role of dietary fats and oils. *Journal of the American College of Nutrition*, 29(3): 289S.
- Misra, A.; N. Singhal; B. Sivakumar; N. Bhagat; A. Jaiswal and L. Khurana. 2011. Nutrition transition in India: secular trends in dietary intake and their relationship to diet-related non-communicable diseases. *Journal of Diabetes*, 3(4): 278-292.



Research Article

Constraints in Adoption of Environmentally Friendly Agricultural Practices as Perceived by the Farmers: A Garrett Ranking Analysis

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ABSTRACT

The agriculture sector contributes around 18.3 percent to the country's gross domestic product and generates employment for approximately half of the country's population. India has a rich history of farming practices that are deeply grounded in the culture and traditions of the country. Owing to the diverse agro-climatic regions and traditional knowledge, there is significant potential for natural and organic products. Environmentally friendly agricultural practices are farming methods that sustainably preserve the state of the environment, soil health, water availability, production, and productivity. It includes natural and organic farming, which helps to restore soil fertility, and the use of bio-formulations, green manures, mulching, crop rotation, and animal manure. The components prepared in natural farming are backed by rich traditional knowledge and are a practice of agriculture based on locally available resources, which makes it a sustainable and viable practice. Through natural farming, soil organic matter and soil fertility are restored, less water is required, and a climate-friendly agricultural system is promoted. This study was conducted in Haryana and Uttarakhand states to identify the constraints faced by farmers in adopting environmentally friendly agricultural practices. Four districts were selected purposively (Karnal and Jind from Haryana state, Nainital, and Almora from Uttarakhand) with the highest number of registered farmers on PGS-India as natural crop growers for comparison in plain and hill regions. From each district, 60 respondents were selected, which consisted of 30 respondents registered in PGS-India as natural crop growers, constituting a sample size of 120. Farmers faced constraints in the adoption of natural agricultural farming practices, which may vary depending on the region, socio-economic constraints, technological advancement, and ecological constraints. The major findings of the study were that most farmers faced constraints such as high labor cost in the preparation of bio-formulations", "unwillingness of consumers to pay a high price for organic produce", "short-shelf life of natural formulations", "lack of package of practice for organic production", and "poor market linkage". The identified constraints would be a useful input for policy planners to increase the adoption of environmentally friendly agricultural practices among farmers.

Keywords: Adoption, Environmentally friendly, Natural farming, Constraints, Organic farming

INTRODUCTION

India has a significant potential for use in natural and organic products owing to its diverse agro-climatic regions and traditional knowledge. According to (APEDA, 2023) India has 4.3 million hectares of land under organic farming, a composite of wild harvest

(1.6 million hectares) and cultivable land (2.6 million hectares). Uttarakhand officially certified 23 percent of its total land for organic farming and was the first Indian state to introduce a state-level act on organic farming. Under certified organic farming, the Haryana state has 5,303 ha of land, of which 4,903 ha is under the

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National Programme for Organic Production and 400 ha under partnership guarantee system certification (Singh, 2012). In organic farming, green manuring crops are grown, and vermicompost, oil cakes, farmyard manure, and bio-fertilizers are utilized to promote soil health, enhance biodiversity, and provide healthy food (Das *et al.*, 2021). Crop rotation, bio-pesticides such as agniastra, neem-based formulations, bio-control agents, stale seed beds, and other environmentally friendly agricultural practices are used in natural farming. Moreover, organic farming promotes economic, environmental, and social sustainability, and supports sustainable development goals (Bandanaa *et al.*, 2021). However, there are barriers to the adoption of natural and organic farming. With this consideration, the present study was conducted with the objective of constraining the adoption of natural farming practices as perceived by farmers.

MATERIALS AND METHODS

The present study was undertaken purposively in Haryana and Uttarakhand states. From each state two districts namely Almora and Nainital from Uttarakhand and Karnal and Jind from Haryana state on the basis of highest number of registered farmers as natural crop growers in PGS-India. From each district two blocks were selected randomly and from each block 30 farmers were interviewed. Thus, the total sample size consists of 120 respondents. The data regarding constraints faced by farmers in adoption of natural agricultural farming practices were collected using interview schedule. Based on the inputs from the review of literature, pilot study and expert suggestions various constraints were identified and categorized. The farmers were asked to rank these constraints from 1 to 25. The responses were analyzed by using Garrett Ranking Technique.

Garret ranking. It is a method to rank the preferences indicated by the respondents on different factors. Factors having highest mean value are considered as the most important.

Steps:

1. Assigning ranks to the factors based on responses from respondents.
2. Converting ranks into percent positions with the help of formula.

$$\text{Percent position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

R_{ij} = Rank given for the i^{th} factor by the j^{th} respondent

N_j = Number of factors ranked by the j^{th} respondent.

3. Assigning scores to percent positions with the help of Garret table.
4. Calculating mean scores of all the factors.
5. Assigning ranks to the factors based on the mean value

RESULTS AND DISCUSSION

The constraints faced by the farmers were grouped into five categories which includes infra-structural constraints, economic constraints, technological constraints, ecological constraints and socio-psychological constraint.

Infra-structural constraints faced by the farmers:

The findings in the Table 1 revealed that the most of the farmers of Haryana faced the problem of lack of access to financial institution for funding organic farming with 55.00 mean score and was assigned first rank followed by poor market linkage with 47.70 mean score and was assigned second rank, inadequate training facilities with 36.00 mean score and was assigned third rank. Whereas, lack of storage facility for biopesticides and biofertilizers lack of timely information regarding practices with 32.23 mean score and less availability of natural formulation in market with mean score 29.24 was given fourth and fifth rank respectively. The farmers of Uttarakhand also faced constraints such as poor market linkage with 70.63 mean score and was given first rank followed by lack of access to financial institution for funding organic farming with 45.30 mean score and was assigned second rank, lack of storage facility for biopesticides and biofertilizers with 41.72 mean score and was given third rank. Whereas, inadequate training facilities with 38.65 mean score and less availability of natural formulation in market with 28.22 mean score was assigned fourth and fifth rank respectively. From the pooled data poor market linkage with 69.04 mean score was the biggest constraints faced by farmers followed by lack of access to financial institution for funding organic farming with 42.55 mean score, lack of storage facility for biopesticides and biofertilizers with 39.09 mean score. Whereas,

Table 1: Infra-structural constraints faced by the farmers in adoption of environmentally friendly agricultural practices

S.No.	Infra-structural constraints	Haryana (n=60)		Uttarakhand (n=60)		Pooled (n=120)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Poor market linkage	47.70	II	70.63	I	69.04	I
2.	Lack of access to financial institution for funding organic farming	55.00	I	45.30	II	42.55	II
3.	Lack of storage facility for biopesticides and biofertilizers	32.23	IV	41.72	III	39.09	III
4.	Inadequate training facilities	36.00	III	38.65	IV	32.25	IV
5.	Less availability of natural formulation in market	29.24	V	28.22	V	30.76	V

inadequate training facilities with 32.25 mean score and less availability of natural formulation in market with 30.76 mean score was least faced by the farmers. The extension agents can overcome this constraint by helping the farmers to establish linkage with local markets and consumers who value organic produce. This can create a demand pull for organic products encouraging farmers to invest in necessary infrastructure to meet market demand. Kumara *et al.* (2015) concluded that the constraints perceived were high transport cost, lack of exclusive organic market, lack of subsidy support in conversion period and inability to obtain premium price for produce. Ravindran and Kalamkar (2020) founded the constraints in organic and natural farming include supply and demand uncertainty, processing technology, certification costs, and market development. The government policies are crucial to address these challenges for organic agribusiness growth in India. Papzan and Shiri (2012) in the study of Barriers toward development of organic farming reported the lack of adequate infrastructure is a significant barrier which includes insufficient facilities for processing and distributing organic products. The extension services can overcome this constraint by helping the farmers

to establish linkage with local markets and consumers who value for natural and organic products. This can create a demand pull for organic products encouraging farmers to invest in necessary infrastructure to meet market demands.

Economic constraints faced by the farmers: The findings in the Table 2 revealed that the most of the organic farmers of Haryana faced the problem of high labor cost for preparation of natural formulations with 71.30 mean score and was assigned first rank followed by lack of provision of subsidized credit facilities with 60.00 mean score and was assigned second rank, low price for organic produce in locality with 41.70 mean score and was assigned third rank. Whereas, lack of market for organic produce in locality with 38.56 mean score and high cost of biofertilizers in market with 30.89 mean score was given fourth and fifth rank respectively. The organic framers of Uttarakhand faced the major problem of low price for organic produce in locality with 69.40 mean score and was given first rank followed by lack of provision of subsidized credit facilities with 55.70 mean score and was assigned second rank, lack of market for

Table 2: Economic constraints faced by the farmers in adoption of environmentally friendly agricultural practices

S.No.	Economic constraints	Haryana (n=60)		Uttarakhand (n=60)		Pooled (n=120)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	High labor cost for preparation of natural formulations	71.30	I	41.78	IV	72.02	I
2.	Low price for organic produce in locality	41.70	III	69.40	I	67.00	II
3.	Lack of provision of subsidized credit facilities	60.00	II	55.70	II	54.03	III
4.	Lack of market for organic produce in locality	38.56	IV	53.15	III	46.68	IV
5.	High cost of biofertilizers	30.89	V	34.43	V	41.05	V

organic produce in locality with 53.15 mean score and was given third rank. Whereas, high labor cost for preparation of natural formulations with 41.78 mean score and high cost of biofertilizers in market with 34.43 mean score was assigned fourth and fifth rank respectively.

From the pooled data high labor cost for preparation of natural formulations with 72.02 mean score was the biggest constraints faced by organic farmers followed by low price for organic produce in locality with 67.00 mean score, lack of provision of subsidized credit facilities with 54.03 mean score. Whereas, lack of market for organic produce in locality with 46.68 mean score and high cost of biofertilizers in market with 41.05 mean score was least faced by the organic farmers. Extension agents can assist farmers in accessing credit and financing options, such as loans, grants or subsidies specifically targeted at supporting organic farming initiatives. Farmer can be encouraged to form groups or cooperatives so that working together in farm operations can lead to economies of scale, joint purchasing of inputs and collective marketing which can lower the costs and increase income opportunities Singh (2021) who reported that the laborious nature of organic farming was one of the major reasons for the non-adoption of organic farming as reported by 40.00 percent respondents in Haryana, about 27.00 percent in Uttarakhand, about 22.00 percent respondents in Punjab and 10.00 percent respondents in Himachal Pradesh. Other reasons for non-adoption were lack of organized market for organic produce, unsuitability of soil and risk in organic farming. Extension agents can assist farmers in accessing credit and financing options, such as loans, grants or subsidies specifically targeted at supporting organic

farming initiatives. Farmers can be encouraged to form groups or cooperatives so that working together in farm operations can lead to economies of scale, joint purchasing of inputs and collective marketing which can lower the costs and increase income opportunities Singh and Thakur (2022) founded the major constraints were low productivity of organically cultivated crops and challenges in marketing organic produce due to a lack of specialized agencies. The farmers faced difficulty in certifying natural and organic produce, emerging problems such as crop loss due to birds and stray animals were also reported, indicating additional challenges for organic farmers Argyropoulos *et al.* (2013) study also revealed the lack of labeled products, financial support based on land area, and farmers prioritizing subsidies over labeling and marketing organic products were the constraints in organic farming.

Technological constraints faced by the farmers:

The results presented in the Table 3 revealed that the most of the organic farmers of Haryana faced the problem of lack of reliable package of practices with 58.60 mean score and was assigned first rank followed by lack of standard of procedure for preparing natural formulations with 58.60 mean score and was assigned second rank, short shelf life of natural formulations with 47.65 mean score and was assigned third rank. Whereas, lack of timely information regarding practices with 34.65 mean score and lack of technical know-how for organic farming in training institute with 28.97 mean score was given fourth and fifth rank respectively. The natural crop growers of Uttarakhand faced the major problem of lack of standard of procedure for preparing natural formulations with 58.85 mean score and was given first rank followed by lack of reliable

Table 3: Technological constraints faced by the farmers in adoption of environmentally friendly agricultural practices

S.No.	Technological constraints	Haryana (n=60)		Uttarakhand (n=60)		Pooled (n=120)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Lack of reliable package of practices	58.60	I	55.40	II	52.00	I
2.	Short shelf life of natural formulations	47.65	III	51.82	III	49.50	II
3.	Lack of timely information regarding practices	34.65	IV	38.00	V	48.67	III
4.	Lack of standard of procedure for preparing natural formulations	55.68	II	58.85	I	44.98	IV
5.	Lack of technical know-how for organic farming in training institute	28.97	V	34.23	IV	41.67	V

package of practices with 55.40 mean score and was assigned second rank, short shelf life of natural formulations with 51.82 mean score and was given third rank. Whereas, lack of timely information regarding practices with 38.00 mean score and lack of technical know-how for organic farming in training institute with 34.23 mean score was assigned fourth and fifth rank respectively. From the pooled data lack of reliable package of practices with 52.00 mean score was the biggest constraints faced by natural crop growers followed by short shelf life of natural formulations with mean score 49.50, lack of timely information regarding practices with 48.67 mean score. Whereas, lack of standard of procedure for preparing natural formulations with 44.98 mean score and lack of technical know-how for organic farming in training institute with 41.67 mean score was least faced by the organic farmers. Azam *et al.* (2019) reported that limited knowledge about premium prices, costly transportation, variation in the price of the crops, and insufficient support from the government were the major problems. Kabir *et al.* (2007) in the study on constraints of adopting ecofriendly rice farming practices founded the lack of extension services, limited government support, and few alternatives to pesticides during severe infections were hindering organic farming adoption. Kumar *et al.* (2023) reported the scarce raw materials, lack of knowledge on liquid fertilizers, high labor wages, limited market structure, and market integration as the major challenges. About 94.2 percent of farmers found the non-availability of improved organic production technology is a significant barrier to the adoption of organic farming (Shehrawat *et al.*,

2016). So, there is a need to disseminate the relevant information and best practices related to organic farming through pamphlets, workshop and digital platforms.

Socio-psychological constraints faced by the farmers: The data in the Table 4 revealed that the most of the organic farmers of Haryana faced the problem of declining interest due to shortage of owned resources with 53.80 mean score and was assigned first rank followed by belief that organic farming does not produce as much as yield as chemical farming with 50.27 mean score and was assigned second rank, unwillingness of consumers to pay high price for organic produce with 43.00 mean score and was assigned third rank. Whereas, inclination towards use of chemical farming due to high observability with 42.56 mean score and natural formulations not widely used by fellow farmers in village with 34.00 mean score was given fourth and fifth rank respectively. The organic farmers of Uttarakhand faced the major problem of unwillingness of consumers to pay high price for organic produce with 53.00 mean score and was given first rank followed by belief that organic farming does not produce as much as yield as chemical farming with 52.50 mean score and was assigned second rank, declining interest due to shortage of owned resources with 42.50 mean score and was given third rank. Whereas, natural formulations not widely used by fellow farmers in village with 39.65 mean score and inclination towards use of chemical farming due to high observability with 35.80 mean score was assigned fourth and fifth rank respectively. From the pooled data unwillingness of consumers to pay high price for

Table 4: Socio-psychological constraints faced by the farmers in adoption of environmentally friendly agricultural practices

S.No.	Socio-psychological constraints	Haryana (n=60)		Uttarakhand (n=60)		Pooled (n=120)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Unwillingness of consumers to pay high price for organic produce	43.00	III	53.00	I	62.63	I
2.	Declining interest due to shortage of owned resources	53.80	I	42.50	III	54.65	II
3.	Belief that organic farming does not produce as much as yield as chemical farming	50.27	II	52.50	II	43.92	III
4.	Inclination towards use of chemical farming due to high observability	42.56	IV	35.80	V	41.35	IV
5.	Natural formulations not widely used by fellow farmers in village	34.00	V	39.65	IV	32.78	V

Table 5: Ecological constraints faced by the farmers in adoption of environmentally friendly agricultural practices

S.No.	Ecological constraints	Haryana (n=60)		Uttarakhand (n=60)		Pooled (n=120)	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1.	Long period to convert from conventional farming to organic farming	45.30	I	39.75	I	47.68	I
2.	Extreme climate events like hail storm/heat waves	22.80	V	37.53	II	31.04	II
3.	High diseases incidence compared to chemical farming	29.00	II	24.27	V	27.73	III
4.	High insect attack compared to chemical farming	27.56	III	25.42	IV	26.67	IV
5.	Water availability is less to prepare liquid formulation	24.34	IV	26.45	III	25.98	V

organic produce with 62.63 mean score was the biggest constraints faced by organic farmers followed by declining interest due to shortage of owned resources low price for organic produce in locality with 54.65 mean score, belief that organic farming does not produce as much as yield as chemical farming with 43.92 mean score. Whereas, inclination towards use of chemical farming due to high observability with 41.35 mean score and natural formulations not widely used by fellow farmers in village with 32.78 mean score was least faced by the organic farmers. The study of (Azam *et al.*, 2019) reported that inadequate consumer demand as the significant problem and (Ghanghas *et al.*, 2021) reported that inclination towards use of chemical pesticides due to high visual impact was top ranked among the constraints.

Ecological constraints faced by the farmers: The data in the Table 5 clarify that the most of the organic farmers of Haryana faced the problem of long period to convert from conventional farming to organic farming with 45.30 mean score and was assigned first rank followed by high diseases incidence compared to chemical farming with 29.00 mean score and was assigned second rank, high insect attack compared to chemical farming with 27.56 mean score and was assigned third rank. Whereas, water availability is less to prepare liquid formulation with 24.34 mean score and extreme climate events like hail storm/heat waves with 22.80 mean score was given fourth and fifth rank respectively. The organic farmers of Uttarakhand faced the major problem of long period to convert from conventional farming to organic farming with 39.75 mean score and was given first rank followed by extreme climate events like hail storm/heat waves with 37.53 mean score and was assigned second rank, water

availability is less to prepare liquid formulation with 26.45 mean score and was given third rank. Whereas, high insect attack compared to chemical farming with 25.42 mean score and high diseases incidence compared to chemical farming with 24.27 mean score was assigned fourth and fifth rank respectively. From the pooled data long period to convert from conventional farming to organic farming with 47.68 mean score was the major constraint faced by organic farmers followed by extreme climate events like hail storm/heat waves with 31.04 mean score, high diseases incidence compared to chemical farming with 27.73 mean score. Whereas, high insect attack compared to chemical farming with 26.67 mean score and water availability is less to prepare liquid formulation with 25.98 mean score was least faced by the organic farmers. The study (Ghanghas *et al.*, 2021; Kumar *et al.*, 2023) reported the low production during conversion period, and slow process due to long conversion period as the significant problem in adoption of organic farming.

CONCLUSION

The major identified constraints were high labor cost in preparation of bio-formulations, unwillingness of consumers to pay high price for organic produce, short-shelf life of natural formulations, lack of package of practice for organic production and poor market linkage. It can be concluded that there is need for an efficient planning and execution on the ground level to overcome the challenges faced in adoption of environmentally friendly agricultural practices. The timely dissemination of information through mass media to the specific target groups as well as to establish consumer to producer proper channels is very

necessary. Thus, focused and detailed interventions is need to be implemented by the working agencies at the local level for natural and organic farming practices.

REFERENCES

- APEDA. 2023. Organic Products: National Programme for Organic Production (NPOP). *Agricultural & Processed Food Products Export Development Authority (APEDA)*. Retrived <https://apeda.gov.in/apedawebsite/organic/organic-products>. Retrieved on April 4, 2023.
- Argyropoulos, C.; M.A.S. Tsiafouli; S.P. Gardelis and J.D. Pantis. 2013. Organic farming without organic products. *Land use Policy*, 32: 324-328.
- Azam, M.S. and M. Shaheen. 2019. Decisional factors driving farmers to adopt organic farming in India: a cross-sectional study. *International Journal of Social Economics*, 46(4): 562-580.
- Bandanaa, J.; I.K. Asante; I.S. Egyir; C. Schader; T.Y. Annang; J. Blockeel; I. Kadzere and A. Heidenreich. 2021. Sustainability performance of organic and conventional cocoa farming systems in Atwima Mponua District of Ghana. *Environmental and Sustainability Indicators*, 11: 100121.
- Das, S.; A. Chatterjee and T.K. Pal. 2021. Organic farming in India: A vision towards a healthy nation. *Food Quality and Safety*, 4(2): 69-76.
- Ghanghas, B.S.; A.K. Rohila; P.K. Chahal and R. Mukteshwar. 2021. Prospects and constraints experienced in organic farming by farmers. *The Indian Journal of Agricultural Sciences*, 91(10).
- Harish, N. 2020. Organic farming in India: status, constraints and challenges. *Shanlax International Journal of Economics*, 8(3): 11-15.
- Heena, M.D.P. and P.O.O.J.A. Pant. 2022. Constraints faced by farmers practicing organic farming in Haryana. *Pollution Research*, 41(1): 158-163.
- Kabir, M.S.; M.E. Haque; M.M. Uddin; A.M. Samsuddula and M.M.H. Sarker. 2007. Constraints of Adopting Ecofriendly Rice Farming Practices. *Journal of Innovation and Development Strategy*, 1(1): 6-11.
- Kumar, S.; M.S. Nain and V. Sangeetha. 2023. Determinants and Constraints for Adoption of Zero Budget Natural Farming (ZBNF) Practices in Farmer Field School. *Indian Journal of Extension Education*, 59(4): 135-140.
- Papzan, A. and N. Shiri. 2012. Study of barriers toward development of organic farming. *Space Economy and Rural Development*, 1(1): 113-126.
- Ravindran, P.Y. and S.S. Kalamkar. 2020. Organic agribusiness in India: status, potential, and constraints. *Indian Journal of Economics and Development*, 16(2s): 160-167.
- Shehrawat, P.S.; R. Mukteshwar and N.A.B. Saeed. 2016. Study of constraints analysis in organic farming cultivation in Sonipat and Hisar district of Haryana state, India. *Journal of Applied and Natural Science*, 8(1): 100-106.
- Singh, A. and R.K. Thakur. 2022. Understanding the perception, constraints and reasons for the adoption of organic farming. *Indian Research Journal of Extension Education*, 22(5): 110-117.
- Singh, D. 2021. Comparative Study of Conventional and Organic Farming in Northern India. Ph.D. Thesis. Punjab Agricultural University Ludhiana, India.
- Singh, S.; R. George and B. Prafull. 2012. Organic farming practices of plains and hills farmers and their extent of compliance with national program for organic production (NPOP) guidelines. *Journal of Agricultural Sciences*, 3(1): 55-62.

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Research Article

Perception of Faculty towards Online Education in State Agricultural Universities

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ABSTRACT

The covid-19 pandemic had forced the closure of educational institutions all over the world. To maintain academic activities, educational institutions had shifted to online learning platforms. Since, online education was new concept in India, especially in State Agricultural Universities (SAU's). Therefore, present study was planned to access perception of faculty towards online education. Data were collected through questionnaire and Google form from 120 faculty members equally distributed in Punjab Agricultural University, Ludhiana and Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh. The findings of the study revealed that faculty had medium level of perception towards online education. However, respondents also reported that in agricultural education system, many courses are practical in nature, therefore it is not possible to shift completely to online mode and faculty preferred a blended mode of education. Age and teaching experience of faculty was negatively and significantly related to perception towards online education. This suggests that as age of faculty members' increases, their perception towards online education tends to decrease. The negative correlation might indicate that younger faculty members were more likely to embrace and actively participate in online teaching methodologies, while older faculty members might be more resistant or less inclined to adopt these methods.

Keywords: State Agricultural Universities, Online education, Perception

INTRODUCTION

Online education is rapidly becoming a prominent trend in the global education market. This educational approach relies on the internet as its primary medium for delivering instruction. It represents a teaching and learning methods that utilizes technology. Under the umbrella of online education, students can complete their entire courses or academic years (Anderson, 2008) through digital means. This approach provides students with the flexibility to study from the comfort of their homes or any other location that suits their convenience. Additionally, they can access the learning materials, guidance experts and educators available on the internet. The educational institutions accepted and encouraged the online education for learning, the educational

scenario in the world has been changed to online education in order to continue academic year after the Covid- 19 out break. The rise of globalization has positioned Information and Communication Technology (ICT) tools as the pivotal technology of the information age, as highlighted (Castells, 2014). Consequently, individuals worldwide have come to acknowledge the internet as their most recent instrument for development (Sethi, 2004).

Everyone in the educational system is adopting the new methods of teaching and learning process using the technology (Mamattah, 2016). Transitioning to online teaching faculty experienced difficulty to adopt online education though they have good teaching experience in their own subject. There were cases where

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faculty members began cultivating an interest in online mode of teaching and promptly embraced the strategies. Conversely, some instructors who encountered difficulties in adapting began identifying weaknesses towards the online teaching and learning system (Joshi, 2020).

Most of the teachers are getting trained for the ease use of the technology and also to avoid the complications during the class. All the study material is mailed or posted in the form of pdf or word file or PPT format so that it will be easy for the students to study. Traditionally, the education done by using chalk & board and face to face teaching. Later on due to the huge advancements in the technology the scenario has been changed from chalk and talk method traditional education to remote kind of learning (Almahasees, 2021). Teachers started using projectors, microphones, virtual and smart classrooms to teach the students. Various apps like WhatsApp, Google Classroom, Zoom, Skype, Microsoft Teams, Google hangouts etc., are being used for online education and communication between the teacher and student (Rahayu and Wirza, 2020). Both the teacher and the students can schedule classes at any time that is convenient for them (Mahmodi, 2017). Better time management, convenience, cost effective flexibility (Aithal and Aithal, 2016) and self-paced learning, improved self-motivation, the development of new technological skills, ease of access to online content regardless of location and time (Anderson 2008) are various advantages of online education.

A paradigm change from conventional to technology-driven teaching occurred in the most widely used educational system. E-learning platforms were introduced, and with time, they gained popularity. E-learning was being used by numerous institutions throughout the world to instruct and develop their faculty (Bhavani, 2022).

If faculty perceptions are positive towards the use of online educational technology then they can easily provide useful insight about integrating of technology into teaching and learning process. Online education is still a relatively new method of teaching and learning in India especially in State Agricultural Universities (SAU's). As a result, faculty perception towards online education is important in facilitating online learning

environment. Hence, the present study has been planned to assess the perception level of online education by the faculty of State Agricultural Universities of India.

MATERIALS AND METHODS

The present study was carried out in two Agricultural Universities i.e., Punjab Agricultural University (PAU), Ludhiana, Punjab and Acharya N G Ranga Agricultural University (ANGRAU), Lam, Guntur, Andhra Pradesh. From each of the university 60 faculty members engaged in online teaching were selected randomly. The study includes 20 Assistant Professors, 20 Associate Professors and 20 Professors. Thus, in total 120 faculty members from both the universities constituted the sample of the study. Data was collected by using Google forms and questionnaire. Statements were prepared to study perception of faculty in terms of perceived usefulness and perceived ease of use towards online education. The responses were recorded on the five point scale i.e., strongly agree, agree, neutral, disagree, strongly disagree. The collected data was subjected to qualitative as well as quantitative analysis. The statistical tests i.e. Arithmetic mean, values, t - test, chi square test and Karl Pearson Coefficient of correlation (r) were used for analyzing the data.

RESULTS AND DISCUSSION

Table 1 highlights the perceived usefulness of online education. Both PAU and ANGRAU faculty acknowledged the role of the COVID-19 pandemic in facilitating access to e-learning resources. The mean scores for this statement of both the universities are quite close, with PAU at 4.60 and ANGRAU at 4.65. This indicates a shared belief that the pandemic has encouraged the use of e-learning resources. ANGRAU faculty secured slightly high mean score of 2.50 for the statement, "improvement in job performance due to online education" compared to PAU faculty (mean score 2.33). ANGRAU faculty also believed that online education enables them to accomplished tasks more quickly, as indicated by their mean score of 3.25, whereas PAU faculty had a mean score of 3.60. Faculty from both the universities agreed that online education helps in clarifying doubts through various communication channels like chat, call, or email. However, ANGRAU faculty (mean score 3.05) seem to have a slightly higher belief in this aspect compared

Table 1: Faculty perceived usefulness regarding online education (n=120)

Statements	PAU (n ₁ =60)	ANGRAU (n ₂ =60)	t value	Over all mean
COVID-19 pandemic helped teachers to access various e- learning resources.	4.60	4.65	0.87	4.62
Improved job performance of teachers through online education.	2.33	2.50	0.69	2.41
Online education enabled teachers to accomplish task more quickly.	3.60	3.25	1.56	3.42
Did not help me to improve on my digital creativity.	2.07	2.17	0.42	2.12
There is better faculty-teacher interaction.	2.17	1.90	1.17	2.03
Doubts can be clarified using chat box/ call/email in using online education.	2.88	3.05	0.80	2.96
Ppt's or other similar tools makes lessons interesting.	3.97	3.55	2.07*	3.76
Rapidly delivers information to the learners.	4.35	4.12	0.08	4.23
More interactive than traditional learning.	2.30	2.33	0.14	2.31
Syllabus is covered easily	3.02	2.92	0.42	2.97
A participatory, collaborative and active form of education.	2.43	2.17	1.27	4.17
Enhances the effectiveness of communication.	4.26	4.63	1.90	4.44
Due to its virtual accessibility, online education is convenient.	4.02	3.67	1.58	3.84
Content creation for online education is not time consuming.	2.72	2.50	0.90	2.61
Helps to catch individual faculty needs.	2.33	2.50	0.69	2.41

Score range = 1-5,*significant at 0.05

to PAU faculty (mean score 2.88). ANGRAU faculty also showed greater agreement that there is better faculty teacher interaction in online teaching (mean score 1.90) compared to PAU (mean score 2.17). While both groups agreed that online education enhances the effectiveness of communication, ANGRAU faculty (mean score 4.63) exhibit a stronger belief in this aspect than PAU faculty (mean score 4.26).

Similarly, ANGRAU faculty had a higher mean score (4.12) for the statement “rapidly delivers information to the learners” compared to PAU faculty (mean score 4.35). PAU faculty (mean score 3.97) seem to find PowerPoint presentations and similar tools more interesting in online lessons compared to ANGRAU faculty (mean score 3.55). Additionally, ANGRAU faculty (mean score 2.17) perceived online education to be more participatory, collaborative, and active compared to PAU faculty (mean score 2.43). Both groups recognize the convenience of online education due to its virtual accessibility, with PAU faculty (mean score 4.02) and ANGRAU faculty (mean score 3.67). Faculty also believed that online education helps in catching individual faculty needs, with ANGRAU faculty (mean score 2.50) slightly more inclined to this idea compared to PAU faculty (mean score 2.33). Disagreement to the statement that content creation

for online education is time consuming was reported by fewer respondents with mean score of 2.72 from PAU and 2.50 from ANGRAU

Data in Table 2 pertains to faculty perceived ease of use regarding online education. Findings illustrates that objective paper evaluation is standout strength of online education as reported by faculty of both the universities with overall mean score of 4.70. The ease of evaluating objective answer sheets garners the highest scores from both the universities reinforcing the efficiency of digital assessment strategies. Marking online attendance also receives high mean score (4.45) as far as ease of use of online education was concerned. This indicates the efficacy of attendance management in the digital sphere. While both universities acknowledge the importance of interacting via chat, email, and phone, ANGRAU indicates a slightly lower mean score (3.32) than PAU (3.95). This implies a potential variance in communication preferences of faculty of both the universities. Additionally, both universities perceived the potential for online education to simplify teaching processes, though ANGRAU (3.10) sees this as more feasible than PAU (2.77). This suggests an evolving acceptance of online tools as facilitators of streamlined teaching. Online education's convenience for instructors is not acknowledged yet ANGRAU

Table 2: Faculty perceived ease of use regarding online education (n=120)

Statements	PAU (n ₁ =60)	ANGRAU (n ₂ =60)	t value	Over all mean
It is easy to				
to interact via chat, email, and phone	3.95	3.32	3.12**	3.63
to make ppt's, word file and video recordings for lectures	2.93	2.87	0.25	2.90
to perform searches and download documents	3.63	3.28	1.61	3.45
to download software's and apps to computer to facilitate online teaching.	2.75	2.62	0.49	2.68
to manage time efficiently.	3.65	3.30	1.93	3.47
for doing multi-tasking is easy during online classes.	2.73	2.87	0.53	2.8
to release the grade sheets online.	4.10	3.98	1.84	4.04
to mark online attendance	4.26	4.64	1.90	4.45
The interaction between faculty and teacher is clear.	2.48	2.65	0.79	2.56
Online education can simplify the teaching process.	2.77	3.10	1.73	2.93
Online platforms are user friendly.	3.37	3.37	0.00	3.37
The setup of online education is compatible with the way of teachers teaching method.	2.37	2.18	0.71	2.27
Convenient for the learner and the instructor.	2.53	2.78	1.16	2.65
Evaluation of objective answer sheets is easy using online education.	4.78	4.62	0.88	4.70
Evaluation of descriptive answer sheets is easy using online education.	1.17	1.90	0.24	1.53

Score range = 1-5, **significant at 0.01

perceives a higher level of convenience (2.78) compared to PAU (2.53).

Meanwhile, the feasibility of multitasking during online classes is moderately appreciated by both universities. Majority of faculty members perceived that through online education, it is easy to manage time (3.47), easy to perform searches (3.45), online platforms are user friendly (3.37). The clarity of interaction between student and teachers garners moderate attention, revealing the dynamic nature of engagement within the online learning paradigm. Lowest mean score was obtained for the statement "evaluation of the subjective paper is easy" by the faculty of both the universities i.e. PAU (1.17) and ANGRAU (1.90).

The overall perception of faculty was calculated on the basis of perceived usefulness and perceived ease of use of online education which is discussed in Table 3. The data shows that among the faculty members' majority (76.5%) of the respondents had medium scores for perceived usefulness for online education. While 13.33 per cent had high scores for perceived usefulness and ten per cent of the respondents fall under low score category. In university wise comparison

it was found that in both the universities majority of faculty members fall under medium level category of perceived usefulness i.e. PAU (78.33%) and ANGRAU (75%). This suggests that a substantial majority of faculty members from both institutions hold moderate perceived usefulness about online education. Whereas, higher percentage of ANGRAU respondents (16.66%) fall within the low perception level as compared to PAU respondents (3.33 percent). This indicates that a high proportion of ANGRAU faculty members have a relatively lower score for perceived usefulness of online education. Interestingly, a higher percentage of PAU faculty members (18.33%) fall within the high perception level range (55-75) compared to ANGRAU faculty members (8.33%). This suggests that a larger proportion of PAU faculty members have a relatively higher perception of usefulness of online education.

In case of perceived ease of use overall, 70.8 per cent of the respondents fall under medium score of perceived ease of use followed by high (15.8%) and low scores (13.33%). University wise comparison shows that majority of respondents had medium scores for perceived ease of use i.e. 71.66 per cent for PAU and 70 per cent for ANGRAU. For the high perceived

Table 3: Distribution of faculty according to perception scores for online education (n=120)

Constructs	PAU (n ₁ =60) f(%)	ANGRAU (n ₂ =60) f(%)	Total (n=120) f(%)
Perceived usefulness			
Low (15-35)	2(3.33)	10 (16.66)	12(10)
Medium (35-55)	47(78.33)	45(75)	92(76.5)
High (55-75)	11(18.33)	5(8.33)	16(13.33)
Perceived ease of use			
Low (15-35)	10(16.66)	6(10)	16(13.33)
Medium (35-55)	43(71.66)	42(70)	85(70.8)
High (55-75)	7(11.66)	12(20)	19(15.8)
Overall perception			
Low (30-70)	4(6.66)	8(12.76)	12(10)
Medium (70-110)	37(61.66)	43(72.76)	80(66.66)
High (110 -150)	19(31.66)	9(14.43)	28(23.33)

ease of use scores PAU had 11.66 per cent faculty, while ANGRAU had 20 per cent faculty. This indicates that ANGRAU had a little higher proportion of faculty with high perception levels compared to PAU. Less percentage of respondents from PAU (16.66%) and ANGRAU (10%) had low score for perceived ease of use. This indicates a slightly higher percentage of faculty with low perception levels at PAU compared to ANGRAU, though the difference is not substantial.

For overall perception, 66.66 per cent of the respondents fall under medium level followed by high (23.335%) and low (10.0%) level of perception towards online education. Majority of respondents from both the universities had medium level of perception towards online education PAU with 61.66% and ANGRAU with 72.76%.

However, in Figure 1 significant difference can be seen where a higher percentage of PAU faculty members (31.66%) falls in high perception score category as compared to ANGRAU (14.43%). It can be inferred that large proportion of PAU faculty members have a relatively higher perception towards online education as compared to faculty of ANGRAU.

The Chi-Square test in Table 4 indicates that there is no significant difference in the distribution of gender among the three levels of the perception. Females account for 3.3 per cent in the low category, 41.7 per

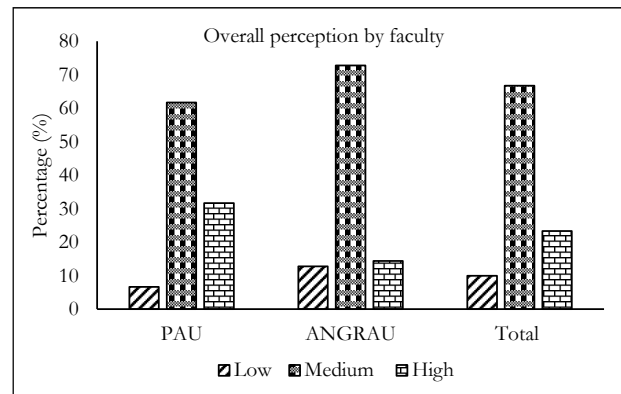


Figure 1: Distribution of faculty according to overall perception scores

cent in the medium category, and 1.7 per cent in the high category. Males constitute 6.7 per cent in the low category, 43.3 per cent in the medium category, and 3.3 per cent in the high category.

The Chi-Square analysis reveals that the distribution of place of residence is not significantly associated with the perception. Those from rural areas make up 1.7 per cent in the low category, 12.5 per cent in the medium category, and no data for the high category. Urban residents represent 8.3 per cent in the low category, 72.5 per cent in the medium category, and 5.0 per cent in the high category.

The Chi-Square test suggests no significant relation between marital status and the perception. Married faculty constitute 8.3 per cent in the low category, 78.3 per cent in the medium category, and 5.0 per cent in the high category. Unmarried participants account for 1.7 per cent in the low category, 6.7 per cent in the medium category, and no data for the high category.

Table 4: Association of faculty profile with perception towards online education (n=120)

Parameter	Low	Medium	High	χ^2 value
Gender				
Female	4(3.3)	50(41.7)	2(1.7)	1.513
Male	8(6.7)	52(43.3)	4(3.3)	
Place of Residence				
Rural	2(1.7)	15(12.5)	-	1.076
Urban	10(8.3)	87(72.5)	6(5.0)	
Marital status				
Married	10(8.3)	94(78.3)	6(5.0)	1.668
Un-Married	2(1.7)	8(6.7)	-	

It is observed from the Table 5 that the correlation analysis revealed a negative relationship between age and perception of online education ($r = -0.14^*$). This suggests that as age of faculty increases, their participation towards online education tends to decrease. The negative correlation might indicate that younger faculty members were more likely to embrace and actively participate in online teaching methodologies, while older faculty members might be more resistant or less inclined to adopt these methods.

Table 5: Relationship between profile of faculty and perception towards online education (n=120)

Variable	r value
Age	-0.14*
Teaching experience	-0.21*

Similarly, the study uncovered a negative correlation between teaching experience and online education perception ($r = -0.21^*$). This implies that faculty members with more teaching experience were somewhat less likely to engage in online education. It could be inferred that experienced educators might be more comfortable with traditional teaching methods they have mastered over their careers, leading to a potential hesitancy to transition to online teaching platforms.

CONCLUSION

The findings of the study revealed that faculty felt keeping track and meeting deadlines were not easy while using the online education from both the universities. The results showed that though online education enhanced the faculty's digital creativity they felt content creation for online classes were time consuming and downloading the software's to facilitate the online learning is difficult. Faculty perceive online education as cost-effective, convenient, and flexible. However, they consider it to be less interactive than traditional classroom education. Additionally, they find that the coverage of the syllabus and the process of clarifying doubts were more challenging. Overall it was found that faculty from both the universities had medium level of perception towards online education. According to the results. the study uncovered a negative correlation between teaching experience and online education. This implies that faculty members with more

teaching experience were somewhat less likely to engage in online education. It could be inferred that experienced educators might be more comfortable with traditional teaching methods they have mastered over their careers, leading to a potential hesitancy to transition towards online teaching platforms. It is suggested that proper training with hands on experience should be given to faculty before they deal online classes to avoid ambiguities during the classes and to make online education more interesting

REFERENCES

- Aithal, P.S. and S. Aithal. 2016. Impact of on-line education on higher education system. *International Journal of Engineering Research and Modern Education*, 1: 225-235.
- Almahasees, Z.; K. Mohsen and M.O. Amin. 2021. Faculty's and students' perceptions of online learning during COVID-19. *Frontiers in Education*, 6: 638470.
- Anderson, T. and F. Elloumi. 2008. Theory and practice of online learning, Athabas. *Handbook E-learning Research*, 4(3): 36-44.
- Bhavani, K. 2022. *E-readiness for online education among teachers and students of ANGRAU, Andhra Pradesh during COVID -19* M.Sc. thesis, Acharya N G Ranga Agricultural University, Guntur, India
- Castells, M. 2014. The impact of the internet on society: A global perspective. Retrieved from: <https://www.technologyreview.com/s/530566/the-impact-of-the-internet-on-society-a-global-perspective/> on 2 February, 2018.
- Joshi, P.K.; D. Jamadar, Rohit and Dixit. 2020. Perception of faculty toward online teaching and learning in the undergraduate medical students during coronavirus disease-19 pandemic. *International Journal of Medical Sciences*, 9(8): 484-487.
- Mahmodi, M. 2017. The analysis of the factors affecting the acceptance of e-learning in higher education. *Interdisciplinary Journal of Virtual Learning in Medical Sciences*, 8: 1-8.
- Mamattah, R.S. 2016. *Students' perceptions of e-learning*. M.Sc. Thesis, Linkopings University, Linkoping, Sweden.
- Rahayu, R.P. and Y. Wirza. 2020. Teachers' perception of online learning during pandemic Covid-19. *Jurnal Penelitian Pendidikan*, 20: 392-406.
- Sharma, P. and A. Nayal. 2020. An Empirical Study on Intention to Use Online Utility Services. *Journal of Community Mobilization and Sustainable Development*, 15: 160-174.



Research Article

Enhancing Productivity of Clusterbean through Front Line Demonstration in Water Stress Condition of Nagaur District of Rajasthan

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ABSTRACT

Keeping in view of an effective approach of frontline demonstration for transfer of technology in clusterbean the frontline demonstrations were conducted by Krishi Vigyan Kendra, Maulasar, Nagaur-II during *kharif*, 2017-2019 in Dabra village of Maulasar block. There was total 60 demonstrations on clusterbean crop were laid out in area of 24 ha by using farmer participatory mode with the objective to demonstrate the improved variety (RGC-1038/RGC-1033) of clusterbean with other technologies in water stress conditions of Nagaur district. Under demonstration the improved practices like sowing of improved variety, seed treatment with fungicide & biofertilizers, line sowing by ferti-seed drill, INM and weed management. The demonstrated plot observed 21.99 per cent higher seed yield in tune of 8.46 q ha⁻¹ as compared to local check (6.90 q ha⁻¹). Technology gap, extension gap and the technology index values in demonstrated plot were 6.88 q ha⁻¹, 1.56 q ha⁻¹ and 44.90 per cent, respectively. The net returns and benefit cost ratio (Rs. 24125 ha⁻¹ and 2.23) was observed higher under demonstrated plot against local check (Rs. 17940 ha⁻¹ and 1.94).

Keywords: Front line demonstration, Clusterbean, Improved technology, Yield, Economics

INTRODUCTION

Clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.) is a drought resilient leguminous crop grown on sandy soils of arid and semi-arid regions. India is having first rank in production of clusterbean seed and its contribution about 80% to the total globally production (Agricultural Statistics at a Glance, 2018). The major producer states are Rajasthan, Gujarat, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh. Rajasthan state stands first in respect to area and production accounting 65-70 per cent of India's total production. Amongst the legume crops, clusterbean is grown for fodder, vegetable and cattle feed. It has now assumed great significance with increasing demand for high quality gum which is used in different industrial applications (Kumawat *et al.*, 2006). The calorific and nutritive value of clusterbean seed is high and it contains 28-32% of

gum (Kherawat *et al.*, 2013). Clusterbean seeds consist of a greater amount of galactomannan gum, which having valuable uses like production of water proof biocide films where as other legumes are deficient. Guar gum is used in fabric industry, pharmaceuticals, paper industry, cosmetics, imprinting, oil rig, mining industries etc. Besides, clusterbean is a legume crop so as like other legume crops it also help in soil improvement and increase available nitrogen through nitrogen fixation which also fulfill 25 per cent nitrogen requirement of succeeding crops. It fits better in crop rotation in arid and semi arid region. It also can be grown as green manure crop in area where salty soils are serious problem. Clusterbean is a warm season legume crop having deep and well developed tap root system. Due to its drought and salt tolerance nature it may be a good alternative crop for the semiarid environment,

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where uneven distribution of rains, erratic rainfall, late onset and early withdrawal of monsoon, high temperature, heat stress and salt content in soils hamper the production of other crops in changing climatic condition.

Front line demonstrations are long term educational activity conducted in a systematic manner to prove the superiority of a new improved technology at farmer's fields. The yield level of cluster bean is not achieving significant level because of several constraints like timely non availability of improved varietal seed, poor soil fertility, no proper seed treatment & plant protection measures and erratic rainfall in the districts. (Balai *et al.*, 2021). Farmers generally sow seed of clusterbean varieties RGC-936/RGC-1003/RGC-1017 at higher seed rate without seed treatment. As a result, the farmers selected under FLD programme on clusterbean were provided seed of clusterbean variety RGC-1038 & RGC-1033. Taking into account of the above considerations, frontline demonstrations on clusterbean was undertaken to improve the yield and economics of clusterbean with proven improved production technologies at farmer's fields.

MATERIALS AND METHODS

The present study was carried out in the Nagaur district which is located on the North-western part of Rajasthan state and lies at 27°20'N latitude and 73°74' E longitude with an altitude of 302 m above the mean sea level. To assess the better productivity and economic feasibility of technology transfer for crop management of clusterbean, the front line demonstrations were conducted on 60 farmers field of NARI adopted village Dabra of Nagaur district in Rajasthan during *Kharif* 2017 to 2019 in rainfed condition on sandy loam soil with low-medium fertility status under Pearl millet/ Greengram-Fallow cropping system. Each demonstration was conducted on an area of 0.4 ha and the same area adjacent to the demonstration plot was kept as farmer's practices. Before conducting FLDs, farmers were selected from group meeting and specific training regarding different aspects of cultivation etc. were followed to bridge the gap existing between nation, state and district productivity and the whole package approach demonstrated to farmers through FLD trials. The package of improved production technologies included improved variety (RGC-1038/RGC-1033), fertilizer 10-15:30-40 kg ha⁻¹ NP per

schedule. Seeds were treated with *carbendazim* @ 2 g kg⁻¹ seed and inoculated with *NPK liquid consortia* @ 5 ml kg⁻¹ seed. Seed sowing was done in 15th June-15th July during the onset of monsoon in every year with a seed rate of 15 kg ha⁻¹ in line sowing with row to row spacing of 35 cm and 10 cm between plants. Optimum plant population was maintained in the demonstrated plots. Recommended dose of fertilizer was applied through DAP as basal application (drilled at the time of sowing, whereas, under farmers' practice, broadcast method of fertilization was adopted). One hand weeding was done at 25-30 DAS for weed control. The crop was harvested during October after the leaves turn yellow and start dropping. The benefit cost ratio and additional returns was calculated based on gross return and net returns, respectively. The observations were collected from both the demonstrated plot and local check and their technology gap, extension gap and technology index were worked out according to Samui *et al.* (2000) formula which is given below-

$$\% \text{ increased yield} = \frac{\text{Demonstration yield} - \text{farmers yield}}{\text{farmers yield}} \times 100$$

$$\text{Technology gap} = \text{Potential yield} - \text{Demonstration yield}$$

$$\text{Extension gap} = \text{Demonstration yield} - \text{Farmers yield}$$

$$\text{Technology Index} = \frac{\text{Technology gap}}{\text{potential yield}} \times 100$$

$$\text{B/C Ratio} = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

$$\text{Additional Returns} = \frac{\text{Net returns from demonstrated plot} - \text{Net returns from local check}}{\text{Net returns from local check}}$$

RESULTS AND DISCUSSION

From the gap analysis Table 1 it was observed that the major differences between demonstration package and farmer's practices regarding recommended varieties, seed treatment, sowing method, time of sowing and nutrient & weed management was observed. The performance of clusterbean crop after adopting the improved technologies was assessed over a period of three years (*Kharif*, 2017 to 2019) and is presented in Table 1 & 2. It is also observed that under farmer situation, normally sowing of clusterbean is earlier to escape from water shortage for irrigation, thus leading to reduction in yield.

The seed yield of demonstrated plots was observed 6.55, 9.60 & 9.22 q ha⁻¹ as compared to local check (5.60, 7.40 & 7.70 q ha⁻¹) during 2017, 2018

Table 1: Details of Gap analysis in clusterbean

Particulars	Farmers practices	Recommended practices
Improved variety	RGC-986, RGC-1017, RGC-1066	RGC-1038, RGC-1033, RGC-1031
Seed rate (kg ha ⁻¹)	12-15	15-18
Seed treatment	No seed treatment	Seed treated with Carbendazim 2 g kg ⁻¹ seed, Streptocyclin 200 ppm and biofertilizers
Fertilizer management	Use of DAP (50 kg ha ⁻¹)	15-20 kg N & 30-40 kg P ₂ O ₅ ha ⁻¹
Sowing method	Broadcasting	Line showing (30-35 cm x 10 cm)
Weed management	One hand hoeing at 20-25 DAS	Use of Pendimethalin @ 500 g a.i. ha ⁻¹ at 1-2 DAS and Imazethapyr 50 g a.i. ha ⁻¹ at 20-25 DAS or hand hoeing at 20-30 DAS
Plant protection	Use of monocrotophos and quinalphos	Application of Imidacloprid 17.8% SL @ 300 ml ha ⁻¹ or Thiomethoxam 250 g ha ⁻¹ for sucking pest control and Streptocyclin 250 ppm or COC 0.3% for bacterial blight.

and 2019, respectively in the same village. The percent increase of seed yield under demonstrated plot was 21.99 over local check. The yield improvement in demonstrated plot was due to use of improved variety, seed treatment, use of bio fertilizers, timely sowing, line sowing, nutrient & weed management and integrated pest management practices. The similarly observations were also obtained by Aswal *et al.* (2020) in cluster bean, Bamboriya *et al.* (2020) in mothbean, Balai *et al.* (2021) in clusterbean and Bamboriya *et al.* (2022) in greengram crop.

Wide technology gap and technology index values were observed during three years. The values for extension gap 0.95, 2.20 and 1.52 q ha⁻¹, technology gap 8.45, 5.40 and 6.78 q ha⁻¹ and technology index 56.33, 36.00 and 42.37% were observed (Table 2) during 2017, 2018 and 2019, respectively. Extension gap is a parameter to know the yield dissimilarities between the demonstrated technology and farmers practice. The technology gap was differed due to dissimilarity in the soil fertility status and weather

conditions. The technology index exhibited the feasibility of evolved technology at the farmer's field. These results are in accordance with the findings of Jain (2018) in pearl millet, Gaur and Jadav (2020) in greengram and Balai *et al.* (2021) in clusterbean.

From the Table 3 it was observed that demonstrated plot was recorded higher net returns (Rs. 19000, 20900 & Rs. 32474 ha⁻¹) as compared to local check (Rs. 15500, 12800 and Rs. 25520 ha⁻¹) during 2017, 2018 and 2019, respectively. The average additional returns were obtained Rs. 26,825 ha⁻¹. Benefit-cost ratio for demonstrated plot and local check was 2.08, 2.08 & 2.53 and 1.91, 1.69 & 2.23, respectively (Table 3). The higher additional returns and BC ratio obtained under demonstrations could be due to use of improved technology. The significantly higher value of BCR could be motivate the farmers under aberrant and rainfed conditions to adopt the technology. This finding is in corroboration with the findings of Patil *et al.* (2015), Jain *et al.* (2019) and Bamboriya *et al.* (2020).

Table 2: Yield performance, technology gap, extension gap and technology index of clusterbean under demonstrated plot and local check

FLD conducted year	Crop	Variety	No. of demonstrations	Area (ha)	Seed yield (q ha ⁻¹)			% increase yield	Tech-nology gap (kg ha ⁻¹)	Exten-sion gap (kg ha ⁻¹)	Tech-nology index (%)
					Potential of variety	Demons-trated plot	Local check plot				
2017	Clusterbean	RGC-1038	10	04	15	6.55	5.60	16.54	8.45	0.95	56.33
2018	Clusterbean	RGC-1038	25	10	15	9.60	7.40	29.73	5.40	2.20	36.00
2019	Clusterbean	RGC-1033	25	10	16	9.22	7.70	19.69	6.78	1.52	42.37
Average			60	24		8.46	6.90	21.99	6.88	1.56	44.90

Table 3: Economics of clusterbean under demonstrated plot and local check

Conducted year	Cost of cultivation (Rs. ha ⁻¹)		Gross returns (Rs ha ⁻¹)		Net Returns (Rs ha ⁻¹)		Additional Return (Rs ha ⁻¹)	BC Ratio	
	Demonstrated plot	Local check plot	Demonstrated plot	Local check plot	Demonstrated plot	Local check plot		Demonstrated plot	Local check plot
2017	17500	17000	36500	32500	19000	15500	3500	2.08	1.91
2018	19300	18500	40200	31300	20900	12800	8100	2.08	1.69
2019	21272	20800	53746	46320	32474	25520	6954	2.53	2.23
Average	19357	18767	43482	36707	24125	17940	6185	2.23	1.94

CONCLUSION

It may be concluded that the frontline demonstrations are effective tool for increasing the productivity and profitability of clusterbean by changing knowledge, attitude and skill of farmers. The average per cent increment in yield of clusterbean 21.99 over the farmers practice created more awareness and motivated the other farmers to adopt the improved package of practices of pulses. The partner farmers also play an important role as source of information and quality seeds for wider dissemination of the improved varieties with other technologies of clusterbean for other nearby farmers. The results showed that the frontline demonstrations gave positive impact over the dryland farming community of Nagaur district as they were motivated by the new agricultural technologies applied in the FLD plots (Table 1). The farmers' should be encouraged to adopt the recommended package of practices for realizing higher returns.

REFERENCES

- Agricultural Statistics at a Glance. 2018. Directorate of Economics and Statistics. Area, production and yield along with coverage under irrigation, pp 131.
- Aswal, S.; S. Kumar; D.K. Singh; T.C. Verma; K.C. Meena and P. Khatik. 2020. Impact of cluster frontline demonstrations on yield, knowledge adoption and spread of blackgram in tribal belt of Rajasthan. *International Journal Current Microbiology Applied Science*, 9(11): 1692-1698.
- Balai, L.R.; B.L. Asiwal and S. Verma. 2021. Enhancing yield and profitability through front line demonstrations of cluster bean variety RGC-1066 in Sikar district of Rajasthan. *Forage Research*, 46(4): 385-388.
- Bamboriya, S.D.; G.C. Jat and M.D. Choudhary. 2020. Performance of cluster front line demonstrations on mothbean crop in arid regions of Rajasthan. *Indian Research Journal of Genetics & Biotechnology*, 12(1): 50-55.
- Bamboriya, S.D.; G.C. Jat; M.D. Choudhary and L.R. Choudhary. 2022. Impact assessment of cluster frontline demonstration on greengram crop. *Journal of Community Mobilization and Sustainable Development*, 17(2): 1-4.
- Bamboriya, S.D.; G.C. Jat; A.S. Jat; I. Singh and M. Kumar. 2020. Impact of frontline demonstration on productivity and profitability of pearl millet in dryland areas of Rajasthan. *Indian Research Journal of Genetics & Biotechnology*, 12(1): 18-23.
- Gaur, V. and P. Jadav. 2020. Impact of demonstrations on productivity and profitability of greengram in Gandhinagar district of Gujarat. *Journal of Krishi Vigyan*, 8(2): 174-177.
- Jain, L.K. 2018. Technology and extension gaps in pearl millet productivity in Barmer district, Rajasthan. *Indian Journal of Dryland Agricultural Research and Development*, 33: 39-42.
- Jain, L.K.; H.P. Parewa and S.D. Ratnoo. 2019. Impact of frontline demonstration on productivity and profitability analysis of clusterbean in Barmer District of Rajasthan. *Forage Research*, 44(4): 283-286.
- Kherawat, B.S.; L. Munna, M. Agarwal, H.K. Yadav and S. Kumar. 2013. Effect of applied potassium and manganese on yield and uptake of nutrients by cluster bean (*Cyanosis tetragonoloba*). *Journal of Agricultural Physics*, 13(1): 22-26.
- Kumawat, P.D.; G.L. Yadav; M. Singh and B.L. Jat. 2006. Effect of varieties and fertilizer levels on yield attributes and yield of clusterbean {*Cymopsis Tetragonoloba* (L.) Taub.}. *Agricultural Science Digest*, 26(1): 63-64.
- Patil, L.M.; D.J. Modi; H.M. Vasava and S.R. Gomkale. 2015. Evaluation of front line demonstration programme on green gram variety Meha (IPM-99-125) in Bharuch district of Gujarat. *IOSR Journal of Agriculture and Veterinary Science*, 8(9): 1-3.



Research Article

Dependent and Independent Variables of Cardiovascular Disease in Rural and Urban Men of Punjab, India

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ABSTRACT

Objective: To study major determinants of cardiovascular disease among adult men. **Method:** One hundred twenty men (30–50 years old), sixty belonging each to rural and urban community of Punjab, India who were diagnosed with a heart condition and were visiting OPD of Hero DMC heart institute, were selected. Anthropometric parameters namely height, weight, waist and hip were measured. Derived anthropometric measurements namely BMI, waist/hip ratio, weight/height ratio, conicity index and abdominal volume index were computed. The blood samples were assayed for vitamin D, fasting blood glucose level and total lipid profile of the subjects. **Results:** Average body mass index of rural and urban men was 27.20 ± 3.27 and 28.74 ± 4.87 kg/m², respectively. Both were on the higher side than the cut off value of 22.9 kg/m². The average weight was higher in both the groups, but the conicity Index and waist to hip ratio was higher in urban group than the standard value. Sleeping and sitting hours were higher in urban men while 39 and 49 per cent of rural and urban subjects were moderately active. There was a significant difference in consumption of legumes, roots, green leafy vegetables, other vegetables and nuts and oils. Intake of energy and protein was lower than but the intake of fats and carbohydrates was higher than the RDA. Sleeping hours was positively correlated with weight, BMI, waist circumference, total cholesterol, LDL-C, triglycerides, VLDL-C. **Conclusion:** The study concluded that more sleeping hours, higher carbohydrate and fat intake, low vitamin D levels, more conicity index in urban men and abdominal volume index resulted in pre obese condition of the subjects that leads to cardiovascular associated problems. Therefore, it is recommended to emphasize on proper diet, not more than 8 hours sleeping restricted use of sugar and alcohol and increase exposure to sun for vitamin D.

Keywords: Cardiovascular disease, BMI, Soluble fibre, Obesity, Vitamin D

INTRODUCTION

Cardiovascular disease (CVD) is a group of pathological disorders of the heart and its blood vessels and one of the leading cause of morbidity and mortality. According to WHO reports (2021), around 17.9 million people died from cardiovascular disease in 2019, or 32 per cent of all deaths worldwide. Over the next 15 years, the country would host more than half of the world's heart disease cases. India has been through dramatic lifestyle changes from agricultural diets and active lifestyles to fast food and sedentary lifestyles over a much shorter period of time than other

countries (Chauhan and Aeri, 2015). According to the Global Burden of Disease report, India has a CVD death rate of 272 per 100,000 people, which is higher than the global average of 235 per 100,000 people. Age, gender, poor diet, sedentary lifestyle, smoking, and problematic alcohol use are the most major behavioral risk factors for cardiovascular disease and stroke (WHO, 2021). Countries with a high prevalence of cardiovascular disease appear to have citizens who consume excessive alcohol, eat high-carbohydrate diets, smoke heavily, and are fat. Inactivity, drug use, and a poor diet all contribute to an increased risk of

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cardiovascular disease (Havranek *et al.*, 2015). Punjab is a prosperous Indian state with the highest per capita income and lifestyles similar to that of the industrialized western population. In Punjab, the prevalence of various risk factors such as hypertension, sedentary lifestyle, obesity, diabetes and high cholesterol has increased in 20 years in the rural population. Increased blood pressure, blood sugar, blood lipids, overweight and obesity are all symptoms of behavioral disorders (WHO, 2017). Hypertension is the most important preventable cause of cardiovascular disease. However, it is a major risk factor for death in India, especially Punjab. In Punjab, 2 out of 5 adults suffer from high blood pressure. This puts 40 per cent of adults in the state at risk of heart disease and stroke. It is increasingly recognized that developing countries are undergoing an epidemiologic transition, accompanied by an increasing burden of CVD linked to urbanization and lifestyle modifications (Dominguez *et al.*, 2006). The health transition is occurring at an increased pace in urban societies widely exposed to lifestyle modernization, sedentary occupation, and to lipid and sugar rich foods often poor in fibre and micronutrients. The causative factors of cardiovascular disease in Punjabi population are different from those present in west and other parts of India. The identification of dominant risk factors of cardiovascular diseases among urban and rural population of Punjab is thus important to take timely preventive measures to control the high incidence of the disease.

MATERIALS AND METHODS

One hundred twenty volunteer adult men aged 30 to 50 years old 60 each from urban and rural areas from Punjab were selected. The data was collected from patients who attend the OPD at Hero DMC Heart Institute in Ludhiana. The participants chosen had previously been diagnosed with a cardiac condition. A questionnaire was developed to collect data on general information, medical history and daily food intake. The "24-hour recall method" was used to measure the food intake of the subjects over three consecutive days. Nutrient intake was calculated using Diet Cal (Kaur, 2018). The food intake was compared with the suggested dietary intake and nutrient intake with recommended dietary allowances given by ICMR (2020). The anthropometric parameters namely height, weight, waist and hip were measured using standard

methods given by Jelliffe (1966). Further derived anthropometric measurements namely BMI (Garrow, 1981), waist/hip ratio (Ghafoorunisa and Krishnamurthy, 2000), weight/height ratio (Browning *et al.*, 2010), conicity index and abdominal volume index (Wang *et al.*, 2017) were computed. The blood samples were assayed for the estimation of vitamin D, fasting blood glucose level and total lipid profile including total cholesterol, triglycerides, HDL-c and LDL-c of the subjects. The subjects were clinically examined for their systolic and diastolic blood pressures. The blood pressure (BP) was taken with a sphygmomanometer with the help of physician. Lifestyle pattern includes the physical activity (Craig *et al.*, 2003), sleeping pattern, smoking habit and alcohol consumption were also determined. Mean and standard deviations for several parameters were computed using Microsoft excel (2010) Statistical Analysis Tool Pack. Coefficient of correlation was used to determine the relationship of anthropometry, nutrient intake and blood lipid profile.

RESULTS AND DISCUSSION

The mean age of the subjects was 42 years in both groups. It was observed that majority of rural and urban subjects i.e. 54 and 45 per cent were studied till senior secondary and 15 and 33 per cent were graduates, respectively. In rural and urban group, 45 and 58 per cent subjects were nuclear families and rest were joint families. Majority of subjects from urban group (56%) were engaged in business where as in rural group majority (55%) were engaged in farming.

Family history of hypertension was 66 and 78 per cent in rural and urban families, followed by diabetes (65 and 63%) and obesity (35 and 48%). Higher incidence of hypercholesterolemia was seen in urban family with the percentage of 53 per cent and in rural it was 41 per cent. Studies showed that higher the prevalence of hypercholesterolemia, higher the incidence of heart diseases. In the present study, the cholesterol was higher in urban families thus the heart sufferers were also from urban families with percentage of 38 and 31 per cent in rural families. A global study conducted in 52 countries of seven continents confirmed that cardiovascular disease is closely related to family history, male sex and aging (Yusuf *et al.*, 2004 and Scheuner *et al.*, 2010). It was reported that Punjabi population in North India has genetic tendency to have higher lipid levels (Nayar, 2002).

The reference values given by (ICMR) for body weight is 65 kg for an adult man, so both the groups exhibited a higher body weight as compared to the reference value. Waist circumference is a measure of amount of fat in adipose tissue. The average waist circumference was slightly lower in both the groups than the cut off values i.e. 102 cm (NCEP ATP III, 2001) as shown in Table 1. But average hip circumference of urban men (96.22 cm) and rural men (95.35 cm) was higher than the reference value i.e. 94 cm (NCEP ATP III, 2001).

The average Body Mass Index of rural and urban men was higher in both the groups as compared to the guidelines issued by Asian cut off value of 23.0 kg/m². The data represents that the average waist/hip ratio was higher in urban group (1.02) and in rural group it was (0.99) that is the same as to the cut off value of 0.99. There was significant difference in waist to hip ratio in both the groups at 5% level significance. Waist to height ratio is used to measure central obesity (central adipose tissue) which differentiate in body frames. The subjects from the rural and urban group had average waist to height ratio of 0.54 and 0.5 as compared to reference value of 0.5. The conicity index is standard to measure central obesity and both the groups had a value higher than the cut-off of < 0.5. The abdominal volume index was also more than the cut-off value of < 14.25.

The average haemoglobin levels of the rural and urban subjects were 13.77±1.57 and 13.21±1.37 g/dl

(Table 2). Similarly, the average fasting blood glucose levels was within the range of standard value of glucose concentration i.e., <110mg/dl. Serum Vitamin D is important marker in CVD as seen in studies that people with CVD tends to have a lower vitamin D levels. The average serum Vitamin D levels were 25.9±12.7 and 23.7±16.2, ug/dl in rural and urban subjects. Serum Vitamin D levels of < 30 nmol/l is considered as insufficient (25 - Hydroxy Vitamin D test, Searleman *et al.* (2019)). Lipid profile is another test used in the study and is considered as an important biomarker in pathology of CVD. The average serum total cholesterol level was slightly higher among the urban group. Average LDL levels were higher in urban group 108.7±38.66 mg/dl whereas marginal in rural group 97.65±34.6mg/dl. The average values of HDL-C was marginal in urban group 39.61±8.6 mg/dl but satisfactory in rural group 51.38±35.59 mg/dl. The higher the HDL-C, lower the heart risks. VLDL-C is the bad cholesterol hence needed within the range whereas the urban subjects were having more VLDL levels than the standard. Triglycerides is a type of fat in blood are the major contributor to hardening of artery walls which increase the risk of CVD and also decreases the HDL - C in blood. Higher prevalence of excess TG was in urban group as compared to the standard value <150 mg/dl and it was within range among the rural group.

The intake of cereals was more in urban men than in rural men as compared to the suggested intake. The

Table 1: Basic and derived anthropometric parameters of the subjects (N=120)

Anthropometric measurements	Rural (n=60)		Urban (n=60)		t value
	Range	Mean±SD	Range	Mean±SD	
Basic					
Height, cm	163.2–182	172.57±4.9	162.7–186	173.19±4.8	NS
Weight, kg	58–112	80.95± 9.96	49–120	85.36±14.53	1.94*
Waist circumference, cm	77.7–121.91	94.55±9.4	76.2–120	98.41±11.7	NS
Hip circumference, cm	71.12–106	95.35±6.4	70.2–115	96.22±7.66	NS
Derived					
Body mass index, kg/m ²	21.76–37.65	27.20±3.27	17.57–40	28.74±4.87	NS
Waist/Hip ratio	0.87–1.15	0.99±0.06	0.87–1.2	1.02±0.08	2.38*
Waist/ Height ratio	0.44–0.74	0.54–0.06	0.42–0.69	0.5–0.06	NS
Conicity index	1.167–1.451	1.26±0.09	1.13–1.41	1.29±0.07	NS
Abdominal volume index	12.10–29.90	18.07±3.67	11.63–28.62	19.68±4.60	NS

*Significant at 5% level; NS-Non-significant

Table 2: Biochemical and clinical profile of the subjects (N=120)

Parameters	Rural (n=60)		Urban (n=60)		Normal	t value
	Range	Mean±SD	Range	Mean±SD	values	
Haemoglobin level, g/dl	8.6–17	13.77±1.57	10.3–16.2	13.21±1.37	>13	NS
Fasting Blood Sugar, mg/dl	72–173	104.35±22.39	78–209	107.3±21.2	70–110	NS
Vitamin D mmol/l	4–72.22	25.9±12.7	5.6–87.4	23.7±16.2	< 30 insufficient	NS
Total cholesterol, mg/dl	99–395	182.2±50.74	105–398	214±61.93	125–200	2.94**
HDL - cholesterol, mg/dl	25–208	51.38±35.59	21–63	39.61±8.6	>40	2.69**
LDL - cholesterol, mg/dl	34–208	97.65±34.6	26–194	108.7±38.66	<100	NS
VLDL cholesterol, mg/dl	10.6–93	33.2±17.25	16.6–150.6	44.7±27.28	<30	NS
Triglycerides, mg/dl	53–465	166.0±86.29	83–753	223.58±136.41	<150	2.76**
Blood pressure, mmHg						
Systolic	120–166	129.13±16.2	123–170	132.7±13.3	130	2.49**
Diastolic	71–116	83.06±13.88	80–112	88.3±6.14	85	2.26**

**Significant at 1% level; NS-Non-Significant

Table 3: Food intake of the subjects (g/day)

Food Groups	SDI	Range	Mean±SD	Range	Mean±SD	t value
Cereals	275	80.7–244.64	245.3±37.10	105.84–363.1	280.9±57.05	NS
Pulses and legumes	80	0–58.72	32.5±11.2	25.62–60	40.2±7.46	4.41*
Roots and tubers	100	22.9–236.4	76.2±42.1	50–306.9	128.65±57.19	2.79*
Green leafy vegetables	150	0–129	7.05±27.1	0–250	10.16±45.27	1.79*
Other vegetables	200	99.53–353.7	214.6±59.66	60–446.06	195.10±87.33	2.39*
Fruits	150	0–300	59.44±82.46	0–300	126.01±97.33	NS
Milk and products	300	184.6–800.64	430.84±140.25	100.36–700.65	381.0±157.64	NS
Eggs and poultry	300	0–150	10±32.9	0–200	14.1±38.8	NS
Fats and oils	25	18.3–42.3	29.6±5.8	25.14–45	33.2±4.9	NS
Sugar	20	0–30	9.9±8.26	0–30	10.2±8.3	NS
Nuts and oil seeds	30	0–10	0.53±1.9	0–30.45	2.24±5.35	2.29*

*Significant at 5% level; NS-Non-Significant; SDI – Suggested Dietary Intake

intake of pulses and legumes was significantly higher in urban men than rural men and was nearly half than the SDI of 80g/day in both rural and urban men. The intake of roots and tubers, green leafy vegetables as well as nuts and oilseeds was significantly higher in urban men than the intake of rural men (Table 3).

The energy intake was significantly higher in urban men than rural men but no significant difference was in protein intake of rural and urban men. The intake of energy and protein was less when compared with the RDA. The intake of total carbohydrate and total dietary fibre was significantly higher in rural men than urban men. In total dietary fibre, insoluble fibre intake

was more in urban men while soluble fibre intake was more in rural men (Table 4). The average total fat intake was more than the RDA of 25g/day in both the groups and significantly higher in rural men than urban men both the groups. Saturated fatty acids tends to accumulate in vessels and causes blockage. A ratio of 1:1:1 for the three fatty acids have been reported as an ideal one for protecting against metabolic complications (Ghafoorunissa and Krishnaswamy, 2000). Average intake of ascorbic acid and iron was less in both the groups when compared with recommended allowance of ascorbic acid (80 mg), and iron (19mg) per day (Table 5). Average vitamin D intake was more in rural than urban group. The average

Table 4: Macronutrient intake by the selected subjects

Macro-nutrients	Rural (n=60)		Urban (n=60)		RDA	t value
	Range	Mean±SD	Range	Mean±SD		
Energy, Kcal	1125–2449	1665±316	928–2594	1797±437	2110	1.82*
Protein, g	32.55–77.42	50.14±12.14	28.4–80.6	49.64±11.80	54	NS
Total Carbohydrates, g	106.16–478	245.76±73.55	139.25–356	222.5±51.69	130	2.14*
Total Dietary fibre, g	14–76.51	36.25±12.36	15–45.06	27.10±6.37	25–40	4.96*
Insoluble fibre, g	10.75–45.89	25.90±7.7	16.41–41.89	30.75±4.89	–	4.43*
Soluble fibre, g	2.34–10.58	6.10±1.95	4.61–10.39	6.92±1.26	–	3.47*
Total fats, g	35.2–67.31	49.12±7.56	25.70–69.9	40.45±10.73	25	3.26*
Cholesterol, g	38.4–231.62	47.75±46.05	13.2–155.25	40.46±32.18	–	2.53*

*Significant at 5% level; NS-Non Significant; RDA-Recommended Dietary Allowances (ICMR, 2020)

Table 5: Micronutrient intake by the selected subjects

Micro-nutrients	Rural (n=60)		Urban (n=60)		RDA	t value
	Range	Mean±SD	Range	Mean±SD		
Ascorbic acid, mg	23.34–241	51.62±60.85	8.5–217	60.39±53.54	80	NS
Vitamin D, µg	0–6.88	0.72±1.55	0.01–1.98	0.44±0.29	-	1.14*
Iron, mg	6.2–21.35	10.7±2.89	5.45–27.02	13.20±4.76	19	3.30*
Magnesium, mg	194.36–425	303.56±60.46	148.5–753.46	359.96±129.33	385	2.89*
Potassium, mg	1468.0–3741	2364.7±507.01	563.09–5277.68	2246.4±985.69	3500	2.44*
Sodium, mg	1098.20–3842.3	1475.5±415.66	1015.9–4307.9	1689.21±613.8	2000	3.11*
Zinc, mg	4.6–12.94	6.80±1.54	2.66–16.97	7.58±2.82	17	1.69*
Calcium, mg	169.87–1350.7	760.46±254.3	330.25–1083.9	674.52±150.17	1000	0.94*

*Significant at 5% level; NS-Non Significant; RDA-Recommended Dietary Allowances (ICMR, 2020)

consumption of magnesium, sodium and zinc was significantly higher in urban men than rural men, whereas the potassium and calcium intake was higher in rural men than urban men.

The results revealed a significantly ($p<0.01$) higher MET-minutes/week score of rural subjects (1758.41) in comparison to urban counterpart i.e. 1528.5. As presented in Table 6, classification of subjects on the basis of physical activity (MET) revealed that majority of urban and rural subjects were moderately active. Low physical activity with MET-minutes/week score of less than 599 was reported in 20 per cent of rural and 13 per cent of urban subjects. Blood clots, high blood pressure, heart attack, stroke, and other cardiac disorders can all be caused by a lack of physical activity. Getting more active, on the other hand, can drop your blood pressure by 4 to 9 mm Hg, which is the same reduction in blood pressure that anti-hypertensive drugs can provide. Physical activity might also help to raise your good cholesterol levels (Nazari *et al.*, 2020).

Majority of rural subjects (55%) were taking a sleep of 6 - 7 hours a day. and majority of urban subjects (49%) were taking sleep of 8 - 9 hours a day. Adults who sleep less than 7 hours each night are more likely to report having health issues such as a heart attack, asthma, or depression. During normal sleep, blood pressure goes down. Having sleep problems means blood pressure stays higher for a longer period of time. High blood pressure is one of the leading risks for heart disease and stroke (Chandola *et al.*, 2010). Sleep deprivation might result in unhealthy weight gain. This is particularly true for children and teenagers, who require more sleep than adults. Sleep deprivation may have an impact on a region of the brain that regulates appetite.

The data in Table 6 showed that 42 per cent of rural and 65 per cent of urban subjects were consuming alcohol. Out of 65 per cent urban subjects, there were 20 per cent of subjects who were consuming alcohol on the regular basis whereas in 42 per cent of rural

Table 6: Physical activity level of the subjects

MET - minutes/week score	Rural Men (n=60)	Urban men (n=60)
Range	256–6556	189–3415
Mean±SD	1758.41±1441.2	1528.5±642
Level of physical activity (MET-minutes/week Score)	N (%)	N (%)
Low <599	12(20)	8(13)
Moderate 600 - 2999	39(65)	51(85)
High >3000	9(15)	1(2)

subjects only 3 per cent were regular drinkers. Weekly consumption of alcohol was reported by 17 per cent of rural and 23 per cent of urban subjects followed by 5 per cent rural and 12 per cent urban consuming twice a week. Majority of rural subjects were non-drinker with a percentage of 58. Studies showed that higher the alcohol consumption higher the risk for health to develop CVD. Excess amount of alcohol per day affects the liver and decrease the production of HDL. The men who are heavy drinkers tends to have increased blood pressure (Briasoulis *et al.*, 2012). Damage of epithelial cells that may leads to build of plaque in vessels also impairs the cell function and nitric oxide production from cells which causes vasodilation. Alcohol also changes intracellular calcium levels, heart rate and activation of other neurohormonal systems (Marchi *et al.*, 2014). Ronksley *et al.* (2011) reported from 84 investigations that different ethanol utilization levels (g/day) between 2.5 g/day and 30 to 60 g/day (<1 standard beverage/day to ~5 drinks/day) were cardioprotective for both CV mortality and CHD mortality.

All the rural subjects were consuming only whiskey. On the other hand, 29 per cent of urban men were consuming beer and 69 per cent were consuming whiskey. The consumption was also divided into sub category range of milliliters of alcohol consumed. In urban men 42 per cent of beer consumers were taking 330 - 375 ml of beer at a time i.e. 1 bottle beer. 58 per cent subjects were consuming more than 375 ml beer at a time. From the urban group, out of 69 per cent whiskey consumers, 62, 19 and 19 per cent were consuming <25, 35 and >50, respectively. In rural group 60 per cent were consuming less than 25 ml of whiskey, 28 per cent were consuming 35 ml of whiskey and 12 per cent were taking 50 ml whiskey.

Consumption of larger amount of whiskey on the daily basis increases cholesterol in blood and raises the blood pressure. Consumption of one beer daily is considered safe. Men and women are advised not to drink more than 14 units a week on a regular basis (NHS 2018).

Majority of the rural and urban subjects were non-smokers i.e. 77 and 68 per cent followed by 15 per cent rural and 17 per cent urban subjects who smoked daily. Smoking just one cigarette a day carries a much greater risk of coronary heart disease and stroke than expected - about half that of someone who smokes 20 cigarettes a day. Smokers should aim to quit rather than significantly reduce the risk of these two major common diseases, among men, the aggregate relative risk for coronary heart disease was 1.48 for smoking one cigarette per day and 2.04 for 20 cigarettes per day (Hackshaw *et al.*, 2018). Paroxysmal tachycardia is a recently identified smoking - related risk. The chemicals in cigarette smoke cause atherosclerosis and thicken the blood in the arteries, making it more difficult for blood cells to move through the arteries and other blood vessels to reach vital organs such as the heart and brain.

Table 7 represents the relationship of sleep hours and physical activity or MET with weight, BMI, WC, total Cholesterol, LDL - C, TG, VLDL - C. Sleep hours have a positive correlation with weight, BMI, WC, total Cholesterol, LDL, TG, VLDL with level of significance >0.05. Over sleep alters the lipid profile and increases the weight. Compared with a 7 h sleep duration, long sleep duration (≥9 h) was significantly associated with low high - density lipoprotein

Table 7: Relationship of sleep and physical activity with anthropometric parameters and blood profile

Parameters	Sleep hours	MET
Weight	.227*	NS
BMI	.217*	NS
Waist Circumference	.186*	NS
Total Cholesterol	.263**	.329**
LDL Cholesterol	.187*	NS
Triglycerides	.292**	-.356**
VLDL	.277**	-.374**

*Significant at 5% level; ** Significant at 1% level; NS- Non-Significant

cholesterol (HDL - C) levels (Song *et al.*, 2020). An inverse linear association most consistently characterized the association between sleep duration and BMI and waist circumference (Ford *et al.*, 2014). Over a six - year period, people who slept more than 9 hours per night gained more weight than “average” sleepers, and fat people were more likely to gain significant weight. BMI, physical activity, and lipid profile indices have strong associations among Ghanaian students (Ofori and Angmorterh, 2019).

The higher MET values have a negative significant correlation with TG and VLDL levels in blood. Regular physical activity has been demonstrated to raise HDL cholesterol while lowering LDL cholesterol and triglycerides, theoretically balancing increases in LDL and triglycerides. Between exercise levels and HDL cholesterol levels, there appears to be a linear dose-response relationship (Mann *et al.*, 2014). Abnormalities in lipid metabolism will result from an infection in abdominal fat. Total cholesterol, low - density lipoprotein (LDL), triglyceride levels rise, and high - density lipoprotein (HDL) levels fall. One of the leading causes of cardiovascular disease is abdominal fat. Higher BMI and WHR were associated with an increased risk of CVD or mortality and WHR appeared to have the best predictive value among three indices (Myint *et al.*, 2014). There was positive correlation between protein and BMI. Higher total protein intake, expressed as percentage of energy, was significantly associated with a greater risk of weight gain when protein replaced carbohydrates (Alonso *et al.*, 2016). BMI was positively correlated with cholesterol concentration $P > 0.05$. Total cholesterol and low - density lipoprotein were positively co - related with BMI ($p < 0.05$) (Nwaiwu and Ibe, 2015). In general

population BMI is positively correlated with RBS and cholesterol (Faheem *et al.* 2010). Direct association of BMI and total cholesterol ($P < 0.005$) and LDL - cholesterol ($P < 0.006$), in men was observed by Schroder *et al.* (2003).

Data in Table 8 represents a negative but significant correlation between soluble fibre and total cholesterol. Consuming 10 to 25 grams of soluble fiber a day can lower cholesterol by 18 per cent (Moll, 2021). A positive correlation was observed in total fat intake and serum triglycerides and VLDL - C and negative relation with HDL - C. High fat diet increases the fat accumulation around body muscles and in abdominal area.

Odds ratio predicts that number of urban men was higher with respect to high LDL -C levels than rural men (OR 1.398 CI lower 0.681, upper 2.869). There was a significant association between alcohol consumption and sleeping hours with high LDL levels in this study (Table 8). Lindberg *et al.* (1998) showed that combination of snoring and excessive daytime sleepiness had a twofold increase in the risk of incident heart failure with hazard ratio 2.2 indicating that the combination of snoring and excessive daytime sleepiness increased the risk of developing heart failure. Subjects having low vitamin D levels were at risk of developing heart failure because of their high LDL levels.

CONCLUSION

The study concluded that more sleeping hours, higher carbohydrate and fat intake, low vitamin D levels, more conicity index in urban men and abdominal volume index resulted in pre obese condition of the subjects.

Table 8: Relationship of nutrients with blood profile

Correlation	Soluble Dietary Fibre	Total Fat	Total Dietary Fibre	Carbo-hydrate	Energy in Kcal	Total Available Carbohydrate	Total Saturated Fatty Acids	Total Mono unsaturated Fatty Acids	Insoluble Dietary Fibre
Total Cholesterol	-.260**	NS	NS	NS	NS	NS	.297**	-.242**	-.283**
LDL Cholesterol	NS	NS	NS	NS	NS	.222*	.188*	NS	NS
HDL Cholesterol	NS	-.205*	.210*	NS	NS	NS	NS	NS	NS
Triglycerides	NS	.223*	NS	.251**	.210*	NS	.298**	-.309**	NS
Vitamin D	.216*	NS	NS	NS	NS	NS	NS	NS	.240**
Systolic BP	NS	NS	-.309**	NS	NS	-.210*	NS	NS	NS
VLDL	NS	.229*	NS	.255**	.194*	NS	.309**	-.325**	NS

*Significant at 5% level; ** Significant at 1% level; NS - Non-Significant

This leads to cardiovascular associated problems. Therefore, it is recommended to emphasize on proper diet, not more than 8 hours of sleep and and limited use of sugar and alcohol and have increased exposure to sun for vitamin D.

REFERENCES

- Alonso, P.H.; J. Salas-Salvado; M. Ruiz-Canela; D. Corella; R. Estruch; M. Fito; F. Aros; E. Gómez-Gracia; M. Fiol; J. Lapetra; J. Basora; L. Serra-Majem; M.A. Muñoz; P. Buil-Cosiales; C. Saiz and M. Bulló. 2016. High dietary protein intake is associated with an increased body weight and total death risk. *Clinical Nutrition*, 35: 496-506.
- Briasoulis, A.; V. Agarwal and F.H. Messerli. 2012. Alcohol consumption and the risk of hypertension in men and women: A systematic review and meta-analysis. *Journal of Clinical Hypertension (Greenwich)*, 14: 792-798.
- Browning, L.M.; S.D. Hsieh and M. Ashwell. 2010. A systematic review of waist-to-height-ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. *Nutrition Research Reviews*, 23: 247-269.
- Chandola, T.; J.E. Ferrie; A. Perski; T. Akbaraly and M.G. Marmot. 2010. The effect of short sleep duration on coronary heart disease risk is greatest among those with sleep disturbance: A prospective study from the Whitehall II Cohort. *Sleep*, 33: 739-744.
- Chauhan, S. and B.T. Aeri. 2015. The rising incidence of cardiovascular diseases in India: Assessing its economic impact. *Journal of Preventive Cardiology*, 4: 735-740.
- Craig, C.L.; A.L. Marshall; M. Sjostrom; A.E. Bauman; M.L. Booth; B.E. Ainsworth; M. Pratt; U. Ekelund; A. Yngve; J.F. Sallis and P. Oja. 2003. International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, 35: 1381-1395.
- Dominguez, L.J.; A. Galioto; A. Ferlisi; A. Pineo; E. Putignano and M. Belvedera. 2006. Ageing, lifestyle modifications and cardiovascular disease in developing countries. *Journal of Nutrition, Health and Aging*, 10: 143-149.
- Faheem, M.; S. Qureshi; J. Ali; Z. Hameed; F. Abbas; A.M. Gul and M. Hafizullah. 2010. Does BMI affect cholesterol, sugar and blood pressure in general population? *Journal of Ayub Medical College*, 22: 74-77.
- Ford, E.S.; C. Li; A.G. Wheaton; D.P. Chapman; G.S. Perry and J.B. Croft. 2014. Sleep duration and body mass index and waist circumference among U.S. adults. *Obesity (Silver Spring)*, 22: 598-607. doi: 10.1002/oby.20558
- Garrow, J.S. 1981. *Treat obesity seriously: A clinical manual*. Churchill Livingstone, London.
- Ghafoorunissa and K. Krishnaswamy. 2000. Diet and Heart Disease, National Institute of Nutrition, Hyderabad, India.
- Hackshaw, A.; J.K. Morris; S. Boniface; J.L. Tang and D. Milenkovic. 2018. Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports. *BMJ*, 360: j5855. doi: 10.1136/bmj.j5855.
- Havranek, E.P.; M.S. Mujahid; D.A. Barr; I.V. Blair; M.S. Cohen; S. Cruz-Flores; G. Davey-Smith; C.R. Dennison Himmelfarb; M.S. Lauer; D.W. Lockwood; M. Rosal and C.W. Yancy. 2015. Social determinants of risk and outcomes for cardiovascular disease -A scientific statement from the American Heart Association. *Circulation*, 132: 873-898.
- ICMR. 2020. *Recommended dietary allowances and estimated average requirements. Nutrient Requirements for Indians*. National Institute of Nutrition. Indian Council of Medical Research, Hyderabad.
- Jelliffe, D.B. 1966. *The assessment of nutritional status of community*. World Health Organization Monograph series No. 53, Geneva pp 50-84.
- Kaur, G. 2018. Diet Cal: A tool for dietary assessment and planning profound tech solutions. Department of Dietetics, AIIMS, New Delhi, India.
- Lindberg, E.; C. Janson; K. Svardsudd; T. Gislason; J. Hetta and G. Boman. 1998. Increased mortality among sleepy snorers: a prospective population based study. *Thorax*, 53: 631-637.
- Mann, S.; C. Beedie and A. Jimenez. 2014. Differential effects of aerobic exercise, resistance training and combined exercise modalities on cholesterol and the lipid profile: review, synthesis and recommendations. *Sports Medicine*, 44: 211-221. doi: 10.1007/s40279-013-0110-5.
- Marchi, K.C.; J.J. Muniz and C.R. Tirapelli. 2014. Hypertension and chronic ethanol consumption: What do we know after a century of study? *World Journal of Cardiology*, 6: 283-294.
- Moll, J. 2021. Soluble fibers for lowering your cholesterol. *Heart health* updated on September 22, 2021.
- Myint, P.K.; C.S. Kwok; R.N. Luben; N.J. Wareham and K. Khaw. 2014. Body fat percentage, body mass index and waist-to-hip ratio as predictors of mortality and cardiovascular disease. *Heart*, 100: 1613-1619.
- Nayar, A. 2002. Heart matters. *Sunday Tribune*, The tribune, April 7.

- Nazari, L.N.; M. Reisi; R. Tahmasebi and H. Javadzade. 2020. The effect of web-based educational intervention on physical activity-related energy expenditure among middle-aged women with overweight and obesity: an application of social cognitive theory. *Obesity Medicine*, 100181.
- NCEP ATP III. 2001. Third report of the National Cholesterol Education Program (NCEP) Expert panel on detection: Evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *JAMA*, 285: 2486-2497.
- NHS, 2018. Alcohol Units London: National Health Services England (updated 13 April 2018).
- Nwaiwu, O. and B.C. Ibe. 2015. Relationship between serum cholesterol and body mass index in Nigeria schoolchildren aged 2-15 years. *Journal of Tropical Pediatrics*, 61: 126-30. doi: 10.1093/tropej/fmu080.
- Ofori, E.K. and S.K. Angmortherh. 2019. Relationship between physical activity, body mass index (BMI) and lipid profile of students in Ghana. *Pan African Medical Journal*, 33: 30.
- Ronksley, P.E.; S.E. Brien; B.J. Turner; K.J. Mukamal and W.A. Ghali. 2011. Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. *BMJ*, 342: 671. doi: 10.1136/bmj.d671.
- Scheuner, M.T.; C.M. Setodji; J.S. Pankow; R.S. Blumenthal and E. Keeler. 2010. General Cardiovascular risk profile identifies advanced coronary artery calcium and is improved by family history: the multiethnic study of atherosclerosis. *Circulation. Cardiovascular Genetics*, 3: 97-105.
- Schroder, H.; J. Marrugat; R. Elosua and M.I. Covas. 2003. Relationship between body mass index, serum cholesterol, leisure-time physical activity, and diet in a Mediterranean Southern-Europe population. *British Journal of Nutrition*, 90: 431-39. doi: 10.1079/bjn2003899.
- Searlaman, E. 2019. 25- Hydroxy Vitamin D test. *Healthline Newsletter* Online.
- Song, Q.; X. Liu; W. Zhou; S. Wu and X. Wang. 2020. Night sleep duration and risk of each lipid profile abnormality in a Chinese population: a prospective cohort study. *Lipids in Health and Disease*, 19: 185. doi: 10.1186/s12944-020-01363-y.
- Wang, H.; A. Liu; T. Zhao; X. Gong; T. Pang; Y. Zhou; Y. Xiao; Y. Yan; C. Fan; W. Teng; Y. Lai and Z. Shan. 2017. comparison of anthropometric indices for predicting the risk of metabolic syndrome and its components in Chinese adults: a prospective and longitudinal study. *BMJ Open*, 7: e016062.
- WHO. 2017. Cardiovascular diseases WHO updates.
- WHO. 2021. Cardiovascular diseases [https://www.who.int/news-room/factsheets/detail/ cardiovascular diseases-cvds](https://www.who.int/news-room/factsheets/detail/cardiovascular-diseases-cvds)
- Yusuf, S.; S. Hawken; S. Ounpuu; T. Dans; A. Avezum; F. Lanas; M. McQueen; A. Budaj; P. Pais; J. Varigos and L. Lisheng. 2004. Effect of potentially modifiable risk factors associated with MI in 52 countries (the INTERHEART study): case-control study. *The Lancet*, 364: 937-952.

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Research Article

Training Counsellors for Lifestyle Issues: Survey to Speak and Deal about the Unsaid

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ABSTRACT

The times are changing fast and so are families and lifestyles. There is immense perceived pressure on all age groups with consequent mental health issues. This brings a need to identify issues and design interventions for those feeling the stress and challenge in relationships. Training counsellors to be a part of the care giving at the school level in the Indian context has also to bring in the new, not so discussed, issues. The study has been done with the objectives of finding and compiling issues on the new challenges (over engaged dual working parents, digital distractions, peer pressure, the need to look nice and seeking belongingness and more such contemporary issues); drawing out possible content in terms of intervention and specifying the stakeholders who can be included; the challenges on denial mode or uncooperative behaviour of one or more significant others; and the creative approach possible by the counsellors at the school (including school teachers, observations from peers and such possibilities. Self-developed questionnaire was developed with 30 items under 5 subheads. The recent trained counsellors, present batch of counsellors and pupil teachers (N=200) were included. The findings brought out stereotyped issues such as conservative approach of the parents, school hierarchy as a barrier, ignorance and denial, OTTs and movies bringing new ideas and approach to relationships, and more such reasons as the affecting causes to mental health chaos and making children over confident (some under-confident under peer/parental pressure). Friendly counsellors, group activities and sessions talking about the 'hush-hush' topics avoided otherwise, breaking the hierarchy in redressal mechanisms, and protecting the counsellors were some suggestions.

Keywords: Trainee counsellors, Creative approach, Over engaged parents, Hierarchy (in school system)

INTRODUCTION

In today's fast-paced world, individuals grapple with an array of lifestyle challenges that often go unspoken (Keyes *et al.*, 2010). These issues, ranging from stress and burnout to relationship struggles and existential crises, deeply impact individuals' well-being, yet they often remain concealed due to stigma, fear, or lack of understanding (Thoits, 2010). Addressing these lifestyle issues requires a multifaceted approach, one that involves not only individual introspection but also professional guidance and support. This is where the role of trained counsellors becomes paramount. Lifestyle issues encompass a broad spectrum of challenges that affect individuals' daily lives, behaviors,

and overall well-being (Corey *et al.*, 2018). These issues may include but are not limited to stress, anxiety, depression, substance abuse, work-life balance, relationship conflicts, self-esteem issues, and existential concerns. They arise from various sources such as societal pressures, cultural norms, personal experiences, and physiological factors (Neukrug and Schwitzer, 2015).

Counsellors are trained professionals who provide guidance, support, and therapeutic interventions to individuals facing various challenges in life (American Counselling Association, 2014). They employ a range of techniques including active listening, empathy, cognitive-behavioural therapy, and mindfulness

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practices to help clients navigate through their issues and develop coping mechanisms. Counsellors create a safe and confidential space for clients to explore their thoughts, emotions, and behaviours without fear of judgment.

There is the need for specialized training to the counsellors. While many counsellors receive general training in psychology and counselling techniques, addressing lifestyle issues requires specialized knowledge and skills (Prochaska and Norcross, 2018). Training programs tailored to lifestyle counselling are needed to address the unique complexities of modern-day challenges based on understanding the socio-cultural context of lifestyle issues, recognizing the intersectionality of identities, and staying updated on emerging trends and research in the field.

To effectively train counsellors for lifestyle issues, it is essential to conduct a comprehensive survey of the current landscape (Ritter and Jensen, 2019). This involves identifying prevalent lifestyle issues within different demographic groups, understanding the barriers to seeking help, and assessing the efficacy of existing counselling approaches. By gathering data through surveys, interviews, and focus groups, researchers can gain valuable insights into the needs and preferences of both counsellors and clients.

One of the key objectives of training counsellors for lifestyle issues is to create a culture where individuals feel comfortable speaking about the unsaid (Corey *et al.*, 2018). This involves breaking down stigma, fostering open dialogue, and promoting mental health literacy within communities. By encouraging candid conversations about taboo topics and providing education on healthy coping strategies, counsellors can empower individuals to seek help proactively and address issues before they escalate.

Lifestyle issues are often intertwined with a myriad of factors, including psychological, social, economic, and environmental influences (Neukrug and Schwitzer, 2015). Counsellors must be equipped to navigate this complexity and provide holistic support to their clients. This may involve collaborating with other healthcare professionals, advocating for systemic change, and addressing underlying root causes of lifestyle issues such as inequality and discrimination.

Existing research underscores the growing significance of lifestyle issues in student well-being. Studies by the author and (Institute Report, 2022) highlight the prevalence of digital dependence, substance abuse, and mental health concerns among students, demonstrating their detrimental impact on academic performance and life satisfaction. The crucial role of school counsellors in addressing these challenges is widely acknowledged (Professional Association, 2021), yet concerns regarding the adequacy of training in dealing with such multifaceted issues have been raised (Research Group, 2020).

Hence, to address the hidden challenges that individuals face today some possibilities to be explored include providing specialized education, fostering open dialogue, and advocating for systemic change, counsellors can play a pivotal role in promoting mental health and well-being. Through ongoing research, collaboration, and innovation, we can continue to improve the quality of counselling services and create a more supportive and inclusive environment for all.

REVIEW OF LITERATURE

In recent years, there has been a growing recognition of the importance of training counsellors to address lifestyle issues effectively. Lifestyle issues include stress, anxiety, depression, relationship conflicts, substance abuse, and existential concerns. However, these issues often go unspoken due to stigma, fear, or lack of understanding.

Prevalence and impact of lifestyle issues: Research indicates that lifestyle issues are highly prevalent in modern society, affecting individuals across various demographic groups (Keyes *et al.*, 2014). These issues can have significant consequences on individuals' mental, emotional, and physical well-being, as well as their relationships, work performance, and overall quality of life (Thoits, 2010). Understanding the prevalence and impact of lifestyle issues is essential for informing counselling training programs and interventions aimed at addressing these challenges effectively.

Barriers to seeking help: Despite the prevalence of lifestyle issues, many individuals hesitate to seek help due to various barriers, including stigma, lack of awareness about available resources, financial constraints, and cultural factors (Gulliver *et al.*, 2010).

Counsellors need to be trained to recognize and address these barriers sensitively, creating a supportive and non-judgmental environment where clients feel comfortable seeking help (Mittal and Walker, 2014).

Training counsellors for lifestyle issues: Training programs for counsellors must go beyond traditional counselling techniques to equip them with the knowledge and skills necessary to address lifestyle issues effectively (Cashwell and Young, 2011). This includes training in trauma-informed care, cultural competency, ethical considerations, and evidence-based interventions for specific lifestyle issues (Lambert and Dollahite, 2020). Experiential learning opportunities, such as role-plays, case studies, and supervised practicum experiences, are also essential for enhancing counsellors' competence and confidence in working with clients (Geldard and Geldard 2018).

Specialized approaches and interventions: There is a growing body of literature exploring specialized approaches and interventions for addressing lifestyle issues in counselling settings. Mindfulness-based interventions have been shown to be effective in reducing stress, anxiety, and depressive symptoms, as well as improving overall well-being (Kabat-Zinn, 2003). Cognitive-behavioural therapy (CBT) is another evidence-based approach commonly used in counselling to help clients identify and modify maladaptive thoughts and behaviors associated with lifestyle issues (Beck, 2011).

Integration of technology: With the advancement of technology, there is increasing interest in the integration of digital tools and platforms into counselling training and practice. Online counselling platforms, mobile applications, and virtual reality simulations offer innovative ways to deliver counselling services and reach individuals who may not have access to traditional face-to-face therapy (Sucala *et al.*, 2012). However, it is essential to consider ethical and privacy considerations when using technology in counselling, as well as to ensure that counsellors receive adequate training in its use (Glueckauf *et al.*, 2018).

Cultural considerations: Cultural factors play a significant role in shaping individuals' experiences of lifestyle issues and their willingness to seek help. Counsellors need to be culturally competent and sensitive to the diverse needs and perspectives of their

clients, taking into account factors such as language, religion, ethnicity, and socio-economic status (Sue *et al.*, 2019). Culturally tailored interventions that incorporate clients' cultural values, beliefs, and practices have been shown to be more effective in promoting positive outcomes in counselling (Leong and Leem, 2006).

Collaboration and interdisciplinary approaches: Collaboration between counsellors and other healthcare professionals, such as psychologists, social workers, and medical doctors, is essential for providing holistic care to individuals with lifestyle issues. Interdisciplinary approaches that integrate medical, psychological, and social interventions can address the complex needs of clients more effectively and improve treatment outcomes (Hoge *et al.*, 2014). Counsellors should also collaborate with community organizations, schools, and employers to create supportive environments and promote mental health and well-being at the systemic level (Miller and Rollnick, 2013).

Future directions and recommendations: Moving forward, there is a need for continued research and innovation in training counsellors for lifestyle issues. This includes the development of evidence-based training programs, the integration of technology into counselling education and practice, and the promotion of diversity and inclusion in the counselling profession (Erford, 2019). Additionally, efforts should be made to reduce stigma surrounding lifestyle issues and increase access to mental health services for all individuals, regardless of background or circumstances (Corrigan *et al.*, 2014).

Reviews indicate-lack of support from school authorities, high expectations but not so good resources in the school, balance issues among work and personal space (Joseph and Nirmala, 2019); teachers not enough skilled, and NEP 2020's expectations found too tough (Masood, 2023); addressing diverse student needs, managing workload, and navigating the evolving educational landscape (St. Bonaventure University Online, 2020); less than 3% counsellor in Delhi NCE contributing to inadequate support for students in managing emotional, behavioral, and academic challenges during their vulnerable teenage years (Sood, 2018); lack of specialized training, role confusion, and insufficient integration into the educational system (Akos *et al.*, 2014); lack of communication, ignoring

cultural differences, insufficient collaboration with teachers, and neglecting continuous professional development (Asian School of Teachers, n.d.); critical shortage of trained and full-time school counsellors (Gaur, 2019); diverse challenges faced by students, including mental health issues, suicidal tendencies, bullying, and personal problems; the need for qualified, experienced counsellors (Shah, 2017); post Pandemic - adapting to virtual environments for student access and counselling, and addressing the increased need for social-emotional learning (Schaffhauser 2021); and that the counsellors face difficulties in effectively applying counselling theories and approaches due to a lack of skills, confusion in adapting these approaches, and challenges in addressing local needs and cultural contexts (Sakiz and Saricali, 2019).

Rationale of the study: It provides a detailed understanding of the perceived significance of lifestyle issues among counsellors, educators, and students themselves and evaluates the comprehensiveness of existing counsellor training programs in equipping them to address these concerns. It further identifies the specific knowledge, skills, and resources needed by counsellors for effective intervention and brings forth the unspoken aspects and communication barriers surrounding student lifestyle issues. The study then, by bridging the gap between existing research and the lived experiences of those directly involved, our findings aim to inform the development of evidence-based training modules, promote open communication, and empower counsellors to become more effective advocates for student well-being in the modern educational landscape.

Thus, training counsellors to speak and deal with the unsaid aspects of lifestyle issues is essential for addressing the complex challenges faced by individuals today. By understanding the prevalence and impact of lifestyle issues, addressing barriers to seeking help, providing specialized training and interventions, integrating technology, considering cultural considerations, and fostering collaboration and interdisciplinary approaches, counsellors can play a vital role in promoting mental health and well-being. However, there is still much work to be done to ensure that all individuals have access to high-quality counselling services that meet their unique needs and preferences.

MATERIALS AND METHODS

A mixed-methods approach, utilizing both quantitative and qualitative data collection methods to comprehensively assess the landscape of training counsellors for student lifestyle issues was used.

Sampling and participants

Survey 1: Counsellors (n=100): Selected through stratified random sampling among 10 government and 5 private schools of Chandigarh and our trained counsellors in the last five batches were included.

Survey 2: Educators (n=150): Sampled proportionately across grade levels and subject areas within Chandigarh

Survey 3: Students (n=200): Stratified random sampling was used; students from classes 8th, 9th and 10th in equal numbers of boys and girls were included.

Semi-structured interviews: A smaller subsample (n=15) of counsellors and students were included for in-depth interviews to gain richer insights and explore the nuances of their experiences. School heads: 15 school heads were interviewed.

Data collection instruments

- Surveys: Online questionnaires were developed. The items included prevalence and perceived impact of various lifestyle issues on students, adequacy of current counsellor training in addressing these issues, knowledge, skills, and resources needed for effective intervention, and communication barriers and unspoken aspects of lifestyle issues.
- Recommendations for improving counsellor training and support structures were included in interactions.
- Interviews: Semi-structured interviews included open-ended questions to delve deeper into specific topics from the surveys to explore individual experiences in greater detail.

Data analysis

- Quantitative data (surveys): Statistical analysis using SPSS were conducted to identify patterns, assess differences between groups, and test hypotheses.
- Qualitative data (interviews): Thematic analysis was

used to identify recurring themes, patterns, and meanings across interview transcripts.

Triangulation and mixed-methods integration

- Findings from quantitative and qualitative data were compared and cross-validated to increase the validity and reliability of the research.
- Mixed-methods analysis were combined quantitative and qualitative insights to generate a comprehensive understanding of the complexities surrounding lifestyle issues, counsellor training, and student well-being.

Informed consent was obtained from all participants. Anonymity and confidentiality was assured throughout the research process.

RESULTS AND DISCUSSIONS

School counselling challenges span four domains: internal (school-specific), external (community etc.), system (policy, funding), and personal (counsellor skills). These domains interact, influencing each other and shaping solutions. Counsellors can leverage this interplay to address challenges. In specific there can be changes brought by:

Networking with external agencies for specialized programs (internal challenge). Adapting clinical approaches to student needs (personal and internal domains). Engaging stakeholders in policy discussions to improve guidelines (internal and system domains). Understanding these interactions empowers counsellors to develop holistic strategies and enhance work-life and performance. The findings indicate a framework for practitioners to analyze challenges and find solutions across domains.

A: Prevalence and perceived impact of various lifestyle issues on students

- Over occupied parents (35% students, 55% teachers, 67% counsellors)
- Poor role models among parents (57% counsellors, 78% teachers)
- Media and Internet distractions (79% students, 82% parents, 87% counsellors)
- Unsensitive teachers (65% parents, 35% administrative heads)

- Mothers extremely busy for personal care in food and time spent (66% girls, 43% boys)
- Lazy children, non-participating at home tasks also (63% parents)
- Over burden of school home-work and other tasks (45% fathers, 56% mothers)

B: Communication barriers and unspoken aspects of lifestyle issues

- Parents skip talking to children on sexual orientation (68%)
- Parents avoid talk in about relationships with opposite gender (59%)
- Teachers don't allow to express on personal issues (35%)
- Can walk to the school counsellor on any issue (25%)
- Can approach principal of the school on any issue that bothers the child (16%)

C: Knowledge, skills, and resources needed for effective intervention

- Need for more trained and experienced counsellor (77%)
- Need for curriculum revisions (63%)
- Need to increase hands on training (72%)
- Need to have better mentors to train counsellors (55%).

D: Adequacy of current counsellor training in addressing these issues

Data based on demographic profile and length of service of the counsellors reflected that

- Internship experience less than 6 months (85%)
- Internship experience less than 3 months (68%)
- Internship and experience as counsellor less than 4 years (56%); Distance education trained counsellors (69%).

The findings from the qualitative analysis reveal several key themes related to school counselling challenges and the perceived impact of lifestyle issues on students. These themes are categorized into four domains: internal (school-specific), external (community etc.), system (policy, funding), and personal (counsellor

skills). These domains interact with each other, influencing school counselling practices and shaping potential solutions.

A: Prevalence and Perceived Impact of Various Lifestyle Issues on Students

The prevalence and perceived impact of lifestyle issues on students are significant concerns among stakeholders. Over-occupied parents, poor role models among parents, media and internet distractions, unsensitive teachers, and imbalanced household responsibilities were identified as notable lifestyle issues affecting students. These findings highlight the multifaceted nature of lifestyle challenges and the complex interplay between familial, societal, and educational factors.

B: Communication Barriers and Unspoken Aspects of Lifestyle Issues

Communication barriers and unspoken aspects of lifestyle issues emerged as prominent challenges in addressing students' well-being. Parents often avoid discussing sensitive topics such as sexual orientation and relationships with their children, while teachers may not create opportunities for students to express personal issues. Despite the availability of school counsellors and principals as resources for students, there remains a significant gap in communication and accessibility.

C: Knowledge, Skills, and Resources Needed for Effective Intervention

Stakeholders emphasized the need for additional resources and support to effectively address lifestyle issues among students. This includes the demand for more trained and experienced counsellors, curriculum revisions to incorporate relevant topics, increased hands-on training opportunities, and better mentoring for counsellors. These findings underscore the importance of investing in professional development and capacity-building initiatives within the school counselling framework.

D: Adequacy of Current Counsellor Training in Addressing These Issues

The adequacy of current counsellor training programs in addressing lifestyle issues was also examined. Data based on demographic profiles and length of service

of counsellors revealed several areas of concern. For instance, a significant proportion of counsellors reported limited internship experience, particularly those with less than six months or three months of internship experience. Additionally, counsellors with fewer than four years of experience or those trained through distance education programs expressed concerns about their preparedness to address lifestyle issues effectively.

Implications and Recommendations

Interdisciplinary collaboration: Addressing lifestyle issues requires collaboration among various stakeholders, including parents, teachers, school counsellors, and administrators. Creating opportunities for interdisciplinary dialogue and collaboration can facilitate more comprehensive and coordinated approaches to student well-being.

Professional development: Investing in ongoing professional development and training opportunities for counsellors is essential by providing hands-on training, mentorship programs, and access to resources to enhance counsellors' skills and competencies in addressing lifestyle issues.

Curriculum revisions: Schools should consider revising their curricula to incorporate relevant topics related to mental health, well-being, and lifestyle management and hence promote a culture of openness, awareness, and proactive support for students' holistic development.

Accessibility and communication: Improving accessibility to counselling services and promoting open communication channels between students, parents, and school staff are critical. Schools should create supportive environments where students feel comfortable seeking help and discussing sensitive topics with trusted adults.

CONCLUSION

The findings from this qualitative analysis shed light on the complex challenges and opportunities associated with addressing lifestyle issues in school counselling settings. By understanding the prevalence, impact, and underlying factors contributing to lifestyle issues among students, stakeholders can develop more informed and effective strategies for supporting student well-being.

Moving forward, it is imperative to prioritize interdisciplinary collaboration, invest in professional development initiatives, revise curricula, and promote open communication to create supportive and inclusive school environments that nurture students' holistic development. This framework provides a guide for practitioners to analyse challenges and find solutions across domains, ultimately enhancing their work and impact.

THE WAY FORWARD

School counselling challenges are complex, involving interactions between internal (school), external (community), system (policy), and personal (counsellor) domains. There is a need to develop holistic solutions to empower counsellors through – Networking for Accessing external resources, adapting approaches to meeting student needs, advocacy by engaging in policy discussions and influencing the system and self-care using effective support. Further researches can include developing modules for administrative position holders, curriculum developers, counsellors, parents and age wise groups of students (NEP 2020 classification can be followed).

REFERENCES

- Akos, P.; S. Jain and S. Gurjar. 2014. School counselling in India. *Journal of Asia Pacific Counselling*, 4(2): 169-180.
- American Counseling Association. 2014. *ACA Code of Ethics*. Alexandria, VA: Author.
- Asian College of Teachers. (n.d.). '8 school counselor mistakes you can avoid successfully.'
- Beck, J.S. 2011. Cognitive behavior therapy: Basics and beyond. Guilford Press.
- Cashwell, C.S. and J.S. Young. 2011. Integrating mindfulness practices into counselor preparation. *Journal of Humanistic Counseling, Education and Development*, 50(4): 438-451.
- Corey, G.; M.S. Corey and P. Callanan. 2018. Issues and ethics in the helping professions. Cengage Learning.
- Corrigan, P. W.; B.G. Druss and D.A. Perlick. 2014. The impact of mental illness stigma on seeking and participating in mental health care. *Psychological Science in the Public Interest*, 15(2): 37-70.
- Erford, B.T. 2019. Transforming the future of counseling through technology, research, and practice. *Journal of Mental Health Counseling*, 41(3): 203-205.
- Gaur, P. 2019. Indian schools need counsellors as mental illness strikes early in children. *Indiatimes*.
- Geldard, K. and D. Geldard. 2018. Basic personal counseling: A training manual for counselors. Cengage Learning.
- Glueckauf, R.L.; M.M. Maheu; K.P. Drude; B.A. Wells; Y. Wang; D.J. Gustafson and E.L. Nelson. 2018. Survey of psychologists telebehavioral health practices: Technology use, ethical issues, and training needs. *Professional Psychology: Research and Practice*, 49(3): 205-219.
- Gulliver, A.; K.M. Griffiths and H. Christensen. 2010. Perceived barriers and facilitators to mental health help-seeking in young people: A systematic review. *BMC Psychiatry*, 10(1): 113.
- Hoge, M.A.; J.A. Morris; A.S. Daniels; G.W. Stuart; L.Y. Huey and N. Adams. 2014. An action plan for behavioural health workforce development. *Psychiatric Services*, 65(6): 759-763.
- Kabat-Zinn, J. 2003. Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, 10(2): 144-156.
- Keyes, C.L.; S.S. Dhingra and E.J. Simoes. 2010. Change in level of positive mental health as a predictor of future risk of mental illness. *American Journal of Public Health*, 100(12): 2366-2371.
- Lambert, N.M. and D.C. Dollahite. 2020. Integrating trauma-informed care into counselor education: Strategies and resources. *Journal of Counseling & Development*, 98(4): 417-427.
- Leong, F.T. and S.H. Lee. 2006. A cultural accommodation model for cross-cultural psychotherapy: Illustrated with the case of Asian Americans. *Psychotherapy: Theory, Research, Practice, Training*, 43(4): 410-423.
- Masood, A. 2023. Navigating the changing educational landscape: The vital role of high school counselors in India. *Linkedin*.
- Miller, W.R. and S. Rollnick. 2013. Motivational interviewing: Helping people change. Guilford Press.
- Mittal, D. and R. Walker. 2014. Impact of information on attitudes toward mental illness: A systematic review. *Journal of Mental Health*, 23(5): 261-273.
- Neukrug, E.S. and A.M. Schwitzer. 2015. Essentials of testing and assessment: A practical guide for counselors, social workers, and psychologists. Cengage Learning.
- Nirmala, D. 2019. Professional challenges faced by women school counsellors -A case study analysis. *International Journal of Research in Social Sciences*, 9(2).
- Prochaska, J.O. and J.C. Norcross. 2018. Systems of psychotherapy: A transtheoretical analysis. Oxford University Press.
- Ritter, K. and E.W. Jensen. (Eds.). 2019. Handbook of counseling and psychotherapy with lesbian, gay, bisexual,

- and transgender clients. American Counseling Association.
- Sakiz, H. and M. Saricali. 2019. Paradigmatic challenges in school counselling: correlates and reflections on practice. *Journal of Psychologists and Counsellors in Schools*, 29(1): 69-81.
- Schaffhauser, D. 2021. Pandemic has changed main challenges of school counselors. THE Journal.
- Shah, A.J. 2017. Latest trends and initiatives in school counselling by Educure. LinkedIn.
- Sood, V. 2018. With serious lack of school counsellors, are we failing our kids? The Quint.
- St. Bonaventure University Online. 2020. School counselors: Overcoming 9 key challenges to a Rewarding Career.
- Sucala, M.; J.B. Schnur; M.J. Constantino; S.J. Miller; E.H. Brackman and G.H. Montgomery. 2012. The therapeutic relationship in e-therapy for mental health: A systematic review. *Journal of Medical Internet Research*, 14(4): e110.
- Sue, D.W.; D. Sue and S. Sue. 2019. Understanding abnormal behavior. Cengage Learning.
- Thoits, P.A. 2010. Stress and health: Major findings and policy implications. *Journal of Health and Social Behavior*, 51(1_suppl): S41-S53.

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Research Article

Farmers' Willingness to Pay for Climate-Resilient Agriculture Technologies: A Case Study from the Coastal Low-lying Region of Kerala

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ABSTRACT

Climate change poses complex challenges to agriculture in terms of multiple abiotic stresses on crops and livestock, shortages of water, land degradation, and loss of biodiversity. In order to make agriculture adaptable to climate change, it is necessary to promote climate-resilient agriculture (CRA) technologies, and to ensure that these technologies are affordable from the perspective of farmers. In light of this, the present study was designed to analyse farmers' willingness to pay (WTP) as well as the factors affecting WTP for the selected CRA technologies in the Muttar village of Alappuzha district in Kerala. A total of three technologies and 60 beneficiary farmers (20 for each technology) were selected at random for the purpose of this study. The farmers' WTP was determined using the contingent valuation method, and then the factors influencing farmers' WTP were determined using the interval regression model. The findings of the study revealed that the majority of the beneficiary farmers (>85%) were willing to pay for the technologies Crop field mechanisation and Site-specific acidity & nutrient management, while only 45.00 per cent of them were willing to pay for the technology Intercropping short-duration cassava. It was also observed that the factors affecting farmers' WTP varied from technology to technology based on its nature, purpose, and utility. Therefore, technologies in the future should be carefully developed with these considerations in mind.

Keywords: Climate change, Climate-resilient agriculture, Contingent valuation method, Interval regression model, Willingness to pay

INTRODUCTION

Due to climate change, farmers in Kerala, a state on India's tropical Malabar coast, particularly in the lower Kuttanad region, are experiencing more frequent flooding and erratic rains. Hence, they are restricted to growing only one crop of paddy in a year (Reddy and Dixit, 2017). According to Reddy (2015), there is a potential to increase the resilience of agriculture to

climate change through the application of existing knowledge and technologies as well as the development of improved technologies. Climate-resilient agriculture (CRA) is an approach that attempts to improve livelihoods and food security, particularly for smallholders, by utilising appropriate methods and technologies for the production, processing, and marketing of agricultural goods, as well as by managing natural resources more effectively (FAO, 2012). In light

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of this, Krishi Vigyan Kendra-Alappuzha (KVK-Alappuzha) introduced several CRA technologies in their adopted village of Muttar, in the Alappuzha district of Kerala, to enhance the resilience of the farming community to climate change (Reddy and Dixit, 2017). In order to maintain the availability of such technologies, many have advocated imposing service charges, particularly in developing countries (Ulimwengu and Sanyal, 2011).

It's important to understand the economic values of such CRA technologies from the farmers' perspective, because determining a technology's economic value is a useful tool to enhance its allocation, decrease its wasteful use, and achieve sustainable management (Bozorg-Haddad *et al.*, 2016). Thus, the purpose of this study is to analyse farmers' willingness to pay (WTP) for the selected CRA technologies in the coastal low-lying region of Kerala using the contingent valuation method (CVM). It also makes an effort to understand the factors influencing farmers' WTP for the successful implementation of such technologies. We anticipate that the farmers' WTP for CRA technologies depends on their level of satisfaction with the technology as well as their socio-economic characteristics.

MATERIALS AND METHODS

The study was conducted in the purposively selected Muttar village of Alappuzha district in Kerala. A total of three technologies were selected: i. Crop field mechanisation (using drum seeder for the optimization of seed rate and plant population) ii. Site-specific acidity & nutrient management (through soil test-based fertilizer and dolomite application) iii. Intercropping short-duration cassava (in coconut gardens to overcome waterlogging). Further, a total of 60 beneficiary farmers, 20 for each technology, were selected to estimate farmers' WTP for the CRA technologies. WTP was defined as the maximum amount in rupees (Rs.) that the farmers were willing to pay for the CRA technology. Since CVM is the most widely used technique for the estimation of WTP (Alhassan *et al.*, 2013), farmers' WTP for the CRA technologies was determined using CVM. For each CRA technology, the respective beneficiary farmers were asked to indicate their preferred WTP, assuming it was a paid one.

In accordance with Morey *et al.* (2002), the interval regression model was used to understand the factors influencing differential amounts of WTP. In order to achieve this, we used the methodology developed by Cameron and Huppert (1989) in this study. The variables influencing specified WTP were then identified by estimating the maximum likelihood function using the interval regression command in STATA 12.

$$WTP_i = \alpha + \beta_i X_i + \varepsilon_i$$

where, α = constant, β_i = coefficients of different variables, X_i = a series of explanatory variables that influence farmers' WTP (Table 1), and ε_i = the error term, including all unobserved determinants.

Hence, the following three interval regression models were used to identify the determinants of WTP for the selected CRA technologies:

WTP for the technology Crop field mechanisation

$$WTP_{(CFM)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \varepsilon_i$$

where, X_1 = AFM, X_2 = FES, X_3 = SCP, X_4 = FFE, X_5 = OLH, X_6 = MFE, X_7 = PMC, X_8 = IFA, X_9 = ANI, X_{10} = ECT, and X_{11} = SAT

WTP for the technology Site-specific acidity & nutrient management

$$WTP_{(SNM)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \varepsilon_i$$

where, X_1 = AFM, X_2 = FES, X_3 = SCP, X_4 = EXC, X_5 = FFE, X_6 = OLH, X_7 = MFE, X_8 = PMC, X_9 = IFA, X_{10} = ANI, X_{11} = ECT, and X_{12} = SAT

WTP for the technology Intercropping short duration cassava

$$WTP_{(ISC)} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon_i$$

where, X_1 = AFM, X_2 = FES, X_3 = SCP, X_4 = EXC, X_5 = FFE, X_6 = MFE, X_7 = ANI, and X_8 = SAT

RESULTS AND DISCUSSION

The technology Crop field mechanisation was intended to persuade the farmers to use a drum seeder, a new piece of farm equipment, for the sowing of paddy in order to reduce the cost of cultivation and guarantee a

Table 1: Variables to measure farmers' WTP for the CRA technology

Code	Variable	Brief Description	Hypothetical relationship
AFM	Average age of family members	Average of the ages (in years) of adult family members in the households.	+/-
FES	Family education status	Average educational achievement of the family members (calculated by the index developed by Ray (1967) as quoted by Ray and Mondal (2006).	+/-
SCP	Social participation	Involvement of respondent in formal and informal social organisations as a member or as an office bearer.	+/-
EXC	Extension contacts	Both acquaintance and frequency of respondent's contact with experts, VLW, ADO, BDO, VO, bank officials etc.	+/-
FFE	Farmer-farmer extension	Numbers of fellow farmers from whom respondent was seeking information on different aspects of crop production and climate change adaptation.	+/-
OLH	Operational land holding	Total land area held under a single management for the purpose of cultivation.	+/-
MFE	Number of modern farm equipment used	Number and type of modern farm equipment used (own or hired) by the household.	-/+
PMC	Average productivity of major crops	Production of major crops per unit area of the respondent.	+/-
ANI	Annual income	Summation of income in rupees of the households from all the sources on annual basis.	+/-
IFA	Proportion of income from crop production to the total income	Percentage of income from crop production to the total income of the household on annual basis.	+/-
ECT	Proportion of expenditure for crop production to the total household expenditure	Percentage of households' expenditure on crop production to the total household expenditure on annual basis.	-/+
SAT	Farmers' satisfaction with the CRA technology	Degree to which a respondent realises the utility of received technology in fulfilling his or her needs.	+/-

healthy and optimal plant population. Farmers reported that the quantity of seeds needed was drastically reduced (by approximately 75%) compared to the previous broadcast method of sowing, which used 120 kg of seeds per hectare; the drum seeder, on the other hand, only used 30 kg of seeds per hectare. Additionally, for the paddy crop, it was noticed that there was an increase in the production of healthy tillers, a reduction in the susceptibility to pests and diseases, and an increase in the resistance to water-logging. Similarly, it was also observed that the farmers could readily harvest the crop with a combined harvester. Therefore, it's evident from Table 2 that the majority of the respondents (85%) were willing to pay Rs. 3402.94, with a standard error of Rs. 110.85 per drum seeder, for this technology.

Under the technology like Site-specific acidity & nutrient management, farmers received recommendations for the scientific application of fertilisers and dolomite (liming material) based on soil tests to check soil acidity and excess use of fertilisers. Dolomite not only lowers soil acidity but also increases nutrient availability and crop magnesium content. Additionally, in an effort to lower the cost of cultivation and environmental pollution, farmers were encouraged to use eco-friendly pest and disease management practices. As a result, there was a substantial reduction in the expenses of chemical fertilisers and pesticides, which appeared to offset the cost of dolomite. Therefore, all the respondents were willing to pay Rs. 912.50 for this technology, with a standard error of Rs. 30.32 per package (Table 2).

Table 2: Farmers' WTP for the CRA technology (n=20)

Technology	WTP		
	No	Yes	Amount willing to pay (Rs.) (Mean $\pm$ SE)
Crop field mechanisation	3(15)	17(85)	3402.94 $\pm$ 110.85
Site-specific acidity & nutrient management	-	20(100)	912.50 $\pm$ 30.32
Intercropping short duration cassava	11(55)	9(45)	1477.78 $\pm$ 71.74

Values in parenthesis indicate percentage

The primary goal of the technology Intercropping short duration cassava was to give farmers an additional crop so they could earn income during the rainy season, which runs from June to September. Due to water-logged, flooded circumstances, farmers in the low-lying Kuttanad region of Kerala were unable to produce any crops during this season for approximately three to four months. Hence, the short-duration cassava variety, *Vellayani braswa*, with a crop duration of four and half months, was introduced to guarantee optimal land utilisation and facilitate an early crop harvest. However, the cassava variety didn't behave as planned. Hence, it is evident from Table 2 that a majority of the respondents (55%) were unwilling to pay for this technology. While a portion of the respondents (45%) were willing to pay Rs. 1477.78, with a standard error of Rs. 71.74 per hectare of land, for this technology, thanks to the technology, women farmers were able to engage in cooperative farming, which guaranteed additional revenue for their families.

The pattern of farmers' WTP for the technology Crop field mechanisation is clearly shown in Figure 1.

Farmers stated a wide range of WTP preferences for this technology, from less than Rs. 2900 to more than Rs. 3900. The majority of the beneficiary farmers (58.82%) were willing to pay between Rs. 2900 and Rs. 3900. While 17.65 per cent of the beneficiary farmers were willing to pay even more—that is, more than Rs. 3900. However, the remaining beneficiary farmers (23.53%) were only willing to pay less than Rs. 2900.

Figure 2 makes it clear that the farmers' WTP for the technology Site-specific acidity & nutrient management ranged from less than Rs. 750 to more than Rs.1050, with a large concentration between Rs.750 and Rs.1050. It was observed that 70.00 per cent of the beneficiary farmers had WTPs between Rs.750 and Rs.1050, with 10.00 per cent having WTPs over Rs.1050 and 20.00 per cent having WTPs below Rs.750.

The WTP pattern for the farmers using Intercropping short duration cassava technology is displayed in Figure 3. The data makes it abundantly evident that farmers were willing to pay between Rs. 1100 and Rs. 1700 for this technology. While a majority

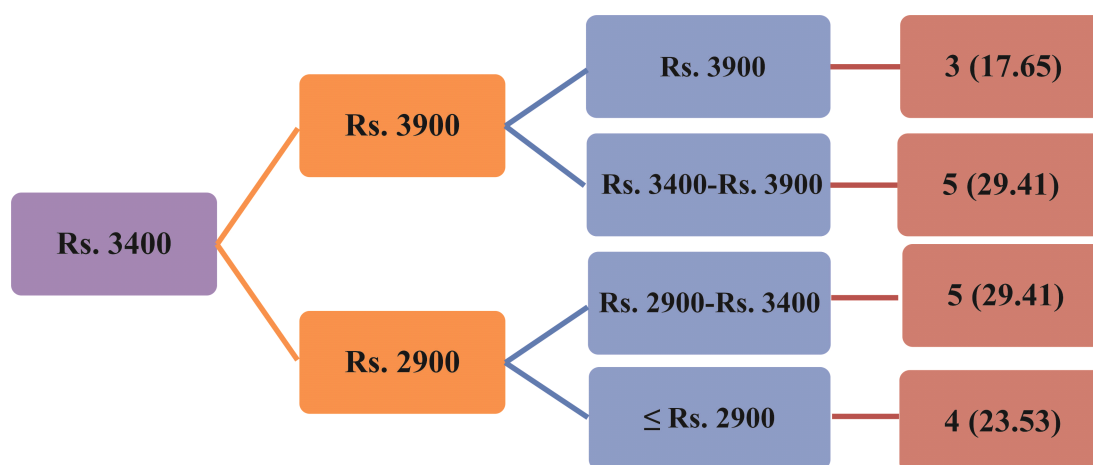


Figure 1: Pattern of farmers' WTP for the technology Crop field mechanisation (per drum seeder) (n = 17, values in the last column indicate frequency and percentage of farmers)

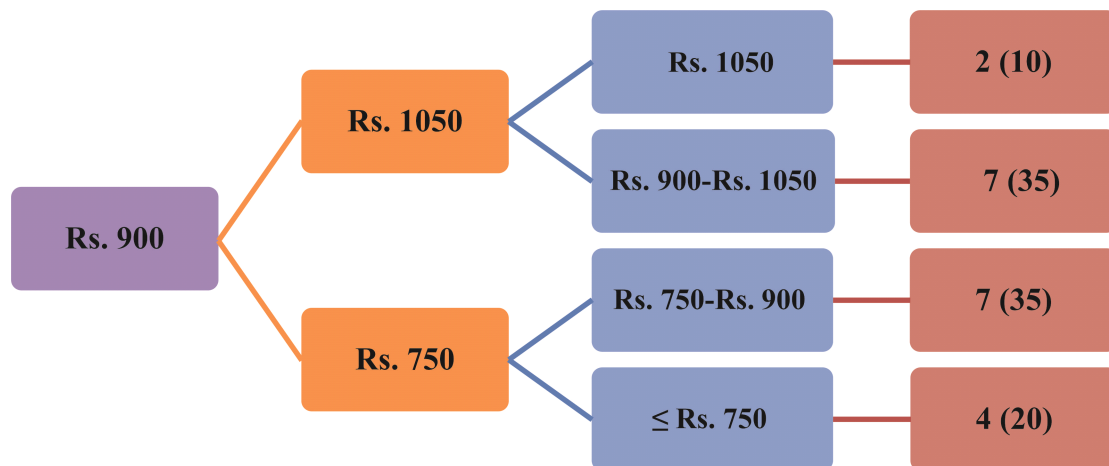


Figure 2: Pattern of farmers' WTP for the technology Site-specific acidity & nutrient management (per package) (n = 20, values in the last column indicate frequency and percentage of farmers)

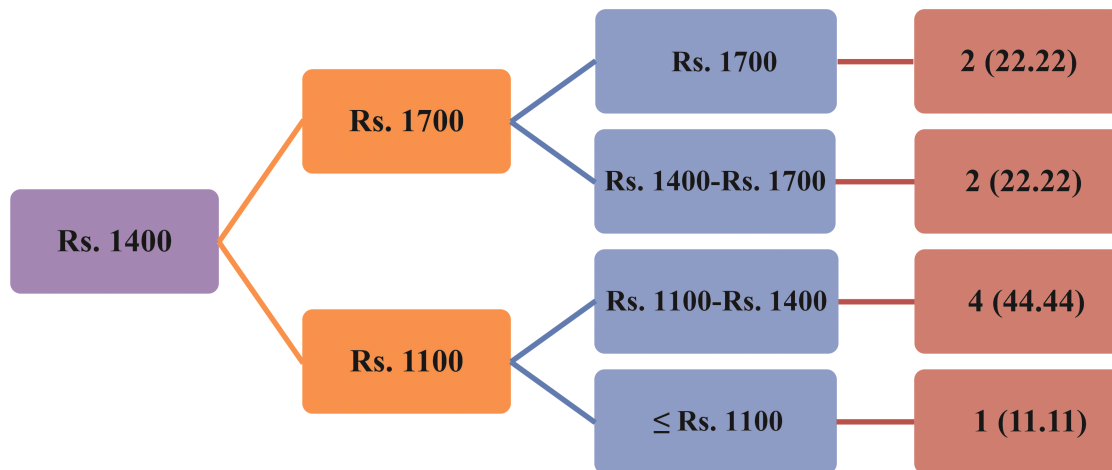


Figure 3: Pattern of farmers' WTP for the technology Intercropping short duration cassava (per hectare) (n = 9, values in the last column indicate frequency and percentage of farmers)

of the beneficiary farmers (88.88%) were willing to pay more than Rs. 1100, a minority of the beneficiary farmers (11.11%) were only interested in paying less than Rs. 1100.

Table 3 lists the factors that affected farmers' WTP for the technology Crop field mechanisation. The factors that benefited farmers' WTP for this technology were average age of family members, family education status, average productivity of major crops, proportion of income from crop production to the total income, annual income, and proportion of expenditure for crop production to the total household expenditure. Education and experience can help farmers recognise the value of CRA technology and make decisions in terms of agricultural production

in the context of climate change. The effect of education on the use of CRA technologies is in line with the findings of Lybbert *et al.* (2007) and Zongo *et al.* (2015). However, the data reveals that farmers' WTP was unaffected by the variable farmers' satisfaction with the CRA technology. This was due to the fact that, even if farmers were happy with the technology, increased farmer-farmer extension enabled them to borrow drum seeders from their fellow farmers; hence, they were not willing to pay. Similarly, larger land holdings prevented them from affording a new drum seeder by encouraging them to buy more efficient, high-performing farm equipment. Therefore, farmers' WTP had been negatively affected by factors farmer-farmer extension, operational land holding, and number of modern farm equipment used.

Table 3: Factors affecting farmers' WTP for the technology Crop field mechanisation (n=20)

Explanatory variables	Coefficient	Standard error	z value	p > z	95% confidence interval of coefficient
AFM	10.82***	2.09	5.17	0.00	6.72 – 14.92
FES	63.45***	25.90	2.45	0.01	12.69 – 114.21
SCP	43.57	31.29	1.39	0.16	-17.75 – 104.90
FFE	-191.47***	37.96	-5.04	0.00	-265.87 – -117.07
OLH	-265.50***	76.72	-3.46	0.00	-415.87 – -115.12
MFE	-61.87***	24.87	-2.49	0.01	-110.62 – -13.12
PMC	0.19***	0.06	3.36	0.00	0.08 – 0.29
IFA	9.22**	3.96	2.33	0.02	1.46 – 16.98
ANI	0.0009***	0.0003	3.39	0.00	0.0004 – 0.0014
ECT	22.47***	3.25	6.92	0.00	16.11 – 28.84
SAT	15.69	36.80	0.43	0.67	-56.43 – 87.82

Note. ***, ** and * respectively denote significant levels of 1%, 5%, and 10%.

Table 4: Factors affecting farmers' WTP for the technology Site-specific acidity & nutrient management (n=20)

Explanatory variables	Coefficient	Standard error	z value	p > z	95% confidence interval of coefficient
AFM	2.82***	0.76	3.73	0.00	1.34 – 4.31
FES	-7.53*	4.53	-1.66	0.10	-16.40 – 1.34
SCP	15.16***	5.99	2.53	0.01	3.43 – 26.89
EXC	-1.53	5.78	-0.26	0.79	-12.85 – 9.80
FFE	49.40***	18.17	2.72	0.01	13.78 – 85.02
OLH	-276.56***	28.49	-9.71	0.00	-332.39 – -220.72
MFE	-85.79***	15.29	-5.61	0.00	-115.75 – -55.83
PMC	-0.02	0.02	-0.90	0.37	-0.06 – 0.02
IFA	1.96***	0.78	2.52	0.01	0.44 – 3.49
ANI	0.0008***	0.00008	9.94	0.00	0.0006 – 0.0009
ECT	16.73***	2.25	7.43	0.00	12.32 – 21.14
SAT	138.27***	24.51	5.64	0.00	90.22 – 186.31

Note. ***, ** and * respectively denote significant levels of 1%, 5%, and 10%.

Table 4 clearly illustrates the variables affecting farmers' WTP for the technology Site-specific acidity & nutrient management. Indeed, farmers' age might affect their WTP since younger farmers are less interested in using CRA technologies because they want to engage in non-agricultural activities that provide higher cash income (Thune, 2011). Increased revenue and spending on agriculture show how vital farming is to their livelihoods, which further encourages the use of better technologies. Similarly, farmers will be more inclined to pay for the technology if they see its

benefits and believe it to be beneficial and satisfactory for their agricultural circumstances. Hence, variables such as average age of family members, social participation, farmer-farmer extension, proportion of income from crop production to the total income, annual income, proportion of expenditure for crop production to the total household expenditure, and farmers' satisfaction with the CRA technology exhibited a positive influence on the farmers' WTP. On the other hand, factors like family education status, operational land holding, and number of modern farm equipment used had a negative impact.

Table 5: Factors affecting farmers' WTP for the technology Intercropping short duration cassava (n=20)

Explanatory variables	Coefficient	Standard error	z value	p > z	95% confidence interval of coefficient
AFM	4.16	5.15	0.81	0.42	-5.94 – 14.26
FES	-18.25	32.54	-0.56	0.58	-82.03 – 45.53
SCP	173.02***	65.58	2.64	0.01	44.49 – 301.54
EXC	-44.15	76.78	-0.58	0.57	-194.64 – 106.33
FFE	-247.97**	103.32	-2.40	0.02	-450.47 – -45.47
MFE	-32.57	57.97	-0.56	0.57	-146.19 – 81.05
ANI	-0.0001	0.0003	-0.34	0.74	0.0007 – 0.0005
SAT	449.24***	135.53	3.31	0.001	183.61 – 714.86

Note. ***, ** and * respectively denote significant levels of 1%, 5%, and 10%.

It is evident from Table 5 that social participation, farmer-farmer extension, and farmers' satisfaction with the CRA technology were the main factors affecting farmers' WTP for the technology Intercropping short duration cassava. Notably, this technology was mostly practiced by groups of four to five women farmers; hence, social participation and cooperation were crucial. According to Tarhule and Lamb (2003), the organisation of agricultural groups enables enhanced access and utilisation of available services. Similarly, their satisfaction with the technology's capacity to give their family more revenue significantly influenced their WTP. Therefore, farmers' WTP was positively influenced by variables social participation, and farmers' satisfaction with the CRA technology. At the same time, variable farmer-farmer extension was negatively affecting farmers' WTP. This can be related to the dominance of men in society because, if there was more farmer-farmer contact amongst the male farmers, they dissuaded the female farmers from engaging in cassava cultivation by claiming that it was not very lucrative.

CONCLUSION

The present study revealed the farmers' WTP for the selected CRA technologies that were introduced by the KVK-Alappuzha in the Muttar village of Alappuzha district in Kerala. It was found that the majority of the beneficiary farmers (>85%) were willing to pay for the technologies Crop field mechanisation and Site-specific acidity & nutrient management, while only 45.00 per cent of them were willing to pay for the technology Intercropping short duration cassava. According to the pattern of WTP

for the CRA technologies, it was observed that the majority of the beneficiary farmers were willing to pay between Rs. 2900 and Rs. 3900 for the technology Crop field mechanisation, Rs. 750 and Rs. 1050 for the technology Site-specific acidity & nutrient management, and Rs. 1100 and Rs. 1700 for the technology Intercropping short duration cassava. The study also attempted to identify the factors affecting farmers' WTP. It was found that variables average age of family members, family education status, social participation, farmer-farmer extension, operational land holding, number of modern farm equipment used, average productivity of major crops, proportion of income from crop production to the total income, annual income, and proportion of expenditure for crop production to the total household expenditure were affecting farmers' WTP for the technology Crop field mechanisation. Whereas, the farmers' WTP for the technology Site-specific acidity & nutrient management was influenced by variables average age of family members, family education status, social participation, farmer-farmer extension, operational land holding, number of modern farm equipment used, proportion of income from crop production to the total income, annual income, proportion of expenditure for crop production to the total household expenditure, and farmers' satisfaction with the CRA technology. While, the farmers' WTP for the technology Intercropping short duration cassava was affected by variables social participation, farmer-farmer extension, and farmers' satisfaction with the CRA technology. Hence, it was understood that the determinants of farmers' WTP for the selected CRA technologies varied depending on the nature, purpose, and utility of the technology

from their perspective. Policymakers, planners, and extension agents may find the study's conclusions useful in the future as they develop and promote the same or related technologies.

REFERENCES

- Alhassan, M.; J. Loomis; M. Frasier and S. Davies. 2013. Estimating Farmers' Willingness to Pay for Improved Irrigation: An Economic Study of the Bontanga Irrigation Scheme in Northern Ghana. *Journal of Agricultural Science*, 5: 31-42. doi: 10.5539/jas.v5n4p31
- Bozorg-Haddad, O.; M. Malmir; S. Mohammad-Azari and H.A. Loáiciga. 2016. Estimation of farmers' willingness to pay for water in the agricultural sector. *Agricultural Water Management*, pp 284-290.
- Cameron, T.A. and D.D. Huppert. 1989. OLS versus ML estimation of non-market resource value with payment card interval data. *Journal of Environmental Economics and management*, 17: 230-246. doi: 10.1016/0095-0696(89)90018-1
- FAO. 2012. Climate-smart agriculture: managing ecosystems for sustainable livelihoods. FAO, Rome.
- Lybbert, T.J.; C.B. Barrett; J.G. McPeak and W.K. Luseno. 2007. Bayesian Herders: Updating of Rainfall Beliefs in Response to External Forecasts. *World Development*, 35(3): 480-497. doi: 10.1016/j.worlddev.2006.04.004
- Morey, E.R.; K.G. Rossmann; L.G. Chestnut; S. Ragland; S. Navrud and R.C. Ready. 2002. Valuing reduced acid deposition injuries to cultural resources: marble monuments in Washington, DC. *Valuing cultural heritage: Applying environmental valuation techniques to historic buildings, monuments and artifacts*. Edward Elgar, Cheltenham, UK, pp 159-183.
- Ray, G.L. and S. Mondal. 2006. Research Methods in Social Sciences and Extension Education. Kalyani Publishers, Ludhiana.
- Reddy, D.S. and S. Dixit. 2017. *Enhancing Resilience and Adaptive Capacity of Farmers to Climate Variability - Experience of NICRA*. Bengaluru, ICAR-ATARI. 170p.
- Reddy, P.P. 2015. *Climate Resilient Agriculture for Ensuring Food Security* (Vol. 373). New Delhi, Springer India. doi: 10.1007/978-81-322-2199-9
- Tarhule, A. and P.J. Lamb. 2003. Climate research and seasonal forecasting for West Africans: perceptions, dissemination, and use? *Bulletin of the American Meteorological Society*, 84(12): 1741-1759. doi: 10.1175/BAMS-84-12-1741
- Thune, M. 2011. L'industrialisation de l'exploitation de l'or à Kalsaka, Burkina Faso: Une chance pour une population rurale pauvre? *EchoGéo*, 17.
- Ulimwengu, J. and P. Sanyal. 2011. Joint estimation of farmers' stated willingness to pay for agricultural services. *International Food Policy Research Institute Discussion Paper*.
- Zongo, B.; A. Diarra; B. Barbier; M. Zorom; H. Yacouba and T. Dogot. 2016. Farmers' Perception and Willingness to Pay for Climate Information in Burkina Faso. *Journal of Agricultural Science, Canadian Center of Science and Education*, 8(1): 175-187. doi: 10.5539/jas.v8n1p175

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Research Article

Socio-economic Impact of Mechanisation Through Paddy Group Farming in Kerala: An Analysis on Farmers' Perception

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ABSTRACT

Paddy cultivation involves labour intensive operations starting from tillage to harvest. Over the past ten years, there has been a major emphasis on mechanization of paddy cultivation across Kerala. An institutional arrangement based on collective farming has been followed to overcome the twin problems of labour shortage and lack of capital investment in mechanisation faced by small farmers. These collective ventures based on partnerships of farmers and labourers had the full support of the State government and Local self-governments. All these efforts have resulted in various socio-economic benefits to the paddy farmers in Kerala. In this context, the present study was undertaken to assess the farmers' perception on the socio-economic impact of mechanization through paddy group farming. The study was conducted in the Palakkad district, which is having maximum area under paddy cultivation in Kerala. 120 farmers randomly selected from the paddy farming groups in the two major blocks in the district were the respondents of the study. Nine socio-economic impact factors due to mechanisation related to paddy cultivation were identified through judges' rating and pilot study conducted in the district. A semi-structured interview schedule was employed to collect data from the respondents. An overall socio-economic impact perception index was computed by assigning suitable weights for various factors, obtained by Principal Component Analysis. Major factors of socio economic impact were savings in time spend on farming activities, provision of livelihood option and the farmers' access to assets. The extent of mechanisation, annual income, area under paddy cultivation, extension contact, social participation, innovativeness and attitude towards collectivism were identified as determinants of socio-economic impact due to mechanization among paddy farmers.

Keywords: Mechanisation, Paddy cultivation, Group farming, Socio-economic impact

INTRODUCTION

Kerala produces less than 20 per cent of its rice requirements and relies on other States for the rest. The area under paddy cultivation, as well as production, has been steadily declining in the state. Farmers in Kerala despise paddy cultivation because it is found unprofitable, with high cultivation costs and very low prices. This situation adversely affects the sustainability of farming in Kerala. Consequently, the Government has enacted The Kerala Paddy land and Wet land Conservation Act in 2008, which is primarily intended to prevent conversion of wet lands for non-farming

purpose. It also recognizes that the wet lands and paddy lands provide various kinds of ecosystem services. In this context, the State needs a suitable strategy to make paddy cultivation profitable and viable. As paddy farming is labour intensive and labour costs being the most expensive component, the best strategy will be one that controls and reduces labour costs while increasing paddy productivity. Thus, farm mechanization and a collective approach in paddy cultivation are the best strategies for increasing paddy production (Sugden, 2016). Paddy cultivation needs appropriate mechanisation to cope with the increased

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cost of cultivation due to high wages and scarcity of labourers (Amadi, 2018). However, the fragmented agricultural landholding and the relatively high cost of mechanisation is a major problem in Kerala for implementing farm mechanization and thus arose the concept of mechanization through paddy group farming. Group farming *Samithies* were also equipped by providing them with the necessary resources, knowledge, and support to adopt mechanization and sustainable techniques in rice cultivation. Adoption of appropriate agricultural technologies and implementation through group farming helps to expand the area under paddy cultivation and could be successful in controlling and reducing the conversion of paddy lands, protecting the existing paddy area and to bring more fallow land under cultivation. (Sajeena, 2012).

Various paddy mechanization projects initiated in the State during the past decade and institutionalisation of group farming *Samithies* with the support of State Department of Agriculture and local self-governments might have contributed to increase the paddy productivity, farm income and improved living standards of paddy farmers in Kerala.

MATERIALS AND METHODS

The present study adopted an *ex-post facto* research design. Palakkad district was purposively selected for the study as it has maximum area under paddy cultivation in Kerala and also owing to the presence of different types of successful group farm mechanisation interventions in paddy. Two blocks representing maximum area of paddy cultivation and where different rice mechanization programs implemented were selected from the district. 120 farmers were selected randomly from the *Padasekhabara Samithies* in two Blocks, where mechanization was practiced for the past ten years. Primary data on various socio-economic and psychological aspects and perception on impact of mechanisation through group farming was collected using a semi-structured interview schedule. Secondary data were collected from literature, published reports, KVK records etc. and Directorate of Economics and Statistics, and reports of Government of Kerala.

RESULTS AND DISCUSSION

It was observed that the majority of the paddy farmers (85.8%) belonged to the old aged group which is above

55 years followed by 14.2 per cent of farmers under the middle age category (36-55 age). Most of the farmers were male (75%). Majority of the farmers (44%) had high school education. 90 per cent of the farmers were cultivating paddy in their own land, while 21 percent of the farmers had leased out a part of their land. Majority of the farmers (39%) had land area of 1-2.5 acre. Seventy three per cent farmers followed farming as their only source of income while 27 per cent of them had non-farm activities too along with farming. Most of the farmers (79%), fell in the medium category of extension contact. Nineteen per cent of the farmers were having higher social participation and majority belonged to the medium category as they were members of group farming *Samithies*, cooperatives, etc. Only 10 per cent of the farmers were found to have higher achievement motivation, while majority belong to medium category. Most of the farmers (71.7%) fell under medium category of self confidence and 17.5 per cent of them had high scientific orientation. Favourable attitude towards collectivism was noted among a good majority of paddy farmers. This indicated that rice mechanisation through paddy group farming *Samithies* was a better option for them.

The overall Socio-economic Impact Perception Index was calculated by assigning weights for various impact factors, which was generated by Principal Component Analysis (PCA).

The results in the Table 1 showed that higher percentage score is obtained for the factor 'time spend

Table 1: Weightage and percentage score of perceived socio-economic impact factors of farmers

Perceived impact factors	Weightage using PCA	Percentage score
Time spend on farming activities	3.56	66.73
Livelihood	2.61	60.28
Access to assets	2.74	58.46
Yield	4.45	56.98
Income	2.37	53.21
Post-harvest handling benefits	2.13	53.05
Knowledge gained on benefits of paddy mechanization	3.10	51.78
Savings in cost of cultivation	1.72	50.32
Increase in area	1.86	49.87

Overall Socio-economic impact perception index= 52.74

on farming activities', followed by 'livelihood' and 'access to assets'. It could also be noted that highest weightage score was obtained for the factor 'yield'. A higher variance observed on the yield data has resulted in the higher weightage of the component. Better yields could have been obtained due to timely management and mechanized intercultural operations. However, the mean score on the perceived impact on yield is less (56.98%) even though the weightage is higher.

The comparatively higher percentage score for perceived impact on livelihood and access to assets shows that they are the significant socio-economic impact factors due to paddy mechanization. Paddy farmers were able to satisfy their needs and they were able to lead a healthy and better livelihood after the introduction of mechanisation. *Padasbekhara Samithies* were able to buy some machineries like, tractor, winnower, sprayer, thresher etc of their own. Large machinery like transplanter and combined harvesters were provided by the State Department of Agriculture through various government schemes. Thus, even the very small and marginal farmers could have access to various machineries at affordable rate. Improved productivity and post-harvest management practices gained due to mechanization could have resulted in better income for the farmers as they have assured market through the State Civil Supplies Department (SupplyCo) which procures the produce at MSP rate. It is evident from the table that post-harvest operation had a significant impact after the introduction of mechanisation and farmers were able to have clean and quality produce for selling to Supplyco. It is also worth to note that introduction of mechanisation paved way for the gain of new knowledge to the farmers. Even though farmers were able to save the cost of cultivation in comparison with doing operations manually in the current scenario, the cost of operating machinery became higher in Kerala as compared to other States. It could also be noted from the results that increase in area under paddy cultivation due to mechanization was perceived as the least significant factor, as it gained the least percentage score (49.87%) and less weightage.

It was evident from the study that group farm mechanization could lead to significant benefits for paddy farmers in Kerala. Advanced machinery such as rice transplanters, threshers and combine harvesters

have reduced the time and effort required for various farming operations. This might have resulted in improved overall productivity and post-harvest management in paddy cultivation. With the use of machineries, tasks that were once labour intensive and time- consuming could be completed more efficiently and within the appropriate time. Mechanized operations could save labour and thereby reduce cost of cultivation to some extent. The Agriculture Department and Panchayats supplied subsidy for machineries only through group farming *Samithies*. Thus Proper institutionalization of the paddy group farming and strengthening of group dynamics in the *Samithies* could also be achieved.

The determinants of socio-economic effect due to mechanisation among paddy farmers were identified by the analysis of Spearman's rank correlation between socio-economic impact perception index and the independent variables. It is evident from the Table 2 that the factors like extent of mechanisation, annual income, area under paddy cultivation, extension contact, social participation, innovativeness and attitude towards collectivism are having a significant positive

Table 2: Correlation of independent variables with perceived socio-economic impact index of farmers

Independent variable	Spearman correlation coefficient
Age	-0.176*
Education	0.113
Annual income	0.267*
Extent of mechanization	0.521**
Land ownership status	0.136
Training received	0.468**
Extension contact	0.387*
Social participation	0.272*
Economic motivation	0.034
Achievement motivation	0.114
Innovativeness	0.332*
Self confidence	-0.056
Scientific orientation	0.023
Risk orientation	-0.122
Attitude towards collectivism	0.232*
Occupational status	0.178

*Correlation is significant at 0.05 level (2-tailed)

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

correlation with the perceived impact index. Age is the variable that has a negative correlation (significant at 0.05 level) to the perceived socio-economic impact index. The younger generation was found to be more tech-savvy, while the older generation would take more time to learn the most recent technologies. The extent of mechanisation is having the highest correlation with the perceived impact index. This could be due to the fact that more use of machinery has paved way to have more positive impacts on socio-economic factors. As more paddy area is mechanized, it became more economical and easy for the farmers to carry out operations for a larger field area. Instead of using manual labour, adopting mechanisation helped in reducing the cost of cultivation and thus helped in increasing their income, which resulted in creating significant positive impact on the lives of farmers. It is also important that farmers maintain a good extension contact through group farming *Samithies* for getting information and advice on farm mechanisation. Paddy farmers have a good relationship with the extension agents, especially the Krishibhavadans and the scientists of KVK. Innovativeness of the farmers is another key factor in adopting mechanization. Participation in mechanisation programmes implemented through group farming *Samithies* and various other group activities is an indicator of good social participation and significant socio-economic impact.

CONCLUSION

The introduction of mechanization in paddy group farming has significantly transformed paddy cultivation in Kerala, greatly impacting farmers' livelihoods. By

adopting mechanized methods, paddy farmers have been able to address critical production challenges, particularly labour scarcity, which have been a persistent issue in the State. Mechanization has not only improved efficiency but also allowed for timely completion of farm tasks, which farmers recognize as a substantial benefit. This approach has also helped to sustain the area under paddy cultivation. Although there hasn't been a notable expansion in paddy acreage, mechanization has contributed to maintaining existing paddy fields and even enabling the cultivation of fallow lands in certain regions. As a result, paddy farming has become a more viable livelihood option, particularly for small and marginal farmers, helping to sustain and potentially improve their income and quality of life.

REFERENCES

- Abhilash Joseph, E.; V.M. Abdul Hakkim and S. Sajeena. 2020. Precision Farming for Sustainable Agriculture. *International Journal of Agriculture Innovations and Research*, 8(16): 543-553.
- Amadi, N.S. and A.I.A. Ekezie. 2016. Rural farmers' perception on the use of agricultural mechanisation in agricultural production in Rivers State, Nigeria. *Journal of Agriculture and Social Research*, 16(2): 9-15.
- Harilal, K.N. and K.K. Eswaran. 2018. The Agrarian Question and Mechanisation of Agriculture in Kerala. *Review of Agrarian Studies*, 8(1): 2-27.
- Sugden, F. 2016. Tenant Farmer Collectives for Sustainable Intensification of Agriculture: Reflection from Mithilanchal. M.Sc. (Ag) thesis, Central Agricultural University, Pusa, 198p.



Research Article

A Study on Workplace Environment of Candle Manufacturing Units

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ABSTRACT

Present study was carried out to investigate the workplace environment and facilities provided to the workers in candle manufacturing units. Field survey was conducted in six candle manufacturing units of Ludhiana city from which 120 respondents were selected purposively. Data was collected with the help of interview schedule. Results revealed that respondents spend 6-9 hours daily at the workplace and had 7 to 11 year of experience in making candles. Workplace conditions of the candle manufacturing units in different sections were not upto the mark as there was lack of filtered drinking water and sanitary facilities. None of the units provided Personal Protective Clothing kit to the workers. Temperature level was found higher and illumination level was found lower than the recommended level in all the sections of candle manufacturing units. The air quality was poor and the concentration of PM 2.5 was higher than the recommended limits.

Keywords: Workplace environment, Work conditions, Facilities provided, Health hazards

INTRODUCTION

Candle manufacturing units produce a wide range of candles which includes decorative candles, scented candles, and utility candles. They come in various shapes, sizes, colours and scents and are often used for decoration rather than functional lighting. Although this industry has the potential to expand every year, the workers are exposed to health hazards due to poor working conditions, exposure to high temperatures, exposure to gases and volatile organic compounds. A study on “Hidden dangers of scented candles” determined that wax emits pollutants that can threaten human health and it should not be burned in indoor or closed areas or where there is a lack of ventilation system (Anonymous, 2016). Chandrashekar (2011) conducted a study on “Workplace environment and its impact on organizational performance in public sector organizations” and revealed that a comfortably designed workplace energizes workers to lift their

performance. The indoor environment in candle making units like air quality and humidity can significantly affect the health of workers in several ways. Extreme temperature and high humidity levels can make the indoor environment uncomfortable for workers, leading to heat stroke, fatigue, dehydration, and decreased productivity. According to the study by Sanjog (2013) a good indoor environment is beneficial in terms of increased productivity, satisfaction and overall well-being of people. Machinery used in candle manufacturing units can generate high levels of noise which can lead to hearing loss or other auditory problems among the workers if proper protection is not provided. The slippery floor seems to be the primary reason behind the accidents like slips and falls. According to Hassard and Cox (2013), it was of immense implication to design the workplace according to the job of the workers to minimize their physical as well as psychological stress.

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MATERIALS AND METHODS

The study was conducted in Ludhiana city of Punjab state. There are approximately 15 candle manufacturing units in Ludhiana city. Out of these, six small scale candle manufacturing units were selected purposively where all types of candles are being manufactured. A total sample of 120 respondents were selected purposively for the field survey who had work experience of more than 3 years. The collection of the data was through personal contact method using interview schedule and self-observation techniques. The field experiments were conducted in the months from June to October. Analysis of the workplace environment of the candle manufacturing units was done using the 5 in 1 Environment meter which was used to measure the humidity, temperature, air velocity,

light and sound and the Air quality meter was used to measure the air quality at the workplace by using the in built laser particulate matter sensors of the FREEMANS PM 2.5 detector.

RESULTS AND DISCUSSION

The data in Table 1 depict that half of the respondents (50.00%) belonged to the middle age group of 35-45 years followed by majority of the respondents were male (74.16%) and nearly one forth (25.84%) were female in candle manufacturing units. Regarding Job type more than half of the respondents (58.34%) were working on contract basis and the distance of 41.66 per cent of the respondents was below 1 km from home to workplace. Mode of transport reveals that maximum per cent of the respondents (65.00%) reached to workplace by walking. More than half of

Table 1: Work profile of the respondents (n=120)

Work characteristics	Category	Frequency	Percentage
Age (years)	25-35	40	33.33
	35-45	60	50.00
	45-55	20	16.67
Gender	Male	89	74.16
	Female	31	25.84
Job Type	Permanent	45	37.50
	Contractual	70	58.34
	Daily wager	05	4.16
Distance (km) from home to workplace	Below 1	50	41.66
	1 to 5	45	37.50
	5 to 10	25	20.84
Mode of transport	Own vehicle	30	25.00
	Public transport	12	10.00
	By walk	78	65.00
Work Experience	3-7 years	25	20.83
	7-11 years	67	55.83
	11-15 years	28	23.34
Working hours per day	3-6 hours	40	33.34
	6-9 hours	65	54.14
	9-12 hours	15	12.52
No. of breaks per day (Including lunch break)	1-2	69	57.50
	2-3	35	29.17
	3-4	16	13.33
No of holidays	Every Sunday (per month)	120	100.00
Payment Method	Daily	05	4.16
	Monthly	115	95.84

the respondents (55.83%) had 7 to 11 years of work experience in candle making units and 54.14 per cent of the respondents said that they were engaged 6 to 9 working hours per day. Further, results revealed that 57.50 per cent of the respondents had 1 to 2 breaks per day and majority of the respondents (95.84%) were paid monthly.

Table 2 depicts that the activities performed by the respondents in units were melting & mixing of wax and adding the fragrances and colours into the wax, pouring of wax into machines/moulds, demoulding of candles, finishing of candles, making the boxes, packaging of candles and storage of candles. From which the majority of the respondents (45.83%) were engaged in pouring of wax into machines and more than half of the respondents (54.55%) required 3 to 6 hours for completing the activity. The posture adopted while performing this activity was standing and forward bending, lifting and side bending. Upper body extremities were getting affected by this activity. Almost 30 per cent of the respondents were engaged in packaging of candles activity and majority of the respondents (88.58%) were working 3 to 6 hours with

squatting and forward bending posture. This posture affected the lower and upper back of the workers. More than half of the respondents (57.50%) were engaged in finishing and storing of candles in standing, squatting and forward bending, lifting and standing posture.

The analysis of the storage space for materials in candle manufacturing units in Table 3 depicts that the raw material like wax, colors, fragrance oils and threads were stored in specific space or in particular rooms which specially made for storage of bulk materials by the majority of the candle making units i.e. (66.67%) and 33.33 per cent of the units stored it in shelves. The finished goods (manufactured candles) were stored in racks by half of the units (50.00%). 33.33 per cent of the units stack on ground and 16.67 per cent store in boxes and racks both. Majority of the units (66.67%) stored the packed material on shelves and on floor both. 33.33 per cent of the units stored packed material in organized spaces.

The results of facilities provided at the workplace revealed that every unit provided the facility of

Table 2: Activities performed by the respondents (n=120)

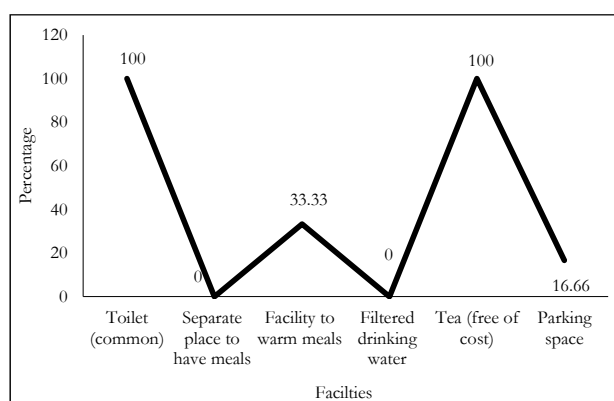
Activities	Frequency	Duration of work			Posture adopted	Body parts Affected
		≤ 1(hr)	1-3 (hr)	3-6 (hr)		
Melting of wax, adding colour and fragrance oil	35(29.17)	-	30(85.71)	05(14.29)	Standing, forward bending	Upper body parts
Greasing the moulds and placing the thread	35(29.17)	-	-	35(100)	Sitting on a chair, Squatting and forward bending	Upper body parts, knees and ankles
Pouring of wax into moulds	55(45.83)	24(43.63)	01(1.82)	30(54.55)	Standing and forward bending, lifting and side bending	Chest, arms, hands, shoulder and neck
Demoulding of candles	44(36.67)	-	44(100)	-	Standing	Hands, arms, neck, upper back
Finishing the candles and storing	69(57.50)	-	39(56.52)	30(43.48)	Standing and forward bending, Squatting and forward bending	Shoulder, arms, lower back, neck, upper back
Making boxes	31(25.83)	08(25.81)	13(41.94)	10(32.25)	Sitting on Chair with hunched back	Upper body, left foot and legs & lower back
Packaging of candles in boxes	35(29.17)	-	04(11.42)	31(88.58)	Squatting with forward bending	Hands, arms, upper body
Cleaning of workplace	50(41.60)	50(100)	-	-	Squatting/ Standing and forward bending	Lower back and neck

*Multiple response, Figures in the parenthesis indicate percentage

Table 3: Provision of storage space for materials (n=06)

Storage Material	Storage Space	Frequency
Raw material (wax, colors, fragrance oils and wicks/threads)	Specific space or particular room for bulk materials	04(66.67)
	Shelves	02(33.33)
Finished Goods (Candles)	Racks	03(50.00)
	Stacked on floor	02(33.33)
	Boxes and racks	01(16.67)
Packaging material (Boxes)	Organized space for packaging supplies.	02(33.33)
	Shelves / Stacked on floor	04(66.67)

Figures in parenthesis indicate percentage

**Figure 1: Facilities provided at the workplace**

common toilets and none of the units provided the facility to warm meals and filtered drinking water. All of the units provided tea (free of cost) to their workers, which contributed positively to the work environment.

The analysis of data in Table 4 revealed the perception of occurrence of hazards among the

respondents at the workplace. According to the data, 16.67 per cent of the respondents were aware of occurrence of Chemical hazards due to exposure to toxic chemicals, dyes and fragrances. Almost 42 per cent of the respondents were aware of the physical hazards. Nearly 40.00 per cent of the respondents were aware of musculoskeletal hazards that can occur due to the lifting of load and forceful movements during work. Majority of the respondents (80.00%) were aware of the possibility of occurrence of fire hazards. Almost 2/3rd of the respondents (74.16%) were aware of environmental hazards that can occur from exposure to heat stress. While 45.83 per cent were aware of noise hazards from machinery.

Table 5 provided information on the availability of hazard control measures in the candle manufacturing units. The data revealed that none of the units used lifting aids to prevent accidents at workplace. However, all of the units had non-slippery floor and majority

Table 4: Perception of respondents regarding occurrence of hazards at the workplace (n=120)

Type of hazards	Perception of respondents about potential risk	Frequency
Chemical hazards	Exposure to toxic chemicals, dyes and fragrances	20 (16.67)
Physical hazards	Risks associated with burns due to hot wax, cuts/injuries from equipment, slips and falls due to slippery floor	50(41.67)
Musculoskeletal hazards	Repetitive motions	10(8.33)
	Lifting of load	52(43.33)
	Forceful work	48(40.00)
	Awkward postures	16(13.33)
Fire hazards	Risks related to flammable materials and equipment	96(80.00)
Environmental hazards	Poor ventilation	23(19.16)
	Exposure to heat	89(74.16)
	Noise from the machine	55(45.83)
	Poor lighting	46(38.33)

*Multiple response; Figures in parenthesis indicate percentage

Table 5: Hazard control measures available at the units (n=06)

Hazard control measures	Frequency	Percentage
Lifting aids	Nil	00
Non-slippery floor	06	100.00
Fire extinguishers	04	66.67
Guarded machine edges	Nil	00
Exhaust fan in all sections	02	33.33
First aid kit	04	66.67
Hand washing facility	01	16.67
Personal Protective Clothing (Gloves, Apron, Eye protection Goggles, Anti-pollution Mask)	Nil	00
Regular inspection of equipment	02	33.33
Regular training about fire safety and first aid	01	16.67
Immediate cleaning of any spills	Nil	00

were equipped with fire extinguishers. Regarding provision of first aid kits at workplace 66.67 per cent of the units had kits. Personal protective clothing (PPC) such as gloves, aprons, and goggles were not provided to the respondents. Regular inspection of the equipment was conducted in only 33.33 per cent of the units. Additionally, there was a complete absence of immediate cleaning procedures for spills and hand washing facilities near areas where workers handled chemicals and infectious materials.

Regarding the data in Table 6 it was found that the temperature level at the workplace was higher than the recommended level. Low illumination was recorded in almost all the units. As far as the humidity level and noise level were concerned, these were found slightly higher than the recommended levels. The air quality at the units was poor and higher than the recommended

Table 6: Environment parameters at the workplace (n=06)**Assessment of Illumination Level (Average)**

Section	Illumination level (Lux)	Recommended level
Working	190.1 ± 12.40	375 lux*
Packaging	190.1 ± 12.40	
Storage	181.16 ± 16.70	

Assessment of Noise Level (Average)

Section	Noise level (dB)	Recommended level
Working	89.00 ± 2.86	30-60dB **& 90 dB** (upper limit)
Packaging	84.00 ± 2.00	
Storage	67.66 ± 16.02	

Assessment of temperature Level (Average)

Section	Temperature level (°C)	Recommended level
Working	41.48 ± 1.25	20-29 °C ***
Packaging	40.95 ± 0.83	
Storage	38.83 ± 7.22	

Assessment of Humidity Level (Average)

Section	Humidity level (RH%)	Recommended level
Working	64.41 ± 10.92	40-60RH% ****
Packaging	64.05 ± 9.00	
Storage	62.16 ± 5.46	

Assessment of Air Quality Level (Average)

Sections	Air quality µg/m ³	Recommended level µg/m ³
Working area	191.33 ± 4.76	35~150***** µg/m ³
Packaging area	191.33 ± 4.76	
Storage area	174.83 ± 10.74	

*and****Gandotra *et al.* (2013), **Aggarwal (2001), ***Singh (2016).

*****National ambient air quality standards (2009).

level of 35 to 150 $\mu\text{g}/\text{m}^3$ by National Ambient Air Quality Standards (2009). Elevated temperatures and humidity can lead to decreased cognitive function and increase fatigue (Zhang *et al.*, 2020)

CONCLUSION

It was concluded from the present study that the majority of the candle manufacturing units had poor working conditions as none of the units had proper workstations to work and store the materials, there was no provision of facilities provided at the workplace and none of the unit provided filtered drinking water and proper sanitary facilities. Majority of the respondents were aware of the fire hazards and environment hazards that can occur at the workplace. Most of the work was done manually in poor posture so it affected the lower back, upper back and shoulder joints of the workers. Moreover, Environmental parameters such as temperature, noise, and amount of particulate matter were found higher and illumination level found lower than the acceptable limit. So, there is a need of providing proper training sessions on right posture while working, on identifying workplace hazards, safe handling of materials, and emergency response protocols.

REFERENCES

- Anonymous. 2016. *Hidden dangers of scented candles*. Retrieved from iqair.com/in-en/newsroom/hidden-dangers-scented-candles on 14.04.2023
- Chandrashekar, K. 2011. Workplace environment and its impact on organizational in performance in public sector organisations. *International Journal of Enterprise Computing and Business Systems*, 1: 1-19.
- Gandotra, V.; K. Oberoi and P. Sharma. 2013. *Essentials of Ergonomics*. pp. 35-54. Dominant Publisher and Distributor Pvt Ltd, New Delhi.
- Hassard, J. and T. Cox. 2013. *The physical work environment and work-related stress: Mechanisms and consequences*. EU-OSHA (European Agency for Safety & Health at Work), Bilbao, Spain.
- Sanjog, J.; T. Patel and S. Karmakar. 2013. Indoor physical work environment: An ergonomics perspective. *International Journal of Science Technology and Research*, 2: 507-513.
- Zhang, Y.; X. Li and J. Chen. 2020. The impact of elevated temperatures on workplace performance and health. *Journal of Environmental Psychology*, 69: 101-431.

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Research Article

Perception of Tribal Farmers towards Technological Demonstrations Conducted by Krishi Vigyan Kendra Kanker, Chhattisgarh

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ABSTRACT

Krishi Vigyan Kendra (KVK) is an innovative science based institution which conducts OFT for technology assessment and refinement; and FLD to promptly demonstrate the latest agricultural technologies to the farmers as well as the extension workers in India. The current study was conducted in Kanker district of Chhattisgarh state during 2021-22 to assess the perception of beneficiaries towards technological demonstrations conducted by KVK. 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 the majority 47.27 per cent of the beneficiaries had a less favourable perception towards On Farm Trials and 52.74 per cent of the beneficiaries had a more favourable perception towards Front Line Demonstration conducted by KVK. Based on the findings of the study, it can be concluded that KVK changed the perspective of the tribal farmers from traditional to modern technologies, which helped in uplifting their economic status and enhancing their knowledge level.

Keywords: Beneficiaries, KVK, Technological demonstrations, OFT, FLD, Tribal farmers

INTRODUCTION

Tribe refers to a collection of families linked by kinship, usually descended from a shared mythical or legendary ancestor, living in the same area, speaking the same language and sharing a common historical past (Srivani *et al.*, 2020). India is an agrarian country as agriculture is the primary source of livelihood for the majority of the Indian population. Still, there is a large section of the farming community that is still unaware of technological developments and recent advances in the field of agriculture. Awareness about advance agricultural technologies is one of the key inputs for the farming community. At the KVK, Scientists play a vital role in fulfilling the mandates that are framed. It also works like a super vehicle for technology dissemination. KVK also provides vocational training

to rural people, which helps in uplifting their economic conditions. KVK works at the ground level on the farmers' field for assessment of location-specific problems and to find out the proper solution to a particular problem and then provide training for allocation of resources and resource use efficiency in order to minimize the costs and maximize profits. The KVK's are serving as the lighthouse for overall rural development in the district (Rajan *et al.*, 2020). KVK organises many training programme to bring awareness about new technologies and make them familiar to rural people.

Rural youth have significant contributions to the local and national economy by being participated in Income generating activities (IGAs) such as vegetable production, nursery establishment, crop production,

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mushroom cultivation, bee keeping, livestock, goatry and poultry rising, cottage industry and small business etc. Unfortunately, the rural youth community is almost unknown to modern agricultural technology and has been left out from the main stream of economic development (Rajan *et al.*, 2014, 2015; Rana *et al.*, 2018). The level of adoption of technology determines the level of productivity (Nahatkar *et al.*, 2017; Rajpoot *et al.*, 2023). The developed technology is disseminated to its end users by SMS using different extension programme such as FLDs, OFTs, training, krishi mela, farmers' advisory services, etc. (Sarnaik *et al.*, 2020). OFT and FLD are the most important pillars of this project regarding technology dissemination. Basically, On-Farm Trial tries to test a novel idea or technology in a farmer's fields under the conditions and management of a farmer while utilizing the farmer's own methods as a control. Front-Line Demonstrations are field tests carried out under the close supervision of scientists because the scientists themselves first used the technologies before they were introduced to the primary extension programme of the state department of agriculture.

There are now around 28 KVKs functioning in Chhattisgarh and KVK, Kanker is one of them. The KVK, 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 Prothsaan Award-2017' from the Prime Minister of India. Therefore, based on the above importance the present study is entitled as "Perception of Tribal Farmers towards technological demonstrations conducted by KVK, Kanker, Chhattisgarh."

MATERIALS AND METHODS

The study was conducted in the Kanker district which is located in the southern region of Chhattisgarh. It was selected specifically because it is a 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, i.e., Kanker, Charama, and Narharpur which has maximum tribal population. From the selected 3 blocks, two villages were selected from each block based on the maximum

number of beneficiaries and villages which were adopted by the KVK in the past three years (2019–2021). A list of respondents was prepared with the help of the KVK, Kanker. A total of 110 beneficiaries were selected from 6 villages by taken 30 per cent proportionate sample. The primary data was collected through an interview schedule, on the basis of tribal beneficiaries' perception towards technological demonstrations conducted by KVK, Kanker. Perception was classified into two categories which were prepared based on the objectives of the study while taking independent variables into consideration. The statistical analysis was done by using appropriate statistical tools namely mean, standard deviation, per centage, frequency and correlation coefficient.

RESULTS AND DISCUSSION

The data presented in Table 1 reveals that the majority (66.36%) of beneficiaries belonged to the middle-aged category (36 to 55 years). This may be attributed to the fact that individuals in this age group were married and typically bear family responsibilities, which could motivate them to adopt new and profitable agricultural technologies to enhance their income and economic stability.

With respect to educational attainment, a significant proportion (32.75%) of beneficiaries had completed high school education. The inability to pursue further education beyond this level could be associated with various socio-economic constraints, including financial limitations, prevailing traditional beliefs, and the geographical distance of educational institutions from their residences. Regarding occupation, 60.90 per cent of the beneficiaries were primarily dependent on agriculture. This could be due to limited formal educational qualifications, which restrict employment opportunities outside the agricultural sector. Furthermore, the persistence of conventional perceptions toward agriculture as a primary livelihood option might contribute to this occupational pattern.

In terms of annual income, a significant proportion (61.82%) of beneficiaries fell within the medium-income category (Rs. 81,068 to 1,83,932). This income distribution aligns with the predominance of agriculture as the principal occupation, coupled with limited access to alternative employment opportunities.

Table 1: Distribution of Socio-economic profile of the tribal farmers

Categories	Frequency	Percentage
Age		
Young	11	10.00
Middle	73	66.36
Old	26	23.64
Education		
Illiterate	11	10.00
Primary School	17	15.45
Middle School	31	28.18
High School	36	32.75
Higher Secondary	13	11.81
Graduate and above	02	01.81
Occupation		
Agriculture	67	60.90
Agriculture + Labour	22	20.00
Agriculture + Indep. Business (Shop, garage)	09	08.20
Agriculture + other (Allied agricultural activities)	12	10.90
Annual income		
Low	22	20.00
Medium	68	61.82
High	20	18.18
Land holding		
Small	29	26.36
Medium	49	44.55
Large	32	29.09
Farming experience		
Low	23	20.90
Medium	65	59.10
High	22	20.00

In land holding, 44.55 per cent of beneficiaries had medium land holdings (2.1 to 4 ha). The most probable reason was that majority of the beneficiaries were from joint families and their land was not distributed. Furthermore, the findings indicate that the most (59.10%) of the beneficiaries had medium-level farming experience (20 to 32 years). Their prolonged engagement in agriculture may be influenced by limited employment opportunities in other sectors, necessitating their continued dependence on farming for livelihood sustenance.

The data presented in Table 2 illustrates the distribution of beneficiaries according to their responses towards On-Farm Trials (OFT). The findings indicate that 54.55 per cent of the farmers were undecided about whether Krishi Vigyan Kendra (KVK) effectively identifies location-specific problems during OFTs. Additionally, nearly half (48.18%) of the respondents disagreed that the objectives of the research carried out by extension officers are relevant and properly laid out experiments.

Furthermore, 43.64 per cent of the farmers expressed disagreement regarding the critical observation and recording of data from trials by KVK scientists. Similarly, 40.91 per cent of the respondents remained undecided about whether OFT trials are an easy way for farmers to understand how new practices, products, and equipment function within their cropping systems.

Moreover, a significant proportion i.e. 40.91 per cent of farmers were undecided towards the efficacy of KVK's research on the farmer's field to get maximum production. Additionally, 40.91 per cent of

Table 2: Distribution of beneficiaries according to their responses towards On Farm Trials

Statements	Responses					
	Agree		Undecided		Disagree	
	f	%	f	%	f	%
Carrying out research on the farmer's field to get maximum production	39	35.45	45	40.91	26	23.64
OFT trials are an easy way for farmers to learn how practices, products and equipment will work in their cropping systems	21	19.09	45	40.91	44	40.00
Finding out location specific problems	38	34.55	60	54.55	12	10.91
The objectives of the research are relevant and properly laid out experiments	20	18.18	37	33.64	53	48.18
Critically observing and recording data of trials	17	15.45	45	40.91	48	43.64
Design & modifying training programme on the basis of feedback received from previous on - farm trials	27	24.55	38	34.55	45	40.91

the respondents disagreed with statement “Design & modifying training programme on the basis of feedback received from previous on – farm”.

Table 3 presents the distribution of beneficiaries according to their perception towards on-farm trials conducted by KVK. The findings indicate that a substantial proportion of beneficiaries (47.27%) had a less favourable perception towards these trials. This was followed by 27.28 per cent of respondents had favourable perception, while 25.45 per cent expressed a more favourable perception. These results highlight the need for enhanced extension efforts to improve farmers’ understanding and confidence in on-farm trials, ensuring greater participation and adoption of recommended practices.

The findings in Table 4 indicate that majority (80%) of farmers agreed that KVK organizes field days at regular intervals. Additionally, 74.55 per cent of farmers agreed that FLD is oriented towards the dissemination of new technology/ varieties, while 71.82 per cent agreed that KVK scientists conducted continuous and regular monitoring through field visits, recorded observations and obtained feedback from farmers.

Table 3: Distribution of beneficiaries according to their perception towards On Farm Trials

Categories (Score)	Frequency	Percentage
Less favourable (Up to 4)	52	47.27
Favourable (5 to 8)	30	27.28
More favourable (9 to 12)	28	25.45
Total	110	100.00

Furthermore, more than 62.73 per cent of the farmers agreed that KVK provided instructions on important farm operations during demonstrations and 62.73 per cent farmers agreed that KVK ensured proper site selection for demonstrations. However, a considerable proportion of farmers (54.55%) remained undecided and more than 30 per cent disagreed with the statement “organization of orientation training for all participating individuals or agencies on various aspects of new technologies and methodologies to be demonstrated”. These findings suggest that while FLD initiatives are generally well-received, there remains a need for greater emphasis on training and orientation programmes to enhance farmers’ understanding and adoption of new technologies.

Table 5 indicate that the most of the beneficiaries (52.74%) had a more favourable perception towards FLDs, followed by 40.90 per cent who had a favourable perception. A smaller proportion (6.36%) of beneficiaries expressed a less favourable perception. These results suggest that most farmers acknowledge the benefits of FLDs, reinforcing the need to continue and further enhance such extension activities to maximize their impact.

Table 5: Distribution of beneficiaries according to their perception towards Front line demonstration

Categories	Frequency	Percentage
Less favourable (Up to 4)	07	6.36
Favourable (5 to 8)	45	40.90
More favourable (9 to 12)	58	52.74
Total	110	100.00

Table 4: Distribution of beneficiaries according to their responses towards Front Line Demonstration

Statements	Responses					
	Agree		Undecided		Disagree	
	f	%	f	%	f	%
FLD is oriented towards new technology varieties’ dissemination.	82	74.55	13	11.82	15	13.64
There is a proper selection of site for demonstration	68	61.82	22	20.00	20	18.18
Give instructions on all important farm operations carried out by the demonstration.	69	62.73	21	19.09	20	18.18
Organizing field days at regular intervals	88	80.00	11	10	11	10
Monitoring on a continuous and regular basis through visits to FLD plots, recording observations, and getting feedback from the farmers.	79	71.82	13	11.82	18	16.36
Organizing an orientation training for all the participating individuals or agencies about all aspects of new technologies and methodologies to be demonstrated	13	11.82	60	54.55	37	33.64

Table 6: Correlation between characteristics of beneficiary farmers and their perception towards technological demonstrations

Variables	Coefficient of correlation (r)
Age	0.008 ^{NS}
Education	0.237*
Occupation	0.224*
Annual Income	0.215*
Land holding	0.014 ^{NS}
Farming experience	0.211*

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

Table 6 presents the correlation coefficients between selected characteristics of beneficiary farmers and their perception towards technological demonstrations. The findings indicate that education, occupation, annual income and farming experience exhibited a positive and significant relationship with farmers' perception at a 0.05 level of probability. This suggests that higher educational attainment, occupational engagement, better economic conditions, and extensive farming experience contribute to a more favourable perception towards technological demonstrations. Whereas, age & land-holding were found to be non-significant, indicating that these factors do not have a notable influence on farmers' perception towards technological demonstrations.

CONCLUSION

It is concluded that the maximum number of farmers were in the middle age group, had matriculation level of education, with agriculture as their major occupation and medium annual income, and land holding with medium farming experience. It was also revealed that education, occupation, annual income and farming experience had positive and significant effects on their perception regarding the on-farm trial and front-line demonstration provided by KVK. Whereas age and land holding had a non-significant relationship with their perception. According to the findings, nearly 40 per cent of farmers had a more favourable perception of OFT and FLD, followed by more than one-third of farmers who had a less favourable perception of KVK. The results were good in respect of both OFT and FLD. FLD was perceived more positively by farmers than OFT. The majority of the farmers had perceived that FLD is oriented towards new technology/ varieties' dissemination and tribal farmers

were aware about new technologies and the proper selection of sites for demonstrations. KVK maintains a healthy relationship between scientists and farmers. With this information, the extension organization's management and policymakers can reevaluate their strategies and organise the extension operations that the KVK will carry out. Consequently, the OFT and FLD administered by KVK's will benefit each and every farmer under the jurisdiction of the respective KVKs. 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 helped in uplifting their economic status.

REFERENCES

- Nahatkar, S.B.; M. Thomas and P. Rajan. 2017. Bridging Yield Gap in Soybean Production through Technology Demonstration: Potential Source for Increasing Farmers Income in Central India. *Soybean Research*, 15(2): 39-47.
- Rajan, P.; N. Khare and S.R.K. Singh and M. Thomas. 2014. Constraints Perceived by Tribal Farmers in Adoption of Recommended Practices. *Indian Journal of Extension Education*, 50(3): 65-68.
- Rajan, P.; N. Khare and S.R.K. Singh. 2015. Factors affecting the Income generation of tribal farmers in Madhya Pradesh State of India. *Journal of Community Mobilization and Sustainable Development*, 10(2): 147-151.
- Rajan, P.; N.K. Khare and S.R.K. Singh. 2020. Impact of Krishi Vigyan Kendra on crop productivity of tribal farmers in Madhya Pradesh. *Indian Journal of Extension Education*, 56(4): 115-120.
- Rajpoot, A.S.; P. Rajan; A. Raut; A. Srivastava and R.B. Singh. 2023. Profile of National Rural Livelihood Mission (NRLM) beneficiaries' in Madhya Pradesh. *Asian Journal of Agricultural Extension, Economics and Sociology*, 41(11): 249-257.
- Rana, K.K.; P. Rajan and S.R.K. Singh. 2018. Assessing Impact of Krishi Vigyan Kendra on Employment Generation of Rural Youth. *International Journal of Current Microbiology and Applied Sciences*, 6(SI): 2822-2826.
- Sarnaik, S.D.; P.P. Bhole; D.M. Mankar and V.S. Tekale. 2020. Perception of Farmers towards Effectiveness of Extension Services of KVK. *Indian Journal of Extension Education*, 56(4): 43-48.
- Srivani, T.N.S.S.; P. Rajan; S. Naberia and D.K. Singh. 2022. Knowledge of Tribal Farmers about VDK Activities in Andhra Pradesh. *Asian Journal of Agricultural Extension, Economics and Sociology*, 40(11): 101-108.



Research Article

Organic Vegetable Cultivation and Perceptions of Farmers of Hoshiarpur, Punjab, India

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ABSTRACT

The study was undertaken to determine the attitude of farmers towards organic vegetable cultivation in Hoshiarpur district located in Punjab state and explore the relationships between their selected characteristics with their attitude. Data were collected through personal interview using pre-tested structured questionnaire from a sample of 50 randomly selected vegetable farmers. Majority of the growers had positive attitude towards organic vegetable cultivation.

Keywords: Attitude, Vegetable farmers, Organic farming and Hoshiarpur

INTRODUCTION

Organic farming is a form of agriculture which excludes the use of synthetic fertilizers, pesticides and plant growth regulators. The system also seeks to maintain the fertility demands of various crops to avoid excessive depletion of soil nutrients. According to Parrot *et al.* (2006), farmers have often resisted “Green revolution” viewing them not only as unsuitable but also risky and inaccessible. The obvious choice for that would be reintroduction of organic farming without compromising agricultural production. India is the second largest producer of vegetables next to China. In the next decade it is supposed that there will be increased area under vegetable crops as vegetable farming is about 4-5 times more profitable than cereals and other field crops. Chemical-free vegetables, which are standardized, have more demand from the developed high- income countries due to health considerations. The concept of organic farming practices refers to the farm as an organism in which all the component parts (the soil minerals, plants, organic matter, micro-organisms, insects, animals including humans) interact to create a coherent and stable whole. Organic farming combines scientific knowledge of

ecology and modern technology with traditional farming practices based on naturally occurring biological processes. According to FAO (2008), organic agriculture provides environmental goods and services. Considering these facts the present study was undertaken to measure the attitude of vegetable farmers towards organic vegetable cultivation and to investigate relationship between their selected characteristics and their attitude towards organic vegetable cultivation.

MATERIALS AND METHODS

The study was conducted in Punjab state of Hoshiarpur district. The population of the study was the farmers who cultivate vegetables mainly. Data were collected from the fifty farmers through personal interview using pre tested structured questionnaire. Farmers attitude towards organic vegetable cultivation was the focus variable of the study. For measuring attitude of the respondents, a 5 point Likert scale (Likert, 1932) was used. There were 8 statements and each respondent was asked to indicate his extent of agreement or disagreement against each statement along a 5 point scale: strongly agree, agree, undecided, disagree and

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strongly disagree. Weights assigned to these responses were 5, 4, 3, 2, and 1 respectively. The total score of a respondent was determined by summing up the weights for responses against all 8 statements.

$$\text{Attitude score} = 5 \times \text{SA} + 4 \times \text{A} + 3 \times \text{U} + 2 \times \text{DA} + 1 \times \text{SDA}$$

Where, SA= Total number of respondents expressing their attitude 'strongly agree' for the statement

A= Total number of respondents expressing their attitude 'agree' for the statement

U= Total number of respondents expressing their attitude 'undecided' for the statement

DA=Total number of respondents expressing their attitude 'disagree' for the statement

SDA= Total number of respondents expressing their attitude 'strongly disagree' for the statement

Attitude score of a respondent would be range from 10 to 50. The data were collected through face to face interview using a structured questionnaire from the respondents of the selected areas.

RESULTS AND DISCUSSION

The information in Table 1 revealed that the respondents have highly favourable attitude towards organic vegetable cultivation regarding reduction of production cost, chemical pesticides are hazardous for environment and organic products are good health. Now-a-days organic products are sale in the market for high price also. The possible attitude score of the farmers ranged from 10 to 50 with an average score of 10.2 and standard deviation 3.61. The respondents were categorized into five groups (highly favourable, favourable, neutral, unfavorable and highly unfavorable) based on their attitude score. The distribution of the farmers based on their attitude score has been shown in Table 2.

It appears from the Table 2 that only 8.0 per cent farmers have unfavourable attitude of organic vegetable cultivation. Nearly all the respondents (92.0%) have favourable and highly favourable attitude towards organic vegetable cultivation. Mohan and Helen (2014) showed that, in India Majority of the organic farmers

Table 1: Attitude of the farmers towards individual statement regarding organic vegetable cultivation

Statement	Extent of opinion					Total Score
	SA	A	U	D	SD	
Organic vegetable cultivation reduces the production cost	23	27	-	-	-	223
Organic vegetable cultivation ensure balanced utilization of natural resources	15	20	13	2	-	198
Organic cultivation keeps soil fertile for long time	14	22	9	5	-	195
Organic vegetable cultivation is environment friendly	20	25	5		-	215
It reduces water pollution both surface and under ground	6	30	10	4	-	188
Products from organic cultivation are good for health	17	29	0	4	-	209
Chemical pesticides are harmful for our environment	19	29	2	0	-	217
Use of excessive chemical fertilizer reduces long time soil fertility	9	30	8	3	-	195

SA= Strongly Agree, A=Agree, U=Undecided, D=Disagree and SD= Strongly Disagree

Table 2: Distribution of the respondents based on their attitude score

Range	Categories of farmers	Respondents		Mean	SD
		Number	Percentage		
10 to 50	Highly favourable	11	22	10.2	3.61
	Favourable	35	70		
	Neutral	0	0		
	Unfavourable	4	8		
	Highly unfavourable	0	0		
	Total	50	100		

Table 3: Profile characteristics of vegetable growers

Profile characteristics	Measuring unit	Category	Frequency	Percentage
Age	year	Young age < 30	6	12
		Middle age 31-45	11	22
		Old age > 45	33	66
Education	level	Illiterate	3	6
		Primary	8	16
		Secondary	20	40
		Higher secondary	19	38
Experience in vegetable cultivation	Number of years	Low	9	18
		Medium	32	64
		High	9	18
Family size	Number	Small (upto 4)	8	16
		Medium (5-6)	34	68
		Large (above 6)	8	16
Farm size	Hectare	Small (upto 1 ha)	41	82
		Medium (1.0-3.0 ha)	4	8
		Large (> 3.0 ha)	2	4
Mass media exposure	Scale score	Low	6	12
		Medium	38	76
		High	6	12
Agricultural training received	Days	1 day	10	20
		2 days	32	64
		3 days	6	12
		4 days	2	4

(86.67%) had a favourable attitude towards organic farming practices followed by more favourable (10%) and less favourable (3.33%) attitude. More than 80 per cent of the conventional farmers had favourable attitude towards organic farming practices. Above 90 per cent of the organic as well as conventional farmers believed that use of organic farming practices was essential for better quality of vegetables. 95.4 per cent respondents have favourable and highly favourable attitude towards organic vegetable cultivation results were observed by Rana *et al.* (2017).

Table 3, majority of the vegetable growers (66%) belonged to old age category. Most of the vegetable growers (40%) had secondary school education. Sixty four per cent of them were having medium level of experience in vegetable cultivation. Most of the vegetable growers (64%) belonged to medium category with respect to family size. Nearly 82 per cent

of the respondents had small level of farm size. Seventy six per cent of the vegetable growers belonged to medium category with respect to mass media exposure. Most of them (64%), had done 2 days level of agricultural training. The result was in agreement with the findings of Jaganathan *et al.* (2009). The present findings were similar with the observations of Rana *et al.* (2017) found that 73.8 per cent farmers accessed training and demonstration on various agricultural issues like organic vegetable production, IPM, biological pest control etc. Accessible agricultural extension services on organic farming for the farmers. For the above reasons the farmers' possess a favourable and highly favourable attitude towards organic vegetable cultivation. Ullah *et al.* (2011) found that 18 per cent farmers had favourable perception and 16 per cent had highly favourable perception of One House One Farm Approach. Oluwasusi (2014) showed

that majority of the farmers in Nigeria had positive attitude toward organic agriculture practices.

CONCLUSION

It can be concluded that most of the respondents have favorable and highly favorable attitude towards organic vegetable cultivation. From the selected characteristics of the farmers level of education, extension media contact and agricultural training received has positive relationship towards organic agricultural practices. It is therefore recommended that the extension service providers like Krishi Vigyan Kendras (KVKs), departments, universities and other NGOs should take into active consideration on providing training to the vegetable farmers and need based advisory services for organic vegetable cultivation.

REFERENCES

- FAO. 2008. Organic Agriculture and climate change. Food and Agriculture Organization, Rome.
- Jaganathan, D.; C. Bhaskaran; A. Chandru and V. Lennin. 2009 Attitude of Vegetable Growers towards Organic Farming Practices. *Indian Journal of Extension Education*, 45(3&4): 63-67.
- Likert, R. 1932. A technique for the measurement of attitudes. *Archives of Psychology*, 140.
- Mohan, D.J. and S. Helen. 2014. Attitude of farmers towards organic vegetable cultivation. *Agriculture Update*, 9(3), 364-367. <https://doi.org/10.15740/HAS/AU/9.3/364-367>
- Oluwasusi, J.O. 2014. Vegetables farmers attitude towards organic agriculture practices in selected states of South West Nigeria. *Journal of Agricultural Extension and Rural Development*, 6(7): 223-230. <https://doi.org/10.5897/JAERD2013.0572>
- Parrott, N.; A.C. Sockyew; C. Makunike and S.N. Ntambi. 2006. Organic farming in Africa. In: Helga, W. and M. Youssefi (eds). *The world of organic farming agriculture: statistics and emerging trends*. A joint Publication of International Federation of Organic Agriculture movement, Bonn, Germany and research Institute of organic agriculture (FiBL) Frick Switzerland.
- Rana, S.; H. Hafiz; M.S. Alam and M.S. Islam. 2017. Farmer attitude towards organic vegetable cultivation in Rangunia Upazila, Chittagong, Bangladesh. *Journal of Bioscience and Agricultural Research*, 14(1): 1151-1156.
- Ullah, S.M.A.; M.G. Farouque and M.Z. Rahman. 2011. Farmers' perception of one house one farm approach. *Bangladesh Journal of Extension Education*, 23(1&2): 75-82.

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Research Article

Starch, Dietary fibre, *in vitro* Starch Digestibility, and Predicted Glycemic Index of Representative Meals of Individuals Living with Diabetes: A Cross-sectional Study

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ABSTRACT

An analysis of starch, dietary fibre, *in-vitro* starch digestibility, and predicted glycemic index (GI) in lunch meals consumed by diabetic men and women (n=50 each), from Ludhiana, India, revealed high digestible starch (39.05g), low resistant starch (0.73g) with adequate fiber (8.64g) in the meals of the participants. Meals exhibited negative correlations ($p \leq 0.01$) between protein, ash, crude fiber, fat, dietary fiber, and glycemic load (GL). *In vitro* starch digestion rate showed a significant negative correlation ($p \leq 0.01$) with GI. The meals exhibited a negative correlation ($p \leq 0.01$) between protein, ash, crude fibre, fat, dietary fibre, and the GL. *In-vitro* starch digestion rate demonstrated a significant negative correlation ($p \leq 0.01$) with the GI of the meals. Significant ($p \leq 0.01$) association was noted between higher carbohydrates and higher GL. Findings are particularly relevant in India due to high diabetes prevalence. Implementing awareness programs to regulate meal GL emerges as a practical and cost-effective strategy in diabetes care.

Keywords: Diabetes, Composite meal, Dietary fibre, Starch, Glycemic index, Glycemic load

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disease characterized by persistent hyperglycemia (high blood glucose or sugar levels) when pancreas doesn't produce enough insulin or do not respond normally to insulin (IDF, 2021; Goyal and Jialal, 2023). If uncontrolled or untreated, it can lead to severe complications (such as retinopathy, nephropathy, neuropathy and cardiovascular diseases) and even death (Goyal and Jialal, 2023). Globally, there were approximately 537 million adults (20 to 79 years) with diabetes in 2021, predominantly in low- and middle-income countries. This number is projected to rise to 783 million by 2045 (IDF, 2021). Diabetes was responsible for 6.7 million deaths worldwide in 2021 (IDF, 2021). South-East Asia has a significant burden of diabetes, with 90 million cases, and India ranks

second after China, with over 74 million adults affected and an additional 25 million individuals classified as prediabetic (WHO, 2023). In India, more than half of the people with diabetes remain undiagnosed, highlighting the substantial health challenge it poses (IDF, 2021). A state-wide survey conducted in Punjab, India, revealed a diabetes prevalence of 14.3 per cent among individuals aged 18-69 years, exceeding the global average of nine percent. However, due to low level of awareness (34%), treatment (28%) and control that contribute to the challenge of managing diabetes in India, there is a need to implement more robust measures at both the state and national levels (Thakur and Nangia, 2022).

In addition to medications, early lifestyle modifications including diet therapy and physical exercise play an important role in the managing and

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treating DM (Goyal and Jialal, 2023). Dietary factors are particularly important as it is closely linked to the development of diabetes, with carbohydrates being the major contributor in altering postprandial glucose response as they are directly related to glycemic index (GI). GI is an *in-vitro* measurement of increase in blood glucose concentration after consuming carbohydrate rich foods. Foods can have high (>70), medium ($55 \leq 70$) to low GI (≤ 55) values (Singh, 2017). High GI foods increase the blood glucose levels at much faster rate as compared to low GI foods (whole grains, legumes) high in dietary fibre (DF) and resistant starch (RS) which tend to prevent insulin resistance and reduce postprandial glucose response, thereby alleviating the risk of DM (Singh, 2017). However, the GI alone does not indicate the extent and duration of increased blood sugar levels resulting from the consumption of a specific amount of carbohydrates. To address this limitation, a separate measure called the glycemic load (GL) is used, which combines both the GI of a food or diet and the quantity of carbohydrates present in a specific food, meal, or diet, providing a more accurate assessment of its impact on postprandial glycemia. For example, although watermelon has a high GI (74), a 100 g serving of watermelon contains such a small amount of carbohydrates that its GL is only 4. GL is classified into three categories: low (<10), medium (11–19), and high (>20) GL (Vlachos *et al.*, 2020).

The carbohydrate fraction in food is categorized into three types based on the rate of digestion: rapidly digestible starch (RDS, digested within 20 minutes), slow digestible starch (SDS, digested between 20–120 minutes) and RS (RS, remains undigested even after 120 minutes) (Lehmann and Robin, 2007; Perla *et al.*, 2017). The rate as well as the extent of starch digestion are nutritionally important for individuals with diabetes. The glycemic response of a food is influenced by the proportions of RDS, SDS and RS present. The composition of total starch, RDS, SDS and RS in a meal depends on a combination of food components consumed together (Sharavathy *et al.*, 2001). Traditional and standardised *in vivo* methods and experimental designs recommended by FAO/WHO The FAO/WHO are time consuming, expensive and raise ethical concerns for analyzing GI values in foods. However, *in vitro* methods are potentially useful alternative as they are more cost-effective, time-efficient, have better

reproducibility and do not have ethical limitations (Barine and Yorte, 2016; Yaman *et al.*, 2019). Furthermore, *in vitro* methodologies are also useful for evaluating the impact of starch-containing foods on postprandial metabolism and as provide insight into molecular mechanisms of amylolysis (Butterworth *et al.*, 2022).

Researchers and food technologists have shown a growing interest in reducing the GI of carbohydrate-rich foods, as studies have demonstrated the protective effects of consuming low GI foods against diabetes and cardiovascular diseases (Reshmi *et al.*, 2017; Singh, 2017). However, there is a limited amount of literature available that provides information on the *in vitro* starch digestibility and predicted glycemic index (PGI) of typical meals consumed by individuals with diabetes. Given the increasing prevalence of diabetes among Indians, a cross-sectional study was conducted to analyse representative lunch meals of individuals living with diabetes, examining their proximate components, starch, DF, *in vitro* starch digestibility and calculating the predicted glycemic index. This information would enable consumers to make appropriate adjustments to their diets based on the GI profile of their meals (Thakur and Nangia, 2022; WHO, 2023). Additionally, these findings would assist nutritionists and dietitians in recommending scientifically tested therapeutic diets for individuals with diabetes and carbohydrate metabolism disorders.

MATERIALS AND METHODS

Punjab, a state in northern India, shares its border with Pakistan and has a population exceeding 27 million (National Census, 2011). It is composed of 23 districts, categorized into three regions: Majha, Doaba, and Malwa. The majority of Punjab's geographical area is encompassed by the Malwa region, which comprises 14 districts. Among these districts, Ludhiana stands out as the largest in terms of both land area and population (Kaur *et al.*, 2017; Government of Punjab, 2023). The study participants were recruited from the health centre of publicly funded institution in Ludhiana.

In this analytical, cross-sectional study, a total of 100 hundred men and women ($n=50$ each) were enrolled in the study between January to April, 2021. A convenient sampling method was used to select the study participants from health center. The inclusion

criteria were having 40–60 years old living with diabetes. The exclusion criteria were pregnancy or lactation, and having any other co-morbidities. A pre-tested interview schedule was utilised to collect general information (age, education, religion, type of family and income) and dietary pattern of the participants.

Prior to the participation, all participants received detailed oral and written information about the study's objectives and procedures. All participant's information in the database was anonymous, and all participants provided informed consent before collecting data. No further ethical approval was required for this study.

The collection and analysis of samples were carried out as follows:

Duplicate samples of lunch meals, including beverages, consumed by the participants over three consecutive days, were collected and transported to nutrition laboratory of the institute. The representative meal samples were weighed and homogenized using an electric mixer. Subsequently, they were dried in a hot air oven at a temperature of $60 \pm 5^\circ\text{C}$. The samples were then subjected to various analyses using standard methods.

Proximate components (moisture, crude protein, crude fat, ash, crude fibre, carbohydrates and energy) were determined following the AOAC method (AOAC, 2000). Starch content (total, digestible and resistant starch), the rate of in vitro starch digestibility, hydrolysis index and PGI were assessed using the method outlined by Goni *et al.* (1997). DF (total, soluble and insoluble fibre) was estimated employing method described by Asp *et al.* (1983). All analyses were performed in triplicate, and the averages were reported on a dry matter (DM) basis (NMKL, 1985).

Moisture: The fresh sample weighing 5g was taken in triplicates and dried in a hot air oven for 8 hours at a temperature of 60°C till a constant weight was achieved. The dried samples were then cooled in a desiccator and weighed again. The moisture content of the samples was calculated using the following formula:

$$\text{Moisture (\%)} = \frac{\text{Loss in weight (g)}}{\text{Weight of sample (g)}} \times 100$$

Crude protein

Principle: The organic matter in the food sample is digested using sulfuric acid in the presence of a catalyst. This digestion process converts the reaction product into an alkaline state. Subsequently, the liberated ammonia is distilled and titrated. The nitrogen content obtained from the titration is then multiplied by the conventional factor of 6.25 to determine the crude protein content.

Reagents: Conc. sulphuric acid, Digestion mixture: potassium sulphate and copper sulphate (5:1), boric acid (4%), sodium hydroxide (40%), Mixed indicator: methyl red and bromocresol green and H_2SO_4 (0.1N).

Procedure: The sample weighing 0.2 g was carefully measured and mixed with a digestion mixture (4 g) and concentrated sulfuric acid (10 ml). The resulting mixture was transferred into digestion tubes. The digestion process was carried out using the Kelplus digestion equipment KES12L (VA) manufactured by Pelican equipments, India. Initially, the samples were pre-digested at a temperature of 300°C , followed by a final digestion step at a higher temperature of 420°C . After digestion, the digested samples were diluted by adding 30 ml of distilled water. The diluted samples were then subjected to distillation using Kjeldahl Plus distillation apparatus (Kelplus-classic DXVA, Pelican equipment). The equipment was set by using 40 per cent sodium hydroxide for a duration of nine minutes. The distillate, containing the liberated ammonia, was collected using a 4% solution of boric acid. To estimate the amount of nitrogen in the flask, 0.1 N sulfuric acid was used for titration. The nitrogen value obtained was then converted to protein content using a conversion factor of 6.5.

Crude fat

Reagents: Petroleum ether, Cotton and Filter paper.

Procedure: Thimbles were created using Whatman No. 1 sheets and a test tube with a diameter of approximately 2 cm. The empty beakers of the Socs Plus apparatus were weighed separately to determine their initial weight (W1). Representative meal samples, free of moisture, weighing 5 grams, were placed inside the thimbles. The thimbles were then placed inside the pre-weighed empty beaker and sealed with cotton plugs. Petroleum ether was added to the beakers, and

they were placed in the Socs Plus apparatus. The temperature was set to 120°C initially until the ether started boiling. The temperature was set to 120°C initially until the ether started boiling. Then, the temperature was lowered to 90°C and maintained for 45 minutes. Afterward, the temperature was raised again to 120°C for an additional fifteen minutes. The beakers were then removed from the apparatus and placed in a hot air oven to completely remove the ether. Once the samples had cooled, they were transferred to a desiccator for further cooling. After cooling, the thimbles were separated from the beakers, and the final weight (W_2) of each beaker with the sample was measured. The crude fat in the meal samples was calculated by the following formula:

$$\text{Percent fat} = \frac{W_2 - W_1}{W} \times 100$$

Where, W_2 = final weight of the beaker

W_1 = initial weight of the beaker

W = weight of the sample

Ash: A pre-weighed crucible was used to weigh five grams of the representative meal sample. The crucible with the sample was then placed in a muffle furnace and subjected to a temperature of 550°C for a duration of four hours. After the heating process, the crucibles were allowed to cool down in a desiccator. Once cooled, the residue remaining in the crucible was weighed.

$$\text{Percent Ash} = \frac{\text{Weight of ash, g}}{\text{Wt. of representative sample, g}} \times 100$$

Crude fibre

Reagents: Sodium Hydroxide (1.25 %) and Sulphuric acid (1.25 %)

Procedure: The moisture-free and fat-free representative meal sample weighing five grams was carefully placed in pre-weighed crucibles. These crucibles were then positioned in the metal adapters of the Fibra Plus hot extraction unit apparatus. A Hot plate was used to heat the Acid, alkali and distilled water. A volume of 200 ml of 1.25% H_2SO_4 acid was added to the top of the apparatus, and the temperature was set to 500°C. Once refluxing began, the temperature was lowered to 400°C, and the sample was refluxed in the acid medium for 40 minutes. After the boiling

process, the sulphuric acid was removed, and the sample was rinsed three times with distilled water to ensure complete removal of acid residues. Next, the acid-treated sample was boiled with 200 ml of 1.25% NaOH for another 40 minutes. Following the alkali refluxing process, the sample was again washed thrice with distilled water to eliminate any remaining alkali. The samples were then transferred to dried and pre-weighed crucibles and placed in a hot air oven for drying, followed by cooling in desiccator. The weight of the samples was determined after they had cooled in the desiccator. The crucibles containing the dried samples were subsequently subjected to ashing in a muffle furnace at 550°C for four hours. The weight loss due to ignition was recorded, and the fibre content of the sample was calculated using the provided formula.

$$\text{Percent crude fibre} = \frac{W_1 - W_2}{W} \times 100$$

Where, W_1 = Weight of residue before ignition

W_2 = Weight residue after ignition

W = Weight of sample

Carbohydrates: The carbohydrates were computed by difference using the following formula:

$$\text{Carbohydrates (g)} = 100 \text{ g} - (\text{moisture} + \text{crude protein} + \text{crude fat} + \text{ash}) \text{ g}$$

Energy (Kcal): The gross energy value of the sample was estimated using the factors for protein (4Kcal/g), fat (9 Kcal/g) and carbohydrate (4 Kcal/g), in the following equation:

$$\text{Energy (Kcal)} = (\text{protein} \times 4) + (\text{carbohydrate} \times 4) + (\text{fat} \times 9)$$

Total Starch

Reagents: KOH, Porcine Pancreatic alpha-amylase, Di sodium hydrogen phosphate heptahydrate, Sodium dihydrogen phosphate monohydrate, 3-5 dinitrosalicylic acid and Glucose (Standard).

Preparation of stock solution: Stock solution of alpha-amylase was prepared by adding porcine pancreatic alpha-amylase (20mg) with 50 ml of 0.2m phosphate buffer (pH 6.9).

Procedure: A grounded and sieved sample (25 mg) was dissolved in 6 ml of 2 M KOH (ml) and

homogenised for 30 minutes at room temperature. Then, one ml of alpha-amylase solution was added to the sample and incubated for 45 minutes at 37°C in water bath shaker. To inactivate the enzymes, 3-5 dinitrosolicylic acid (1 ml) was immediately added to the sample and heated for 5 minutes. The solution was then centrifuged for 10 minutes at 3000 rpm, and the absorbance of the glucose concentration in the supernatant was measured at a wavelength of 450 nm. Additionally, different concentrations of standard glucose ranging from 0.02 mg/l to 0.1 mg/l were prepared, and the glucose concentrations of each sample were obtained. To convert glucose to starch, a conversion factor of 0.9 was applied.

Resistant starch

Reagents: Freshly prepared Pepsin solution (20g of pepsin dissolved in 1000ml of distilled water), and alpha-amylase enzyme

Procedure: For each sample (residue obtained from total starch estimation) weighing 100 mg, 1ml of freshly prepared pepsin solution was added and incubated at 40°C for 1 hour to ensure complete hydrolysis and removal of protein. Subsequently, the starch was further hydrolysed by adding 40mg of alpha-amylase solution and incubating it at 37°C for 120 minutes. The samples were then centrifuged at 3000 rpm for 15 minutes, and the supernatant was discarded. The residue was subjected to starch analysis using the same method described for total starch estimation. The digestible starch was computed as the difference between total starch and the RS.

Dietary fibre (DF): The total DF (TDF) is the sum of soluble (SF) and insoluble (ISF).

Reagents: Sodium phosphate buffer (0.1mol/ L, pH 6.0), NaOH (4mol/L), HCl (4mol/L), ethanol (78%), acetone AR grade and technical grade ethanol (95%).

Enzymes: Pepsin NF, Termamyl 60L and Pancreatin 4× NF

Procedure: One gram of defatted and dried representative meal sample was thoroughly suspended in 25 ml of sodium phosphate buffer (0.1 mol/L, pH 6.0) in a pre-weighed flask. To this, 0.1 ml of termamyl (heat stable alpha amylase) was added. The flask was

covered with aluminium foil and incubated in hot water bath for 15 minutes with occasional shaking. After cooling, 20 ml of distilled water was added, and the pH was adjusted to 1.5 using HCl. Next, 100mg of pepsin was added to the flask and covered with aluminium foil. The mixture was incubated for one hour in a 40°C water bath. Following incubation, 20 ml of distilled water was added, and the pH was adjusted to 6.8 using NaOH. The process of incubation was repeated, and finally, the pH was adjusted to 4.5.

For filtration, a dry and pre-weighed crucible with 0.5 g of dry celite as the filter was used. The contents of the flask were filtered through the crucible, and the residue (ISF) was washed with 10 ml of distilled water. The volume of the combined filtrate (SF) and washing waters was adjusted to 100 ml, and 400 ml of warm 95% ethanol (60°C) was added. After one hour of precipitation, the content was filtered through a dried and weighed crucible with 0.5 g celite. The residue was washed twice with 78% ethanol, 2 x 10 ml of 95% ethanol, and 2 x 10 ml of acetone. Then, the residue was transferred to a crucible and dried in a hot air dryer at 105°C until a constant weight was achieved. The crucible was kept in a desiccator for a few minutes and weighed (d2). Finally, the sample was ashed in a muffle furnace at 550°C for 4 hours.

Blank: Blank values of ISF and SF were obtained by running the procedure without sample (B1 and B2).

$$\text{ISF, \%} = \frac{D_1 - I_1 - B_1}{W} \times 100$$

$$\text{SF, \%} = \frac{D_2 - I_2 - B_2}{W} \times 100$$

Where, W= Sample weight (g)

D=Weight after drying (g)

I= Weight after incineration (g)

B= Weight of ash free blank (g)

The starch digestion rate for the representative samples was expressed as the % of the total starch hydrolysed in every half an hour time interval up to 2 hours of incubation i.e. 30, 60, 90 and 120 minutes. The Hydrolysis index (HI) was calculated as ratio of areas under the hydrolysis curve of the test representative sample to the reference sample (glucose).

$$HI = \frac{\text{AUC of the representative sample}}{\text{AUC of glucose}} \times 100$$

Where, AUC = area under the curve

The PGI was calculated using the following equation.

$$PGI = 39.7 + 0.548HI$$

Statistical analysis: The data was analyzed using SPSS software. Categorical variables were summarized using proportions, while continuous variables were presented as mean or median, with 95% confidence intervals. Correlation coefficients (r) were computed to determine the relationships between dietary factors and glycemic load (GL) of the representative meals of the participants.

RESULTS

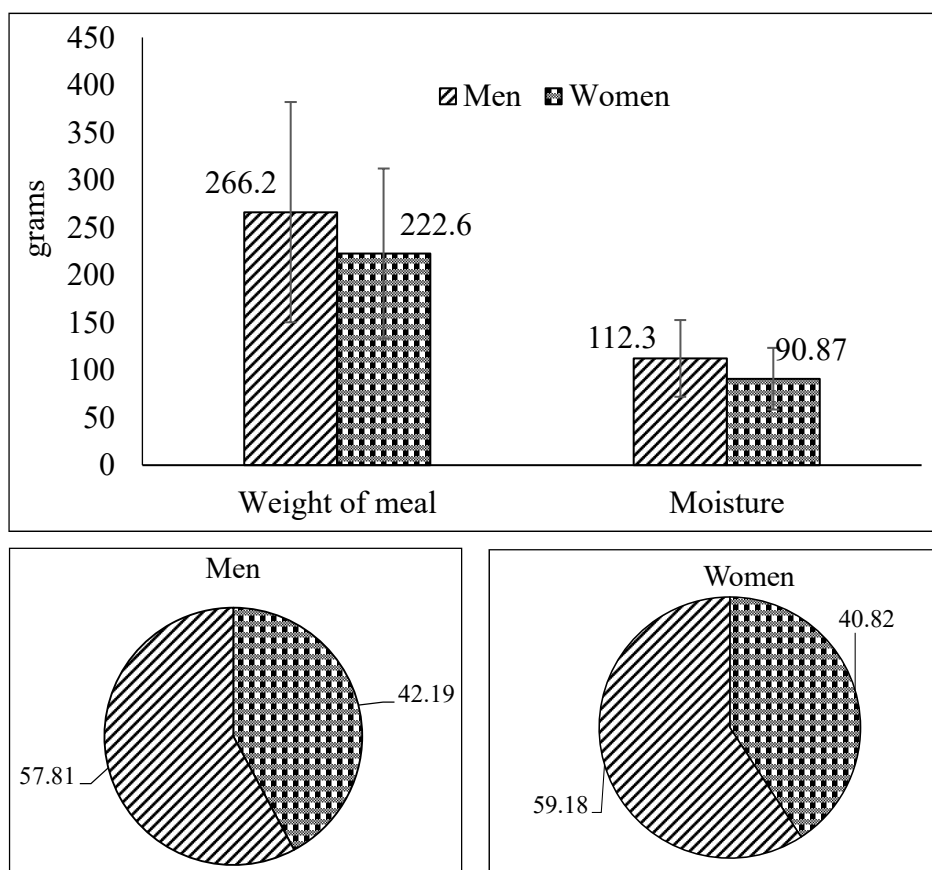
The present cross-sectional study was conducted on 100 men and women with a mean age of 48.0 and 46.6 years, respectively. A majority (62%) of the women lived in joint families, while approximately 54 per cent of men were from nuclear families. In terms of religion, over half of the subjects were Hindus (62%

men vs. 56% women), and while the rest belonged to Sikh religion (38% men vs. 44% women). Post-graduation was the highest level of education for 56 per cent of men and 46% of women, followed by graduation (44% men vs. 54% women). Desk jobs were the primary occupation for the majority of participants (93% men vs. 64% women), and 36 per cent of women were housewives. Regarding average monthly family income, most participants fell with the range of Rs. 30,000-60,000 (83% men vs. 51% women), followed by those earning more than Rs. 60,000 (15% men vs. 44% women) and small percentage had a monthly family income less than Rs. 30,000 (2% men vs. 5% women).

Figure 1 presents the average weight and moisture content of the representative meals of the participants. Proximate composition (g/100g DM) of representative meals of men and women living with diabetes is summarised in Table 1, while that of per meal basis is depicted in Figure 2.

Moisture: In the representative meals consumed by men and women living with diabetes, the average

Figure 1: Average weight and moisture content of the representative meals of diabetic men and women



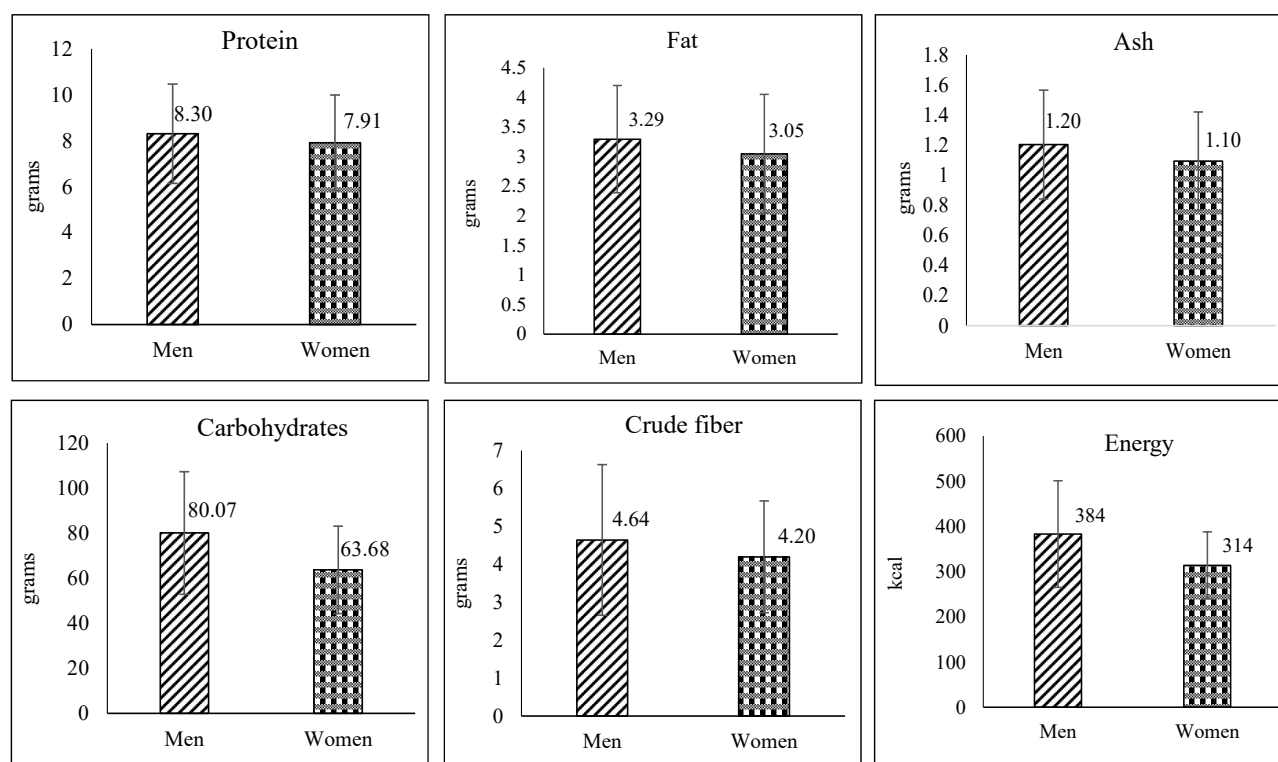


Figure 2: Proximate composition of representative meals of diabetic men and women

Table 1: Proximate composition (g/100g DM) of the representative meals of the participants

Components (g)		Men (n=50)	Women (n=50)	Overall (n=100)
Moisture	Range	2.49-14.92	1.54-13.29	6.66±3.16
	Mean ±SD	7.61±3.25	5.27±2.79	
Protein	Range	2.86-13.32	4.33-14.96	9.02±2.60
	Mean ± SD	8.81±2.47	9.24±2.73	
Ash	Range	0.39-1.73	0.64-1.79	1.25±0.25
	Mean ± SD	1.24±0.25	1.27±0.27	
Crude fibre	Range	1.20-8.49	0.69-9.00	4.92±1.70
	Mean ± SD	4.83±1.55	5.01±1.85	
Fat	Range	1.19-6.86	0.98-5.38	3.54±1.19
	Mean ± SD	3.48±1.11	3.62±1.28	
Carbohydrates	Range	60.21-85.92	62.14-86.10	74.58±5.82
	Mean ± SD	74.03±5.93	75.15±5.71	

moisture content was 112.3 ± 40.3 g and 90.9 ± 32.4 g, corresponding to a moisture percentage of 42.19 and 40.82, respectively. On average, the moisture content in the representative meals of the participant's meals was 6.66 ± 3.16 g per 100g on a DM basis.

Ash: The average ash content in the meals was 1.20g for men and 1.10g for women, equivalent to 1.24 ± 0.25 g and 1.27 ± 0.27 g per 100g on a DM basis.

On average, the ash content in the participant's representative meals was 1.25 ± 0.25 g per 100g on a DM basis.

Meal weight: The weight of representative meals consumed by men varied from 140.6 to 564.5g, with an average of 266.2 ± 116.0 g, while for women living with diabetes, the estimated meal weight ranged from 127.5 to 480.1g, with an average of 222.6 ± 89.4 g.

Carbohydrates and energy: The representative meals of men and women living with diabetes had an average carbohydrate content of 80.07g and 63.68g, (74.03 $\pm$ 5.93 and 75.15 $\pm$ 5.71 per 100g DM), respectively. Overall, the average carbohydrate content in the participants' meals was 74.58 $\pm$ 5.82g per 100g on a DM basis. The gross energy value of the representative meals consumed by men and women living with diabetes was 384 and 314 kcal, respectively.

Protein: The average protein content in the representative meals of men living with diabetes was slightly higher (8.30g) compared to the meals of women (7.91g). On a per 100g DM basis, the average protein content was 8.81 $\pm$ 2.47g for men and 9.24 $\pm$ 2.73g for women. On average, the representative meals of the participants had 9.02 $\pm$ 2.60g of protein.

Fat: The average fat content in the representative meals of men and women living with diabetes was 3.29 and 3.05g (3.48 $\pm$ 1.11 and 3.62 $\pm$ 1.28g per 100g DM), respectively. Overall, the participant's representative

meals had an average fat content of 3.54 $\pm$ 1.19g per 100g on a DM basis.

Crude fibre: The representative meals of men and women living with diabetes had an average crude fibre content of 4.64g and 4.20g, respectively. On average, the crude fibre in the participant's meals was 4.92 $\pm$ 1.70g (4.83 $\pm$ 1.55 for men and 5.01 $\pm$ 1.85g for women, on per 100g DM basis).

The starch and DF content (on per 100g dry matter basis), PGI and GL in the representative meals of men and women living with diabetes is shown in Table 2, while that of per meal basis is depicted in Figure 3.

Starch: The representative meals consumed by men living with diabetes had an average content of 38.43g digestible starch, 0.62g RS, and a total starch content of 39.05g (per 100g on a DM basis). Women's representative meals contained an average of 31.25g digestible starch, 0.66g RS, and a total starch content of 31.91g (per 100g on a DM basis). On average, the

Table 2: Starch, dietary fibre (g per 100g DM basis), predicted glycemic index and glycemic load in the representative meals of the participants

Parameter		Men (n=50)	Women (n=50)	Overall (n=100)
DS, g	Range	27.14-50.75	6.76-53.49	39.05 $\pm$ 8.61
	Mean $\pm$ SD	40.55 $\pm$ 6.78	37.54 $\pm$ 9.96	
RS, g	Range	0.15-1.68	0.09-2.69	0.73 $\pm$ 0.46
	Mean $\pm$ SD	0.68 $\pm$ 0.39	0.79 $\pm$ 0.52	
TS, g	Range	27.92-52.29	7.03-54.42	39.78 $\pm$ 8.79
	Mean $\pm$ SD	41.23 $\pm$ 6.93	38.33 $\pm$ 10.17	
ISF, g	Range	1.58-11.78	1.23-12.49	7.26 $\pm$ 1.96
	Mean $\pm$ SD	7.28 $\pm$ 1.74	7.23 $\pm$ 2.18	
SF, g	Range	0.36-2.15	0.48-2.3	1.40 $\pm$ 0.34
	Mean $\pm$ SD	1.40 $\pm$ 0.33	1.39 $\pm$ 0.34	
TDF, g	Range	1.95-13.51	1.76-14.37	8.64 $\pm$ 2.24
	Mean $\pm$ SD	8.71 $\pm$ 2.01	8.64 $\pm$ 2.47	
<i>In vitro</i> starch digestibility rate (%)	Range	35.16-75.34	32.29-72.16	57.03 $\pm$ 11.97
	Mean $\pm$ SD	59.56 $\pm$ 10.88	54.50 $\pm$ 12.12	
PGI	Range	58.96-80.98	57.39-79.24	70.95 $\pm$ 6.56
	Mean $\pm$ SD	72.33 $\pm$ 6.23	69.57 $\pm$ 6.64	
GL	Range	40.73-65.12	37.72-65.17	52.85 $\pm$ 6.67
	Mean $\pm$ SD	54.64 $\pm$ 11.37	52.29 $\pm$ 6.64	

Values are means of duplicate determinations

DS: Digestible Starch; RS: Resistant Starch; TS: Total Starch; ISF: Insoluble Fibre; SF: Soluble Fibre; TDF: Total Dietary Fibre; PGI: Predicted Glycemic Index; GL: Glycemic Load

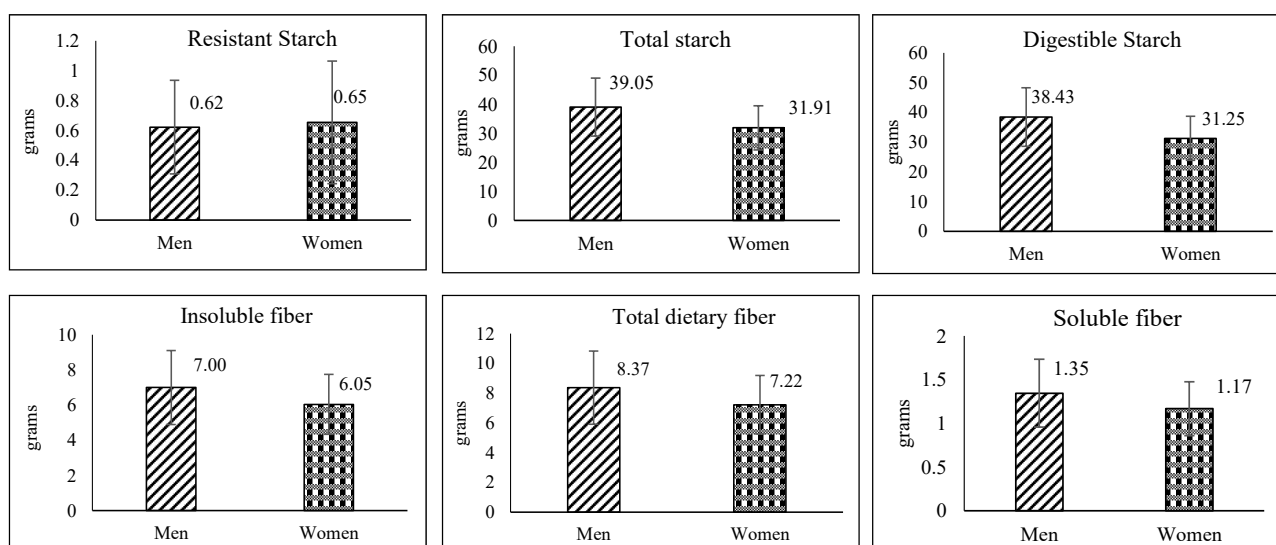


Figure 3: Starch and dietary fibre in the representative meals of the diabetic men and women

digestible, resistant, and total starch content in the participants' representative meals was 39.05g, 0.73g, and 39.78g, respectively (per 100g on a DM basis).

DF: The average TDF in the representative meals of men and women living with diabetes was 8.37 and 7.22g (equivalent to 8.71 ± 2.01 and 8.64 ± 2.47 g per 100g on a DM basis), comprising of 7.00 and 6.05g (equivalent to 7.28 ± 1.74 and 7.23 ± 2.18 g per 100g on a DM basis) of ISF and 1.35 and 1.17g (equivalent to 1.40 ± 0.33 and 1.39 ± 0.34 g per 100g on a DM basis) of SF, respectively. On average, the TDF, ISF and SF in the representative meals of the participants was found to be 8.64 ± 2.24 , 7.26 ± 1.96 and 1.40 ± 0.34 g per 100g on a DM basis, respectively.

The typical percentage of in vitro starch digestion in the meals consumed by men living with diabetes was $59.5\% \pm 10.88$, with PGI of $72.3\% \pm 6.23$ and GL of $54.6\% \pm 10.37$. Women living with diabetes, on the other hand, had representative meals with average rates of in vitro starch digestion, PGI, and GL of $54.5\% \pm 12.12$, $69.5\% \pm 6.64$, and $52.3\% \pm 6.64$, respectively. Overall, the average values for in vitro starch digestion rate, PGI, and GL in the participants' representative meals were 57.03 ± 11.97 , 70.95 ± 6.56 , and 52.85 ± 6.67 percent, respectively.

The correlation between dietary factors and GL in the representative meals of the participants has been shown in Table 3. A significant negative correlation ($p \leq 0.01$) was found between protein, ash, crude fibre,

fat, fibre (total, insoluble, soluble), and the GL of the representative meals consumed by the participants. Additionally, the in vitro starch digestion rate also had a significant negative correlation ($p \leq 0.01$) with the GI of the meals consumed by the participants. On the other hand, the findings showed a significant ($p \leq 0.01$) association of higher content of carbohydrates in the meals with higher GL.

The representative meals of the participants were categorized according to GI of their meals (Figure 4). Majority (77 and 66%) of the men and women living with diabetes were consuming high GI meals, followed by 23 and 34% consuming moderate GI meals, respectively, while none of the participants had low GI meals.

Table 3: Correlation coefficients (r) between dietary factors and glycemic load of the representative meals of the participants

Nutritional components	Correlation Coefficient (r)
Protein (g)	-0.559***
Ash (g)	-0.517***
Crude Fibre (g)	-0.363***
Fat (g)	-0.265***
Carbohydrates (g)	0.668**
Starch Hydrolysis Index (%)	-0.757***
Total fibre (g)	-0.510***
Insoluble fibre (g)	-0.497***
Soluble fibre (g)	-0.522***

*** Significant at $p \leq 0.01$

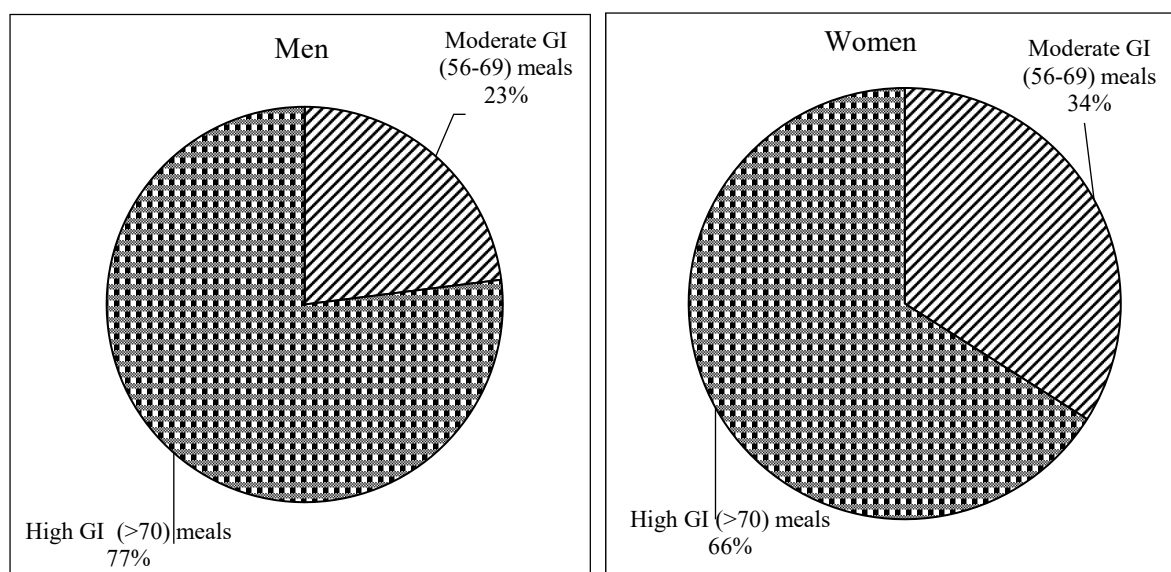


Figure 4: Distribution of the participants on the basis of Glycemic Index of their representative meals

DISCUSSION

We conducted a cross-sectional study on a sample of 100 men and women with diabetes, from university health centre, Ludhiana, India, with the primary objective of analysing their lunch meals for starch, dietary fibre, in vitro starch digestibility and predicted GI. In the present study, most of the participants were consuming meals with high GI and GL, indicating poor dietary choices and low level of awareness regarding GI of foods. Additionally, their meals had high amounts of digestible starch, low level of RS, and sufficient fibre.

The results showed variations in sociodemographic characteristics among the study participants. These findings provide valuable insights for healthcare planning, research endeavors, and public health initiatives. Understanding these sociodemographic features allows for the development of culturally appropriate strategies for nutrition, physical activity, and education tailored to different socioeconomic groups. Additionally, identifying employment patterns can guide vocational training programs and improve employment opportunities (Cowie *et al.*, 2018). Similar findings from a Canadian study highlight the independent relationship between income, diabetes incidence, and physical inactivity (Bird *et al.*, 2015).

The proximate composition of a food sample has been considered as the most important measure of its

quality, and timing (Ismail, 2017). In our study, the weight of the meals varied, with men consuming slightly larger portions with higher energy values than women. Besides meal weight, the size of a meal or food portion is a crucial factor that influence postprandial glucose and insulin response (Takahashi *et al.*, 2018; Vlachos *et al.*, 2020). The insulin index (II) measures the rise in insulin concentration in the blood over a 2-hour period after consuming a specific food. By comparing food portions with equal caloric content, II provides additional insights beyond the GI or GL. Lean meats, despite having minimal carbohydrates, can still elicit an insulin response, making II valuable for dietary management and prevention of diabetes mellitus and hyperlipidemia. The study findings highlight the importance of considering meal size and insulin response, as well as the need for well-controlled intervention trials to establish conclusive results (Vlachos *et al.*, 2020).

The gender-based variation in total meal weight in the study may be due to factors such as beverage inclusion or the different consistencies of individual foods within the meals. Previous studies have yielded conflicting results on the effects of beverage meals versus solid meals on postprandial satiety, glucose, and insulin responses (Mourao *et al.*, 2007; Ticken *et al.*, 2007; The InterAct Consortium, 2015). A meta-analysis investigating the relationship between BMI and evening energy intake, as well as weight changes with altered

evening intake proportions, found a non-significant trend between BMI and evening intake ($P=0.06$), and no significant difference in weight change between small and large dinner groups (-0.89 kg; 95% CI $-2.52, 0.75$, $P=0.29$). However, this analysis had limitations in terms of heterogeneity and potential bias in some trials. Therefore, there is currently insufficient clinical evidence to support recommendations for reducing evening intake as a weight loss strategy. Well-controlled intervention trials are needed to establish more conclusive results (Fong *et al.*, 2017).

The study findings align with previous research, suggesting that reducing the GI or carbohydrate content of mixed meals can lead to decreased postprandial glycemia and insulinemia throughout the day (Liu *et al.*, 2012). Including carbohydrate foods such as green leafy vegetables (e.g., broccoli and spinach) and fruits (e.g., grapefruits and cherries) can be beneficial due to their lower caloric density, lower GI, and higher fibre and water content, resulting in more stable glucose levels after meals (Mitrou *et al.*, 2007). However, it is important to consider both the GI and the quantity of carbohydrates. Portions of high GI foods affect postprandial glucose levels, with smaller amounts resulting in smaller increases, while larger quantities can cause significant spikes. Similarly, even low GI foods can lead to post-prandial glucose spikes when consumed in large amounts. Portion control plays a crucial role in both short-term and long-term health effects related to any diet (Galgani *et al.*, 2006).

The present study found that the lunch meals of the participants provided a relatively low level of protein and fat. The evidence on dietary protein intake for the prevention and management of diabetes is mixed (Beasley and Wylie-Rosett 2013). While some studies suggest that protein is a more satiating nutrient for sustained weight loss, it may only improve metabolic control when accompanied by weight loss (Wolfe 2012; Bradlee *et al.*, 2017; Lonnie *et al.*, 2018). However, it is important to consider potential negative effects of an isocaloric high protein diet, such as increased insulin resistance (Beasley and Wylie-Rosett 2013). Meta-analyses of randomized control trials involving individuals with type 2 diabetes have shown mixed results with high-protein diet, with no significant improvements in weight loss or glycemic control, but potential impacts on lipid metabolism (Zhao *et al.*,

2018) and insulin resistance (Yu *et al.*, 2020). Further clinical trials are needed to validate these findings due to limitations in the existing studies. Contrary to the belief that high-fat diets increase the risk of type 2 diabetes (T2D), evidence suggests that overall consumption of dietary fat is not associated with T2D risk (Bradley, 2018). Certain fats, particularly vegetable fats, may even have a beneficial effect in reducing the risk of T2D. However, it is important to consider overall dietary patterns and maintain a balanced caloric intake and regular physical activity as part of a healthy lifestyle (Neuenschwander *et al.*, 2020).

The study found that the representative meals consumed by men living with diabetes had slightly higher crude fibre content compared to women living with diabetes. Determining the crude fibre in food provides valuable information about fibre content and its potential health benefits, including nutritional labeling, dietary recommendations, digestive health assessment, and blood sugar management (O'Keefe *et al.*, 2020). However, it is important to note that crude fibre measurements underestimate the actual fibre content in human foods by 30-50% due to fibre loss during chemical treatments. To accurately determine DF in the human body, an *in vitro* method using pepsin and pancreatin has been proposed, which maximizes digestion and minimizes residue (Hellendoorn *et al.*, 1975).

The study findings indicated that the participants' representative meals had a high amount of digestible starch and a significantly low presence of RS. This composition could potentially lead to increased blood sugar levels among the participants. In comparison to previous studies, the intake of RS among the participants in this study was much lower than that of Africans (20g-30g/day), Chinese (14.9 ± 9.1 g), Europeans (3.2g-5.7g/day) (Chen *et al.*, 2010), and Americans (3g-8g/day) (Murphy *et al.*, 2008). RS is not digested in the small intestine but instead reaches the large intestine where it undergoes fermentation and produces short-chain fatty acids. It acts similarly to DF and has garnered interest, especially among individuals at risk of diabetes and related diseases (Moongngarm 2013; Barine and Yorte 2016). European Food Safety Authority recognizes the health claim that substituting at least 14% of available carbohydrates in a meal with RS can reduce glycemic response (Agostoni *et al.*, 2011).

Consistent with previous research on the effects of RS on postprandial glucose response and insulin sensitivity, a meta-analysis indicates that both type 1 RS (intact plant cell wall structures) and type 2 RS (high-amylose starch) can effectively reduce postprandial glucose levels in individuals with T2D, demonstrating even greater efficacy compared to individuals with prediabetes. Furthermore, RS 2 has been found to enhance acute postprandial insulin response. In chronic studies, the intake of RS 2 has shown improvements in fasting glucose and insulin levels (Pugh *et al.*, 2023). The estimation of RS intake serves as a valuable tool for researchers and professionals in the field of food and nutrition. It allows for more accurate calculations of overall carbohydrate consumption, specifically accounting for compounds that are not digested in the small intestine. This information contributes to a better understanding of dietary patterns and their impact on health (Murphy *et al.*, 2008).

DF, found in minimally processed plant-based foods, is beneficial for improving post-prandial dysmetabolism, postprandial glycemia, reducing oxidant stress and inflammation, and lowering the risk of coronary artery disease and diabetes (O'Keefe *et al.*, 2008; Kim *et al.*, 2020). The study revealed that the representative meals of men living with diabetes contained slightly higher DF content compared to women's meals. This may be attributed to the presence of whole cereals and salad in the participants' lunch. The Indian diet, which is rich in unrefined grains and vegetable products, makes it relatively easy to meet the recommended daily fibre intake. However, the actual intake of fibre varies across socio-economic groups. Among tribal populations, daily fibre consumption is even lower, typically between 15 and 19 g. Women tend to have low fibre intake, ranging from 15 to 30g per day (IDA 2018).

Food processing techniques can impact the properties and functionality of DF, improving its physiological effects (Dhingra *et al.*, 2012). Specifically, viscous fibres can thicken when mixed with liquids, leading to slower digestion and absorption of starch, thus affecting blood glucose levels. Consuming a snack high in DF may impact the blood glucose response to a subsequent meal, but the specific effects of different DF components in snacks on postprandial blood glucose levels are not well understood (Kim *et al.*, 2020).

A study by Vlachos *et al.* (2020) showed a positive impact on postprandial glucose levels in patients with T2D when soluble fibre intake was increased to lower the GI of the meal. On the other hand, Kamalpour *et al.* (2018) found no significant differences in postprandial glucose levels between two groups: MoCyllium group, which consumed a higher carbohydrate diet with 7 g of psyllium, and the LoCarb group, which consumed a lower carbohydrate diet only. However, the MoCyllium group did show improved insulin sensitivity. Based on these findings, the researchers concluded that patients unable to reduce carbohydrates intake could be advised to increase fibre intake as an alternative approach. Recent systematic reviews also support incorporating soluble viscous fibre into common foods to enhance overall DF content and reduce the GI of those foods (Reynolds *et al.*, 2019).

The representative meals consumed by the participants exhibited elevated values for both PGI and GL. However, the representative meals of men living with diabetes had slightly higher average rates of all these parameters compared to women's meals. The expansion of the concepts of GI and GL has been driven by the understanding that foods can differ in their impact on postprandial blood glucose levels, even with the same amount of carbohydrates in the diet. Although information on GI and GL of the foods helps in the management of hyperglycemia, and reducing the demand for exogenous insulin in type I diabetes, as well as the presence of hyperinsulinemia in T2D, there is paucity of information on GI and GL of meals specifically designed for individuals with diabetes (Dereje *et al.*, 2021).

Existing international tables that document the GI of foods are primarily derived from Western sources, (Europe, Australia, and North America), predominantly covering Western food items and include very few foods from non-Western countries (e.g. Middle East, South Asia, Indian sub-continent) with high diabetes prevalence, limits their applicability on a global scale. To address this gap, a review article has consolidated GI values for a variety of foods consumed in non-Western countries, including both single foods and mixed meals. This compilation provides a valuable resource for researchers and clinicians, particularly in regions with diverse ingredients and flavors (Henry *et al.*, 2021). Maintaining a low GI or GL in meals has

been suggested as an effective strategy for regulating serum glucose and insulin levels (Liu *et al.*, 2012). However, solely focusing on a low GI diet without considering carbohydrate content and overall energy intake may not effectively manage post prandial hyperglycaemia in individuals with T2D. It is crucial to consider both the quantity and quality of carbohydrates in the diet when providing dietary recommendations for T2D patients. Choosing a low-GI diet typically leads to reduced carbohydrate intake, which has been acknowledged as an effective approach for improving postprandial glucose levels in T2D patients (Vlachos *et al.*, 2020).

The postprandial glucose response (PGR), which refers to the change in blood glucose levels following a meal, is primarily affected by carbohydrates. This study confirms that a higher carbohydrate content in meals is associated with a higher GL. However, a recent research (Vetrani *et al.*, 2022) suggests that other dietary components also have an impact on PGR. In our study, we observed a significant negative correlation between different nutritional factors and GL, as well as between *in vitro* starch digestion rate and GI of the representative meals consumed by the participants. Similarly, a study conducted in Okada, Edo State, revealed that protein, fat, carbohydrates and minerals have an impact on the GI of commonly consumed mixed meals. The proportions of each nutrient were also found to influence the body's response to glycemic increase (Omage and Omage, 2018). In another study, it was reported that consuming a high-protein meal during night eating led to a 71.4% reduction in postprandial glucose levels compared to a standard meal based on dietary guidelines (Davis *et al.*, 2020). This indicates that substituting some carbohydrates with protein in a meal can improve the body's metabolic response after eating. Protein-rich meals can also influence PGR during subsequent meals, resulting in lower glucose levels following the second meal (Meng *et al.*, 2017).

According to an EPIC-InterAct study, higher intake of total fibre, cereal fibre, and vegetable fibre is associated with a reduced risk of T2D, although the associations became non-significant after adjusting for BMI. However, a meta-analysis of prospective studies suggests that increased intake of total fibre and cereal fibre was independently lowers the risk of T2D,

regardless of BMI. This implies that a fibre-rich diet, especially cereal fibre, may lower the risk of developing T2D (The InterAct Consortium, 2015). Similarly, a study compared the effects of regular biscuits and high-fibre biscuits (DF-biscuit) on postprandial glucose levels. The DF-biscuit trials resulted in lower 24-hour blood glucose levels compared to the regular biscuit trials. Specifically, after dinner, the blood glucose levels and corresponding areas under the curve (AUCs) were significantly reduced in the DF-biscuit group compared to the regular biscuit group. Furthermore, the DF-biscuit group showed suppressed blood glucose levels and AUCs following breakfast on the subsequent day, whereas the regular biscuit group did not exhibit the same effect (Kim *et al.*, 2020).

Another study explored the effect of three isocaloric breakfast meals (high carbohydrate, high fat, or high protein) on glycemic response and the determination of GI and GL values for white bread. The results showed that consuming a high-protein breakfast prior to the white-bread challenge significantly ($P < 0.0001$) reduced postprandial serum glucose response and led to lower glucose AUCi, GI, and GL values compared to high-carbohydrate and high-fat breakfasts. The high-protein breakfast also resulted in a lower insulin AUCi for white bread compared to the high-fat breakfast and a lower insulin index value compared to the high-carbohydrate breakfast ($P < 0.05$). However, all three breakfasts had similar effects on serum lipid in responses to the white-bread challenge. This study demonstrated that the macronutrient composition of the prior meal affects the glycemic response and the determination of GI and GL values for white bread. Further research is needed to explore how overall dietary patterns affect these values and their associations with the risk of chronic diseases (Eleazu, 2016).

Research has shown that a high amount of carbohydrates, as well as the overall nutritional composition of the meal can influence blood glucose control in individuals with diabetes, leading to the development of complications (Menget *et al.*, 2017). Thus, comprehensive nutritional education is crucial for optimizing blood glucose management, even in the presence of advanced technologies. Furthermore, there is a need for improved algorithms that consider nutrient sensing and individual nutrient responsiveness, enabling

predictive insulin delivery rather than reactive measures (Vetrani *et al.*, 2022).

Our study found that a majority of the participants were consuming high GI meals, indicating a lack of awareness about the benefits of low GI meals for blood glucose control. A clinical trial showed that individuals consuming a low GI breakfast had significantly lower postprandial glucose levels compared to those consuming high GI breakfast. Both meals had the same caloric content and provided equal amounts of macronutrients, differing only in their fibre content (Lobos *et al.*, 2017). Similar results have been reported in other studies, highlighting the potential of reducing GI content of meals for individuals with diabetes, through food selection (De Carvalho *et al.*, 2017). Educating patients about low GI diets and substituting high GI foods with lower GI alternatives can improve glycemic control, by lowering the quantity of carbohydrate in the diet and improving post prandial glucose response (Vlachos *et al.*, 2020). It is recommended to focus on overall diet quality and nutrient-rich foods, along with a reduction in caloric intake for overweight and obese individuals. Various dietary patterns have been studied, but their success depends on patient adherence and long-term sustainability (Petroni *et al.*, 2021).

One of the limitations of this study is the small sample size ($n=100$), which may limit the generalizability of the findings to the broader population. Although the sample size was determined based on feasibility and convenience, future research with a larger and more diverse sample is recommended. The study focused solely on lunch meals and did not assess other meals throughout the day, potentially limiting the generalizability of the findings to overall dietary patterns. The study provides limited information on potential confounding variables, which may influence glycemic control as demonstrated in other studies. Despite these limitations, the study conducted a detailed analysis of the collected meals, which allows for a thorough understanding of the nutritional components and their potential impact on blood sugar control. The study's focus on the context of India, where the prevalence of diabetes and prediabetes is increasing, makes the findings particularly relevant and applicable to the local population. This highlights the importance of managing the glycemic load of meals through dietary

interventions and improve diabetes outcomes by implementing effective public health strategies in India.

CONCLUSION

The study's findings revealed that the meals consumed by men and women living with diabetes were characterised by high glycemic index, glycemic load, good amount of digestible starch, fibre and low resistant starch content. There was a significant negative correlation between protein, ash, crude fibre, fat, fibre, *in vitro* starch digestion rate and the GL of the meals. Additionally, a significant association was observed between higher carbohydrate content in the meals and higher GL. The optimization of low glycemic meals hold significance in the management of diabetes. The study offers a scientific approach for the patients living with diabetes, recommending the inclusion of high protein and high fibre foods while restricting high carbohydrate foods in their meals. This approach can result in lower GI of their meals. The modern diet, characterized by highly processed, calorie-dense foods lacking essential nutrients, coupled with a sedentary lifestyle and abdominal obesity, leads to excessive post-meal spikes in glucose levels. Conversely, adopting a diet rich in minimally processed, high-fibre, plant-based foods such as low GI vegetables and fruits, whole grains, legumes, and nuts, has a significant impact on attenuating the post-meal glucose surge. Accordingly, to reduce their blood sugar levels, there is need to modify and standardise the meals of patients living with diabetes.

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REFERENCES

- [IDF] The International Diabetes Federation. 2021. Diabetes Atlas 11th Edition. Diabetes facts and figures [online], Available from: <https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html>. [Accessed 13 May 2023].
- [WHO] World Health Organization. 2023. Diabetes in India [online], Available from: <https://www.who.int/india/health-topics/mobile-technology-for-preventing-ncds#:~:text=In%20India%2C%20there%20are%20estimated,developing%20diabetes%20in%20near%20future>. [Accessed 13 May 2023].
- Agostoni, C.; J-L. Bresson; S. Fairweather-Tait. 2011. EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA). *EFSA Journal*, 9: 2024.
- AOAC. 2000. Official Methods of Analysis. 13th ed. Washington, DC: Association of Official Analytical Chemists.
- Asp, N.G.; C.G. Johnos; H. Hollmer and M. Siljestrom. 1983. Rapid enzymatic assay of dietary fibre. *Journal of Agricultural and Food Chemistry*, 31(3): 476-482.
- Barine, D.K. and G.S. Yorte. 2016. *In vitro* starch hydrolysis and prediction of glycemic index (PGI) in “Amala” and plantain-based baked products. *Journal of Food Research*, 5(2): 73-80.
- Beasley, J.M. and J. Wylie-Rosett. 2013. The role of dietary proteins among persons with diabetes. *Current Atherosclerosis Reports*, 15(9): 348.
- Bird, Y.; M. Lemstra; M. Rogers and J. Moraros. 2015. The relationship between socioeconomic status/income and prevalence of diabetes and associated conditions: A cross-sectional population-based study in Saskatchewan, Canada. *International Journal for Equity in Health*, 14: 93. doi: 10.1186/s12939-015-0237-0.
- Bradlee, M.L.; J. Mustafa; M.R. Singer and L.L. Moore. 2017. High-protein foods and physical activity protect against age-related muscle loss and functional decline. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 73(1): 88-94.
- Bradley, R.B.H. 2018. Dietary Fat and Risk for Type 2 Diabetes: A Review of Recent Research. *Current Nutrition Reports*, 7(4): 214-226. doi: 10.1007/s13668-018-0244-z.
- Butterworth, P.J.; B.H. Bajka; C.H. Edwards; F.J. Warren and P.R. Ellis. 2022. Enzyme kinetic approach for mechanistic insight and predictions of in vivo starch digestibility and the glycaemic index of foods. *Trends in Food Science and Technology*, 120: 254-264. doi: 10.1016/j.tifs.2021.11.015.
- Chen, L.; R. Liu; C. Qin; Y. Meng; J. Zhang; Y. Wang and G. Xu. 2010. Sources and intake of resistant starch in the Chinese diet. *Asia Pacific Journal of Clinical Nutrition*, 19(2): 274-282.
- Davis, R.; M.P. Bonham; K. Nguo and C.E. Huggins. 2020. Glycaemic response at night is improved after eating a high protein meal compared with a standard meal: A cross-over study. *Clinical Nutrition*, 39(5): 1510-1516.
- De Carvalho, C.M.; T.P. de Paula; L.V. Viana; V.M. Machado; J.C. de Almeida and M.J. Azevedo. 2017. Plasma glucose and insulin responses after consumption of breakfasts with different sources of soluble fibre in type 2 diabetes patients: a randomized crossover clinical trial. *The American Journal of Clinical Nutrition*, 106(5): 1238-1245.
- Dereje, N.; G. Bekele; Y. Nigatu; Y. Worku and R.P. Holland. 2019. Glycemic Index and Load of Selected Ethiopian Foods: An Experimental Study. *Journal of Diabetes Research*, 2019: 8564879.
- Dhingra, D.; M. Michael; H. Rajput and R.T. Patil. 2012. Dietary fibre in foods: a review. *Journal of Food Science and Technology*, 49(3): 255-266.
- Eberhardt, M.S.; S.S. Casagrande and C.C. Cowie. 2018. Sociodemographic Characteristics of Persons with Diabetes. In: Cowie CC, Casagrande SS, Menke A, Cissell MA, Eberhardt MS, Meigs JB, Gregg EW, Knowler WC, Barrett-Connor E, Becker DJ, Brancati FL, Boyko EJ, Herman WH, Howard BV, Narayan KMV, Rewers M, Fradkin JE, editors. Diabetes in America. 3rd ed. Bethesda (MD): National Institute of Diabetes and Digestive and Kidney Diseases (US). Chapter 8. PMID: 33651553.
- Eleazu, C.O. 2016. The concept of low glycemic index and glycemic load foods as panacea for type 2 diabetes mellitus; prospects, challenges and solutions. *African Health Sciences*, 16(2): 468-479. doi: 10.4314/ahs.v16i2.15.
- Fong, M.; I.D. Caterson and C.D. Madigan. 2017. Are large dinners associated with excess weight, and does eating a smaller dinner achieve greater weight loss? A systematic review and meta-analysis. *British Journal of*

- Nutrition*, 118(8): 616–628. doi: 10.1017/S0007114517002550.
- Galgani, J.; C. Aguirre and E. Díaz. 2006. Acute effect of meal glycemic index and glycemic load on blood glucose and insulin responses in humans. *Nutrition Journal*, 5: 22. doi: 10.1186/1475-2891-5-22.
- Goni, I.; A. Garcia-Alonso and F. Saura-Calixto. 1997. A starch hydrolysis procedure to estimate glycemic index. *Nutrition Research*, 17(3): 427–437.
- Government of Punjab, India. 2023. Regions in Punjab [online], Available from: <http://www.discoveredindia.com/punjab/about-punjab/regions-in-punjab.html>. [Accessed 1 July 2023].
- Goyal, R. and I. Jialal. 2023. Diabetes Mellitus Type 2 [Updated June 19, 2022]. In: StatPearls [online]. Treasure Island (FL): StatPearls Publishing.
- Hellendoorn, E.W.; M.G. Noordhoff and J. Slagman. 1975. Enzymatic determination of the indigestible residue (dietary fibre) content of human food. *Journal of the Science of Food and Agriculture*, 26(10): 1461–1468.
- Henry, C.J.; R.Y.C. Quek; B. Kaur; S. Shyam and H.K.G. Singh. 2021. A glycaemic index compendium of non-western foods. *Nutrition Diabetes*, 11: 2. doi: 10.1038/s41387-020-00145-w.
- IDA. 2018. Position paper of the Indian Dietetic Association: Dietary Fibre and Health. Dec, pp. 1–14.
- Ismail, B.P. 2017. Food Analysis Laboratory Manual. Nielson SS, editor. Cham, Switzerland: Springer; p. 117–119.
- Kamalpour, M.; H. Ghalandari and J. Nasrollahzadeh. 2018. Short-Term Supplementation of a Moderate Carbohydrate Diet with Psyllium Reduces Fasting Plasma Insulin and Tumor Necrosis Factor- α in Patients with Type 2 Diabetes Mellitus. *Journal of Dietary Supplements*, 15(4): 507–515.
- Kaur, S.; K. Bains and H. Kaur. 2017. Malnutrition among school-going children in the perspective of regional and socioeconomic disparity in Punjab [Ph.D. dissertation]. Ludhiana: Punjab Agricultural University.
- Kim, H.K.; T. Nanba; M. Ozaki; H. Chijiki; M. Takahashi; M. Fukazawa; J. Okubo and S. Shibata. 2020. Effect of the Intake of a Snack Containing Dietary Fibre on Postprandial Glucose Levels. *Foods*, 9(10): 1500.
- Lehmann, U. and F. Robin. 2007. Slowly digestible starch - its structure and health implications: a review. *Trends in Food Science and Technology*, 18(7): 346–355.
- Liu AG, Most MM, Brashear MM, Johnson WD, Cefalu WT, Greenway FL. 2012. Reducing the glycemic index or carbohydrate content of mixed meals reduces postprandial glycemia and insulinemia over the entire day but does not affect satiety. *Diabetes Care*, 35(8): 1633–1637.
- Lobos, D.R.; I.A. Vicuña; V. Novik and C.A. Vega. 2017. Effect of high and low glycemic index breakfast on postprandial metabolic parameters and satiety in subjects with type 2 diabetes mellitus under intensive insulin therapy: Controlled clinical trial. *Clinical Nutrition ESPEN*, 20: 12–16.
- Lonnie, M.; E. Hooker; J.M. Brunstrom; B.M. Corfe; M.A. Green; A.W. Watson; E.A. Williams; E.J. Stevenson; S. Penson and A.M. Johnstone. 2018. Protein for life: Review of optimal protein intake, sustainable dietary sources and the effect on appetite in ageing adults. *Nutrients*, 10(3): 360.
- Meng, H.; N.R. Matthan; L.M. Ausman and A.H. Lichtenstein. 2017. Effect of prior meal macronutrient composition on postprandial glycemic responses and glycemic index and glycemic load value determinations. *The American Journal of Clinical Nutrition*, 106(5): 1246–1256.
- Mitrou, P.N.; V. Kipnis; A.C. Thiebaut; J. Reedy; A.F. Subar; E. Wirfält; A. Flood; T. Mouw; A.R. Hollenbeck; M.F. Leitzmann and A. Schatzkin. 2007. Mediterranean dietary pattern and prediction of all-cause mortality in a US population: results from the NIH-AARP Diet and Health Study. *International Archives of Internal Medicine*, 167(22): 2461–2468.
- Moongngarm, A. 2013. Chemical Compositions and Resistant Starch Content in Starchy Foods. *American Journal of Agricultural and Biological Sciences*, 8(2): 107–113.
- Mourao, D.M.; J. Bressan; W.W. Campbell and R.D. Mattes. 2007. Effects of food form on appetite and energy intake in lean and obese young adults. *International Journal of Obesity (Lond)*, 31(11): 1688–1695.
- Murphy, M.M.; J.S. Douglass and A. Birkett. 2008. Resistant Starch Intakes in the United States. *Journal of the Academy of Nutrition and Dietetics*, 108(1): 67–78.
- National Census. 2011. Punjab Population [online], Available from: <https://www.census2011.co.in/census/state/punjab.html>. [Accessed 10 June 2023].
- Neuenschwander, M.; J. Barbaresko; C.R. Pischke; N. Iser; J. Beckhaus; L. Schwingshackl and S. Schlesinger. 2020. Intake of dietary fats and fatty acids and the incidence of type 2 diabetes: A systematic review and dose-response meta-analysis of prospective observational studies. *PLoS Medicine*, 17(12): e1003347.
- NMKL. 1958. Analytical determination by weight in tomato puré. Denmark: Solids; 28.
- O’Keefe, J.H.; N.M. Gheewala and J.O. O’Keefe. 2008. Dietary Strategies for Improving Post-Prandial Glucose, Lipids, Inflammation, and Cardiovascular

- Health. *Journal of the American College of Cardiology*, 51(3): 249–255.
- Omage, K. and S.O. Omage. 2018. Evaluation of the glycemic indices of three commonly eaten mixed meals in Okada, Edo State. *Food Science & Nutrition*, 6(1): 220–228.
- Perla, M.C.; F.S. Pamela and B.P. Luis. 2017. Starch structure influences its digestibility: A review. *Journal of Food Science*, 82(9): 2016–2023.
- Petroni, M.L.; L. Brodosi; F. Marchignoli; A.S. Sasdelli; P. Caraceni; G. Marchesini and F. Ravaioli. 2021. Nutrition in Patients with Type 2 Diabetes: Present Knowledge and Remaining Challenges. *Nutrients*, 13(8): 2748. doi: 10.3390/nu13082748.
- Pugh, J.E.; M. Cai; N. Altieri and G. Frost. 2023. A Comparison of the Effects of Resistant Starch Types on Glycemic Response in Individuals with Type 2 Diabetes or Prediabetes: A Systematic Review and Meta-Analysis. *Frontiers in Nutrition*, 10: 1118229.
- Reshmi, S.K.; M.L. Sudha and M.N. Shashirekha. 2017. Starch digestibility and glycemic index of Paranthas supplemented with *Citrus maxima* (Burm.) Merr. fruit segments. *Journal of Food Science and Technology*, 54(13): 4370–4377. doi: 10.1007/s13197-017-2909-9.
- Reynolds, A.; J. Mann; J. Cummings; N. Winter; E. Mete and L. Te Morenga. 2019. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. *Lancet*, 393(10170): 434–445. doi: 10.1016/S0140-6736(18)31809-9.
- Sharavathy, M.K.; A. Urooj and P. Shashikala. 2001. Nutritionally important starch fractions in cereal-based Indian food preparations. *Food Chemistry*, 75(2): 241–247.
- Singh, K. 2017. In-vitro starch digestibility and predicted GI of bread - effect of baking and storage [undergraduate thesis]. Linnaeus University.
- Takahashi, M.; M. Ozaki; M.I. Kang; H. Sasaki; M. Fukazawa; T. Iwakami; P.J. Lim; H.K. Kim; S. Aoyama and S. Shibata. 2018. Effects of Meal Timing on Postprandial Glucose Metabolism and Blood Metabolites in Healthy Adults. *Nutrients*, 10(11): 1763.
- Thakur, J.S. and R. Nangia. 2022. Prevalence, Awareness, Treatment, and Control of Hypertension and Diabetes: Results from Two State-Wide STEPS Survey in Punjab and Haryana, India. *Frontiers in Public Health*, 10: 768471. doi: 10.3389/fpubh.2022.768471.
- The InterAct Consortium. 2015. Dietary fibre and incidence of type 2 diabetes in eight European countries: the EPIC-InterAct Study and a meta-analysis of prospective studies. *Diabetologia*, 58(7): 1394–1408.
- Tieken, S.M.; H.J. Leidy; A.J. Stull; R.D. Mattes; R.A. Schuster and W.W. Campbell. 2007. Effects of solid versus liquid meal-replacement products of similar energy content on hunger, satiety, and appetite-regulating hormones in older adults. *Hormone and Metabolic Research*, 39(5): 389–394.
- Vetrani, C.; I. Calabrese; L. Cavagnuolo; D. Pacella; E. Napolano; S.D. Rienzo; G. Riccardi; A.A. Rivellesse; G. Annuzzi and L. Buzzetto. 2022. Dietary determinants of postprandial blood glucose control in adults with type 1 diabetes on a hybrid closed-loop system. *Diabetologia*, 65(1): 79–87. doi: 10.1007/s00125-021-05587-0.
- Vlachos, D.; S. Malisova; F.A. Lindberg and G. Karaniki. 2020. Glycemic Index (GI) or Glycemic Load (GL) and Dietary Interventions for Optimizing Postprandial Hyperglycemia in Patients with T2 Diabetes: A Review. *Nutrients*, 12(6): 1561. doi: 10.3390/nu12061561.
- Wolfe, R.R. 2012. The role of dietary protein in optimizing muscle mass, function and health outcomes in older individuals. *British Journal of Nutrition*, 108(Suppl): S88–S93.
- Yaman, M.; H.S. Sargin and O.F. Mizrak. 2019. Free sugar content, *in vitro* starch digestibility and predicted glycemic index of ready-to-eat breakfast cereals commonly consumed in Turkey: An evaluation of nutritional quality. *International Journal of Biological Macromolecules*, 135(15): 1082–1087. doi: 10.1016/j.ijbiomac.2019.06.037.
- Yu, Z.; N. Fengwei; L.Y. Wang; H. Jiang; W. Chen and Y. Jiang. 2020. Effects of high-protein diet on glycemic control, insulin resistance and blood pressure in type 2 diabetes: A systematic review and meta-analysis of randomized controlled trials. *Clinical Nutrition*, 39(6): 1724–1734.
- Zhao, W.T.; Y. Luo; Y. Zhang; Y. Zhou and T.T. Zhao. 2018. High protein diet is of benefit for patients with type 2 diabetes: An updated meta-analysis. *Medicine (Baltimore)*, 97(50): e13149.



Research Article

Construction and Validation of Knowledge Test regarding Scientific Backyard Poultry Farming: A Methodological Approach

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ABSTRACT

Backyard poultry farming is a low input based enterprise for resource poor farmer. Backyard poultry farming with improved breeds of poultry is gaining popularity as a potential tool to eradicate malnutrition and provides subsidiary income in rural and tribal areas. Many of the institute provides training to the farmers and youth regarding poultry farming but they lack standardised tool to measure their knowledge level in this aspect. Thus, an attempt has been made to develop a knowledge test regarding scientific backyard poultry farming. The standardised knowledge test has 24 items. The Spearman Brown formula (0.885) and Cronbach's alpha (0.846) were used to measure the test's reliability. The overall test content validity index was 0.91. The test's reliability and validity are indicators of its consistency and precision in the results. The developed test will help in assessing the knowledge level of farmers and youth regarding scientific backyard poultry farming.

Keywords: Backyard poultry farming, Knowledge test, Reliability, Validity, Farmers and youth

INTRODUCTION

India is one of the most vulnerable countries to climate change (FAO, 2002) and is also considered as one of the most drought-prone countries in the world (Shetty *et al.*, 2013). Climate change has aggravated the problems of small and marginal farmers due to their high dependence on cultivable lands. Recently, frequent occurrence of drought in agriculture making it risky sector and those who are solely dependent on it become highly vulnerable group. Further increasing population, shrinking natural resource per capita had deteriorated their conditions. Overall this situation has forced migration of rural youth in search of livelihood options in urban areas. The changing climate scenario which increases the chances of crop failure; in such situation backyard poultry farming is feasible option for resource poor farmers to sustain their livelihood under changing climate scenario as these animals require

a smaller investment compared to larger livestock viz. cattle and buffalo and with their short breeding cycle, a quicker return on investment is ensured. Further, these enterprises not only stabilise farm income but also provide nutritional security. Apart from this they can enrich their arable lands with poultry manure to boost farm production and that will strengthen the socio-economic stability of the farmers.

India's egg and meat production is ranked third and eighth in the world, according to the Economic Survey 2021-22. In 2019, there were 851.81 million poultry in the country, which is an increase of 16.8 per cent from the previous Census. In 2019, there were 317.07 million backyard poultry in the country, an increase of 45.8 per cent over the previous census (Livestock Census, 2020). Backyard poultry farming with improved breeds of poultry is gaining popularity as a potential tool to eradicate malnutrition and

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provides subsidiary income in rural and tribal areas across the country (Kumar *et al.*, 2013). Backyard poultry is a low input enterprise and it mainly depends on scavenging on the natural feed base with little supplementary feeding, night shelter, and minimum health care practices (Rajkumar *et al.*, 2021). There are numerous native poultry breeds in India, including Kadak Nath, Aseel, Nicobari, Danki, Tellicherry, Haringhata Black, etc., that are still popular in rural and tribal areas for backyard poultry farming. In India, each person consumes just 3.5 kilos of meat and 30 eggs whereas the ICMR recommended consuming 10.5 kilos of poultry meat and 180 eggs per annum to meet nutritional security. This requirement of the resource poor farmers can be easily met by rearing improved breed of chickens through backyard poultry farming. Also, the poultry farming gives faster return from the investment. Therefore, Backyard poultry farming can be a good intervention for alleviation of poverty, eradication of malnutrition and creation of gainful employment in rural and tribal areas across the country. Hence, it is important to measure the knowledge level of farmers regarding scientific backyard poultry farming and formulate the strategy to bridge this knowledge gap in order to generate new source of income among farmers especially tribal. Till date no instrument is available to measure the knowledge of farmer regarding scientific backyard poultry farming. Therefore, the knowledge test has been developed regarding scientific backyard poultry farming which would help in assessing the knowledge level of farmers regarding the scientific backyard poultry farming practices. Also, this test will be helpful to researcher, veterinarians, extension agent, progressive farmers etc. to measure the knowledge level of farmers towards scientific backyard poultry farming.

MATERIALS AND METHODS

For the present study, the construct was knowledge of tribal farmers regarding scientific backyard poultry farming. A thorough review of literature was carried out to identify the items responsible for scientific backyard poultry farming under major dimension of feeding, brooding, housing and bio-security and disease control management practices. Apart from literature reviewed, the discussion was carried out with the scientists and experts of ICAR-Central Avian Research Institute (CARI) and ICAR- Indian Veterinary Research

Institute regarding item selection and editing. The 41 items were compiled and edited based on 14 informal criteria recommended by Edwards (1957).

Finally the 41 statements on a five point continuum viz., Most relevant, Somewhat relevant, Relevant, Least relevant and Not relevant with the score of 5,4,3, 2 and 1, respectively and reverse for the negative statements were mainly sent by Google form survey and some were handed over personally to the total of 35 judges. The experts were from ICAR-Central Avian Research Institute (CARI) and ICAR- Indian Veterinary Research Institute. The judges were asked to make any necessary changes and add or delete items as needed. A total of 25 responses were obtained in time out of 35. The Relevance Weightage (RW) and Mean Relevance Score (MRS) were calculated for all the selected indicators. For item analysis, statements were chosen that had relevancy weightages of over 0.80 and mean relevancy scores of 4.00 or more. As a result, a total of 32 statements selected for the item analysis. The similar method was used for relevancy testing by Singh *et al.* (2018) and Shruti *et al.* (2022).

RESULTS AND DISCUSSION

Item analysis was carried out in order to evaluate the item characteristics of each item of the Knowledge Test. For item analysis, researcher interacted with 36 farmers who were engaged in poultry farming as a source of their livelihood from *Nisoi, Atarchedi and Sadullaganj* villages of Majhgawan Block, Bareilly, Uttar Pradesh. The responses were tabulated and then the item difficulty index and item discrimination value were calculated.

The difficulty index was calculated with the objective to drop the items that are extremely easy or extremely difficult. The item difficulty index was calculated as a percentage of the total number of correct responses to the test items. It was calculated using the formula $p = R/T$,

Where, p - item difficulty index,

R - number of correct responses, and

T - total number of responses (which includes both correct and incorrect responses).

The value of p (proportion) ranges from 0 to 1 (Hotiu, 2006). When multiplied by 100, p -value converts

to a percentage, which is the percentage of farmers who got the item correct. Those items with a p-value between 20 and 90 per cent are considered as good and acceptable. Among these, items with p-value between 40 and 60 per cent are considered excellent, because DI is maximum at this range. The higher the p-value, the easier the items. Whereas, items with p-value (difficulty index) less than 20 per cent (too difficult) and more than 90 per cent (too easy) are not acceptable and need modification.

In this study from Table 1 it can be divulged that 24 items were falling in good (20-90%) category out of which 4 items belongs to excellent (40-80%) category. However, 8 items were very difficult (< 20%) and none of the item was found too easy (> 90%) to answer. Therefore, 8 items were eliminated and 24 items were retained based on difficulty index. Among the selected items (32) after relevancy test, the item no. 5, 8 and 9 were eliminated as farmers lack information regarding size of shed. Further, item no 15, 17 and 23 were eliminated as farmers found difficult to answer question related to temperature of brooder house, concentrate ration and calcium source. Thus, 75.00 per cent of items were falling in good category and 25.00 per cent were too difficult to answer.

Table 1: Frequency and mean of difficulty index

Difficulty index	Category	No. of items	Mean
20 to 90%	Good	24	75.00
40 to 60%	Excellent	4	12.50
<20%	Too difficult	8	25
>90%	Too easy	0	0

The calculation was used to assess the ability of each item to distinguish between those who scored high on the total test score and those who scored low. The higher the Discrimination index (DI) the better the test item discriminates between the farmers with higher test scores and those with lower test scores.

The DI was calculated using the formula $DI = (UGHLG)/N$

Where, UG is the number of farmers in the upper group who got an item correct and

LG is the number of farmers in the lower group who got an item correct and

N is the total number of farmers in the largest of the two groups.

The categories of discriminating indices (Ebel's, 1979):

1. If $DI \geq 0.40$, then the item is functioning satisfactorily.
2. If $0.30 \leq DI \leq 0.39$, then little or no revision is required.
3. If $0.20 \leq DI \leq 0.29$, then the item is marginal and needs revision.
4. If $DI \leq 0.19$, then the item should be eliminated or completely revised.

In the present study from Table 2, 21 items were falling in good (>.40) whereas 3 statements i.e. item no 13, 18 and 25 were falling in little revision category (.30<= to <=.39); thus, these statements with little revision were retained. However, two items i.e. item no. 5 and 9 were eliminated due to marginal discrimination index whereas 6 items i.e. item no. 15, 17, 23, 29, and 32 were eliminated due to lowest discrimination index of below 0.19.

Table 2: Mean and frequency of discrimination indices

Discrimination index	Category	No. of items	Mean
>.40	Good	21	65.63
.30<= to <=.39	Little revision	3	9.37
.20<_ to <_.29	Marginal	2	6.25
<=.19	Eliminate	6	18.75

Table 3, it can be divulged that the item number 5, 8, 9, 15, 17, 23, 29 and 32 were eliminated. Thus, the final knowledge test consists of 24 items for assessing the knowledge regarding scientific backyard poultry farming.

The standardization of the present test involved reliability and validity testing, which was determined using the split-half method and cronbach's alpha and content validity, respectively.

The testing instrument's reliability is defined as the degree to which it produces stable and consistent results. It will help in assessing the homogeneity of test items. The test was administered to a new group of 40 farmers to test its reliability. Using the split-half method, the reliability of the present test was calculated by dividing

Table 3: Developed knowledge test regarding scientific backyard poultry farming

Items	Difficulty index	Discrimination Index	Remarks
Do you know that a bird requires an average area of 1 sq ft?	0.28	0.83	Retained
Do you know that overcrowding of birds is harmful and should be avoided?	0.75	0.75	Retained
Are you aware of construction of shed should be on well raised platform to avoid water logging?	0.72	0.83	Retained
Do you know that the orientation of shed should be in east-west direction?	0.89	0.50	Retained
Are you aware that the shed in the center is 12 feet tall?	0.17	0.25	Eliminated
Do you know poultry shed should be well ventilated & have proper sunlight exposure?	0.86	0.42	Retained
Do you know floor should be elevated from ground at minimum 2 ft level?	0.44	0.50	Retained
Are you aware that width of shed should not be wider than 32-34 feet?	0.14	0.42	Eliminated
Do you keep the thickness of litter 5 cm in shed?	0.08	0.25	Eliminated
Do you know that proper care should be given to chicks in first week of brooding?	0.75	0.75	Retained
Do you use electric bulb for artificial brooding?	0.25	0.75	Retained
Do you know brooder guard should be kept for minimum period of 7-10 days?	0.81	0.58	Retained
Do you know chicks crowded at heat source in brooder indicate low temperature?	0.89	0.33	Retained
Do you know chicks staying away from the heat source in brooder indicate high temperature?	0.72	0.83	Retained
Do you know the brooder house temperature should be 37°C in first week?	0.06	0.17	Eliminated
Do you provide balance feed in early period of growth of chicks?	0.81	0.58	Retained
Do you know for better performance of backyard poultry, we can give extra concentrate ration @ 30-50g/day/chick?	0.02	0.08	Eliminated
Do you provide ingredients such as maize, soybean, groundnut oil, rice polish, fish meal etc.?	0.89	0.33	Retained
Do you regularly clean the feeder and waterer?	0.72	0.83	Retained
Do you provide supplements such as salt, minerals & vitamins etc. to birds?	0.72	0.83	Retained
Do you know that ready-made feed are available in the market for poultry?	0.72	0.83	Retained
Do you know chickens typically consume twice as much water as feed?	0.75	0.58	Retained
Do you know calcium source like limestone powder, DCP, stone grit shell grit is required after 5-6 week of age?	0.50	0.17	Eliminated
Do you know poultry needs special health and management care during initial 6 week of age?	0.25	0.75	Retained
Do you know about important poultry diseases like Marek's disease, Ranikhet disease, Infectious bursal disease, Fowl pox?	0.89	0.33	Retained
Do you know about vaccination schedule of poultry?	0.42	1.00	Retained
Do you provide deworming at 3-4 month interval regularly?	0.36	1.00	Retained
Do you know wet litter is potential source of disease transmission?	0.22	0.67	Retained
Do you know rodent's, lice, mite can also transmit the diseases?	0.06	0.17	Eliminated
Do you clean shed regularly to prevent fungal and microbial infection?	0.75	0.75	Retained
Do you know the safe methods of disposal of dead birds are burial or incineration?	0.42	0.58	Retained
Do you follow the practice of beak trimming at 3 rd week of age to prevent cannibalism among birds?	0.06	0.17	Eliminated

it into two halves based on the even and odd number of statements. The Pearson product moment correlation between odd and even scores was 0.794. The split-half reliability of the test is indicated by this coefficient. To adjust the split half reliability in to full test reliability, Spearman- Brown (1910) prophecy formula was used which is as follows;

$$R = \frac{2r}{1+r} = \frac{2 \times 0.794}{(1+0.794)} = 0.885$$

Where, R= The reliability coefficient for the entire test.
r = The Pearson correlation estimated between two halves

The overall test reliability was found to be 0.885, which is significant at the 1% level of significance. The test's reliability coefficient is over 0.7, making it highly reliable. The split-half method is widely used to evaluate reliability of test mainly due to the advantage of single administration of the test and use of one sample. Split-half method is limited by the fact that there are multiple ways to split a test, and each method of splitting-half has a different level of reliability. Rudner *et al.* (2002) found that split-half reliability is a function of how the test was split. A solution to the problem was provided by Cronbach's alpha which is interpreted by many researchers as the average of all possible split-half correlations (Cortina, 1993). Cronbach's alpha is based on the assumption that average covariance among non- parallel items is equal to the average covariance among all parallel items. To achieve more stability and accuracy, standard Cronbach's alpha was utilized in this study with the following formula:

$$\alpha_{\text{standardized}} = \frac{K\bar{r}}{(1 + (K - 1)\bar{r})}$$

Where K is number of items in test

$\bar{r}$ is mean of the $K(K-1)/2$ non-redundant correlation coefficients

The test's measurement was consistent as Cronbach's alpha was calculated to be 0.846. A commonly accepted rule for describing internal consistency using Cronbach's alpha (Table 4).

Validity is the capability of an instrument to measure what it is meant to measure. The developed test was checked for its content validity. According to Kerlinger (1987) content validity of test is the representative or

Table 4: Depicting the internal consistency using Cronbach's alpha (DeVellis, 2012)

Cronbach's alpha	Internal Consistency
$0.9 \leq \alpha$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

sampling adequacy of the content, the substance, the matter and the topics of a measuring instrument. The degree of experts' agreement with the content relevancy of a test can be quantified using various methods. The paper considered the most acceptable method as suggested by Lynns' in 1986. For quantifying the content validity, the 24 selected statements ('t' value >1.75) were given to 6 experts. The 6 experts were selected as with increase in number of experts the likelihood of achieving total agreement decreases. The 4-point scale was used to avoid a neutral and ambivalent midpoint as per Davis (1992) 1= not relevant, 2 = somewhat relevant, 3= quite relevant and 4= highly relevant. Then for each selected statements Content Validity Index i.e. I-CVI calculated to check its relevance to the underlying construct. Then for calculation of Content Validity Index for entire test S-CVI was worked out. The S-CVI/Ave which means the average of the I-CVIs for all the items of the test calculated to be 0.91.

The final knowledge test comprised of 24 items that would measure the knowledge level of farmers with respect to scientific backyard poultry farming. The test can be administered in dichotomous form viz., Yes or No. The score given by each respondent on their level of knowledge of scientific backyard poultry farming ranges between 0-24.

CONCLUSION

During the project's data collection and field visits, it was found that farmers were lacking information about scientific backyard poultry farming. Therefore, an effort has been undertaken to develop a knowledge test for scientific backyard poultry farming. The developed knowledge test will help in assessing the knowledge level of farmers and rural youth regarding scientific backyard poultry farming. The reliability and

validity value of the developed test demonstrated the precision and consistency of the results. The knowledge gap among farmers/ rural youth can be addressed by this knowledge test by providing them with the proper information on scientific backyard poultry farming through trainings. The increased knowledge level can help them to generate new source of income through scientific backyard poultry farming.

REFERENCES

- Cortina, J.M. 1993. What is Coefficient Alpha: An Examination of Theory and Applications. *Journal of Applied Psychology*, 78(1): 98-104.
- Davis, L.L. 1992. Instrument review: Getting the most from your panel of experts. *Applied Nursing Research*, 5: 194–197.
- Ebel, R.L. 1979. Essentials of educational measurement (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.
- Edward, A.L. 1957. Techniques of Attitude Scale Construction. Vakils, Feffer and Simons Inc, New York.
- FAO. 2002. Report of FAO-CRIDA Expert Group Consultation on Farming System and Best Practices for Drought-prone Areas of Asia and the Pacific Region. Food and Agricultural Organisation of United Nations. Published by Central Research Institute for Dryland Agriculture, Hyderabad, India.
- Hotiu, A. 2006. The relationship between item difficulty and discrimination indices in multiple-choice tests in a Physical science course (MSc thesis). Florida Atlantic University, Boca Raton, FL. Retrieved June 14, 2015 from www.physics.fau.edu/research/education/A.Hotiu_thesis.pdf
- Kumar, B.; R.K. Avasthe; R. Singh and P. Pal. 2014. Scientific backyard poultry farming: A potent tool for socioeconomic stability and nutritional security in Sikkim Himalayan. *Research Journal of Animal Husbandry and Dairy Science*, 5(1): 30-34.
- Livestock Census. 2020. DADF, DADF, Ministry of Fisheries, Animal Husbandry & Dairying, GoI.
- Lynn, M.R. 1986. Determination and quantification of content validity, *Nursing Research*, 35: 382–385
- Rajkumar, U.; S.V. Rama Rao; M.V.L.N. Raju and R.N. Chatterjee. 2021. Backyard poultry farming for sustained production and enhanced nutritional and livelihood security with special reference to India: a review. *Tropical Animal Health and Production*, 53(1): 1-13.
- Rudner, L.M. and W. Schafes. 2002. Reliability: ERIC Digest. www.ericdigests.org/2002-2/reliability/htm
- Shetty, P.K.; S. Ayyappan and M.S. Swaminathan. 2013. Climate Change and Sustainable Food Security. Published by the National Institute of Advanced Studies, Bangalore and Indian Council of Agricultural Research, New Delhi.
- Shruti, M. Singh; B.P. Singh; T.S. Shyamkumar; V.A. Aneesh; A.G. Telang and U.K. Dey. 2022. Construction and validation of knowledge test regarding plant toxicity in dairy animals: A methodological approach. *Journal of Community Mobilization and Sustainable Development*, 17(2): 507-51.
- Singh, M.; B.K.; Singh; P. Singh and R.R. Burman. 2018. Development of Scale to Measure Attitude of Farmers towards IARI-Voluntary Organizations Partnership Extension Model: A Methodological Approach. *Journal of Community Mobilization and Sustainable Development*, 13(2): 221-226.

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Research Article

Strengthening the Capacity of Women Farmers for Accessing to Agri-Resources in Rice Farming

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ABSTRACT

An action research was undertaken in Sankilo village of Cuttack district to empower women farmers and sensitize relevant decision-makers to women's special needs so that they can gain better access to support services and input markets. Socio-economic and technological empowerment of farmwomen largely depends on ability to arrange farm inputs and make decisions to use the farm inputs in rice farming viz., land, money, seeds, fertilizers, pesticides, machines etc. Accordingly, suitable technological and institutional interventions were provided and evaluated. Demonstrations on suitable rice production technologies were conducted with women perspective. The study clearly depicted that the participation level of farm women was high in training programmes followed by demonstrations, and meetings with experts. Regarding, accessibility, it was found that 100 % of farmwomen are fully accessed to land, seeds, fertilizer, and water. Similarly, among the women-friendly farm machineries demonstrated, rice husk combustor, finger weeder and 4-row manual drum seeder were perceived as more appropriate by 85.71%, 70.37% and 57.14% farm women respectively.

Keywords: Gender issues, Role analysis, Women participation in rice farming

INTRODUCTION

Rice production and processing comprise a major source of livelihood of millions of farming communities in India. In India, farmwomen perform up to 80 per cent of the work in rice fields and are involved in almost all activities of rice farming. However, they are often marginalized in business relations and have minimal control over access to factors of production like land, inputs such as seed and fertilizer, credit and technology. So the question remains how to empower women when the available statistics speak volume of the poor condition of women farmers worldwide. Agriculture in India, and especially in Odisha, is characterized by its dependence on small-scale farming, labour-intensive practices, and a significant role played by women. Odisha, being a major rice-producing state, relies heavily on rice

farming, which is the backbone of the agricultural economy and a key component of food security. Women contribute immensely to agricultural activities, from sowing and transplanting to harvesting and post-harvest processing (Das *et al.*, 2021; Singh and Vinay, 2013). Yet, despite their significant contribution to agriculture, women farmers face multiple socio-economic barriers that limit their access to essential agri-resources, including land, credit, training, and technology. This restricted access hinders their productivity and perpetuates inequalities within the sector, impacting the potential growth and resilience of rural agricultural communities. Strengthening the capacity of women farmers is, therefore, essential to bridging gender gaps in agriculture, enhancing food security, and promoting socio-economic development. In Odisha, agriculture accounts for about 30 per cent

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of the state's GDP, and the majority of the state's farmers rely on rice as a primary crop (Odisha Agriculture Department, 2021). Women's involvement in rice farming in Odisha is substantial, as they carry out nearly 60–70 per cent of the labour in rice cultivation (Nayak, 2016). However, women in agriculture often work under informal arrangements and typically lack ownership over the land they cultivate, excluding them from decision-making processes and limiting their access to resources like credit, training, and modern agricultural technology. The labour-intensive tasks in rice cultivation are not only time-consuming but also physically demanding, impacting their health and well-being. Furthermore, women often balance agricultural labour with household responsibilities, which adds to their workload and creates additional constraints on their productivity. (Das *et al.*, 2014; 2021). Recognizing and addressing these gendered roles in rice farming is crucial for the development of policies and initiatives that cater to the specific needs of women farmers. Several barriers prevent women farmers in Odisha from accessing vital agri-resources. According to the National Sample Survey Office (NSSO), only 12 per cent of agricultural landholders in India are women, leaving most women farmers without the collateral needed to access loans or credit. This lack of access to finance limits their ability to purchase quality inputs, such as seeds and fertilizers, or invest in modern tools that could enhance productivity (NSSO, 2019).

Furthermore, the absence of gender-responsive policies and the limited representation of women in agricultural institutions exacerbate these challenges, leaving women farmers isolated from vital support networks (Doss, 2018). Empowering women farmers by enhancing their access to agri-resources has transformative potential. (Das *et al.*, 2008). Research indicates that if women had the same access to productive resources as men, they could increase farm yields by 20–30 per cent, which could lift approximately 100–150 million people out of hunger globally (FAO, 2011). In rice farming, where women play a prominent role, increased access to resources could significantly boost yields and improve household food security. Women's economic empowerment in agriculture also has positive ripple effects; for instance, when women control additional income, they tend to spend more on household welfare, including food,

education, and healthcare, which leads to healthier and more educated families (Quisumbing *et al.*, 2014; IFPRI, 2015).

Strengthening the capacity of women farmers is not only a matter of social justice but also a pathway toward agricultural productivity, food security, and sustainable development. By addressing the barriers that limit women's access to agri-resources and implementing gender-sensitive policies, governments, NGOs, and the private sector can empower women to realize their potential in agriculture. Investing in women farmers, particularly in rice farming, can yield significant benefits for households, communities, and economies at large, creating a more equitable and resilient agricultural sector.

MATERIALS AND METHODS

The study was conducted in Sankilo village under Nischintakoili block of Cuttack district. The village spans its geographical area of 107 ha at latitude 20.28 N and longitude 86.41 E. Demonstrations on six improved rice varieties, *viz.*, Satabdi, Naveen, CR Dhan-303, CR Dhan-304, Pooja and Ketakijoha (aromatic) were conducted by thirty adopted farmwomen in half-an-acre area by each during *kharif* season. Apart from varietal demonstrations, method demonstrations on raising of mat-type nursery, seed treatment, line transplanting, 2 & 4-row manual rice transplanters, 4-row drum seeder, finger weeder, split application of balanced fertilizer, need based plant protection measures and safe spaying of pesticides, mechanized and drudgery reducing post-harvest processing technologies like, NRRI mini parboiling unit and rice husk combustor for meeting domestic fuel need from rice husk were also organized and their responses collected. Since, input arrangement and management play an important role for maximization of profit in rice farming, information on those were collected from all the adopted farmwomen in a women perspective.

RESULTS AND DISCUSSIONS

The information on participation, experience with new knowledge and access of farmwomen to inputs in rice farming were analyzed. Six major extension activities were undertaken which included training programmes (7), demonstrations (12), exposure visits (4), village level field visits/field days (12), meeting with experts (8), and monthly group meeting among the

Table 1: Participation of farmwomen in Various Extension Activities (N=30)

S.No.	Project activities	Frequency of activities (f)	Extent of participation			
			Very High Attendance (80-100%)	High Attendance (60-80%)	Moderate Attendance (40-60%)	Poor Attendance (< 40%)*
1.	Training programme	7	25 (83.33)	4 (13.34)	1 (3.33)	0 (0.00)
2.	Meeting with experts	8	22 (73.33)	4 (13.33)	2 (6.67)	2 (6.67)
3.	Demonstration	12	23 (76.66)	2 (6.67)	3 (10.00)	2 (6.67)
4.	Exposure visit	4	6 (20.00)	7 (23.33)	9 (30.00)	8 (26.67)
5.	Field visits/ Field days	12	16 (53.33)	6 (20.00)	4 (13.33)	4 (13.33)
6.	Monthly group meeting among members	12	20 (66.67)	5 (16.66)	3 (10.00)	2 (6.67)

(Figures in the parentheses indicate percentages); (*Nobody was found complete absent in any of the above activities)

Table 2: Reasons for not having cent percent attendance in the project activities (N=30)

S.No.	Reasons	Total weighted score	Weighted score in percentage	Rank
1.	Important household works	122	35.06	I
2.	Festivals and social functions	73	20.97	II
3.	Illness of self	56	16.09	III
4.	Illness of family members	39	11.21	IV
5.	Weather not favourable to travel	25	7.18	V
6.	Absent in the family on the day	21	6.03	VI
7.	Uneasiness during long travelling	12	3.45	VII

group members (12). Regarding the extent of participation of the thirty adopted farmwomen in various project activities, data in Table 1 reveals very high participation (80-100% attendance) in training programmes (83.33%), followed by demonstrations (76.66%), meetings with experts (73.33%), and monthly group meetings among members (66.67%). However, the participation in exposure visit programmes was observed almost equal (20.00, 23.33, 30.00 & 26.67%) at all levels of participation (very high, high, moderate & low). It may be added here that nobody was complete absent in any of these activities.

Attempts were made to know the specific reasons of their absence which are presented in Table 2. It is observed that the reason 'important household works' ranked first (35.66% weightage) followed by various 'festivals and social functions' (20.97%), 'illness of self' (16.09%) and 'illness of family members' (11.21% weightage), respectively. This indicates pressure on farmwomen due to multiple roles and responsibilities. During field trial, some new technologies (Table 3) were

imparted through training and demonstrations on package of practices for increasing rice production and productivity. Among six rice varieties, 'Pooja' was rated most appropriate by the farmwomen (83.33%) followed by 'Naveen' (70.00%), 'CR Dhan 304' (63.33%) and 'CR Dhan 303' (56.67%) mainly because of their better productivity, local adaptability and marketability. 'Satabdi' was found less suitable by majority (50.00%) due to low productivity, while the scented variety 'Ketakijoha' was reported moderately appropriate by 56.67 per cent farmwomen.

Interestingly, all farmwomen (100.0%) found 'raising of mat-type seedlings' for mechanical transplanting as appropriate, even though only four of them practiced this technology. Similarly, other recommended packages like, seed treatment (100.0%), line transplanting (90.0%), recommended dose of fertilizers (83.33%) and application of need-based pesticides (66.67%) were found very appropriate among the practicing farmwomen, and all of them (100.0%) adopted seed treatment and line transplanting as per the recommendation.

Table 3: Experience of farmwomen with the new knowledge in rice farming (N=30)

S.No.	New knowledge	Nature of experience with new knowledge			Appropriateness of the new knowledge as perceived for farmwomen		
		Doing by self	Experiencing in others field	No Experience	More appropriate	Moderate appropriate	Less appropriate
1.	Rice variety						
	i. Satabdi (120d)	2(6.67)	28(93.33)	0(0.00)	5(16.67)	10(33.33)	15(50.00)
	ii. Naveen (120d)	6(20.00)	24(80.00)	0(0.00)	21(70.00)	9(30.00)	0(0.00)
	iii. CR Dhan-303 (130d)	3(10.00)	27(90.00)	0(0.00)	17 (56.67)	8 (26.67)	5 (16.67)
	iv. CR Dhan-304 (130d)	1(3.33)	29(96.67)	0(0.00)	19 (63.33)	10 (33.33)	1 (3.33)
	v. Pooja (150d)	26(86.67)	4(13.33)	0(0.00)	25(83.33)	5(16.67)	0(0.00)
	vi. Ketakijoha (150d)	4(13.33)	26(86.67)	0(0.00)	12(40.00)	17(56.67)	1(3.33)
2.	Raising of mat type seedling	4 (13.33)	26 (86.67)	0 (0.00)	30 (100.0)	0 (0.00)	0 (0.00)
3.	Line transplanting	30 (100.0)	0 (0.00)	0 (0.00)	27 (90.00)	3 (10.00)	0 (0.00)
4.	Recommended dose of fertilizers	25 (83.33)	5 (16.67)	0 (0.00)	25 (83.33)	5 (16.67)	0 (0.00)
5.	Application of need-based pesticides	4 (13.33)	11 (36.67)	15 (50.00)	10 (66.67)	3 (20.00)	2 (13.33)
6.	Seed treatment	30 (100.0)	0 (0.00)	0 (0.00)	30 (100.0)	0 (0.00)	0 (0.00)
7.	2-Row manual transplanter	4 (13.33)	26 (86.67)	0 (0.00)	4 (13.33)	11 (36.67)	15 (50.00)
8.	4-Row manual transplanter	4 (13.33)	26 (86.67)	0 (0.00)	7 (23.33)	14 (46.67)	9 (30.00)
9.	4-Row manual drum seeder	2 (6.67)	26 (86.67)	2 (6.67)	16 (57.14)	9 (32.14)	3 (10.71)
10.	Finger weeder	5 (16.67)	22 (73.33)	3 (10.00)	19 (70.37)	6 (22.22)	2 (7.40)
11.	Rice parboiling unit	8 (26.67)	15 (50.00)	7 (23.33)	7 (30.43)	12 (52.17)	4 (17.40)
12.	Rice husk combustor	10 (33.33)	11 (36.67)	9 (30.00)	18 (85.71)	3 (14.28)	0 (0.00)
13.	Paddy straw mushroom cultivation	10 (33.33)	16 (53.33)	4 (13.33)	23(88.46)	3 (11.54)	0 (0.00)

(Figures in the parentheses indicate percentages)

Among the women-friendly farm machineries demonstrated, rice husk combustor, finger weeder and 4-row manual drum seeder were perceived as more appropriate by 85.71, 70.37 and 57.14 per cent farm women respectively. Majority opined rice parboiling (52.17%) and 4-row manual rice transplanter (46.67%) as moderate appropriate, while half of them (50.0%) said 2-row manual transplanter was less appropriate. The 4-row transplanter was preferred over 2-row as it could cover double the area in unit time. Paddy straw mushroom cultivation as an income generating activity by converting rice byproduct (straw) was also rated as more appropriate by 88.46 per cent farmwomen.

Since socio-economic and technological empowerment of farmwomen largely depends on ability to arrange farm inputs and make decisions to use the farm inputs in rice farming *viz.*, land, money, seeds, fertilizers, pesticides, water, labour and machines.

Data on above aspects were collected and analyzed. As critical inputs, only 10 kg of paddy seeds and required quantity of chemical fertilizers for 0.5 acre demonstration were provided to the adopted farm women.

A perusal of data in Table 4 shows that apart from half acre demonstration, seven farmwomen (23.33%) had cultivated up to 1 acre and five farmwomen had cultivated in more than 1 acre land on their own during 2014-15. This expansion of area under the control of farmwomen signifies more trust and confidence on women farmers by their male counterparts and a positive impact of the project. Regarding, accessibility to 'Land', was found that, full accessibility by 100.0 per cent farmwomen over 0.5 acre demonstration land, 71.43% on 0.6-1 acre land and full accessibility by 60.0% farmwomen on more than 1 acre land (i.e., a decreasing trend of full accessibility with the increase in acreage).

Table 4: Access of farmwomen to farm inputs in rice farming (N=30)

S. No.	Name of the inputs	Class of the inputs	Source		Who Arranged			Access to Inputs #		
			Own	Hired/ CRRI*/ Borrowed/ Purchased/	Self	Self+ Family members	Family members	Full access	Moderate access	Little access
1.	Land	0.5 acre (Demo.)	18 (60.00)	0 (0.00)	9 (50.00)	6 (33.33)	3 (16.67)	18 (100.00)	0 (0.00)	0 (0.00)
		0.6 - 1 acre	5 (16.67)	2 (6.67)	1 (14.29)	2 (28.57)	4 (57.14)	5 (71.43)	2 (28.57)	0 (0.00)
		> 1 acre	3 (10.00)	2 (6.67)	0 (0.00)	2 (40.00)	3 (60.00)	3 (60.00)	2 (40.00)	0 (0.00)
2.	Money	Upto Rs. 2500	11(36.67)	0(0.00)	4(36.36)	3(27.27)	4(36.36)	5(45.45)	5(45.45)	1(9.00)
		Rs. 2501-5000	9(30.00)	2(6.67)	1(9.00)	8(72.72)	2(18.18)	5(45.45)	4(36.36)	2(18.18)
		>Rs. 5000	4(13.33)	4(13.33)	0 (0.00)	6 (75.00)	2 (25.00)	2 (25.00)	5 (62.50)	1 (12.50)
3.	Seeds	10 kg. (Demo.)	0 (0.00)	18 (60.00)	18 (100.0)	0 (0.00)	0 (0.00)	18 (100.0)	0 (0.00)	0 (0.00)
		> 10 kg.	5 (16.67)	7 (23.33)	5 (41.67)	5 (41.67)	2 (16.67)	7 (58.33)	3 (25.00)	2 (16.67)
4.	Fertilizer	For 0.5 acre (Demo.)	0 (0.00)	18 (60.00)	18 (100.0)	0 (0.00)	0 (0.00)	18 (100.0)	0 (0.00)	0 (0.00)
		For > 0.5 acre	5 (16.67)	7 (23.33)	4(33.33)	8 (66.67)	0(0.00)	7 (58.33)	3 (25.00)	2 (16.67)
5.	Pesticide	Used(2 - 5 kg)	4(13.33)	0(0.00)	1(25.00)	3(75.00)	0(0.00)	2(50.00)	2(50.00)	0(0.00)
		Borewell	2(6.67)	0(0.00)	0(0.00)	1(50.00)	1(50.00)	2(100.00)	0(0.00)	0(0.00)
7.	Labour	Canal water	0(0.00)	30(100.0)	9(30.00)	10(33.33)	11(36.67)	13(43.33)	8(26.67)	9(30.00)
		Family member	—	—	16 (53.33)	4 (13.33)	10 (33.33)	16 (53.33)	12 (40.00)	2 (6.67)
8.	Machine	Hired labour	—	—	0(0.00)	4 (30.76)	9 (64.23)	4 (30.76)	5 (38.46)	4 (30.76)
		Tractor	0(0.00)	5(16.67)	0(0.00)	4(80.00)	1(20.00)	0(0.00)	3(60.00)	2(40.00)
		Powertiller	1(3.33)	24(80.00)	3(12.00)	17 (68.00)	5(20.00)	1(4.00)	15 (60.00)	9 (36.00)
		Transplanter	0(0.00)	2 (6.67)	2 (100.0)	0(0.00)	0(0.00)	1 (50.00)	1 (50.00)	0 (0.00)
		Drum seeder	1 (3.33)	2 (6.67)	2 (66.67)	1 (33.33)	0 (0.00)	1 (33.33)	2 (66.67)	0 (0.00)
		Conoweeder	5 (16.67)	2 (6.67)	7 (100.0)	0 (0.00)	0 (0.00)	7 (100.0)	0 (0.00)	0 (0.00)
		Fingerweeder	1 (3.33)	4 (13.33)	4 (80.00)	1 (20.00)	0 (0.00)	5 (20.00)	0 (0.00)	0 (0.00)
Thresher -cum- winnower	1 (3.33)	23 (76.67)	4 (16.67)	8(33.33)	12(50.00)	5(20.83)	13(54.16)	6(25.00)		

(Figures in the parentheses indicate percentages)

(* Seeds & fertilizers required for 0.5 acre demonstration were provided by CRRI)

(# Full access to inputs: Women independently make their decisions on when, how and where to use the inputs;

Moderate access to inputs: Women, while making decisions, consult the family members and are influenced by their advice and suggestions;

Little access to inputs: Women have almost no access to inputs and use inputs as per decision of others)

Similar trends were also observed in case of 'Money' (45.45%, 45.45%, & 25.0%), 'Seeds' (100.0% & 58.33%) and 'Fertilizers' (100.0% & 58.33%), respectively.

Only four farmwomen had applied 'need-based pesticides', which were arranged mostly with the help of family members (75.0%) and had moderate (50.0%) to full accessibility (50.0%) by them. Only two farmwomen (6.67%) were having their own bore wells and also had full accessibility, while majority (43.33%) women were having full access to canal water for irrigation purpose. In case of labour, majority (53.33%) had full access to family labour, but had moderate access (38.46%) to hired labour.

With regard to farm machineries, most of them were hiring their implements like, power tiller (80.0%), thresher-cum-winnowing (76.67%) and tractor (16.67%), which were mostly arranged in consultation with or by family members (68.0%, 50.0% & 80.0%, respectively). Majority were found having moderate access to tractor (60.0%), power tiller (60.0%), transplanter (50.0%), drum seeder (66.67%) and thresher-cum-winnowing (54.16%), except cono weeder where cent per cent were found having fully accessible.

CONCLUSION

The purpose of this study was to analyze the participation, experience earned from new knowledge on rice farming of farmwomen and access to farm inputs in the rice farming activities. Efforts were made to systematically collate the data and analyze the extent of women participation in the adopted village. The study clearly depicts regarding the extent of participation of farmwomen in various project activities, data in Table 1 reveals very high participation in training programmes, followed by demonstrations, and meetings with experts. However, the participation in exposure visit programmes was observed almost equal. The ranking illustrates the specific reasons of absence in project activities where the reason 'important household works' ranked first followed by various 'festivals and social functions', and 'illness of self'. Regarding, accessibility to 'Land', it was found that, full accessibility by 100.0 per cent farmwomen over 0.5 acre demonstration land, 71.43 per cent on 0.6-1 acre land and full accessibility by 60.0 per cent farmwomen on more than 1 acre land. While we talk of empowerment of women in agriculture, the

discussion invariably focuses around access to and control of women over productive assets and their effective use for sustainable livelihood and income. It is inferred from the findings that, the farmwomen could be the efficient drivers of national agricultural growth and development, if they can be made technologically competent through gender sensitive approaches and socio-economically empowered. This, in turn, would make Indian agriculture more sustainable.

REFERENCES

- Das, L.; S.K. Mishra and N.C. Rath. 2008. Tribal Livelihood and gender empowerment in rice based farming system. *ORYZA*, 45(2): 142-146.
- Das, L.; S.K. Mishra; M.P.S. Arya; B.N. Sadangi; S. Saha and M.K. Behera. 2014. Gender issues and technological refinement for women in rice farming. *ORYZA*, 51(3): 247-254.
- Das, L.; S.K. Mishra; S. Pattanaik; P. Panda and R.S. Panda. 2021. A Case Study on Gender Differentiated Role Analysis in Rice Farming in a Rice Intensive Ecology. *Journal of Community Mobilization and Sustainable Development*, 16(3): 707-714.
- Doss, C.R. 2018. Women and agricultural productivity: Reframing the issues. *Development Policy Review*, 36(1): 35-50.
- Food and Agriculture Organization (FAO). 2011. The state of food and agriculture: Women in agriculture - Closing the gender gap for development. FAO.
- International Food Policy Research Institute (IFPRI). 2015. The gender implications of agricultural commercialization: An overview. *IFPRI*.
- Nayak, P. 2016. Women's roles in agriculture and food security in Odisha. *Indian Journal of Agricultural Economics*, 71(4): 632-638.
- NSSO. 2019. *Land and livestock holdings in India*. National Sample Survey Office, Government of India.
- Odisha Agriculture Department. 2021. Annual Report on Agriculture.
- Quisumbing, A.R.; R. Meinzen-Dick; T.L. Raney; A. Croppenstedt; J.A. Behrman and A. Peterman. 2014. Gender in agriculture: Closing the knowledge gap. *Springer*.
- Singh and Vinay. 2013. Gender participation in Indian agriculture: An ergonomic evaluation of occupational hazard of farm and allied activities. *International Journal of Agriculture, Environment & Biotech.*, 6(1): 157-168.
- World Bank. 2015. *Gender in agriculture: Sourcebook*.



Research Article

An Improvement Over Estimation of Total Livestock Population in Integrated Sample Survey Scheme

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ABSTRACT

In the present article, an effort has been made to develop a survey based approach for establishing estimates of livestock production which is an improved alternative of Integrated Sample Survey (ISS) Scheme. The theoretical variances of the regression estimator and Horvitz-Thompson estimator along with ratio estimator which is not mentioned in ISS scheme are discussed. Empirical evaluation has been carried out to show the relative performance of the regression estimator over the traditional ratio estimator of livestock population using the real survey data.

Keyword: Horvitz-thompson estimator, ISS scheme, Ratio estimator, Regression estimator

INTRODUCTION

Livestock are the domesticated animals raised in an agricultural setting to produce labour and commodities such as milk, meat, eggs, leather, and wool. It is an important source of income for farmers and rural people. Billions of people directly depend on livestock for their livelihoods and food security, and many more are impacted by it in terms of nutrition and health. Thus it is crucial to access accurate and current data pertaining to the key livestock indicators for the purpose of development, monitoring, and assessing various animal husbandry programmes. Use of reliable and efficient statistics is also required for taking important policy decisions and finalizing import-export quantity related to livestock sector.

The production of major livestock products (MLPs) namely, milk, eggs, meat and wool is estimated on the basis of annual sample surveys being conducted under the central sector scheme “Integrated Sample Survey” (BAHS, 2020) in the country. This scheme had been developed by the many scientist of Indian Council of Agricultural Research – Indian Agricultural Statistics

Research Institute (ICAR-IASRI) through conducting many research and surveys in different year, all over the country. Singh *et al.* (1959) developed the sampling methodology for estimation of wool, meat, milk, and egg production by conducting surveys at different places in different years. Goel *et al.* (1979) developed the survey methodology for estimation of livestock numbers and livestock production. Khatri *et al.* (1993) developed a technique for estimation of annual production of major livestock products for the districts by utilising the normal field agency of stockmen or stock assistants in the animal husbandry department of the state. Bhatia *et al.* (2011) modified the existing methodology for estimation of livestock and poultry population and meat production.

MATERIALS AND METHODS

In India livestock population and the production of MLPs are estimated under the ISS scheme. The scheme is implemented by the Department of Animal Husbandry, Dairing and Fisheries through state Animal Husbandry Department. This is the basic and only source of generating data for number of livestock and

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poultry held by the households in the country and the production of all four MLPs. This survey for collecting data from the field is conducted in the entire rural and urban areas of all the States and Union Territories (UT) of the country. The survey is conducted in the selected sample villages or urban wards enlisting all household enterprises and non-household enterprises institutions like farmhouses, slaughter houses and butcher shops following animal husbandry and related activities throughout the year introducing from March and ending in February. The entire period of one survey year is divided into three seasons of 4 months each. These are: Summer season (1st March – 30th June), Rainy season (1st July – 31st October) and Winter season (1st November – 28th or 29th February). The survey is conveyed in each month of the season which has been called as 'round'. Thus there are four rounds in every season. Further, the data is collected once in each round by visiting the selected household three times during the day i.e. morning, evening and noon.

The sampling design used under ISS scheme for the estimation of production of MLPs is stratified three stage random sampling design with districts are the strata, villages or urban wards are the first stage unit (f.s.u.), households are second stage unit (s.s.u.), and third or final stage units (t.s.u.) are the animals. The list of latest Livestock Census villages constitutes the sampling frame. For complete enumeration, 15 per cent of the villages/urban wards are selected in the form of two independent equal sub-samples within a State (5% in each season) which facilitates in calculating relative standard error (RSE) to estimate the livestock and poultry population. From the list of the two subsamples of villages, a representative sample of four villages and one urban ward each is further selected for detailed study for collection of information on yield at the district level. The list of households of the sample villages serve as the sampling frame for the selection of s.s.u. in detailed survey. The selection of sampled households / enterprises is differed according to animals in livestock. For milk production, one cluster of two households each for exotic, crossbred, indigenous and non-descript cattle, and indigenous and non-descript buffalo (total twelve households fixed for every season) are selected as s.s.u. In case the selected households are not having in milk goats, two additional households are selected. And from each selected

household two in milk animals for each category i.e. in all twenty four animals are selected as t.s.u. For egg production, two clusters of five households each (total ten households) are selected as s.s.u. and all layering birds from the selected households are treated as t.s.u. For meat production, all the households and butcher shops in the selected villages/ urban wards are the s.s.u. and the animals/poultry slaughtered in each household / butcher shops are the t.s.u. And for wool production, eight households are selected as s.s.u. from the f.s.u. and two rams/ wethers, two ewes and two lambs (total forty eight sheep) are selected as t.s.u. for detailed survey.

The traditional estimator of livestock population total and the production of MLPs:

This section explains the estimators used for estimating the number of livestock animals and production of MLPs for every season district-wise and state-wise. In the ISS scheme, MLPs are estimated using a stratified three-stage random sampling design, where, the districts are treated as strata and villages are treated as clusters. Generally, estimates are calculated using the Ratio estimator. For a clear understanding of these formulae, the notations are described below.

T : Total number of districts in a state (strata).

N_h : Total number of villages in the h^{th} district.

n_h : Number of selected villages in the h^{th} district for complete enumeration of livestock numbers.

v_h : Number of villages selected from n_h villages in the h^{th} district for detailed study.

x_h' : Number of in milk animals in the h^{th} district both in rural / urban areas according to the latest Livestock Census.

x_{hi}' : Number of in milk animals in i^{th} village of h^{th} district according to the latest livestock census.

y_{shi} : Number of in milk animals in the i^{th} village of the h^{th} district during s^{th} season as per Schedule II.

The ratio estimator of number of in milk animals in h^{th} district in s^{th} season is given by

$$\hat{y}_{shR} = \hat{R}_{sh} \times x_h' \quad \dots(1)$$

where, $\hat{R}_{sh} = \frac{\sum_{i=1}^{n_h} y_{shi}}{\sum_{i=1}^{n_h} x_{hi}'}$.

and its mean square error and its estimate are given by

$$MSE(\hat{y}_{shR}) = N_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h} \right) \left[S_{y_{sh}}^2 + R_{sh}^2 S_{x_{sh}}^2 - 2R_{sh} S_{x_{sh}y_{sh}} \right] \text{ and } \dots (2)$$

$$M\hat{S}E(\hat{y}_{shR}) = N_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h} \right) \left[s_{y_{sh}}^2 + \hat{R}_{sh}^2 s_{x_{sh}}^2 - 2\hat{R}_{sh} s_{x_{sh}y_{sh}} \right] \dots (3)$$

where, $s_{y_{sh}}^2$, $s_{x_{sh}}^2$ and $s_{x_{sh}y_{sh}}$ are the estimates corresponding to population variance-covariances of number of in milk animals in h^{th} district in s^{th} season, $S_{y_{sh}}^2$, $S_{x_{sh}}^2$ and $S_{x_{sh}y_{sh}}$ respectively.

Using the estimator in equation (1), milk production is estimated by multiplying with the yield of different categories of in milk animals in ISS scheme. Similarly, production of other livestock products such as egg, wool and meat, and poultry can be estimated using above formula by estimating the total livestock population.

The regression estimator of population total of number of in milk animals: The ratio method of estimation uses the auxiliary information correlated with the study variable to improve the precision of the estimators when the regression of Y on X is linear and passes through the origin. But when Y and X are being regressed linearly, the line need not always pass through the origin. Under these conditions, the regression type estimator is preferred for estimating population means.

The regression estimator of number of in milk animals in h^{th} district in s^{th} season is given by

$$\hat{y}_{shReg} = N_h \left[\left\{ \left(\sum_{i=1}^{n_h} y_{shi} \right) / n_h \right\} + b_h \left\{ \left(x'_h / N_h \right) - \left(\left(\sum_{i=1}^{n_h} x_{shi} \right) / n_h \right) \right\} \right] \dots (4)$$

where, b_h is the sample regression coefficient of the h^{th} district.

Corresponding to its mean square error and its estimate

$$\text{are given by } MSE(\hat{y}_{shReg}) = N_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h} \right) \left[(1 - \rho_h^2) S_{y_{sh}}^2 \right] \dots (5)$$

where, ρ_h is the population correlation coefficient of number of in milk animals in h^{th} district in s^{th} season and

$$M\hat{S}E(\hat{y}_{shReg}) = N_h^2 \left(\frac{1}{n_h} - \frac{1}{N_h} \right) \left[(1 - r_h^2) s_{y_{sh}}^2 \right] \text{ respectively. } \dots (6)$$

The Horvitz-Thompson estimator of population total of number of in milk animals: In survey analysis, the Horvitz-Thompson (1952) estimator is

commonly used for calculating the population total and mean of a pseudo-population in the sample. It is named after Daniel G. Horvitz and Donovan J. Thompson.

Let the inclusion probability of the i^{th} village of h^{th} district selected in the sample be p_{hi} and probability of i^{th} and j^{th} villages of h^{th} district are included in the sample be π_{hij} . Then the Horvitz-Thompson estimator of number of in milk animals in h^{th} district in s^{th} season is given by

$$\hat{y}_{shHT} = \sum_{i=1}^{n_h} y_{shi} / \pi_{hi} \dots (7)$$

Variance of the Horvitz-Thompson estimator is given as

$$V(\hat{y}_{shHT}) = \sum_{i=1}^{N_h} \sum_{j=1}^{N_h} \left\{ (\pi_{hij} - \pi_{hi}\pi_{hj}) / \pi_{hi}\pi_{hj} \right\} y_{shi} y_{shj} \dots (8)$$

The estimate of variance of Horvitz-Thompson estimator is given as

$$\hat{V}(\hat{y}_{shHT}) = \sum_{i=1}^{n_h} \sum_{j=1}^{n_h} \left\{ (\pi_{hij} - \pi_{hi}\pi_{hj}) / \pi_{hi}\pi_{hj} \right\} y_{shi} y_{shj} \dots (9)$$

If the samples are selected randomly with equal probability of selection of each sampling unit following without replacement sampling technique then the Horvitz-Thompson estimator has been given as the same estimator as Simple Random Sampling Without Replacement (SRSWOR) sampling estimator.

Empirical study: In order to compare the existing ratio estimator with regression estimator and Horvitz-Thompson estimator, empirical analysis has been carried out for the estimation of the total population of in milk animals along with the milk production, using the real survey data of Alappuzha district of Kerala state from Integrated Sample Survey (ISS) scheme in 2021-22 under the ICAR-IASRI project entitled In "Integrated Sample Survey Solution for Major Livestock Products" funded by Department of Animal Husbandry, Govt. of India. The data has been collected using detailed information about the households and villages of Alappuzha district of Kerala state. Using this data first, the number of in milk animals in different categories i.e. cattle (exotic, crossbred, indigenous and non-descript), buffaloes (indigenous and non-descript), and the goat for Alappuzha district of the Kerala state has been estimated by using the ratio estimator, regression estimator and Horvitz-

Table 1: Category wise %RB and %SE of estimates of the total number of in milk animals in Alappuzha district of Kerala state

Animal	Category	%RB		%SE		
		Ratio Estimator	Regression Estimator	Ratio Estimator	Regression Estimator	Horvitz-Thompson Estimator
Cattle	Indigenous	-61.345	-0.258	189.946	58.813	58.661
Cattle	Crossbred	13.059	6.455	10.882	10.225	12.244
Cattle	Non - Descript	-84.765	8.310	391.618	43.307	47.021
Buffalo	Non - Descript	-54.599	-11.332	234.909	111.280	99.238
Goat	Goat	42.981	15.719	10.565	10.387	12.127

Thompson estimator. And using the estimates of number of in milk animals in different categories, the milk production has been calculated for Alappuzha district of Kerala state.

RESULT AND DISCUSSION

The traditional ratio estimator has been compared with the regression estimator and Horvitz-Thompson estimator of the population total of in milk animals using the percent relative bias and the percent standard error. The percent relative bias is defined as

$$\%RB = \left(\frac{\hat{y}_{sh\bullet} - \hat{y}_{shHT}}{\hat{y}_{shHT}} \right) \times 100$$

and the percent standard error (%SE) is computed using the following formula given as

$$\%SE = \left(\frac{\sqrt{\hat{V}(\hat{y}_{sh\bullet})}}{\hat{y}_{sh\bullet}} \right) \times 100$$

The result of percent relative bias (%RB) of ratio and regression estimators have been calculated with respect to the Horvitz-Thompson estimator as under SRSWOR it gives unbiased estimator and the percent standard error (%SE) of ratio, regression and Horvitz-Thompson estimator have been computed for comparison of ration estimator with the regression and Horvitz-Thompson estimator. The results have been given in the Table 1.

Table 1 contains category wise %RB with respect to the Horvitz-Thompson estimator and %SE of the estimates of total number of in milk animals in Alappuzha district of Kerala state in rainy season.

From the above tables, it has been clearly shown that for all categories of animals, except exotic cattle and indigenous buffalo as these categories of animals have not been presented in Alappuzha district, regression estimator has less %RB than traditional ratio

estimator. So, ratio estimator has more bias than the regression estimator. Also it has been shown that %SE of regression estimator of all categories of animals is less than the traditional ratio estimator and Horvitz-Thompson estimator. That has been indicated, the regression estimator has lesser variances or standard error than the ratio estimator and Horvitz-Thompson estimator. So, the regression estimator is more reliable and more precise than the traditional ratio estimator used in ISS scheme.

CONCLUSION

In this study, an alternative technique for estimation of livestock population has been suggested. Variance and estimate of variance has also been given for the estimators of total number of livestock animals. Empirical evaluation has been done for comparing the performance of the traditional ratio estimator with the regression estimator using statistical measures like percent relative bias and percent standard error. The result shows that the regression estimator are more efficient than the traditional ratio estimator adopted in ISS scheme. Thus there is need to improve the estimation technique in ISS scheme.

REFERENCES

- Anonymous. 1961. Sample survey for improvement of livestock statistics. Project report. ICAR-IASRI publication, New Delhi.
- Basic Animal Husbandry Statistics. 2020. Department of Animal Husbandry and Dairying under Ministry of Fisheries, Animal Husbandry and Dairying through State Animal Husbandry Departments, Government of India. (<https://dahd.nic.in/schemes/programmes/animal-husbandry-statistics>).
- Bhatia, D.K.; A.K. Gupta; H. Chandra; U.C. Sud and D.C. Mathur. 2011. Sampling methodology for estimation

- of meat production in Meghalaya. Project report. ICAR-IASRI publication, New Delhi.
- Cochran, W.G. 1977. *Sampling Techniques*. John Wiley and Sons. New York.
- Goel, B.B.P.S. and C.L. Malik. 1980. Estimation of livestock products. Methodology for improvement of data base on livestock resources. Project report. ICAR-IASRI publication, New Delhi.
- Goel, B.B.P.S. and J.S. Maini. 1979. Sample survey for estimation of livestock numbers and products. Project report. ICAR-IASRI publication, New Delhi.
- Horvitz, D.G. and D.J. Thompson. 1952. A generalization of sampling without replacement from a finite universe. *Journal of the American Statistical Association*, 47: 663-685.
- Instruction manual of Integrated Sample Survey. 2015. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India.
- Khatrri, R.S.; J.S. Maini; K.B. Singh and J.P. Goyal. 1993. Pilot sample survey for developing a sampling methodology for estimation of livestock products on the basis of data collected as a part of normal work of the field agency of animal husbandry department of states, Trichur (Kerala). Project report. ICAR-IASRI publication, New Delhi.
- Singh, D.; B.B.P.S. Goel; J.N. Garg and D.V.S. Rao. 1973. Monograph on Sample survey techniques for estimation of egg production. Project report. ICAR-IASRI publication, New Delhi.
- Singh, D.; B.B.P.S. Goel; J.N. Garg and K.B. Singh. 1979. Sampling methodology for estimation of milk production, Southern region (1971-74). Project report. ICAR-IASRI publication, New Delhi.
- Singh, D.; B.B.P.S. Goel; J.N. Garg; K.B. Singh and M. Rajagopalan. 1978. Production and study of poultry keeping practices in Northern region (1969-72) and Southern region (1971-74). Project report. ICAR-IASRI publication, New Delhi.
- Singh, D.; M. Rajagopalan and J.S. Maini. 1966. Sample survey for estimation of wool production, Rajasthan (1960-61). Project report. ICAR-IASRI publication, New Delhi.
- Singh, D.; M. Rajagopalan; J.S. Maini and K.B. Singh. 1978. Monograph on sample survey techniques for estimation of meat production. Project report. ICAR-IASRI publication, New Delhi.
- Sukhatme, P.V.; B.V. Sukhatme; S. Sukhatme and C. Asok. 1984. *Sampling Theory of Surveys with Applications*. Iowa State Univ. Press, Ames, Iowa and Indian Society of Agricultural Statistics, New Delhi (3rd Revised Edition).
- Wu, C. and M.E. Thompson. 2020. *Sampling Theory and Practice*. I.C.S.A book series in statistics. Springer, Switzerland.

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Research Article

Evaluating the Performance of Cluster Front Line Demonstrations on Blackgram in Chhattisgarh

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ABSTRACT

The study aimed at assessing the impact of cluster frontline demonstrations in terms of productivity gains, extension gap, technological gap and economic gains in blackgram cultivation in Chhattisgarh from 2017-2022. Across various Krishi Vigyan Kendras demonstrations were implemented introducing high-yielding varieties like PU-31, Birsa Urd, Pratap Urd 1, Indira Urd Pratham and Mash 479 along with improved package of practices. Results revealed substantial yield enhancements with demonstration plots achieving an average increase of 38% to 62% compared to farmers' traditional practices. Agro-climatic zones like the Chhattisgarh Plains and Bastar Plateau demonstrated significant yield improvements, underscoring the potential of CFLDs to address productivity challenges in blackgram cultivation. The findings clearly demonstrate that the adoption of improved blackgram varieties and modern technologies through CFLDs significantly enhances both productivity and profitability while effectively narrowing the technology and yield gaps.

Keywords: Blackgram, Pulses, CFLD, Yield gap, Extension gap, Technology index

INTRODUCTION

Blackgram (*Vigna mungo* L.) is a major pulse crop cultivated in India, known for its nutritional and soil-enhancing properties due to its ability to fix atmospheric nitrogen. Blackgram is a staple pulse in Indian cuisine, widely used in dishes like *dal*, *papad* and *idli* batter. It is a rich source of protein, essential vitamins and minerals, playing a crucial role in food and nutritional security, particularly in cereal-based diets that dominate India's predominantly vegetarian population. Beyond its dietary significance, blackgram also enhances soil health by contributing organic matter and aiding in nitrogen fixation, making it valuable for sustainable agriculture. India is the world's largest producer of blackgram, contributing 70 per cent of the global production followed by Myanmar. Black gram area holds significant importance among pulses and accounts for about 29 per cent of India's total pulse acreage

and contributes 10.25 per cent of total pulse production (Reddy, 2024). Blackgram is cultivated in an area of 4.63 million hectares with production of 2.78 million tonnes and productivity of 987 kg/ha. In Chhattisgarh, blackgram is cultivated in an area of 0.70 lakh hectares, with total production of 0.26 lakh tonnes and productivity of 368 kg/ha. (DACFW, 2023).

Recognizing the need to enhance pulse production, the Government of India has been actively promoting targeted interventions under the "Cluster Frontline Demonstration on Pulses (CFLD)" initiative, implemented through the National Food Security Mission (NFSM). CFLD focuses on the widespread adoption of advanced agricultural technologies, including high-yielding varieties, improved agronomic practices, integrated pest management and mechanization. These demonstrations, conducted by KVKs, serve as an effective means of technology

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transfer to farmers, ensuring localized adaptation and scaling of innovations. Major objective of CFLDs' on pulses is to demonstrate and popularize the improved farm technology at farmers' fields under varied farming conditions for effective transfer of generated technology, fill the gap between improved technology and indigenous technologies to enhance pulse productivity, farm gains for sustaining the production systems especially under rain fed farming (Choudhary *et al.*, 2009). According to Raj *et al.* (2013), variations in soil fertility and weather conditions contribute to technological gaps in agricultural productivity. A higher technology index indicates a gap in effectively transferring proven technologies to growers and reluctance among farmers in adoption of the technological interventions. Production risks of pulses in view of climate change and vulnerabilities of rainfed agriculture could be marginalized by selection of suitable technological options across the region (Gudadhe *et al.*, 2018).

In spite of being a leading producer, India is still importing pulses to meet consumer demand, due to low productivity of pulses due to various reasons. Hence, there is a need to improve the productivity in pulses (Thriveni, 2024). The decreased availability and import of pulses highlight the urgency of increased production. Pulse included cropping systems are the only way to enhance production as the area available are limited. Adaptability to fit into various cropping systems by introducing pulses into farm production can be a key to increase resilience to climate change (Adarsh, 2019). To provide the nutritional security making pulses affordable through domestic production is the best alternative (Raut, 2021). Blackgram serves as an excellent rotational crop, improving the yield of the primary crop while enhancing soil fertility. It is predominantly grown in a cereal-pulse cropping system, helping to conserve soil nutrients. Being a short-duration pulse crop, it fits well into diverse cropping patterns, contributing to sustainable farming practices.

MATERIALS AND METHODS

Chhattisgarh has diverse agro-climatic zones, including the Chhattisgarh Plains, Bastar Plateau and Northern Hills, each with distinct challenges and opportunities for blackgram cultivation. The state contributes significantly to India's pulse production, yet productivity

remains constrained due to traditional farming methods, lack of quality seeds and inadequate pest and nutrient management practices. Cluster frontline demonstrations (CFLDs) on blackgram conducted under NFSM by ICAR during the kharif season from 2017-2022. The demonstrations were carried out at selected farmers' fields across various KVKs in Chhattisgarh. Prior to implementation, beneficiary farmers were identified, knowledge on improved blackgram cultivation techniques, covering aspects such as seed treatment, soil fertility management, line sowing and pest and disease control measures was imparted through training cum awareness programmes, field day.

Demonstration plots were established using improved blackgram varieties, recommended scientific practices including seed treatment, use of integrated nutrient management, integrated pest and disease management. Farmers' existing cultivation practices were recorded as control plots for comparative analysis. Field days and exposure visits were conducted to enhance awareness and technology dissemination.

The following parameters were used to evaluate the impact of CFLDs:

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstrated yield - Yield under existing practice

$$\text{Technology Index} = \frac{\text{Potential Yield} - \text{Demonstration Yield}}{\text{Potential Yield}} \times 100$$

RESULTS AND DISCUSSION

Cluster Frontline Demonstrations plays a crucial role in demonstrating improved blackgram cultivation practices across different agro-climatic regions of Chhattisgarh by enhancing productivity, sustainability and farmer adoption of advanced technologies.

Table 1 presents data on Cluster Frontline Demonstrations (CFLDs) in blackgram across three agro-climatic regions of Chhattisgarh—Bastar Plateau, Chhattisgarh Plains and the North Hills of Chhattisgarh over five years from 2017-22. In the Bastar Plateau, the highest demonstration area (80 ha) and number of demonstrations (199) were recorded in 2021-22, while the lowest (30 ha) were in 2020-21. The Chhattisgarh Plains had the most extensive demonstrations, peaking in 2017-18 with 543 demonstrations over 250 ha. In the North Hills of Chhattisgarh, the number of

Table 1: Cluster frontline demonstrations in blackgram crop in Chhattisgarh

Year	Bastar Plateau			Chhattisgarh Plains			North Hills of Chhattisgarh			Total		
	KVK	Area (ha)	Demo (No.)	KVK	Area (ha)	Demo (No.)	KVK	Area (ha)	Demo (No.)	KVK	Area (ha)	Demo (No.)
2017-18	2	50	125	7	250	543	4	110	246	13	410	948
2018-19	3	60	150	7	240	478	4	80	196	14	380	824
2019-20	3	40	100	12	160	346	5	50	104	20	250	550
2020-21	2	30	75	8	90	218	2	20	41	12	140	334
2021-22	6	80	199	7	80	191	5	50	107	18	210	497

Table 2: Varietal replacement under Cluster frontline demonstrations in blackgram crop

Agro-Climatic Zone	District	Previously grown varieties	New varieties demonstrated
Chhattisgarh Plains	Bilaspur, Bemetra, Dhamtari, Durg, Gariyaband, Janjgir-Champa, Korba, Kanker, Raipur, Mahasamund, Mungeli, Raigarh, Rajnandgaon	LBG-20, T9, Dashraily urd, Local/ Mixed seed	PU-31, Azad-3, Birsa urd, Indira Urd Pratham, Mash 479
North Hills of Chhattisgarh	Surguja, Balrampur, Jashpur, Korea, Surajpur	Kala urd, Local/ Mixed seed	Azad-3, Birsa urd, Indira Urd Pratham, Pratap Urd 1, Mash 479
Bastar Plateau	Bastar, Bijapur, Dantewada	Gwalior-2, Barkha, Rakhi Urd, Local/ Mixed seed	PU-31, Pratap Urd 1, Mash 479

demonstrations remained relatively stable, with the highest recorded in 2017-18 (110 ha). Overall, the total CFLDs across all regions peaked in 2017-18 with 948 demonstrations over 410 ha. The data highlights regional and temporal variations in blackgram CFLDs.

Under Cluster Frontline Demonstrations in blackgram, varietal replacement was undertaken to introduce improved varieties under across various Agro-Climatic Zones of Chhattisgarh as depicted in Table 2 to enhance productivity and profitability. In the Chhattisgarh Plains, previously grown varieties such as LBG-20, T9 and Dashraily Urd were replaced with improved varieties like PU-31, Azad-3, Birsa Urd, Indira Urd Pratham and Mash 479. In the North Hills of Chhattisgarh shifted from traditional Kala Urd and local varieties to high-yielding varieties such as Azad-3, Birsa Urd, Indira Urd Pratham, Pratap Urd 1 and Mash 479. Similarly, in the Bastar Plateau, older varieties like Gwalior-2, Barkha and Rakhi Urd replaced with improved selections such as PU-31, Pratap Urd 1 and Mash 479. This varietal replacement under CFLDs aimed to enhance productivity, disease resistance and adaptability of blackgram in different agro-climatic conditions, contributing to overall yield improvement

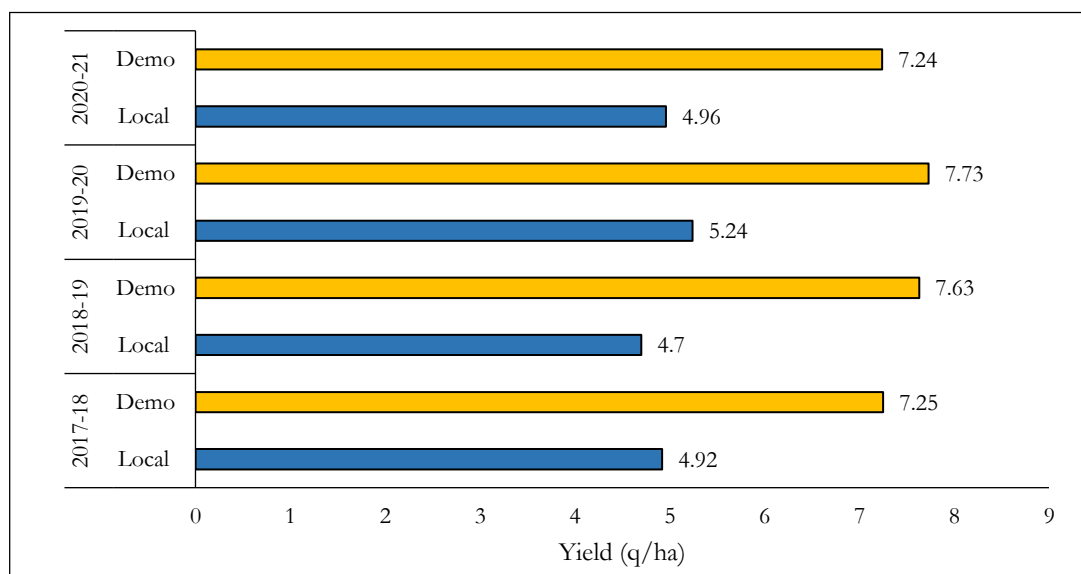
and sustainability as reported by Saikia *et al.* (2018); Sahu *et al.* (2018) and Singh *et al.* (2018).

In demonstration plots line sowing was done with seed treatment and use of biofertilizers. Integrated nutrient management based on soil test results and need based pest and disease management. In farmers' practice broadcast method of sowing with higher seed rate against the recommended line sowing and optimum seed rate was used. Farmers also did not practice seed treatment with rhizobium culture, an important component in increasing the yield and yield attributes of pulse crops (Kumar and Elamathi, 2007).

Table 3 presents the impact of CFLDs on blackgram yield across different agro-climatic zones of Chhattisgarh from 2018 to 2022. Across all years and regions, demonstrated varieties consistently outperformed local varieties, highlighting the effectiveness of improved cultivation practices and superior varieties. In the Bastar Plateau, the demonstrated yield peaked at 9.98 q/ha in 2017-18, while the lowest local yield was recorded at 4.48 q/ha in 2021-22. The Chhattisgarh Plains showed a steady improvement, with demonstrated yields ranging from

Table 3: Impact of Cluster frontline demonstrations blackgram crop during 2018-2022

ACZ	2017-18		2018-19		2019-20		2020-21		2021-22	
	FP (q/ha)	Demo (q/ha)	FP (q/ha)	Demo (q/ha)	FP (q/ha)	Demo (q/ha)	FP (q/ha)	Demo (q/ha)	FP (q/ha)	Demo (q/ha)
Bastar Plateau	5.68	9.98	4.74	7.67	5.79	8.46	4.98	8.2	4.48	6.63
Chhattisgarh Plains	4.77	6.85	6.05	8.42	4.97	7.34	5.04	6.74	5.23	7.75
North Hills of Chhattisgarh	4.74	6.35	4.98	7.65	4.58	6.44	4.42	7.27	6.85	8.68

**Figure 1: Effect of CFLD on blackgram yield improvement in Chhattisgarh**

6.74 to 8.42 q/ha, compared to local yields between 4.77 and 6.05 q/ha. In the North Hills of Chhattisgarh, demonstrated yields fluctuated but remained higher than local varieties, with a peak of 8.68 q/ha in 2021-22.

The overall yield for Chhattisgarh followed a similar trend as depicted in Figure 1, where demonstrated plots consistently achieved higher productivity, ranging from 7.24 to 7.73 q/ha, compared to local yields between 4.70 and 5.41 q/ha. These results underscore the positive impact of CFLDs in promoting improved blackgram varieties and cultivation techniques, leading to significant

yield enhancements across the state. The yield increased under CFLD ranged from 38 per cent to 62 per cent, depending on the agro-climatic conditions and adoption levels.

The analysis of yield gaps in black gram cultivation across different agro-climatic zones highlights the impact of improved technologies demonstrated under the Cluster Frontline Demonstration in blackgram. Table 4 provides a comprehensive assessment of the technology gap, extension gap and technology index in various regions. The average potential yield of improved varieties of blackgram is 10.5 q/ha, but there

Table 4: Agro-climatic zone wise technology gap, extension gap and Technology index in blackgram under CFLD on pulses

Agro-climatic zone	Potential Yield (q/ha)	Farmer Practice Yield (q/ha)	Demo Yield (q/ha)	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
Bastar Plateau	10.5	5.13	8.19	3.06	2.31	28.21
Chhattisgarh Plains	10.5	5.21	7.42	2.21	3.08	41.51
North Hills of Chhattisgarh	10.5	5.11	7.28	2.17	3.22	44.23

is a notable difference between the yields obtained through farmer practices and those achieved under demonstration plots. In the Bastar Plateau, the demonstration yield reached 8.19 q/ha, whereas the farmer practice yield was 5.13 q/ha, resulting in an extension gap of 3.06 q/ha and technology gap of 2.31 q/ha, with a technology index of 28.21 per cent. Similarly, in the Chhattisgarh Plains, the demonstration yield was 7.42 q/ha as compared to farmers' practice 5.21 q/ha, leading to an extension gap of 2.21 q/ha and a technology gap of 3.08 q/ha, with a higher technology index of 41.51 per cent. The North Hills of Chhattisgarh showed the highest technology gap (3.22 q/ha) and technology index (44.23%), with a demonstration yield of 7.28 q/ha compared to a farmer practice yield of 5.11 q/ha, resulting in an extension gap of 2.17 q/ha.

The data highlights the significant potential for bridging the yield gap in blackgram production, particularly with lower baseline productivity of 3.68 q/ha for Chhattisgarh State. These results were in line with the earlier findings by Kumar *et al.* (2020); Nagarjuna *et al.* (2022); Rao *et al.* (2020) and Sharma and Singh (2024). Potential yield is still the great challenge to be achieved for pulses in India as indicated by the wider gap with respect to the reported yield at all level i.e. state, national and farmers' yield (Dubey *et al.*, 2022).

A wide gap in use of improved varieties seed was observed and farmers mostly use local varieties seeds. In farmers' practice broadcast method of sowing usually with higher seed rate was observed. Farmers also did not practice seed treatment with biofertilizers and INM. Weed management and plant protection measure showed partial or full gap under farmers' practice over recommended practice with improved

variety seed, biofertilizer, STV based integrated nutrient management and plant protection measures under frontline demonstrations. Similar findings for adoption gap in improved technologies and farmers practices were also observed by Burman *et al.* (2010) and Kumar *et al.* (2014) in different pulses crops.

Overall, the data reveals significant variation in extension and technology gaps across agro-climatic zones, emphasizing the need for targeted extension efforts are necessary to further bridge the yield gap and enhance blackgram productivity in different agro-climatic zones. The variations in soil fertility and weather conditions contribute to technological gaps in agricultural productivity (Raj *et al.*, 2013). Technology index indicates how practical the developed technology is for farmers in the field. A lower technology index value suggests greater feasibility and adaptability of the technology. A higher technology index in Chhattisgarh Plains and North Hills of Chhattisgarh indicates a gap in effectively transferring proven technologies to growers and reluctance among farmers in adoption of the technological interventions. Production risks of pulses in view of climate change and vulnerabilities of rainfed agriculture could be marginalized by selection of suitable technological options across the region (Gudadhe *et al.*, 2018).

The economic comparison between Cluster Frontline Demonstration and farmers' traditional practices over five years (2017-22) highlights the superior profitability of demonstrated technologies (Table 5). The cost of cultivation was slightly higher in CFLD plots compared to local practices, but the returns were significantly better. The average gross return from CFLD plots consistently exceeded those from farmers practices. Net returns, also demonstrated substantial improvements in demonstration plots.

Table 5: Economical comparison between CFLD demo and farmers' practice

Year	Average Cost of Cultivation (Rs/ha)		Average Gross Return (Rs/ha)		Average Net Return (Rs/ha)		B:C Ratio	
	Local check	Demo plot	Local check	Demo plot	Local check	Demo plot	Local check	Demo plot
2017-18	13604	16340	29074	41408	15470	25068	2.14	2.53
2018-19	14944	17367	31250	42840	16306	25473	2.09	2.47
2019-20	14160	17535	28856	43669	14696	26134	2.04	2.49
2020-21	14934	17208	33330	47218	18396	30010	2.23	2.74
2021-22	13604	16340	29074	41408	15470	25068	2.14	2.53

Notably, the benefit-cost (B:C) ratio was consistently higher for CFLD plots, ranging from 2.47 to 2.74, compared to 2.04 to 2.23 in local practices. This demonstrates the economic viability and effectiveness of CFLD interventions in improving farmers' incomes. The improved profitability was attributed to higher yields, reduced input costs due to integrated nutrient and pest management and better market linkages. Similar findings were also reported by Kumar and Elamathi (2007) and Singh *et al.* (2020).

CONCLUSION

Cluster Frontline Demonstrations on blackgram in Chhattisgarh highlight the significant potential of improved blackgram varieties and modern cultivation techniques in enhancing productivity and profitability. Across all agro-climatic zones, the yield increase under CFLD ranged from 38 per cent to 62 per cent, reflecting the effectiveness of demonstrated interventions. Despite these gains, the analysis highlights persisting technology and extension gaps, particularly in the Chhattisgarh Plains and North Hills of Chhattisgarh, where the technology index was relatively high. This suggests the need for continued efforts in technology dissemination, farmer training and localized adaptation of best practices. Addressing constraints such as access to quality seeds, improved mechanization and climate-resilient agronomic techniques will be crucial for sustaining productivity growth. The success of CFLDs underscores their role in enhancing blackgram production, improving farmers' income and strengthening pulse self-sufficiency in India. The demonstrations successfully bridged the yield gap proving that scientific interventions, when effectively disseminated can transform pulse cultivation in the region. Proactive extension strategies coupled with these demonstrations can further bridge yield gaps and contribute to the long-term sustainability of pulse cultivation in rainfed and resource-limited farming systems.

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REFERENCES

- Adarsh, S.; J. Jacob and T. Giffy. 2019. Role of pulses in Cropping Systems: A Review. *Agricultural Reviews*, 40(3): 185-191.
- Anuratha, A.; R. Ravi and J. Selvi. 2018. Productivity enhancement in black gram by cluster front line demonstrations. *Journal of Krishi Vigyan*, 7(1): 242-244.
- Burman, R.R.; S.K. Singh and A.K. Singh. 2010. Gap in adoption of improved pulse production technologies in Uttar Pradesh. *Indian Research Journal of Extension Education*, 10(1): 99-104.
- Choudhary, A.K.; D.S. Yadav and A. Singh. 2009. Technological extension yield gaps in oilseeds in Mandi district of Himachal Pradesh. *Indian Journal of Soil Conservation*, 37(3): 224-229.
- DAC&FW. 2023. *Agricultural Statistics Yearbook*. Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India.
- Dubey, S.K.; U.S. Gautam and A. Singh. 2022. Yield gap minimization: Consequences of CFLD-Pulses in India. *Indian Journal of Extension Education*, 58(3): 65-69.
- Gudadhe, N.; A.A. Raut; J.D. Thanki; P.S. Bodke and S.R. Imade. 2018. Agronomic technologies for enhancing pulse production ahead of climate change. In A. K. Srivastava & Yoganjan (Eds.), *Climate risks management: Sustainable pulse production*. Astral International Pvt. Ltd pp. 27-52
- Kumar, A. and S. Elamathi. 2007. Effect of nitrogen levels and rhizobium application methods on yield attributes, yield and economics of blackgram. *International Journal of Agriculture Sciences*, 3(1): 179-180.
- Kumar, S.; J. Dev; R. Singh and S. Kumar. 2020. Role of cluster frontline demonstrations in enhancing black gram productivity under rainfed conditions in district Bilaspur of Himachal Pradesh. *Journal of Krishi Vigyan*, 9(1): 293-297.
- Kumar, S.; R. Singh and A. Singh. 2014. Assessment of gaps in pulse production in Hamirpur district of Himachal Pradesh. *Indian Research Journal of Extension Education*, 14(2): 20-24.
- Nagarjuna, D.; M. Mallikarjun; G.L. Siva Jyothi and V. Sumathi. 2022. Impact of Cluster Frontline Demonstration on productivity and profitability of blackgram. *Journal of Krishi Vigyan*, 11(1): 206-210.
- Raj, A.D.; V. Yadav and J.H. Rathod. 2013. Impact of front-line demonstrations (FLD) on the yield of pulses. *International Journal of Scientific & Research Publication*, 3(9): 1-4.
- Rao, P.V.; G. Chittibabu and D.C. Naidu. 2020. Impact of front-line demonstrations on integrated crop

- management in rice fallow black gram in Srikakulam District of Andhra Pradesh. *Journal of Krishi Vigyan*, 9(1): 189-192.
- Raut, A.A.; S.R.K. Singh; B. Shrishti and A. Mishra. 2021. Emerging technologies for sustainable pulses production in Madhya Pradesh. In Narendra Kumar, Nath CP, Sah U and Singh NP. (Eds) Sustainable Production of Pulses in Diverse Agro-ecosystems, Vol. 2. Stress management and livelihood security. (ISBN: 978-93-90749-19-5) Scientific Publisher, Jodhpur, India, pp.201–216.
- Reddy, G.R. 2024. ANGRAU - Crop Outlook Reports of Andhra Pradesh Blackgram—June to May, 2023-24.
- Sahu, J.K.; K.D. Mahant; S.K. Yadav and V. Jain. (2018). Evaluation of cluster front line demonstration trials on blackgram (*Vigna mungo*) in Janjgir-Champa district of Chhattisgarh. *International Journal of Current Microbiology and Applied Sciences*, 7(Special Issue): 3246-3250.
- Sharma, S. and N.D. Singh. 2024. Impact assessment of cluster frontline demonstration in enhancing productivity of kharif blackgram in sub-mountainous region of Punjab, India. *Journal of Food Legumes*, 37(4): 455-461.
- Singh, R.P.; A.K. Singh; R.P. Singh; R.K. Singh and M. Singh. 2020. Impact of cluster frontline demonstrations on pulses productivity and profitability in farmer's field. *Indian Journal of Extension Education*, 56(1): 134-141.
- Singh, S.P.; K.K. Paikra and C.R. Patel. 2018. Performance of cluster frontline demonstration on productivity and profitability of blackgram (*Vigna mungo*) in Raigarh district of Chhattisgarh, India. *International Journal of Current Microbiology and Applied Sciences*, 7(6): 1325-1330.
- Thriveni, P.; B.S. Rani; N. Sunitha; M.M. Mohan and G.K. Sagar. 2024. Enhancing the Productivity and Quality of Blackgram (*Vigna mungo* L.) with Potassium Fertilization. *Legume Research*, 47(5): 855-859. doi: 10.18805/LR-5066.

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Research Article

The Relationship Between Social Maturity and Gender Differences in Urban and Rural Adolescents

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ABSTRACT

The capacity for responsible behaviour is a sign of social maturity. Social maturity, which is required for successful societal adaptation, is extremely important for the future success of the children. Since adolescence is the time when a person begins to establish their identity and exhibit adult behaviour. Social maturity is a crucial component for both the individual and society. The present study was conducted to find out the relationship between social maturity and gender differences in urban and rural adolescents. The purposive sample of 100 adolescents consisting (50 Boys, 50 Girls) from Bikaner city of Rajasthan state. The Nalini Rao's Social Maturity Scale used for data collection and Mean, SD, and the t-test were used to withdraw meaningful inferences of collected data. The results revealed that female adolescents had comparatively better social maturity than male. Significant differences were found in total social maturity scores ($Z=14.27^{**}$, $p<0.01$) of rural and urban adolescents. Further findings reflected that urban areas' adolescents had better social maturity on various aspects.

Keywords: Adolescents, Social maturity, Society, Behaviour

INTRODUCTION

Social development is the way in which a person acquires the appropriate behaviour necessary for good social functioning. Social growth is not required to be subject to group initiation. It is a personal commitment that is based on timeless facts about nature or life that we see every day. Achieving social growth and establishing good relationships with family, friends, neighbours and everyone else in our society are considered key components of social development. However, once a person reaches adulthood, he must decide about maturity. One must be aware of one's own worth, tolerant of the views of others and appreciative of their objectives.

The "emerging" or "realisation of identity" is the definition of adolescence. Throughout one's life, this is a crucial time for development and progress. This time frame is crucial since a person's formative years

are when significant physical, psychological, and behavioural changes take place (Patil *et al.*, 2009).

The ability of the mind to tolerate and the capability of a person to effectively react to uncertainties, circumstances, or surroundings, according to Finley (1996), are both indicators of maturity. The transition from infancy to maturity occurs throughout this time. Maturity goes hand in hand with both development and progress. Teenagers that are mature have the capacity to comprehend things and people and to treat others decently. A person who lacks life experience and is incapable of managing his family's issues cannot be tolerated by society.

According to Raj (1996), social maturity is the level of social awareness and abilities that a person has attained in comparison to specific standards associated to their age group. Adolescent social group adjustment causes many behaviour related problems. Every person

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must personally commit to social maturity as the attitude that will guide their everyday life and be beneficial in developing lifelong experiences. It's a stage that necessitates additional adult supervision as well because it's known to be a time when risk-taking is at peak level. The accomplishment of one's developmental potential, individual agency, and societal responsibility are the objectives and expectations of adolescence. An individual can choose between the socially immature attitude of selfishness and the socially mature attitude of sincere care for the welfare of those involved. Social development throughout adolescence might be influenced by gender differences. Boys who develop earlier get certain social benefits as a result of being taller, stronger, and frequently more well-liked. Girls, on the other hand, could feel more pressure to adhere to gender standards and conventions.

Although individual difference exist among the adolescents. However, rather than being a result of innate genetic characteristics, these individual distinctions might be traced to the differences in how both genders socialise.

MATERIALS AND METHODS

The goal of the current study was to investigate the relationship between social maturity and gender differences in urban and rural adolescents. The sample size consists of 100 adolescent students (N=100) 50 boys and 50 girls living in Bikaner city of Rajasthan state. The school/college students for the final sample were approached according to their availability in Bikaner. The purpose of the study was explained to them and requested to fill up the questionnaires. They were also ensured that whatever information they provide will be used purely for research purposes only and would be kept confidential. Purposive sampling method was used to gather data for this study, students who expressed interest in participating in this study were

taken into consideration. An assessment of the chosen subjects 'social maturity assessment' was conducted by using Dr. Nalini Rao's Social Maturity Scale. Independent variables taken in the study were Personal variables of respondent: Gender and residential area whereas Social maturity was taken as Dependent variable.

Rao's Social Maturity Scale (RSMS), a standardised instrument, was used to evaluate the social maturity of the chosen adolescents (Rao, 1998). The scale assesses social maturity along three dimensions: Personal Adequacy (includes components like work orientation, self-direction and ability to take stress), interpersonal adequacy (includes components like communication, enlightened trust, and cooperation), and social adequacy (includes components like social commitment, social tolerance, and openness to change).

RESULTS AND DISCUSSION

Results related to area wise comparison of adolescents' social maturity components portrayed in Table 1. depicts that highly Significant differences was found only in total social maturity ($Z=14.27^{**}$, $p<0.01$) of rural and urban adolescents.

The mean scores of social maturity components i.e. Personal adequacy, Inter-personal adequacy, Social adequacy and total social maturity ($M=2.02$; $M=2.04$; $M=2.16$; and $M=2.00$ respectively) were low for rural respondents in comparison to urban respondents ($M=2.08$; $M=2.04$; $M=2.16$; and $M=2.06$ respectively), reflecting urban areas' adolescents had comparatively better social maturity on above mentioned aspects.

This study was supported by Sam and Totuka (2021), revealed that the boys who were high on social maturity were from urban area. Mishra *et al.* (2017), also showed majority of boys and girls who belongs to urban area had high social maturity.

Table 1: Social maturity with respect to residential area (N-100)

Residential area → Social maturity ↓	Rural (n=50) Mean ± SD	Urban (n=50) Mean ± SD	Z-value
Personal adequacy	2.02±.31	2.08±.27	0.31 ^{NS}
Inter-personal adequacy	2.04±.19	2.04±.19	0.00 ^{NS}
Social adequacy	2.16±.37	2.16±.37	0.00 ^{NS}
Total Social maturity	2.00±.00	2.06±.24	14.27 ^{**}

^{**} Highly significance at .01% level; NS= Non-significant difference

Table 2: Social maturity with respect to gender differences (N=100)

Gender → Social maturity ↓	Male (n=50) Mean ± SD	Female (n=50) Mean ± SD	Z-value
Personal adequacy	2.06±.37	2.04±.19	4.53*
Inter-personal adequacy	2.04±.19	2.04±.19	0.00 ^{NS}
Social adequacy	2.14±.35	2.04±.19	1.18 ^{NS}
Total Social maturity	2.02±.14	2.04±.19	1.37 ^{NS}

*Significant at 5% level; NS= Non-significant difference

Results related to area wise comparison of adolescents' social maturity components portrayed in Table 2. Significant differences was found only in personal adequacy component of social maturity ($Z=4.53^*$, $p<0.05$) of male and female adolescents.

The mean scores of social maturity components i.e. Personal adequacy, Inter-personal adequacy, Social adequacy and total social maturity ($M=2.06$; $M=2.04$; $M=2.14$; and $M=2.02$ respectively) were lower for male respondents in comparison to female respondents ($M=2.04$; $M=2.04$; $M=2.04$; and $M=2.04$ respectively), reflecting female adolescents had comparatively better social maturity. However male adolescents had better social adequacy component of social maturity as compared to female respondents.

Lawrence (2011), found that female students are more socially mature than male students. Similarly, Mishra *et al.* (2017), also evaluated that girls had more social maturity, according to the findings, than the sample of guys. Whereas Kumar (2022), examined that the female students were significantly more socially matured than male students. Female have high social maturity because they want to integrate their relation and behave socially in their life. Female have the capability to understand the problems and face it smoothly. These attributes make female more capable to take right decision in every situation.

The result indicates that female adolescents from urban area had comparatively better social maturity. However male adolescents had better social adequacy component of social maturity as compared to female respondents and the significant differences were found only in personal adequacy component of social maturity and related to residential area the finding showed urban areas' adolescents were comparatively better socially mature. So, there was significant mean difference between social maturity of adolescents with respect to gender and residential area.

FINDINGS

- Highly significant differences were found in total social maturity ($Z=14.27^{**}$, $p<0.01$) of rural and urban adolescents
- This data reflecting urban areas' adolescents had comparatively better social maturity.
- Significant differences were found only in personal adequacy component of social maturity ($Z=4.53^*$, $p<0.05$) of male and female adolescents.
- The female adolescents had comparatively better social maturity than their counterparts.

CONCLUSION

This study concluded that female adolescents from urban area have better social maturity because the global environmental change scenario, socio interactive and socio educational approaches influences urban areas on earlier phase than rural community. So, fast changing environment of urban gives more opportunities of trial and error to show case socially mature behaviour. Adolescents of urban areas started to make independent and responsible decisions, taking responsibility in uncertain situation and harmoniously balancing personal and social needs earlier than the adolescents of rural.

REFERENCES

- Astha, M.; D. Seema and K. Mamta. 2017. A study on social maturity of adolescent in Sultanpur city. *International Journal of Home Science*, 3(2): 278-283.
- Finley, J. 1996. *Behaviour and development*. New York, NY: Harper and Row. [Google Scholar]
- Lawrence, A.S. and I. Jesudoss. 2011. Relationship between Social Maturity and Academic Achievement of Higher Secondary School Students. *Online Submission*, 3(3): 243-250.

- Lynne, S.D.; J.A. Graber; T.R. Nichols; J. Brooks-Gunn and G.J. Botvin. 2007. Links between pubertal timing, peer influences, and externalizing behaviors among urban students followed through middle school. *Journal of Adolescent Health*, 40(2): 181-e7.
- NCERT, N. 1999. Sixth all India education survey. *Main report. New Delhi, India: National Council of Educational Research and Training*. [Google Scholar].
- Patail, V.; T. Furtado and M. Kulkarni. 2009. Adolescence: An overview. *Indian Journal of Pediatrics*, 76(10): 1003-1007. <https://doi.org/10.1007/s12098-009-0195-z>
- Psychology Today. 2010. Adolescence and the Problems of Puberty. <https://www.psychologytoday.com/us/blog/surviving-your-childs-adolescence/201004/adolescence-and-the-problems-puberty> :
- Raj, M. 1996. *Encyclopaedia Dictionary of Psychology and Education*, New Delhi: Anmol publications.
- Sam, S. and N. Totuka. 2021. Social maturity and academic interests of adolescents.
- Singh, Y. and M. Bhargava. 1999. *Manual for Emotional Maturity Scale (EMS)*. National Psychological Corporation, Agra.
- Singh, R.; K. Pant and L. Valentina. 2014. Impact analysis: Family structure on social and emotional maturity of adolescents. *The Anthropologist*, 17(2): 359-365.
- World Health Organization. 2000. *World Health Organization-WHO*.

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Research Article

Advancement of Hydrodynamic Cavitation in Food Processing and it's Applications

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ABSTRACT

In today's fast-paced world, food industries strive to adopt energy-efficient and advanced technologies. One such promising and innovative approach in the field of food processing is hydrodynamic cavitation technology. This technology offers several advantages over traditional methods. It harnesses the phenomenon of cavitation, which occurs when pressure changes lead to the formation and collapse of microbubbles in a liquid medium. The intense energy generated during these cavitation events can bring about physical and chemical transformations, making it a versatile tool for numerous applications in the food industry. Hydrodynamic cavitation is a technology that has various applications in the food processing industry. It is particularly useful in improving the extraction process, reducing processing times, and enhancing mass transfer processes. This technology is ideal for extracting bioactive compounds from plant materials such as polyphenols and essential oils, which are important in developing functional foods with enhanced nutritional profiles. Additionally, hydrodynamic cavitation effectively inactivates microorganisms and enzymes, improving food safety and extending shelf life. This technology is non-thermal, which helps preserve the sensory and nutritional qualities of food products and also addresses the growing demand for minimally processed and nutritionally rich foods. Thus, hydrodynamic cavitation technology is a cutting-edge and sustainable approach in the food industry that offers a wide range of applications by enhancing processing efficiency, product quality, and overall sustainability.

Keywords: Hydrodynamic, Technology, Cavitation, Food

INTRODUCTION

In response to the contemporary consumer demand for food products that offer exceptional taste, convenience, prolonged shelf life, reduced calorie content, and elevated essential nutrients, ongoing research efforts have consistently centred around the advancement of innovative food processing technologies (Arya *et al.*, 2020). although this pursuit is seamlessly integrated into the ongoing Industrial Revolution 4.0 (Show *et al.*, 2020; Arya *et al.*, 2019; Wang *et al.*, 2020). Lately, researchers have been addressing the limitations of traditional heating methods by exploring various emerging non-thermal

technologies, including high hydrostatic pressure, pulsed electric fields, ultrasound, and cold plasma (Hi *et al.*, 2015; Xuan *et al.*, 2022). Hydrodynamic cavitation (HC) has particularly garnered attention as a highly promising non-thermal technique for food processing. Beyond its remarkable efficacy, the inherent scalability and practicality of HC render it well-suited for large-scale industrial production (Sun *et al.*, 2022).

Over the past decade, there has been comprehensive research on the cavitation technique, successfully implementing it in diverse physical, chemical, and biological processes. This innovative method not only achieves the desired transformations

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but also effectively lowers overall processing costs, proving to be more energy-efficient compared to numerous conventional techniques. Cavitation presents significant opportunities for enhancing various physical and chemical processes in an energy-efficient manner (Gogate and Kabadi, 2009). Cavitation is described as the occurrence of the creation, expansion, and collapse of tiny bubbles or voids, taking place within a few milliseconds to microseconds at various points in the reactor. This process releases a substantial amount of energy within a brief timeframe (Mahulkar and Pandit, 2010). Cavitation initiates when vapor cavities, such as bubbles or voids, form as liquid enters a low-pressure region. These cavities reach their maximum size through isothermal expansion. During the subsequent compression cycle, rapid adiabatic collapse occurs, creating a supercritical state characterized by high local temperature and pressure, referred to as a hot spot. The intense conditions in these hot spots drive the chemical and physical transformations essential for the process. The mechanical effects of cavitation, including microjet streaming and localized turbulence, play a key role in intensifying physical processes such as nano-emulsion synthesis, nanoparticle formation, microbial disruption, and disinfection. In contrast, the chemical effects, such as the generation of highly reactive free radicals in the aqueous environment, are primarily responsible for enhancing chemical processes like chemical synthesis and degradation of water pollutants. Cavitation can be induced in a liquid medium either through flow variation in a flowing liquid, known as hydrodynamic cavitation (HC), or by transmitting ultrasonic waves through the liquid, known as acoustic cavitation (AC). Other modes of generating cavitation, such as optic and particle cavitation, are typically applied to single-bubble cavitation and cannot be scaled up to induce significant physical or chemical changes in the bulk solution (Carpenter *et al.*, 2017a).

Acoustic Cavitation

Ultrasound is used to create cavities with alternating compression and rarefaction cycles in a process called acoustic cavitation. There are three categories of this process: high-frequency, low-power ultrasound with intensities below 1 W/cm², intermediate-frequency, medium-power ultrasound, and low-frequency, high-power ultrasound with intensities above 1 W/cm². Most

dairy applications commonly employ ultrasound within the frequency range of 20 kHz to 40 kHz. This is because both the physical forces and chemical effects of ultrasound are harnessed in various ways, although the focus is predominantly on leveraging the physical forces. (Chandrapala, 2016; Sutariya *et al.*, 2018). At lower frequencies, such as 20 kHz, the predominant effects of ultrasound are physical or mechanical in nature. Conversely, at higher frequencies, ranging from 300 to 500 kHz, the emphasis shifts towards chemical effects, particularly the formation of free radicals. The prominence of these effects depends on the applied energy density (Munir *et al.*, 2019).

Hydrodynamic Cavitation

Hydrodynamic cavitation (HC) is a phenomenon in which high energy is released in a flowing liquid when bubbles implode due to a decrease and subsequent increase in local pressure. While cavitation has traditionally posed challenges in hydraulic systems, its energy can be intentionally utilized for various physical and chemical processes. In industries such as food and beverages, the principle of hydrodynamic cavitation serves as a valuable tool for homogenizing, pasteurizing, breaking down, or mixing food macromolecules (Asaithambi *et al.*, 2019).

Principle and Mechanism of Hydrodynamic Cavitation

Principle: Hydrodynamic cavitation is a swift phase-changing phenomenon. When the pressure drops below the local saturated vapor pressure, nuclei present in the liquid begin to grow due to the pressure difference between the inside and outside of the bubble. Once the bubble undergoes pressure recovery or reaches its maximum diameter, it collapses, releasing substantial energy into the surrounding medium (Bang *et al.*, 2010; Tao *et al.*, 2020). This process induces the sonochemical effect under room conditions, characterized by intense mechanical effects such as shock waves and microjets with high pressure at approximately 500 bar, thermal effects including local hotspots reaching around 5,000K, and chemical effects resulting in the formation of hydrogen and hydroxyl radicals. Additionally, several secondary effects, such as mechanical vibration, turbulence, dispersion, emulsification, and macroscopic heating, can be generated (Sun *et al.*, 2022).

Hydrodynamic cavitation has demonstrated promising performance and industrialization potential across various processes, including water treatment, sludge disintegration, emulsification, biomass pretreatment, and food processing. The exceptional conditions created by hydrodynamic cavitation make it suitable for effective synergies with other intensification means, including ultrasound, chemicals, plasma, or photo or electrochemistry (Fedorov *et al.*, 2022; Kim *et al.*, 2020).

Mechanism: Hydrodynamic cavitation (HC) is generated by directing a liquid through a small orifice or constriction, leading to an increase in kinetic energy. This phenomenon involves several stages, including nucleation, bubble growth, and bubble implosion. At a specific point known as the vena contracta, the flow area of the liquid reaches a minimum. To induce HC, the throttling should be adequate for the pressure drop to go below the threshold pressure at the vena contracta, resulting in the release of numerous cavities. Subsequently, as the pressure further decreases and the liquid expands, these cavities break down, releasing a sharp shockwave of energy into the surroundings. This shockwave generates a potent microscopic mixing effect, controllable rotor/liquid friction, and scale-free heating (Gogate, 2011; Gogate and Pandit, 2005; Oestergaard, 2015). The mechanism of hydrodynamic cavitation (HC) bears resemblance to acoustic cavitation, differing primarily in terms of temperature and pressure. The collapse intensity of individual cavities in HC is notably lower than that produced by ultrasound. By carefully adjusting the system's geometry and operating parameters, both the intensity and the number of cavitation events can be effectively controlled.

Another method to induce HC involves the mechanical rotation of liquid at a specific velocity, achieved through specialized rotors with holes, known as hydrodynamic cavitation. The spinning rotor generates HC away from the metal surface within these holes, and the cavitation effect is entirely controlled within the system, safeguarding the surface from damage. Consequently, the microscopic cavitation bubbles collapse, releasing shockwaves that can blend and inhibit scaling. This process results in the generation of heat, with a uniform temperature distribution throughout the liquid, even in the absence of heat transfer surfaces (SPX Flow, 2013).

Orifice and Venturi Cavitating Device

Orifice and venturi are the preferred constriction geometries for inducing extreme cavitation conditions. Cavities formed in an orifice are transient, while venturi constructions generate stable cavities (Carpenter *et al.*, 2017a). Various forms of orifice geometries, both single and multiple holes, with varying flow areas. Common shapes for orifice openings include circular, rectangular, and triangular. Multiple holes in an orifice plate contribute to controlling cavitation intensity and events. On the other hand, a venturi consists of three sections: convergent, throat, and divergent. Geometrical parameters of a venturi, such as flow perimeter, throat area, convergence, and divergence angle, are crucial, and venturis are available in circular, slit, and elliptical shapes. The cavitation effects in an orifice are contingent on factors such as the opening of the flow area, the shape of the orifice, and the number of holes on the orifice plate. The pressure recovery in the orifice is exceptionally swift, facilitated by the sudden contraction and expansion geometry, leading to a rapid and intense collapse of cavities (Carpenter *et al.*, 2017b). These actions prove highly advantageous for activities like cell wall rupture and contribute to an increased rate of microbe inactivation (Arrojo *et al.*, 20007; Li *et al.*, 2015; Burzio *et al.*, 2020). Notably, cavity generation in an orifice primarily occurs at the throat section, resulting in smaller cavitation activities, representing a significant limitation associated with this constriction geometry.

A multiple-hole orifice addresses several shortcomings associated with a single orifice. It generates a higher number of cavities compared to a single-hole orifice with the same flow area, thanks to a larger perimeter available for flow in a multiple-hole orifice (Simpson *et al.*, 2018; Jangir *et al.*, 2017). The efficiency of the orifice is contingent upon two critical ratios/parameters: i) the perimeter of holes to the total flow area (α), and ii) the throat/hole opening area to the cross-sectional area of the pipe (β).

In a multiple-hole orifice plate, α increases with the number of holes on the orifice plate and decreases with an increase in the hole diameter/size. The perimeter is influenced by the shape of a hole or throat cross-sectional area (Doltade *et al.*, 2019). Thus, α rises with a higher number of holes and shape with a larger perimeter. Numerous studies have confirmed that α

> 2 is beneficial for enhancing cavitation activities and, consequently, microbial inactivation (Jangir *et al.*, 2017). The parameter β signifies the relationship between the operational cavitation number and the volumetric flow rate/discharge from the reactor. Microbial inactivation is influenced by the strength of the cell wall of microbes, and a β in the range of 0.3 to 0.4 is preferred for microbial inactivation (Burzio *et al.*, 2020). However, there are notable drawbacks associated with multiple-hole orifices, including significant energy loss, especially in hydrodynamic cavitation reactors. Another limitation is operational and maintenance issues, necessitating frequent shut-downs, which may pose challenges for the commercialization of the technology. Reports indicate that the venturi addresses several drawbacks associated with the orifice. Cavitation activities in a venturi are influenced by the shape of the throat (circular, elliptical, and rectangular) and divergent sections (Carpenter *et al.*, 2017a). The density and magnitude of cavitation activities are connected to the collapse pressure and lifespan (residence time) of a cavity in a low-pressure region. Concerns related to the early collapse of cavities (as observed in orifices) are mitigated by incorporating a divergent section in the venturi (Dastane *et al.*, 2019). This divergent section helps prevent premature cavity collapse and is beneficial for immediate pressure recovery. The flow area of a divergent section is correlated with the direction of flow, contributing to an increase in bubble size and resulting in stable cavitation activities (Shi *et al.*, 2019). Numerous studies have explored the optimization of venturi shapes and consistently concluded that the venturi is preferred over an orifice for energy recovery and the formation of stable cavitation activities.

Effects of HC in Food Processing

HC has been successfully utilized for processing various categories of foods, such as juice, milk, jam, yogurt, or even ice cream. Due to the induced extraordinary conditions, the physical, chemical, and biological characteristics of foods can be significantly improved by HC. Several physical characteristics of foods (e.g., particle size, viscosity, and temperature) can be affected by HC (Sun *et al.*, 2022).

Effects of HC on Physical Characteristics

The reduction in particle size, which results from the mechanical effect of HC, improves the

homogenization of juices by modifying the physical structure, which leads to a lower rate of sedimentation and separation of sediments from serum and increased apparent viscosity. For example, (Teran-Hilares *et al.*, 2019) found that the volume-based mean diameter of tomato juice was decreased from 291 to 248 μm after only 4-min of HC treatment (reactor: orifice, volume: 1.5 L, pressure drop: 3–0.3 bar, temperature: 45–59°C). Also, HC-treated juice shows high stability with sedimentation index (SI) over 98% during 14-day storage at 5°C. Similar results can be also found in the treatment of orange juice by (Arya *et al.*, 2019). For milk, like ultrasound, HC can disrupt the milk fat globule membrane, reduce the size of milk fat globule (MFG), increase the specific surface area of MFGs, and consequently promote the absorption through the walls of the small intestine. (Pegu and Arya, 2021) found that a 15-min HC treatment (reactor: orifice, volume: 1 L, inlet pressure: 10 psi, outlet temperature: 47.93°C) reduced the size of MFG from 6.3 to 2.22 μm , whereas the high-temperature short-time (HTST) pasteurization did not affect this. In addition, the optical microscopic results show that the MFG of the HC-treated sample is considerably small and evenly distributed, compared with that of HTST. Nevertheless, the HC-induced reduction in MFG size is less than high-intensity ultrasound (HIU) where it can be reduced to <1 mm. This can be attributed to the high local energy density and the timescale of rarefaction–compression periods of HIU (Gregersen *et al.*, 2020). Similar to HC-treated juices, the HC-treated milk is also stable and presented no phase separation even after 12 days of storage (38, 40). In addition, the mechanical effect also decreases the total soluble solid (TSS) content of liquid foods.

Effect of HC on Chemical Characteristics

To enhance effectiveness, most hydrodynamic cavitation (HC)-based approaches in food processing typically integrate HC with heating treatments or directly leverage the heating effect generated from HC. When compared to traditional pasteurization methods, the adverse impact of HC or thermal processes on liquid foods is considerably lower, suggesting that more nutrients can be retained. In a study by (Teran-Hilares *et al.*, 2019), it was reported that after HC treatments with varying outlet temperatures (35–62°C) and durations (0–10 minutes), no degradation of the lycopene content occurred in tomato juice under mild

conditions. Furthermore, both HC and thermal treatments have the potential to release chemicals with high thermal stability. Additionally, hydrodynamic cavitation (HC) or thermal treatment can yield a satisfactory removal effect on undesired thermostable enzymes, which are primarily linked to the deterioration of juice quality. In conclusion, to attain optimal treatment effectiveness, a careful compromise between the intensity of HC and temperature is essential, taking into account the balance between nutrition loss and the benefits specific to each case.

Effect of HC on Biological Characteristics

Hydrodynamic cavitation (HC) brings about improvements in biological characteristics primarily through microbial inactivation, which results from the combined effects of mechanical, thermal, and chemical influences. The physical impact during the collapse of cavitation bubbles can cause significant damage to cells, including plasmolysis, membrane breakage, and cytoplasm disruption (Cerecedo *et al.*, 2018). Furthermore, as microorganisms travel with the high-speed flow, collisions can occur when they impact solid walls, potentially leading to cell cleavage (Xie *et al.*, 2017). Further, thermal inactivation involves processes such as membrane denaturation, ribosome aggregation, DNA strand breaks, and protein inactivation induced by hotspots.

Applications of Hydrodynamic Cavitation in Food

A) Microbial cell disruption: For the inactivation of microorganisms in food substances, microbial cell disruption is considered a fundamental unit operation. By using hydrodynamic cavitation, the shelf stability of food was increased by rupturing the microorganism cell wall.

B) Food sterilization: Cavitations induce physical stresses within cells, leading to cellular inactivation. This mechanism, either employed individually or in combination with other technologies, is utilized for food sterilization. Hydrodynamic cavitation (HC) reactors provide several advantages, including the retention of product freshness, reduced energy consumption, and the ability to have a lethal effect on microbes at lower temperatures.

C) Dairy processing: Hydrodynamic cavitation (HC) has found numerous applications in the dairy processing industry, particularly in milk powder processing.

D) Juice industry: The application of hydrodynamic cavitation (HC) on juices has had a significant impact on various factors related to fruit and vegetable juices.

E) Waste management: Food waste is a concern for many food manufacturers, and researchers have successfully employed hydrodynamic cavitation (HC) for processing food waste. This approach allows for the extraction of valuable compounds, the production of by-products, and advancements in product development (Asaithambi *et al.*, 2019).

CONCLUSION

Hydrodynamic cavitation technology stands out as an energy-efficient technique when compared to other conventional approaches. Beyond its superior energy efficiencies, this technology also offers realistic and immediately cost-efficient industrial applications. In large-scale industries for processes like sterilization, microbial cell disruption, and various other food applications, hydrodynamic cavitation shows potential in enhancing and preserving the functional qualities of food and beverages. It can be considered an emerging technology applicable to laboratory, pilot-scale, and large-scale processing in the food and beverage sector. However, not all types of cavitators yield positive outcomes; the design of cavitators and the composition of food materials play a crucial role in determining the end results. Further research is needed to enhance the hydrodynamic cavitation process for achieving higher-quality products with longer shelf life. In the future, collaborative efforts can explore a vast area of research, applying this technology for energy-efficient, fast, and convincing results in the food and beverage industry.

REFERENCES

- Arrojo, S.; Y. Benito; A. Martinez and Tarifa. 2007. A parametrical study of disinfection with hydrodynamic cavitation. *Ultrasonics Sonochemistry*, 15: 903–908.
- Arya, S.S.; A.M. Kaimal; M. Chib; S.K. Sonawane and P.L. Show. 2019. Novel, energy efficient and green cloud point extraction: technology and applications in food processing. *Journal of Food Science and Technology*, 56: 524–534.

- Arya, S.S.; O. Sawant; S.K. Sonawane; P.L. Show; A. Waghmare and R. Hilares. 2020. Novel, nonthermal, energy efficient, industrially scalable hydrodynamic cavitation – applications in food processing. *Food Reviews International*, 6: 668– 691.
- Asaithambi, N.; P. Singha; M. Dwivedi and S.K. Singh. 2019. Hydrodynamic cavitation and its application in food and beverage industry: A review. *Journal of Food Process Engineering*, 42(5): p.e13144.
- Bang, J.H. and K.S. Suslick. 2010. Applications of ultrasound to the synthesis of nanostructured materials. *Advanced Materials*, 22: 1039–1059.
- Burzio, E.; F. Bersani; G.C.A. Caridi; R. Vesipa; L. Ridolfi and C. Manes. 2020. Water disinfection by orifice-induced hydrodynamic cavitation. *Ultrasonics Sonochemistry*, 60: 104740.
- Carpenter, J.; M. Badve; S. Rajoriya; S. George; V.K. Saharan and A.B. Pandit. 2017a. Hydrodynamic cavitation: an emerging technology for the intensification of various chemical and physical processes in a chemical process industry. *Reviews in Chemical Engineering*, 33(5): 433-468.
- Carpenter, J.; S. George and V.K. Saharan. 2017b. Low pressure hydrodynamic cavitating device for producing highly stable oil in water emulsion: effect of geometry and cavitation number. *Chemical Engineering and Processing: Process Intensification*, 116: 97–104.
- Cerecedo, L.M.; C. Dopazo and R. Gomez-Lus. 2018. Water disinfection by hydrodynamic cavitation in a rotor-stator device. *Ultrasonics Sonochemistry*, 48: 71-78.
- Chandrapala, J. 2016. Handbook of ultrasonics and sonochemistry. *Handbook of Ultrasonics and Sonochemistry*.
- Dastane, G.G.; H. Thakkar; R. Shah; S. Perala; J. Raut and A.B. Pandit. 2019. Single and multiphase CFD simulations for designing cavitating venturi. *Chemical Engineering Research and Design*, 149: 1–12.
- Doltade, S.B.; G.G. Dastane; N.L. Jadhav; A.B. Pandit; D.V. Pinjari; N. Somkuwar and R. Paswan. 2019. Hydrodynamic cavitation as an imperative technology for the treatment of petroleum refinery effluent. *Journal of Water Process Engineering*, 29: 100768.
- Fedorov, K.; K. Dinesh; X. Sun; C.S.R. Darvishi; Z. Wang and S. Sonawane. 2022. Synergistic effects of hybrid advanced oxidation processes (AOPs) based on hydrodynamic cavitation phenomenon – a review. *Chemical Engineering Journal*, 432: 134191.
- Gogate, P.R. 2011. Application of hydrodynamic cavitation for food and bioprocessing. In: H. Feng, G. Barbosa-Canovas, and J. Weiss (Eds.), *Ultrasound Technologies for Food and Bioprocessing*. Food Engineering Series (pp. 141–173). New York, NY: Springer.
- Gogate, P.R. and A.B. Pandit. 2005. A review and assessment of hydrodynamic cavitation as a technology for the future. *Ultrasonics Sonochemistry*, 12: 21–27.
- Gogate, P.R. and A.M. Kabadi. 2009. A review of applications of cavitation in biochemical engineering/ biotechnology. *Biochemical Engineering Journal*, 44: 60–72.
- Gregersen, S.B.; L. Wiking; D.J. Metto; K. Bertelsen; B. Pedersen and K.R. Poulsen. 2020. Hydrodynamic cavitation of raw milk: effects on microbial inactivation, physical and functional properties. *International Dairy Journal*, 109: 104790.
- Hii, C.L.; S.P. Ong and P.L. Show. 2015. Processing of Foods, Vegetables and Fruits – Recent Advances. Abington, PA: Taylor & Francis Online.
- Jangir, N.; P. Diwedi and S. Ghosh. 2017. Design of a hydrodynamic cavitating reactor. *Chemical Engineering and Processing: Process Intensification*, 122: 128–142.
- Kim, H.; B. Koo; X. Sun and J.Y. Yoon. 2020. Investigation of sludge disintegration using rotor-stator type hydrodynamic cavitation reactor. *Separation and Purification Technology*, 240: 116636.
- Li, W.X.; C.D. Tang; Z.L. Wu; W.M. Wang; Y.-F. Zhang; Y. Zhao and G. Cravotto. 2015. Eutrophic water purification efficiency using a combination of hydrodynamic cavitation and ozonation on a pilot scale. *Environmental Science and Pollution Research*, 22: 6298–6307.
- Mahulkar, A. and A.B. Pandit (Ed.) 2010. Analysis of hydrodynamic and acoustic cavitation reactors. Saarbrücken, Germany: VDM publishing, 2010.
- Munir, M.; M. Nadeem; T.M. Qureshi; T.S.H. Leong; C.J. Gamlath; G.J.O. Martin and M. Ashokkumar. 2019. Effects of high pressure, microwave and ultrasound processing on proteins and enzyme activity in dairy systems — A review. *Innovative Food Science and Emerging Technologies*, 57: 102192.
- Oestergaard, B. 2015. Hydrodynamic Cavitation Helps Dairy Powder Processing. Silkeborg, Denmark: SPX Flow Technology.
- Pegu, K. and S.S. Arya. 2021. Comparative assessment of HTST, hydrodynamic cavitation and ultrasonication on physico-chemical properties, microstructure, microbial and enzyme inactivation of raw milk. *Innovative Food Science & Emerging Technologies*, 69: p.102640.
- Shi, H.; M. Li; P. Nikrityuk and Q. Liu. 2019. Experimental and numerical study of cavitation flows in venturi tubes: from CFD to an empirical model. *Chemical Engineering Science* 207: 672–687.

- Show, P.L.; K.W. Chew and H.Y. Leong. 2020. Advanced food process technologies: bridging conventional practices to industry. *Current Nutrition & Food Science*, 16: 1286–1286.
- Simpson, A.; V.V. Ranade. 2018. Modelling of hydrodynamic cavitation with orifice: influence of different orifice designs. *Chemical Engineering Research and Design*, 136: 698–711.
- SPX Flow. (2013). The APX Cavitator. Retrieved from: https://www.spxflow.com/en/assets/pdf/APV_Cavitator_5004_01_03_2013_GB.pdf/.
- Sun, X.; W. You; Y. Wu; Y. Tao; J.Y. Yoon; X. Zhang and X. Xuan. 2022. Hydrodynamic cavitation: a novel non-thermal liquid food processing technology. *Frontiers in Nutrition*, 9: p.843808.
- Sutariya, S.; V. Sunkesula; R. Kumar and K. Shah. 2018. Emerging applications of ultrasonication and cavitation in dairy industry: A review. *Cogent Food and Agriculture*, 4(1): 1–2.
- Tao, Y.; Y. Wu; Y. Han; F. Chemat; D. Li and P.L. Show. 2020. Insight into mass transfer during ultrasound-enhanced adsorption/desorption of blueberry anthocyanins on macroporous resins by numerical simulation considering ultrasonic influence on resin properties. *Chemical Engineering Journal*, 380: 122530.
- Teran-Hilares, R.; J.G. dos Santos; N.B. Shiguematsu; M.A. Ahmed; S.S. da Silva and J.C. Santos. 2019. Low-pressure homogenization of tomato juice using hydrodynamic cavitation technology: effects on physical properties and stability of bioactive compounds. *Ultrasonics Sonochemistry*, 54: 192–197.
- Wang, J.; C. Li; Y. Wan; C. Zhang; J. Ran and M.W. Fu. 2020. Size effect on the shear damage under low stress triaxiality in micro-scaled plastic deformation of metallic materials. *Materials & Design*, 196: 109107.
- Xie, L.; A. Terada and M. Hosomi. 2017. Disentangling the multiple effects of a novel high pressure jet device upon bacterial cell disruption. *Chemical Engineering Journal*, 323: 105–113.
- Xuan, X.; M. Wang; M. Zhang; Y.V. Kaneti; X. Xu and X. Sun. 2022. Nano architectonics of low-dimensional metal-organic frameworks toward photo/electrochemical CO₂ reduction reactions. *Journal of CO₂ Utilization*.

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Research Article

Measuring Sustainability of Zero Budget Natural Farming Practices

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ABSTRACT

Zero Budget Natural Farming (ZBNF) has been popularized as an alternative agriculture in recent years in the country. Based on agroecological principles, ZBNF proved to be cost and resource effective. In the present study, the sustainability of ZBNF practices was assessed and sustainability variable was divided into three dimensions, namely, economic, socio territorial and agro-ecological dimensions. Furthermore, four unique criteria were considered under each dimension. In Economic dimension in case of Andhra Pradesh, the average score of the index of economic dimension was 199.75 out of 300 and fall into medium category. In the Maharashtra state, the average score of the index of economic dimension was 240.33 out of 300 and fall into high category. In case of Socio-territorial dimension in Andhra Pradesh, the average score of the index of the socio-territorial dimension was 242.42 out of 300 and fall under high category. In Maharashtra state, the average score of the index of the socio-territorial dimension was 229.58 out of 300 fall under high category. In case of Agro-ecological dimension in Andhra Pradesh, the average score of the index of agro-ecological dimension was 244.75 out of 300 fall under high category. In Maharashtra state, the average score of the index of the socio-territorial dimension was 248.50 out of 300 fall under high category. The average sustainability measurement index of ZBNF practices for Andhra Pradesh (228.97) followed by Maharashtra (239.47) falls under high level sustainability category.

Keywords: Sustainability, Zero budget natural farming, Agro-ecological sustainability, Sustainability measurement index

INTRODUCTION

Agriculture has been the backbone of Indian economy for centuries. More than half of the country's population at present depends on agriculture and allied services for their livelihoods (Tripathi *et al.*, 2018). For a farm to be sustainable, it must produce adequate amounts of high-quality food, protect its resources and be both environmentally safe and profitable. Instead of depending on purchased materials such as fertilizers,

a sustainable farm relies as much as possible on beneficial natural processes and renewable resources drawn from the farm itself (Reganold *et al.*, 1990). The late 1960s marked the inception of the Green Revolution in India, heralding agricultural prosperity by boosting the productivity of key crops to meet the needs of its growing population. However, as time passed, the intensified utilization of fertilizers and other agricultural chemicals, a fundamental aspect of the Green Revolution, brought about adverse

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consequences such as soil degradation, a gradual increase in multi-nutrient deficiencies, imbalances in nutrient levels, and inefficient utilization of resources. In the light of these growing concerns about the sustainability of the current input-intensive agriculture system, the need for an alternative farming system has arisen (Mader *et al.*, 2002). Zero Budget Natural Farming (ZBNF) offers a compelling rationale by promoting sustainable agriculture. It has been emerged as economically viable for smallholders while conserving the environment, ensuring resilience to climate change, and fostering healthier diets for both farmers and consumers. ZBNF is a grassroots agrarian movement which is low-cost and based on locally sourced home-made amendments. ZBNF, therefore, does not rely on the use of agrochemicals or agribusiness, and it is expected to be able to achieve the twin goals of global food security and conservation of the environment (RySS 2020). ZBNF treatment benefits derive from higher soil moisture content, lower soil temperature and a larger earthworm population as a consequence of mulch addition (Duddigan *et al.*, 2023). Many studies have been done to see the performance of ZBNF farmers in many parts of the country in terms of increase yields (Khadse *et al.*, 2018 and Bharucha *et al.*, 2020), over Non-ZBNF farmers. ZBNF farmers report that in comparison to chemical farming ZBNF did not require frequent spraying of chemicals, or weeding-weeds are considered friends by ZBNF farmers. Farmers reported that hiring of labor was dependent on the size of the land holding. Small farmers are able to manage ZBNF operations using their own family labor if they wish to reduce costs, while larger farmers continue to employ labor for farm operations (Khadse *et al.*, 2018). Evidences suggest that long-term sustainability of the organic model is conditioned upon the interplay of agro-climatic conditions and various socio-economic factors such as economic conditions of the farmers, past agricultural practices, yield and cost of cultivation, subsidy from the government and presence of market premium for organic produce (Koner *et al.*, 2021). Still there are debate about its performance and sustainability in long term and large scale area. So the farm sustainability should be assessed in multidimensional mode. So the present study has been formulated to study the sustainability of ZBNF practice.

MATERIALS AND METHODS

Sustainability of ZBNF practices was measured by adapting Gafsi and Favreau (2010) method. This variable was divided into three dimensions, namely, economic, socio territorial and agro-ecological dimensions. Furthermore, four unique criteria were considered under each dimension. Similarly, three statements were included under each point in order to measure the extent of the opinion of the respondents using 4-point Likert-type scale, viz. very high (3), high (2), moderate (2) and not at all (0). In order to have a composite measure for the criteria considered under each dimension, a Sustainability Measurement Index (SMI) was developed and used.

The SMI of individual statement was measured using following formula:

The score SMI of individual statement =

$$\Sigma (\text{Number of responses opined very high} \times 3 + \text{Number of responses opined high} \times 2 + \text{Number of responses opined moderate} \times 1 + \text{Number of responses opined not at all} \times 0).$$

The possible range of the score of SMI of individual statement is between 0 and 300. Score of 0 indicates no sustainability, on the other hand, score of 300 indicates the highest level of sustainability. As the dependent variable was divided into three dimensions, the average score of the index was measured using following formula:

$$\mu = \Sigma X / N$$

Where, μ = the average score of the index of each dimension of the variable

X= Score of the individual statements,

N= Number of the statements under each dimension of the variable

Again the average score for all dimensions of the dependent variable was calculated al3l together applying same formula.

RESULTS AND DISCUSSION

Economic dimension is divided into four criteria, namely, viability, autonomy, transmissibility and efficiency. Three statements were selected under each of the criterion. In case of Andhra Pradesh, the average

Table 1: Economic dimension of sustainability (N=200)

Economic Dimension	Extent of Opinion (Andhra Pradesh) (n=100)				Sustainability Measurement Index (SMI)	Extent of Opinion (Maharashtra) (n=100)				Sustainability Measurement Index (SMI)
	VH	H	M	NA		VH	H	M	NA	
	(3)	(2)	(1)	(0)		(3)	(2)	(1)	(0)	
Viability										
Profitability of ZBNF practices	58	26	15	01	241	53	27	14	06	227
Uniformity and aesthetic view of the vegetables	43	32	16	09	209	52	36	11	01	239
Satisfaction level of the family members	51	29	13	07	224	64	26	08	02	252
Autonomy										
Willingness of the family members working in ZBNF	58	24	13	05	235	71	19	07	03	258
Requirements of external labour	06	23	10	61	74	57	28	11	04	238
Preparation of different natural farming inputs by own management	59	33	05	03	248	65	25	08	02	253
Transmissibility										
Inspirational to other farmers	46	34	08	12	214	61	29	09	01	250
Creating attraction to farmers for self-motivation	52	29	11	08	225	53	25	16	06	225
Increasing confidence level of the farmers adoption of ZBNF practices	23	61	07	09	198	58	21	11	10	227
Efficiency										
Satisfaction on the amount of yield	06	31	53	10	133	56	24	10	10	226
Market price	09	26	57	08	136	61	27	09	03	246
Taste, texture and food quality	68	26	04	02	260	59	29	08	04	243
The Average score of the index of economic dimension					199.75					240.33

*VH = Very High, H = High, M = Moderate and NA = Not at all

score of the index of economic dimension was 199.75 out of 300 (Table 1). Table 2 revealed that the sustainability of ZBNF practices with respect to the economic dimension fall into medium category. Economically, it can thus be said that, the ability of ZBNF practices to continue in the long term and also withstand external market fluctuations is average. In the Maharashtra state, the average score of the index of economic dimension was 240.33 out of 300 (Table 2). Table 2 revealed that the sustainability of ZBNF practices with respect to the economic dimension fall into high category. Economically, it can thus be said that, the ability of ZBNF practices to continue in the long term and also withstand external market fluctuations is low. The similar positive result was also reported by Koner *et al.* (2020) while studying about economic viability of ZBNF practices in West Bengal.

Socio-territorial dimension is divided into four criteria, namely, working condition, quality of living, contribution of local economy, and social involvement. Three statements were selected under each criterion. In Andhra Pradesh, the average score of the index of the socio-territorial dimension was 242.42 out of 300. Table 2, depicted that the sustainability of ZBNF practices related to the socio-territorial dimension fall under high category. Socio-territorially, the ability of ZBNF practices to ensure sustainability is high. So, the degree of socio-territorial sustainability of ZBNF practices in terms of the quality of life of farmers and the importance of services they offer to the society is high. Here, the socio-territorial sustainability of the ZBNF practices primarily includes employment generation and contribution to the well-being. In Maharashtra state, the average score of the index of

Table 2: Socio-territorial dimension of sustainability (N=200)

Socio-Territorial Dimension	Extent of Opinion (Andhra Pradesh) (n=100)				Sustainability Measurement Index (SMI)	Extent of Opinion (Maharashtra) (n=100)				Sustainability Measurement Index (SMI)
	VH	H	M	NA		VH	H	M	NA	
	(3)	(2)	(1)	(0)		(3)	(2)	(1)	(0)	
<i>Working condition</i>										
Willingness to work in ZBNF	58	34	10	02	252	31	52	10	03	207
Satisfaction for working in ZBNF	62	23	11	04	243	54	31	09	04	233
Self-feelings for using natural farming inputs and IPM practices	78	16	04	02	270	61	32	05	02	252
<i>Quality of living</i>										
Self-dependence on income from ZBNF	68	19	09	04	251	55	29	11	05	234
Palatability of the edible produce	54	31	12	03	236	56	29	11	04	237
Purchase by the local consumers	63	25	08	04	247	65	19	10	06	243
<i>Contribution to local economy</i>										
Jobs created on the farm	69	23	06	02	259	56	29	09	06	235
Contribution towards fulfillment of the needs of the local market	62	19	11	08	235	59	21	13	07	232
Facility of direct sell in the market	52	36	10	02	238	49	31	15	05	224
<i>Social involvement</i>										
Communication with the consumers and the markets	49	36	11	04	230	51	32	12	05	229
Communication with the local input agencies and NGOs	58	22	14	06	232	19	61	12	08	191
Communication with extension organizations, such as DAE, DLS, DOF etc.	46	31	16	07	216	54	22	14	10	220
The Average score of the index of socio-territorial dimension					242.42					229.58

*VH = Very High, H = High, M = Moderate and NA = Not at all

the socio-territorial dimension was 229.58 out of 300. Table 3, depicted that the sustainability of ZBNF practices related to the socio-territorial dimension fall under high category. Rajani (2019) in her study found that ZBNF has contributed to improvements in the agricultural sustainability parameters like soil fertility, quality of crop output, resilience to cope with weather variability, financial empowerment of farmers and respectability towards agriculture occupation.

Agro-ecological dimension is divided into four criteria, namely, fertilizer pollution and soil fertility, crop rotation, agro and natural biodiversity, and resource management. Three statements were selected under each criterion. In Andhra Pradesh, the average score

of the index of agro-ecological dimension was 244.75 out of 300 (Table 3). The results in Table 3 shows that the sustainability of ZBNF practices fall under high category, in relation to agro-ecological dimension. Since the score for agro-ecological dimension is high, then the tendency of the ZBNF practices system to combine efficient use of natural resource and minimal environmental cost is high. Consequently, the practices concerning resources management, particularly, soil, water and energy management, and respecting the balance of the ecosystem. In Maharashtra state, the average score of the index of the socio-territorial dimension was 248.50 out of 300. Table 3, depicted that the sustainability of ZBNF practices related to the socio-territorial dimension fall under high category.

Table 3: Agro-ecological dimension of sustainability (N=200)

Agro-Ecological Dimension	Extent of Opinion (Andhra Pradesh) (n=100)				Sustainability Measurement Index (SMI)	Extent of Opinion (Maharashtra) (n=100)				Sustainability Measurement Index (SMI)
	VH	H	M	NA		VH	H	M	NA	
	(3)	(2)	(1)	(0)		(3)	(2)	(1)	(0)	
Fertilizer pollution and soil fertility										
Improving status of the soil health	78	17	05	00	273	72	21	07	00	265
Use of locally available inputs	64	21	13	02	247	68	17	14	01	252
Use of green manure, compost, poultry litter, ash, cow dung etc.	57	21	16	06	229	61	23	11	05	240
Crop rotation										
Status of following the crop rotation	61	22	11	06	238	65	24	09	02	252
Interest in practicing crop rotation	58	19	22	01	234	59	20	18	03	235
Use of leguminous crops in crop rotation	62	19	13	06	237	66	21	09	04	249
Agro and natural biodiversity										
Control of the insect pest infestation applying IPM techniques e.g. phero- mone trap, Yellow sticky strip	67	19	10	04	249	63	21	11	05	242
Presence of beneficial insects such as honey bee and others	62	17	12	09	232	64	19	11	06	245
Interest in using natural pesticide e.g. Neem, Mahogany etc.	68	21	07	04	253	70	19	06	05	254
Resource management										
Appropriate use of soil	63	19	13	05	240	69	21	07	03	256
Appropriate use of water	68	17	11	04	249	65	16	13	06	240
Appropriate use of energy; e.g. solar ray, labourer, modern agricultural tools etc.	69	21	07	03	256	72	13	10	05	252
The Average score of the index of Agro-ecological dimension					244.75					
The Average Sustainability Measurement Index of ZBNF practices					228.97					

*VH = Very High, H = High, M = Moderate and NA = Not at all

The average sustainability measurement index of ZBNF practices for Andhra Pradesh it was found to be 228.97 which falls under high category, whereas in Maharashtra state the average sustainability measurement index of ZBNF practices was 239.47 falls under high category. Generally, the overall sustainability of ZBNF practices for both the states falls under the high category of sustainability. The similar results was also find by Saharan, *et al.*, (2021) that Jeevamirt improves the soil chemical and microbial properties and also reshapes the microbial community structure, improving the soil biology.

CONCLUSION

Zero Budget Natural Farming (ZBNF) has been emerged as a unique response within the spectrum of alternative agriculture practices. While alternative agriculture encompasses various sustainable farming approaches, ZBNF specifically addresses the need to reduce financial burdens on farmers by eliminating the cost of synthetic inputs. It offers an alternative that is not only environmentally friendly but also economically viable, particularly for small-scale and resource-constrained farmers. By relying on natural resources

and minimizing external inputs, ZBNF stands out as a holistic solution that combines ecological and economic sustainability. In the present study also the sustainability of ZBNF practices were measured and found to be more economically sound, socio-territorial fit for farmers keeping the view of agro-ecologically sound. The study recommend the scaling of ZBNF practices with appropriate technologies and promotional strategies.

REFERENCES

- Babalad, H.B. and G.V. Navali. 2021. Comparative Economics of Zero Budget Natural Farming with Conventional Farming Systems in Northern Dry Zone (Zone-3) of Karnataka. *Economic Affairs*, 66(2): 355-361.
- Bharucha, Z.P.; S.B. Mitjans and J. Pretty. 2020. Towards redesign at scale through zero budget natural farming in Andhra Pradesh, India. *International Journal of Agricultural Sustainability*, 18(1): 1-20.
- Duddigan, S.; L.J. Shaw; T. Sizmur; D. Gogu; Z. Hussain; K. Jirra and C.D. Collins. 2023. Natural farming improves crop yield in SE India when compared to conventional or organic systems by enhancing soil quality. *Agronomy for Sustainable Development*, 43(2): 31.
- Gafsi, M. and J.L. Favreau. 2010. Appropriate method to assess the sustainability of organic farming systems. In *9th European IFSA symposium* (Vol. 398).
- Khadse, A.; P.M. Rosset; H. Morales and B.G. Ferguson. 2018. Taking agroecology to scale: The zero budget natural farming peasant movement in Karnataka, India. *The Journal of Peasant Studies*, 45(1): 192-219.
- Koner, N. and A. Laha. 2020. Economics of zero budget natural farming in Purulia District of West Bengal: Is it economically viable? *Studies in Agricultural Economics*, 122(1): 22-28.
- Koner, N. and A. Laha. 2021. Economics of alternative models of organic farming: empirical evidences from zero budget natural farming and scientific organic farming in West Bengal, India. *International Journal of Agricultural Sustainability*, 19(3-4): 255-268.
- Mäder, P.; A. Fliessbach; D. Dubois; L. Gunst; P. Fried and U. Niggli. 2002. Soil fertility and biodiversity in organic farming. *Science*, 296(5573): 1694-1697.
- Reganold, J.P.; R.I. Papendick and J.F. Parr. 1990. Sustainable agriculture. *Scientific American*. 262(6): 112-120.
- RySS. 2020. Zero budget natural farming: official website of ZBNF programme of Rythu Sadhikara Samstha, Government of Andhra Pradesh. <http://apzbnf.in/>
- Saharan, B.S.; S. Tyagi; R. Kumar; O.H. Vijay; B.S. Mandal and J.S. Duhan. 2023. Application of Jeevamrit improves soil properties in zero budget natural farming fields. *Agriculture*, 13(1): 196.
- Tripathi, S.; T. Shahidi; S. Nagbhushan and N. Gupta. 2018. Zero Budget Natural Farming for the Sustainable Development Goals (Council on Energy, Environment and Water). Council on Energy, Environment and Water.

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Research Article

Empowering People: Millets Processing for Sustainable Nutrition and Livelihood Security

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ABSTRACT

Millets are considered the most beneficial crops in this era of climate change, and they work well with the present conditions of hunger, poverty, nutritional issues, and marginal farming. This paper investigates the critical role of millet processing in increasing both nutritional consumption and livelihood security within communities through the case studies of cereal and millet processing entrepreneurs in Punjab. For this, an in-depth semi structured interview schedule was prepared to elicit the necessary information about the farmers' enterprise. A total of four entrepreneurs who were indulged in cereal and millet processing were compared. Their socio-economic aspects, resources owned, profits generated through enterprise, and role of institutional intervention were studied to get the real picture of their strengths, opportunities, challenges and success. It was analyzed from the case studies that Mr. Paramjit Singh, one of the millet growers in Ludhiana district in Punjab, is reaping enormous benefits from processing of millets, different types of flour, and cookies. The marginal farmer with 2.5 ha land, was able to generate a handsome amount of income of 7-8 lakh per annum by agro-processing. His cookies and flour are gaining much popularity not only in his home district but in Punjab state as a whole. The appropriate trainings for production and processing, besides adoption of new marketing techniques like branding, packaging and advertising through social media led the venture to new heights. The case study showcase that by establishing small-scale processing units, rural communities can harness viable income opportunities. The paper advocates millet processing as a catalyst for sustainable nutrition and livelihood security of farming community.

Keywords: Sustainable livelihood, Nutritional security, Case study, Entrepreneurs

INTRODUCTION

Millets are considered as “minor cereals” and are the world's sixth most important cereal grains (Saleem *et al.*, 2023), which along with maize, sorghum, oats and barley are known as “coarse cereals”. It is categorised into major millets, such as sorghum (*chulam*), pearl millet (*cumbu*) and finger millet (*ragi*) and minor millets, such as barnyard millet (*kudhiraval*), foxtail millet (*thenai*), kodo millet (*varagu*), proso millet (*panivaragu*) and little millet (*samai*). Millets are also known as nutri-grains because they are rich in micronutrients, minerals and B-complex vitamins. They are believed to treat the diabetes, ageing, cancer, celiac disease and cardiovascular disease (Bhat *et al.*, 2003). It has abundant

health promoting phytochemicals and could be consumed as functional foods. It could perform well even in mixed cropping with vegetables and pulses. In India, 600 million people are dependent on the agricultural sector; the majority of them are small farmers with up to 2 hectares of land holding. Rain-fed is two thirds of the net sown area. About 40 million hectares of this land being flood-prone and about two third of it is drought-prone. Millets are well suited for drought prone regions (Tiwari *et al.*, 2022).

Millets production in India

Millets account for only 2% of the world cereal production and 95% of the world millet production

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comes from Asia and Africa (FAO, 2018). India produces all the nine commonly known millets and is the largest producer and fifth-largest exporter of millets in the world (FPO, 2021). Most of the states in India grow one or more millet crop species. India recorded 27 per cent growth in millet production in 2021-22 as compared to millet production in the previous year was 15.92 MMT (APEDA, 2022). The major millets producing states in India are Rajasthan, Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Telangana. Under National Food Security Mission (NFSM) programme, the NFSM-Nutri Cereals is being implemented in 212 districts of 14 states. India has more than 500 Start-ups working in the millet value-added chain, while Indian Institute of Millets Research has incubated 250 Start-ups under Rashtriya Krishi Vikas Yojana - Raftar. Export of millets is increasing year after year. It was worth of *USD 34.32 million during 2021-22*. In 2020-21, India exported millets worth USD 26.97 million against USD 28.5 million in 2019-20. According to 2020 data, India's millets exports have continuously increased at around 3 per cent CAGR in the last five years ending with 2020. The varieties of millets exported by India include Bajra, Ragi, Canary, Jawar, and Buckwheat (PIB, 2022).

Overall, the millets production in India not only serves as a source of food and fodder but also contributes to the livelihoods of many small and marginal farmers. It is a valuable crop for enhancing food security and nutrition in the country, especially in regions prone to drought and water scarcity.

Millets: A nutri-sensitive approach for sustainable future

Millets play a significant role in ensuring nutritional security, particularly in regions with food and nutrition challenges. Millets are highly nutritious, containing essential vitamins, minerals, and dietary fiber. They are rich in iron, calcium, phosphorus, and B vitamins, making them a valuable addition to diets, especially in areas where micronutrient deficiencies are prevalent. Millets are naturally gluten-free, making them a safe and nutritious option for individuals with celiac disease or gluten sensitivities. Millets have a low glycemic index, which means they can help regulate blood sugar levels and are suitable for individuals with diabetes. Millet is

a hardy crop that can grow in conditions of low rainfall and poor soil quality, making it a crucial crop in regions prone to drought and climate variability. Millets offer crop diversification, reducing dependence on a few staple crops, which is essential for food security and resilience in the face of changing environmental conditions.

Processing of millets decreases the anti-nutritional factors in millets and improves the bio-accessibility of nutrients. Many processing methods have been used traditionally like roasting/popping, soaking, germination and fermentation (Jaybhaye and Shrivastva, 2015). All these methods have been reported to have a significant impact on the nutritional value of the grain. Malting of millets improves access to nutrients and has been reported to increase the bio accessibility of iron by 300% and of manganese by 17% (Platel *et al.*, 2010). Millets are considered the most beneficial crops in this era of climate change, and they work well with the present conditions of hunger, poverty, nutritional issues, and marginal farming. This paper investigates the critical role of millet processing in increasing both nutritional consumption and livelihood security within communities through the case studies of cereal and millet processing entrepreneurs in Punjab.

MATERIALS AND METHODS

In this research paper an attempt was made to provide a comprehensive examination of the significance of millets processing in achieving sustainable livelihoods and ensuring nutritional security. A descriptive case study method was used to get the detailed information about the Agri-entrepreneurs in Punjab. For this, an in-depth semi structured interview schedule was prepared to elicit the necessary information about the farmers' enterprise. A total of four entrepreneurs who were indulged in cereal and millet processing were compared on the basis of their personal and entrepreneurial characteristics. After comparison, one best motivating case study of a millet farmer is discussed along its socio-economic aspects, resources owned, profits generated through enterprise, and role of institutional intervention to get the real picture of the venture's strengths, opportunities, challenges and success. Data was mainly showed through the tables and pictures of successful agri-enterprise.

Glimpses of FarMative Enterprise



FarMative outlet



S. Paramjit Singh showing his products



S. Paramjit Singh facilitated during *Kisan Mela*



Cookies production at FarMative



Packaged products of FarMative



S. Paramjit Singh exhibiting his products in exhibition

RESULTS AND DISCUSSION

The result of the study summarizes the findings from the comparison of four agri-entrepreneurs, highlighting key factors contributing to their success. An in-depth analysis of a successful agri-enterprise is discussed in the form of a case study focused on Mr. Paramjit Singh, a visionary individual who has demonstrated exceptional prowess in the agricultural sector, especially in millet production and processing. Through a comprehensive interview, field observations, and a thorough examination of relevant documents, we have unearthed critical insights into the entrepreneur journey, strategies, and accomplishments.

After analyzing the above parameters based on the interviews and observations done during the enterprise visit S. Paramjit Singh was selected for the case study. From all the above entrepreneurs, the selected entrepreneur is a young entrepreneur; therefore his case study will be motivating for the Punjabi youngsters migrating out of the country. Among all four, the entrepreneur with small landholding is selected as he can create a positive impact and inspire farmer to get maximum benefits out of minimum resources. Other factors in the selection of the agri-entrepreneur are the product diversification, creating local opportunities in their area, including creating employment, and providing marketing platforms to other farmers. Professional attributes like strong leadership qualities, self-motivation, and inspiring others are the other main reasons for selecting the farmer. The following are some of his personal and entrepreneurial characteristics due to which his case study was selected for detailed publication.

Case study: Every success begins with the decision to attempt: A motivational case study of a young millet grower in Punjab

This is a case study of a young agri-entrepreneur, S. Paramjit Singh, a fresh graduate in the arts. Initially, he was not much interested in farming but wanted to do some smart job. But after the COVID-19 pandemic, he realized the potential in agriculture and started his own farming enterprise, and is successfully earning from it. This case study helps us determine the importance of agriculture as an occupation for the young wards of farm families. The document also focuses on the strategies adopted and problems faced in the journey

from a part-time farmer to a well-established agri-entrepreneur. This case study will inspire those young entrepreneurs who belong to farm families and are seeking a profession in the field of agriculture.

Background of the agri-entrepreneur

S. Paramjit Singh, 31 years old, lives in Katahri village near Gurdwara Rara Sahib of Ludhiana district. He is a graduate in arts from Punjabi University. He is the only son, living with his mother and father. His father was a small farmer and owned 2.5 acres of land. Initially, he didn't want to become a farmer or pursue the occupation of his father. After graduation, he joined a hosiery company (Saluja Hosiery) in Ludhiana and worked for 4 years for 10,000 per month but was not satisfied. He left the job and started to search for a better option. During his struggle period, he was also doing part-time farming with his father. He came across one of his friends, who told him about the venture in farming. He visited PAU, and the journey started with his participation in a three month training course in "Practical education in agriculture" to successful young millets' grower in Punjab with a profit of 8–10 lakh per year from the venture.

Journey from a job seeker to the MD of FarMative - Pannu Natural Farm.

Paramjit Singh, the owner of Pannu Natural Farm Company, started the company in 2021. He knew that the traditional farming system will not yield much profit in his 2.5 Acres. In a quest, he started to learn the scientific cultivation of crops and attended various training programmes at PAU, Ludhiana. Soon he was ready to implement the learned practices in his own land. He utilized the skills learned during the courses and started to grow new crop patterns with a mixed farming approach. He also turned to millets farming and organic production due to its health benefits and environmental friendliness. He has been practicing organic farming since 2016 and teaching other farmers as well.

The initiation: motivation and technical training

This enterprise is a result of the Corona pandemic, when everybody was struggling whether in jobs or business. Paramjit Singh was also compelled to leave the job and was realised the importance of agriculture. This stimulated him to start a venture related to

Table 1: Comparison of cereals and millets crops agri-entrepreneurs

Agri-entrepreneur		1		2	3	4
Name of the enterprise		FarMative Millet Processing		Virasat Natural Farm	Ekam kisan Hut Pvt. Ltd. – Swaad Ekta Ka	Pind- B
Name of the Agri-entrepreneur		Paramjit Singh		Gurmukh Singh	Kuldeep Singh	Gurwinder Singh
Age		32 years		57	47	48
District		Ludhiana (village kohara, Rara sahib)		Gurdaspur (village batala)	Tarn taran (village koharka)	Mansa (village viro-ke- kalan)
Year of establishment/ no. of years in the business		2012/ 10years		2014/ 8 years	2021/ 2 years	2022/ 1 year
Category/ type of enterprise		Cereals and Millet processing		Cereals and Millets processing	Cereals, pulses and oilseeds processing	Cereals and millets processing
Land Owned		2.5 Acre		9.5 Acre	25 Acre	15 Acre
Leased in land		2.5 Acre		-	100 Acre	-
Type of crop production		Cereals, Millets, Pulses, Sugarcane and spices		Cereals, Millets, and Turmeric	Cereals, Millets, Oilseeds, Sugarcane, Spices,	Cereals, Pulses, Millets, Oilseeds
Enterpr ise growth	Product diversification	- Wheat and rice processing (Whole flour and multigrain flour) - Millet processing (whole and flour of <i>Ragi, Kodra, kangni</i>) - Millet cookies (Ragi and kodra) - Making Pickles (Mango, Lemon, chillies, vegetables) - Jams and murabbas (Amla and Carrot) - Gur and Jaggery powder - Turmeric powder and chilli powder		- Wheat & rice processing (whole flour & multigrain flour) - Millet processing (whole and flour of <i>Ragi, Kodra, kangni</i>) - Turmeric powder	- Wheat processing (whole flour and multigrain flour) - Oilseed processing (wood pressed) - Millets processing (whole and flour of <i>Ragi, Kodra, kangni</i>) - Coconut oil - Turmeric & chilli powder	- Organic wheat rice, pulses, oilseeds production - Millets processing (kodra, oats, ragi) - Turmeric powder
	Hired employees	For Farm product ion	Contractual labour for farm production	Contractual labour for farm production	Contractual labour for farm production	Contractual labour for production.
	Hired employees	For Process ing	5-8 employees for processing, packaging and storing	No employees for processing	2 employees for processing, packaging and storing	Processing done from outside& 1 employee for packaging / storing the produce.
	Marketing levels	B2C	- Local outlet (own) - Started shipping to other state & countries. - Exhibition, <i>Kisan mela</i> & trade fairs - Social media & online platform	Local outlet (rented)	- Local outlet (rented) - Owned sales outlet in Akola, Maharashtra - Exhibition, <i>Kisan mela</i> & trade fairs. - Social media & online platform	- No outlet. - Direct to consumers from home - Exhibitions, <i>kisan mela</i> & trade fairs.
		B2B	Supply products to retailers of Ludhiana, Jalandhar, Khanna.	Supply product to retailers in Punjab, Bangalore & Mumbai.	Supply products to agents in Punjab & other states.	Supply products to retailers.
Motivat ional factors for others	Profitability	Getting good Profit.		Getting normal profit/ sale is not good	Getting good profit.	Getting good profit.
	Demand	- Due to awareness and health consciousness, demand is increasing. - Demand of Organic products is also increasing,		Struggling to create awareness in the area regarding the organic food & millets	Demand of organic products is increasing.	Demand is high due to its nutritional properties and health benefit.
Individ ual/ group approac h	Individual venture	- Individual venture - Providing marketing platform to other farmers		Individual venture	- Individual venture - Providing marketing platform to other farmers	Individual venture

Table 1 contd...

Agri-entrepreneur			1	2	3	4
Infrastructure developed	Owned machinery	For processing	- Bakery unit for cookies production - Packaging machine. - Small Flour processing unit - Millet processing depends on others mill on rent basis - Weighing, sealing & sewing machine	- Millet processing unit - De-husker - Cleaning machinery - Pulveriser for flour mill	- Natural stone chakki-(traditional one) - Wooden pressed oil expeller. - Hammer pounding machine for spices. - Weighing, sealing & sewing machine	- Processing from outside. - Only having packaging & sealing machine.
		Farm production	Tractor, Trolley, Happy seeder, Land leveller, Rotavator, disc harrow, Ridger, seed drill, sprinkler system and all other implements.	Tractor, Trolley, Happy seeder, Land leveller, Rotavator, disc harrow, Ridger seed drill and all other implements	Tractor, Trolley, Happy seeder, Land leveller, Rotavator, seed drill, harrow, Ridger and all other implements	Tractor, Trolley, Happy seeder, Land leveller, Rotavator, seed drill, harrow, Ridger and all other implements
	Units established	Production, Packaging & Storage units	- Processing unit for cookies - Flour mill - Packaging unit - Storage units.	Common unit for processing & packaging of wheat & millets Storage at home	- Processing unit for oilseed. - Processing unit for wheat - Processing unit for spices - Packaging unit. - Storage unit	- No unit for production - Common unit for Packaging & storing of cookies & spices
		Other units	Nursery unit, Vermicompost unit & IFS model	Vermicompost unit	Nursery unit & Vermicompost unit	Vermicompost unit
Awards and recognition			- Awarded with best stall by Horticulture Deptt., Punjab - Best entrepreneur Award by PAU, Ludhiana - Best Trainee Award etc.	- Awarded with best organic farmer by KVK Gurdaspur - Best Organic farmer by Department of Agriculture etc.	- Best stall Award from PAU Ludhiana at University Kisan Mela Oct, 2022. - Participated and felicitated at various Kisan melas organised by Deptt. of Agric. & KVKs.	- Awarded with various awards at district level by Department of Agriculture, Mansa - Awarded with best farmer in organic farming by KVK Mansa.
Success rate	Annual sale (approx.)		16-18 lakh	7-8 lakh	20-25 lakhs	12-14 lakhs
	Annual income (approx.)		8-10 lakh	3-4 lakh	15-20 lakhs	10 lakhs
Professional attributes	Entrepreneurial traits		- Strong leadership qualities - Self-motivated - Enthusiastic - Risk-taking ability - Learning from failure - High competitive spirit. - Achievement motivation	- Strong leadership qualities - Creating demands to customers	- Sense of basic ethics & integrity - Strong leadership qualities - Self-motivated - Enthusiastic - Risk-taking ability	- Self motivated - Creating demands to customers - Risk-taking ability
	Creating opportunities in local area		- Hiring employees - Marketing platform for local farmers	In progress	- Hiring employees - Marketing platform for local farmers	In progress
	Innovativeness		- Creating innovation in product (adding new products) - Product diversification - Meeting demands of customers (Trial/packaging & size of commodity)	Product diversification.	- Creating innovation in product (new products) - Product diversification	- Product diversification - Meeting demands of customers (Trial/packaging and size of commodity)

Table 1 contd...

Agri-entrepreneur		1	2	3	4
	Product profile	• Emphasis on Branding, packaging & hygiene • Labelling (attractiveness/ap propriateness) • Use of food grade quality material. • Packaging in different sizes to meet the varying needs and demands	• No emphasis on branding • Labelling and attractive packaging is still in progress	• Emphasis on Branding, packaging & Hygiene • Labelling (attractiveness/ap propriateness) • Use of food grade quality material	• Emphasis on Branding, packaging & hygiene • Labelling (attractiveness/ap propriateness) • Use of food grade quality material. • Packaging in different sizes to meet the varying needs and demands
	Keen interest for experimentation	• Already doing experiments in his farm. • Interested in trials and testing of new varieties	• Interested in trials and testing of new varieties • Focussing on more production in the area	• Interested in trials and testing of new varieties.	• Interested in trials and testing of new varieties
Creating awareness regarding the products		• Preparation of handouts for its usage and characteristics • Using flexes and hoardings for promotion • Useful information in package • Delivering lecture in various platforms. • Creating awareness through videos in YouTube & websites.	• Delivering lectures in various platforms. • Using flexes and handouts for promotion	• Preparation of handouts for its usage and characteristics • Using flexes and hoardings for promotion • Useful information in package • Delivering lecture in various platforms. • Creating awareness through videos in YouTube & websites.	• Working on packaging and creating awareness. • Preparation of handouts for its usage & characteristics

agriculture as his father was already in agriculture. He had already received training in various sectors like gardening, mushroom cultivation, processing, bakery products, etc. from PAU. Since 2016, he has taken a keen interest in the on farm trials and experimentation of crops. In order to turn his farming into a profitable, he needed some technical guidance for commercial production and marketing. He was informed about the FSSAI registration and successfully registered under licence no. 22121668000801. In 2021, with the help of PAU and KVK Samrala scientists, he started his own processing unit for millets and cookies and registered the brand “FarMative” with the trademark “Pannu Natural Farm” under no. 5146765 on September 24, 2021. He is also successfully registered under MSME and also got the certification of organic farming. PAU scientists guide him in setting up the machinery and instruct him on the processing of millets. He is now

earning 8–10 lakh approx. annually from his enterprise and has a production volume of 10–12 metric tonnes of agricultural produce through organic and mixed farming, including cereals, oilseeds, millets, fruits, vegetables, sugarcane, and spices.

Product diversification and innovation:

As shown in Table 2, there is a wide range of product categories with their prices. With the production of organic produce on his farm, instead of selling the whole produce, he started to process wheat, rice, and oilseeds (mustard and til) from flour mills and gained more monetary benefits. On his 5 acres of land, he has developed an integrated farming system model of agriculture and cultivates almost every crop. He also established a small nursery for fruit and vegetable seedlings and planting material. Farmers from nearby areas purchase the planting material from his nursery.

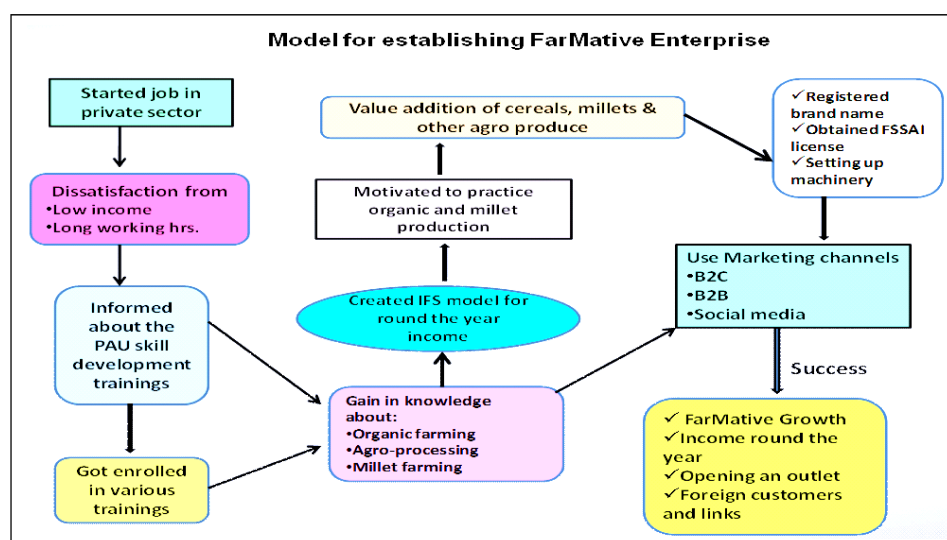


Chart 1: Establishment of FarMative model

Table 2: Details of product diversification and Innovation

Category	Products range	Price range
Cereals	Organic wheat flour, Multigrain flour, unpolished rice	50-150/kg
Millets	Organic processed whole kodra, Ragi, Quinoa, Finger millet, Jowar and Bajra, flours of millets, and cookies of Ragi and Kodra millets, multigrain cookies	120-250/-
Oilseeds	Organic mustard oil and sesame oil	200-250 /-kg
Pickles	Amla, chillies, mango, lemon, and turmeric	150-250/-
Planting materials	Seasonal Fruits, flowers and vegetable seedlings	10-100/piece
Spices and other value added products	Haldi powder, red chilli powder, garam masala powder. Whole masalas like black pepper, zeera, sounf, ajwain, jaggery powder etc	80-200/ pack

It can be interpreted from the Table 3 that Paramjit is now getting good profits from all his products. The annual production of all his products is rising day by day. The annual production of wheat (flours, *dalia* and *sooji*) is 60 q, mustard oil 7 q, rice (Basmati 1121) 60–70 q, millets (processed whole millets, flour and cookies) 100–150 q (10–15 t), *haldi* powder 2 q, and pickles (amla, chillies, mango and lemon) 4–5 q. Paramjit understood the benefit in processing the produce very early. He says, “The cost of processing is less than the marketing value, if we sell crop produce as such, the profit margin would be poor”. The following are the details of the annual product’s production volume and profit generated (based on 2022 data):

Infrastructure and Machinery owned

In the name of infrastructure, he has recently opened a manufacturing unit in his village. Separate units are made for the baking of cookies, storage, and packaging. An

outlet is also hired, which is located near the village market. He established machinery like automated cookie making and baking ovens (which include the preparation of dough, molding machines, and baking ovens), packaging machines, storage drums, etc. Pickles are prepared using the traditional method of processing.

Challenges conquered

Limited land resources: He possessed only limited land for agriculture production so, for the production of finger and *kodra* millets, he took 2.5 acres of land on lease. He plans to go for organic production of wheat, rice, and millets and succeeded.

Maintaining quality in processing: He also faced problems related to processing the produce and maintaining quality standards; he did not have any machinery and processed the flour from others’ processing units on rent basis. The outside baking unit

Table 3: Annual production and profit

Product description	Annual Production (Qts)	Production cost (approx.)	Processing cost (approx.)	Annual sale (approx.)	Annual profit (approx.)
Organic wheat (Flour, sooji, dalia)	60	10,000	5000	1,40,000	1,25,000
Organic rice (processed/ polished)	57	20,000	10000	1,10,000	80,000
Millets (cookies)	10-12	10,000	10,000	1,20,000	1,00,000
Mustard oil	7	5,000	8000	80,000	67,000
Sugarcane (Jaggery powder)	150	5,000	5000	50,000	40,000
Vegetables (including raw and pickles)	40	5,000	10,000	30,000-50,000	30,000
Milk production	1500 l	20,000	10,000	1,10,000	80,000
Flax seeds	25kg	500	500	3500	2500
Til	20kg	500	300	3000	2200
Haldi powder	2 Qtls	2,00,000	50,000	4,00,000	1,50,000
Nursery/ planting material	-	20000	5000	1,00,000	75,000
Total					7,51,920-8,00,000

did not maintain the quality of the cookies, and he has to check the quality in the laboratory for every batch. Therefore, he set up his own baking unit and was able to maintain the quality by using organic ingredients in the cookies.

Market acceptance: Creating a market for millet-based products in a region where rice and wheat were staples required innovative marketing strategies. Paramjit needed to change consumer perceptions and preferences. People were not willing to pay the price as they were not aware of the quality of the organic products and their high processing costs. But he continued to educate people about the importance of organic foods and their nutritional benefits. Now his products are very popular and liked by all.

Awards and recognition

Paramjit Singh is a highly accomplished farmer who is completely devoted to the agriculture profession. His exceptional skills and innovative techniques have earned him numerous awards and recognition throughout his journey. He has been awarded by PAU and KVK on various platforms. He got an appreciation award for the adoption of millet farming by KVK Samrala. He has been presented with a best stall award in the *Kisan Mela* 2020 organized by Desh Bhagat University, Mandi Gobindgarh. He has got 1st prize for best stall in the *Kisan Mela* organized by PAU, Ludhiana, during

September 22-23, 2022. He recently got an award for appreciation for his exceptional venture, FarMative, during the celebration of the PAU Diamond Jubilee year and the International Year of Millets-2023 organized by PAU Ludhiana on May 16, 2023.

Future plans

When asked about his future plans, he said his ambition is to open a chain of outlets in India as well as abroad. To fulfill this dream, he has already taken a step towards the development of enterprise, as recently he met some foreign delegates through his relatives in the Netherlands (Holland), Turkey, and Australia and visited their organic farms and restaurants. While travelling abroad, he also learned how to market the produce according to international standards and markets, so he also made a proposal to foreign company named “De Kas” for opening a modern organic restaurant in other countries.

The SWOT analysis in the Table 4 outlines the internal strengths and weaknesses of FarMative, along with the external opportunities and threats faced by entrepreneur in the agricultural industry. S. Paramjit Singh had a strong agricultural background and extensive technical expertise. He initiated the production of a diversified range of products, including millets; it's processing to millet cookies, pickle, and planting materials. The implementation of the Integrated

Table 4: SWOT analysis of FarMative (Pannu Natural Farm)

Strengths	Weaknesses
• Strong agricultural background. • Extensive technical training and experience in agriculture. • Diversified product range, including millet cookies, pickle, and planting materials. • IFS model supplies round the year income. • Self-reliant approach from production to marketing.	• Shortage of funds • Lack of machinery and infrastructure • Dependency on manual labor for some farm operations.
Opportunities	Threats
• Increasing awareness and demand for organic and health-foods like millets • Potential for expansion into international markets. • Adoption of advanced technologies for processing and production.	• Competition with larger renowned agri-enterprises. • Fluctuations in agricultural commodity prices and environmental factors. • Risks associated with diseases or pests affecting crops. • Supply chain disruptions or logistical challenges

Farming System (IFS) model ensured consistent income throughout the year, supported by a self-reliant approach from production to marketing. However, challenges such as limited land availability, reliance on rented processing units, and initial quality control issues were also addressed with careful planning. Despite few weaknesses, opportunities such as increasing demand for organic products, potential international expansion, and collaboration with government initiatives present avenues for growth. Nevertheless, threats such as competition from larger agri-enterprises and environmental factors highlight the need for strategic planning and risk management.

CONCLUSION

Nutritionally sound and drought-resistant, millets are common crops in Asia and Africa. In recent years, millets have received more attention and scrutiny. The case study underscores the potential for scalability and replicability of FarMative model of processing of millets produce. He is not only a progressive example for the youth of Punjab who have limited land resources but also sets an example for producing and promoting organic food for achieving good health in general. It is hoped that by using various methods of processing and value addition, demand for millet-based food items may be stimulated in addition to production increases. The principles and practices that have employed by the entrepreneur offer valuable insights for aspiring agri-entrepreneurs and policymakers seeking to foster a conducive environment for agricultural innovation and entrepreneurship. In conclusion, the case study of Mr. Paramjit Singh

provides a compelling narrative of visionary leadership, innovative practices, and strategic acumen within the agricultural domain. This effort may serve as a model for Punjab's youth compelling to leave their native place for the livelihood opportunities and for other states as an inspirational beacon for the agricultural community and underscores the potential for transformative change within the sector.

REFERENCES

- APEDA, India. 2022 Retrieved from <https://apeda.gov.in/milletportal/Production.html#:~:text=The%20major%20millets%20producing%20states,in%20Millets%20production%20in%20India> on 24-10-2023.
- Bhatt, A.; V. Singh; P.K. Shrotria and D.C. Baskheti. 2003. Coarse Grains of Uttaranchal: Ensuring sustainable Food and Nutritional Security. *Indian Farmer's Digest*, pp 34-38.
- DHAN Foundations. 2012. Policy Review & Suggestions for Action: Revalorising Small Millets in Rainfed Regions of South Asia (RESMISA).
- Dupdal. 2020. Millets: A Solution to Food and Nutritional Security in India. *Biotica Research Today*, 2(9): 901-904.
- FPO. 2021. Retrieved from <https://fpohub.com/wp-content/uploads/2021/06/2021-White-paper-on-millets.pdf> on 24-10-2023.
- Handa, V.; V. Kumar; A. Panghal; S. Suri and J. Kaur. 2017. Effect of soaking and germination on physicochemical and functional attributes of horsegram flour. *Journal of Food Science and Technology*, 54(13): 4229-4239.
- Hussain, I.; M.B. Uddin and M.G. Aziz. 2011. Optimization of anti-nutritional factors from germinated wheat and mung bean by response surface methodology. *Food Research International*, 18: 957-963.

- Jaybhaye, R.V. and P.P. Srivastav. 2015. Development of barnyard millet ready-to-eat snack food: part II. *Food Science*, 6(2): 285–291.
- Kumar, A.; V. Tomer; A. Kaur; V. Kumar and K. Gupta. 2018. Millets: a solution to agrarian and nutritional challenges. *Agriculture & Food Security*, 7: 31.
- Nirmala, M.; M.V.S.S.T. Subbarao and G. Muralikrishna. 2000. Carbohydrates and their degrading enzymes from native and malted finger millet (Ragi, *Eleusine coracana*, Indaf-15). *Food Chemistry*, 69: 175–180.
- Platel, K.; S.W. Eipeson and K. Srinivasan. 2010 Bioaccessible mineral content of malted finger millet (*Eleusine coracana*), Wheat (*Triticum aestivum*), and Barley (*Hordeum vulgare*). *Journal of Agricultural and Food Chemistry*, 58: 8100–8103.
- Press Information Bureau, ministry of information and broadcasting GOI (2022) International Year of Millets: India Leading The Way Ministry of Agriculture and Farmer's Welfare RU-16-01-0158-261222/EXPLAINER
- Pushparaj, F.S. and A. Urooj. 2011. Influence of processing on dietary fiber, tannin and in vitro protein digestibility of pearl millet. *Food Science & Nutrition*, 2: 895–900.
- Sahoo, J.P. and M. Mahapatra. 2023. International year of millets - 2023: Revitalization of millets towards a sustainable nutritional security *Technology in Agronomy*, 3: 10.
- Saleem; N.U. Mushtaq; W.H. Shah; A. Rasool; K.R. Hakeem; C.S. Seth; I. Tahir and R.U. Rehman. 2023. Millets as smart future food with essential phytonutrients for promoting health. *Journal of Food Composition and Analysis*, 124.
- Tiwari, H.; R.K. Naresh; L. Kumar; S.K. Kataria; S. Tewari; A. Saini; R.K. Yadav and R. Asati. 2022. Millets for Food and Nutritional Security for Small and Marginal Farmers of North West India in the Context of Climate Change: A Review *International Journal of Plant & Soil Science*, 34(23): 1694–1705.

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Research Article

Constraints for Adopting Climate-change Adaptation Strategies among Smallholder Vegetable Farmers

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ABSTRACT

The study was undertaken in Palakkad district of Kerala to evaluate the constraints faced by vegetable farmers with respect to climate change adaptation. 80 male farmers, 80 female farmers with minimum ten years' experience in vegetable cultivation were selected from four randomly selected blocks of Palakkad district. Garrett's ranking technique was used to analyse the constraints. The major constraint faced by vegetable farmers with respect to climate change adaptations were lack of government support (62.22 Garrett score). High cost of the agricultural inputs needed for adaptation strategies was the second major constraint felt by the farmers (59.71 Garrett score). Inadequate credit facilities and lack of agricultural subsidies (51.77 Garrett score), Lack of access to awareness programmes on climate change adaptation (38.33 Garrett score), lack of information about long term climate change and appropriate adaptations (35.89 Garrett score) were the other problems faced by farmers.

Keywords: Climate change, Vegetables, Adaptation strategies, Constraints

INTRODUCTION

The sustainability of agricultural production and the livelihoods of those who depend on it will be impacted by the climate change because agriculture is a biological production process. Agriculture is one of the sectors most vulnerable to changes in the climate (Field *et al.*, 2014). Vegetables are generally sensitive to environmental extremes (Abewoy, 2018). High temperatures and inadequate soil moisture are the main causes of low yields because they have a negative impact on many physiological and biochemical processes, as reduced photosynthesis, altered metabolism and enzymatic activity, thermal injury to the tissues, reduced pollination and fruit set, etc. (Ayyogari *et al.*, 2014). Besides these, the changes in the distribution of existing

pests, diseases, and weeds are among the indirect effects of climate change on the production of vegetables (Deuter, 2014).

Due to its location on a seacoast and steep gradient along the slopes of the Western Ghats, the state of Kerala is especially susceptible to the dynamics of the changing climate. The yield of major rainfed crops cultivated in the state such as rice, banana, rubber, coffee, black pepper, coconut, and areca nut is found to be decreased from 0.3 to 33 per cent. In order to adapt to the adverse impact of climatic change on productivity and quality of vegetable crops there is a need to develop sound adaptation strategies which has only been given limited attention in terms of research. Farmers believe that a variety of adaptation strategies,

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including mixed cropping, crop rotation, shade, increased use of organic manure, and altered irrigation methods can be adopted to address climate change. Kerala has encountered a variety of natural disasters, including coastal erosion, saltwater intrusion, earthquakes, floods, landslides, and sea level rise. Through the development of adaptation actions that are inclusive, participatory, and gender responsive, it is necessary to develop focused strategies for building adaptive capacity, strengthening resilience, and reducing the vulnerability of natural and socioeconomic systems. However, several impediments that prevent adaptation planning and implementation are encountered and reported. To advance scientific discussions and acquire knowledge on the obstacles faced by the farmers to adaptation, it is essential to move beyond inductive assumptions and explore the site-specific constraints faced by the smallholder vegetable farmers in adopting climate change adaptations. The loss of crop yield due to change in climate is highly affected in Palakkad district, with severity in crops like paddy, areca nut and mango. This central district is facing huge loss in yield due to more fluctuation in area under cultivation and also the natural calamities impacting every year (Giridhar *et al.*, 2022). Palakkad district is purposively selected for the study, as it is listed as the one of the highly vulnerable districts of Kerala in climate change, due to its specific geographic locations, humid climate, high percentage of population, dependence on agriculture, a low ranking in the human development index, high social deprivation and a high degree of vulnerability to natural hazards like floods and drought (GoK, 2014). Moreover, the district possesses highest area under the vegetable cultivation and contribute 15 percent of total vegetable production of the State (GoK, 2020). The present study assessed the major constraints faced by vegetable farmers in the district with respect to climate change adaptations.

MATERIALS AND METHODS

To address the chosen research question, an exploratory research approach was used. The following subheadings cover the methodology:

Study area and data collection: Palakkad district is purposively selected, as it is listed as the one of the highly vulnerable districts of Kerala in climate change, Temperature is remarkably high than the Kerala average.

In some summer days the maximum temperature goes well above 40°C (Joby, 2017). Palakkad district is comprised of 13 blocks, from which four blocks, Alathur, Nenmara, Kollengode and Chittur, were randomly selected. 20 female and 20 male farmers with minimum ten years' experience in vegetable cultivation from each block were randomly selected to make the total sample size of 160.

Survey instrument and analysis: Primary data were collected through personal interview technique of the respondents with the help of pre-tested semi-structured interview schedule. The list of constraints was chosen with the assistance of experts and a review of the literature. Garrett's ranking technique was used to rank the constraints. Then the rank given by the farmer respondent to each barrier was converted into the per cent position using the following equation of Garrett ranking:-

$$\text{Percent position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

Where, R_{ij} is the rank for i^{th} constraint experienced by the j^{th} individual

N_j is the number of constraints ranked by the j^{th} individual

With the use of Garrett table, the percent position obtained was reformed into score (Garrett and Woodworth, 1969). The individual user scores for each factor were totaled and divided by the total number of respondents. As a result, the limitations' mean scores were ordered by placing them in descending order, ranks were assigned, and the most important elements were determined. Thereby, the most significant factors were determined, ranks were awarded, and the mean scores of the constraints were sorted by arranging in descending order.

RESULTS AND DISCUSSION

Constraints are any factors that hinders or restricts the farmers from utilizing the resources or practices to combat the impact of climate change. Identifying these constraints is crucial to understand the adaptive capacities of farmers. The present study identified five major constraints faced by the vegetable farmers in adopting climate-change adaptation strategies. Table 1

shows the per cent score values and ranks of the various constraints. The major constraint faced by vegetable farmers with respect to climate change adaptations were lack of institutional support. Farmers reported that there is not enough schemes and subsidies for coping up climate change vagaries. Lack of policy guidance and the limited coordination between different line departments reduces the adaptation levels. Studies indicate that giving additional responsibility without additional resources or facilities to line departments can render them ineffective (Azhoni *et al.*, 2017). Mayaya *et al.* (2015), who studied climate change in the Semi-Arid Areas of Eastern Africa, identified limited institutional support as the major constraint and there should be a supportive institutional mechanisms to promote farmers adaptation decision.

High cost of the agricultural inputs was the second major constraint felt by the farmers. Whenever the farmers want to adopt climate change adaptation strategies like protected cultivation, pest and disease tolerant varieties, they find it challenging since the switching cost is high. Also fragmented landholdings restrict them from avoiding extreme climate areas. Therefore, small land holding farmers forced to opt out certain adaptation strategies due to shortage of income. Nancy *et al.* (2015) in their study on farmers' response and adaptation strategies to climate change in low-hills of Himachal Pradesh in India, reported that 86.6% respondents opinioned high cost of adaptation strategies as one of the primary obstacles in coping with climate change. So efforts needs to be ensured in providing climate smart technologies to farmers in subsidized cost through extension agencies.

Inadequate credit facilities and lack of agricultural subsidies was the third perceived constraint by the farmers. Farmers are identified as one of the most disadvantaged groups where lack of productive

resources such as credit and subsidies is dominant. Some farmers, especially women farmers lack the financial knowledge and skills, hindering their ability to access formal credit and force them resort to borrow from informal sources, such as moneylenders, who often charge exorbitant interest rates. Since financial knowledge upbringing and assistance like formal credit facilities and subsidies to the farmers may ease liquidity constraints faced by farmers in accessing production resources. It is critical in helping them adapt to climate change. Marie *et al.* (2020) analyzed factors affecting adoption of climate change adaptation strategies of northwestern Ethiopia and revealed that 16.5 per cent of the respondents perceived lack of credit services hindering adaptation.

The awareness programme on climate change and adaptation strategies were very limited and farmers opined that majority of the training programmes (38.33 Garrett score), focus on general cultivation practices rather than focusing on specific topics of climate change. Majority of the farmers were unaware of low cost adaptation strategies recommended by the stakeholders involved in research and extension. The lack of access to awareness programmes on specific topics creates serious gaps between the farmers and useful information that should help them in their farm work. However, farmers face the lack of access to these facilities due to distance to the programme location and their round the clock work schedule. This will undoubtedly make the farmers ignorant of the adaptation strategies and hence become vulnerable to the impact of climate change. Singh *et al.* (2017) found that low knowledge of government programmes, particularly in areas far from the Gram Panchayat and especially among women is a primary obstacle to coping with climate change in India. It is clear that government and non-government organization should conduct more accessible awareness programmes to

Table 1: Constraints faced by vegetable farmers with respect to climate change

S.No.	Constraints	Mean score	Rank
1	Lack of institutional support	62.22	1
2	High cost of the agricultural inputs needed for adaptation strategies	59.71	2
3	Inadequate credit facilities and lack of agricultural subsidies	51.77	3
4	Lack of access to awareness programmes on climate change adaptation	38.33	4
5	Lack of information about long term climate change and appropriate adaptations	35.89	5

guide farmers on climate change adaptation so that they can make informed decisions and useful farm plans.

Another problem faced by the farmers was the lack of information about long term climate change and appropriate adaptations (35.89 Garret score). The smallholder farmers viewed a dearth of knowledge about long term climate change and appropriate adaptations. Farmers lacked information about long term climate change and suffered a knowledge gap in appropriate adaptation responses. While studying the adaptation strategies in South Africa's Western Cape, Talanow *et al.* (2020) identified a lack of reliable and long-term information as an additional constraint to adaptation. Farmers' friendly information systems should be developed as effective measures to guide climate change adaptation policies.

CONCLUSION

Study concluded that the institutional and financial support mechanism should be strengthened to transfer technology in the domain of climate change adaptation to cut back on the constraints faced by farmers. Governments, investors, and non-governmental organisations should all be involved in interventions aimed at removing obstacles to adaptation. Ignorance of the connections between adaptation barriers could result in discriminating consequences wherein frequently marginalised groups end up with even less alternatives for adaptation, making them even more susceptible to the effects of climate change.

Authorship Contribution Statement

The authors confirm contribution to the paper as follows: study conception and design: Atheena U P and Smitha S; data collection: Atheena U P; analysis and interpretation of results: Atheena U P, Smitha S, Bino P Bonny, Sreeram V; draft manuscript preparation: Atheena U P, Smitha S, Bino P Bonny, Sreeram V. All authors reviewed the results and approved the final version of the manuscript.

REFERENCES

- Abewoy, D. 2018. Review on impacts of climate change on vegetable production and its management practices. *Advances in Crop Science and Technology*, 6(1): 1-7.
- Ayyogari, K.; P. Sidhya and M.K. Pandit. 2014. Impact of climate change on vegetable cultivation-a review. *International Journal Agricultural Environment and Biotechnology*, 7(1): 145-155.
- Azhoni, A.; I. Holman and S. Jude. 2017. Adapting water management to climate change: Institutional involvement, inter-institutional networks and barriers in India. *Global Environmental Change*, 44: 144-157.
- Deuter, P. 2014. *Defining the impacts of climate change on horticulture in Australia*. Climate Change Review Report, Garnaut.
- Field, C.B.; V.R. Barros; D.J. Dokken; K.J. Mach; M.D. Mastrandrea and T.E. Bilir. 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summary for policymakers*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, United Kingdom.
- Garret, H.E. and R.S. Woodworth. 1969. *Statistics in psychology and education*. p. 329. Vakils, Feffer and Simons Pvt. Ltd., Bombay.
- Giridhar, B.J.; K.J. Raghavendra; D.R. Singh and P. Kuriachen. 2022. Agricultural vulnerability to climate change: a case study of Kerala. *Journal of Community Mobilization and Sustainable Development*, 17(1): 29-34.
- GoK [Government of Kerala]. 2014. *State action plan on climate change*. Government of Kerala.
- GoK [Government of Kerala]. 2020. *Agricultural statistics*. Department of economics and statistics, Government of Kerala.
- Joby, J. 2017. Impact of climate change and agricultural production in Kerala. PhD. (Econ) thesis, Department of economics, Sree Sankara College, Kalady, Mahatma Gandhi University.
- Machado, S. 2009. Does intercropping have a role in modern agriculture? *Journal of Soil and Water Conservation*, 64(2): 55-57.
- Marie, M.; F. Yirga; M. Haile and F. Tquabo. 2020. Farmers' choices and factors affecting adoption of climate change adaptation strategies: evidence from northwestern Ethiopia. *Heliyon*, 6(4): 3867.
- Mayaya, H.K.; G. Opata and E.C. Kipkorir. 2015. Understanding climate change and manifestation of its driven impacts in the semi-arid areas of Dodoma Region, Tanzania. *Ethiopian Journal of Environmental Studies and Management*, 8(4): 364-376.
- Nancy, L.; S.K. Bhardwaj; P.K. Mahajan; D.P. Sharma and S. Ravinder. 2015. Vulnerability assessment of farming community to environmental changes in low-hills of Himachal Pradesh in India. *International of Journal Current Microbiology and Applied Science*, 4(8): 547-560.

- Nguyen, T.H.; O. Sahin and M. Howes. 2021. Climate change adaptation influences and barriers impacting the Asian agricultural industry. *Sustainability*, 13(13): 7346.
- Rohila, A.K.; A. Kumar; R. Mukteshwar; B.S. Ghanghas and R. Kumar. 2021. Constraints in adoption of smart agricultural practices. *Indian Journal of Agricultural Sciences*, 91(1): 142-145.
- Sharma, M. 2014. Constraints in adoption of recommended practices of vegetable crops. *International Journal of Agricultural Sciences and Veterinary Medicine*, 3: 66-72.
- Singh, C.; K. Michael and A. Bazaz. 2017. Barriers and enablers to climate adaptation: Evidence from rural and urban India.
- Talanow, K.; E.N. Topp; J. Loos and B. Martín-López. 2021. Farmers' perceptions of climate change and adaptation strategies in South Africa's Western Cape. *Journal of Rural Studies*, 81: 203-219.
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Research Article

Technology Intervention Through Cluster Frontline Demonstration in Indian Mustard (*Brassica juncea*) in Internal Drainage Dry Zone of Rajasthan

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ABSTRACT

The study aimed to analyze the performance and promote cluster front-line demonstrations in mustard production and assessing CFLDs contribution in yields and the adoption of improved technologies and enhance the profitability of mustard growers, the improved mustard production technologies were show cased through cluster frontline demonstrations. In total-175 no. of on-farm demonstrations were conducted on 110 ha area in Kukanwali, Nagwara, Nimbi kalan, Bhilal, Bardwa and Chavandiya (Six Villages) of Didwana-Kuchaman district of Rajasthan during 2023-2024 to 2024-25 and these were compared with existing farmer's practices of mustard cultivation. The improved production technologies consisting high yielding varieties DRMR-1165-40 and RH-0725, sowing method, nutrient management, chemical weed management and use of plant protection measures were included in the demonstrations. The findings of the study revealed that the package of improved production technologies recorded a mean seed and straw yields of 17.00 and 39.9 q/ha which was 19.50 per cent higher than the farmers practices (14.20 and 35.8 q/ha). Comparatively average higher net returns (Rs. 72583/ha), additional returns (Rs. 16095 /ha) with a B:C ratio of (3.17) and ICBR of 21.48 were recorded with improved technologies as compared to farmers practices (Rs. 56488). Adoption of improved technologies significantly increased the yield as well as yield attributing traits of the mustard than the farmers practices. So, there is a need to disseminate the improved technologies among the farmers with effective extension methods like training and demonstrations. The farmers should be encouraged to adopt the improved crop production technologies as discussed in this paper. So the higher productivity and economic returns from mustard cultivation could be realized. Overall, the study highlights the positive impact of implementing demonstrated agricultural technologies in mustard cultivation. These results indicate that the adoption of improved practices can lead to higher yields, better economic returns, and improved cost-benefit ratios compared to traditional practices.

Keywords: CFLD, Mustard, Productivity, Economics

INTRODUCTION

Indian mustard is an important oilseed crop and determinant of oilseed-based agricultural economy of the country. Brassicas are among the oldest cultivated plants known to humans with written records dating back to 1500 BC Prakash (1980) and archaeological evidence of its importance dating back to 5000 BC

Yan (1990). *Brassica juncea* is the oldest cultivated amphidiploid and is believed to derived from natural interspecific hybridization between *B. rapa* (n=10) and *B. nigra* (n=8), and probably evolved from Asia minor and southern Iran. The oil content in rapeseed-mustard varies from 37–49 per cent. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for

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human consumption throughout the northern India for cooking purposes. It is also used in the preparation of hair oils and medicines. It is used in the manufacture of greases. The oil cake is used as feed and manure. Optimum temperature requirement of different species is also varies with the stage of the crop. In general, these crops require high temperature during early growth stages and cool weather and clear sky during reproductive phase for better quality of oil. The temperature range of 0.5-3°C, 15-25°C and 35-40°C can be considered to be minimum, optimum and maximum, respectively. Crop requires about 18-25°C temperature, low humidity, practically no rains especially at the time of flowering. However, productivity is low due to lack of awareness in farming community regarding improved package and practices of oilseed crops. Cluster frontline demonstrations are important dissemination process for transfer of technology and to establish its production potentials on the farmer's fields. Rapeseed-mustard is the second most important edible oilseed crop in India, next only to groundnut and accounts for nearly 30 per cent of the total oilseeds produced in the country Shivani and Kumar (2002). India is one of the largest rapeseed-mustard growing country in the world, occupying the first position in area and second position in production after China Thakur and Sohal (2014). India is the largest producer of oilseeds in the world and accounts for about 14 per cent of the global oilseeds area, 7 per cent of the total vegetable oil production and 10 per cent of the total edible oil consumption. Indian mustard is an important oilseed crop of Indian subcontinent contributes more than 80 per cent of the total rapeseed-mustard production in India Meena *et al.* (2015). Rapeseed and mustard is grown on 6.69 million ha producing 10.11 million tonnes of output per hectare at an average productivity of 1511 kg/ha, While, in Rajasthan state the rapeseed and mustard is grown on 2.72 million ha producing 4.51 million tonnes of output per hectare at an average productivity of 1659 kg/ha, (GOI, 2020-21). In the Rajasthan state as per advance estimate, the total oilseeds crops were grown in an area of 6.00 M ha with an annual production of over 9.61 million tons with a productivity of 1602 kg/ha, GOR (2024-25). In the Didwana-Kuchaman district, the mustard crop is grown in an area of 15103 ha with an annual production of over 36474 million tons with a productivity of 2415 kg/ha, GOR (2023-24).

This group of oilseed crops offers higher return with low cost of production and low water requirement, so it has greater potential to increase the availability of edible oil from the domestic production. Inspite the high quality of oil and also its wide adaptability for varied agro-climatic conditions, the area, production and yield of rapeseed-mustard have been fluctuating due to various biotic and abiotic stresses together with domestic price support programme. Thus, there is a need to disseminate the improved production technologies of mustard cultivation among the farmers to enhance the productivity and profitability. Accordingly, the present investigation was undertaken to bridge the extension gap.

MATERIALS AND METHODS

Present study was conducted on CFLD mustard in irrigated condition in Didwana-Kuchaman district of Rajasthan. In total 175 frontline demonstrations were conducted on farmers' field in villages of Kukanwali, Nagwara, Nimbi kalan, Bhilal, Bardwa and Chavandiya (Six Villages) of Didwana-Kuchaman district of Rajasthan during 2023-2024 to 2024-25. Each demonstration was conducted on an area of 0.4 and 0.8 ha, adjacent-to the demonstration plot was kept as farmers' practices. The package of improved technologies like line sowing, nutrient management, seed treatment and whole package were used in the demonstrations. The mustard variety DRMR-1165-40 developed by the ICAR-DRMR, Bharatpur (Rajasthan) released in the year of 2020, recommended for Zone: II (Rajasthan, Delhi, Haryana, Punjab and Jammu & Kashmir) for timely sown and rainfed conditions, average yield of this variety having 22-26 q/ha, 133-151 days to maturity, plant height is 177-196 cm and oil content is 40- 42.5 percent, seed size 3.2-6.6 g and heat tolerant at seedling stage and moisture stress tolerant and RH-0725 developed by the CCSHAU, Hisar (Haryana) released in the year of 2018 and having bold seeded long and semi-appressed siliqua, recommended for Haryana, Punjab, Delhi, Jammu & Northern Rajasthan for timely sown and rainfed conditions, average seed yield of this variety having 25-26 q/ha as well as potential yield is 36 q/ha and oil content is 40 per cent were included in demonstrations methods used for the present study with respect to CFLDs and farmers' practices are given in Table 1. In case of local check plots, existing practices being used

by farmers were followed. In general, soils of the area under study were loamy fine to coarse and medium to low in fertility status. The spacing was 30 cm between rows and 10 cm between plants in the rows. The thinning and weeding were done invariably 20-25 days after sowing to ensure recommended plant spacing (10 cm) within a row (30 cm) because excess population adversely affects growth and yield of crop. Seed sowing was done in the mid to last week of October, with a seed rate of 4-5 kg/ha. Other management practices were applied as per the package of practices for *rabi* crops by Department of Agriculture, Internal Drainage dry Zone DOA (2024-25). Data with respect to seed yield from FLD plots and from farmer's fields cultivated following local practices adopted by the farmers of the area were collected and evaluated. Different parameters as suggested by Yadav *et al.* (2004) was used for gap analysis, technology index and calculating the economics parameters of mustard.

Estimation of technology and extension gaps and technology index: The estimation of technology and extension gaps, technology index and other economic analysis was done using formula by Kadian *et al.* (1997).

Extension gap = Average demonstration plot yield – Farmer's average plot yield

Technology gap = Potential yield –Average demonstration plot yield

Technology index = Potential yield –Average demonstration plot yield /Potential yield × 100

Additional cost (Rs.) = Demonstration cost (Rs.) – Farmers' practice cost (Rs.)

Effective gain = Additional returns (Rs.)–Additional cost (Rs.)

Additional returns = Demonstration returns (Rs.)–Farmers' practice returns (Rs.)

B: C ratio =Gross returns/ total costs

Incremental B: C ratio=Additional returns /Additional costs

RESULTS AND DISCUSSION

Improved technology v/s farmer's practices:

Before the commencement of CFLDs at the farmer's field, the participatory rural appraisal was undertaken. Based on this, the gap between farmers' practices and improved technology of mustard cultivation in the

Table 1: Details of technology intervention and FPs under CFLDs on Mustard in Didwana-Kuchaman district of Rajasthan

Technology Component	Improved technology	Farmer's practices	Gap
Farming situation	Irrigated	Irrigated	Nil
Variety	DRMRIJ-31, RH-725, RH-749	Private sector (Pioneer & Krishna)	Full
Seed rate (kg/ha)	4-5	5-6	Partial
Soil treatment	Trichoderma @ 2.5 kg/ha cultured with 100 kg FYM	No use	Full
Seed treatment	2.5 g Mancozeb/kg seed and for white rust Metalexil 35 SD 6 g/kg seed	No seed treatment	Full
Time of sowing	Mid to last week of October	First week of November	Partial
Spacing	Line sowing 30 cm (row to row) and 10 cm (plant to plant)	No proper spacing	Full
Fertilizer management	60:30-40:40 (NPS kg/ha)	Use of urea 40-50 kg/ha and DAP 50-60 kg/ha	Partial
Weed management	Pre- emergence application of Pendimethalin 30 EC @1.0 kg a.i./ha and Oxadiargyl @ 90 g/ha Fb HW at 20-25 DAS	Only HW at 20-25 DAS	Partial
Plant protection	Painted bug–Acephate @ 0.5 kg/ha Aphid- Thaimethoxam @ 100 g/ha White rust- Mancozeb 2 kg/ha	Products suggested by local pesticide dealers	Partial

Jodhpur district of Rajasthan was worked out (Table 1). Among varying technology interventions, no gap was observed under the farming situation, whereas a full gap was observed under variety, soil treatment, seed treatment and Spacing. However, a partial gap was observed for the particulars viz.: seed rate, time of sowing, fertilizer and weed management, and plant protection. These gaps noticed in the farmer's field are ascribed to the slow pace of extension machinery, coupled with unreached public extension systems or improved technologies, especially among smallholder farmers and other vulnerable groups Das and Willey (1991), Badhala and Bareth (2013). Further farmers used local cultivars of mustard showing low yield potential instead of newly released varieties with appropriate adoption of an improved package of recommended technologies. The improved package and practices are more important with technological intervention for productivity and profitability of oilseeds. Detailed package and practices with technological intervention for recommended practice

has been presented in (Table 1). Sulphur is an important supplement for oilseed crops and it is recommended that farmer's should apply single super phosphate fertilizers to meet the requirement of both phosphorus and sulphur in mustard. It was also observed that farmer's use injudicious and non-recommended insecticides and most of the farmer's didn't use fungicides. Similar observations were reported by Singh *et al.* (2011).

Impact of CFLDs on seed & straw yields: The (Table 3) indicated that a average maximum demonstration seed yield of 18.2 q/ha was recorded in Nimbi kalan village, followed by 18.1 q/ha in Bhilal village, 17.9 q/ha in Bardwa village, 17.8 q/ha in Chanvandiya village, 15.5 q/ha Kukanwali village and 14.8 q/ha in Nagwara villages which were found higher over local check 15.00, 15.10, 14.70, 14.50, 13.30 and 12.80 q/ha, respectively. It is clearly shown that 21.1 percent yield increase over farmer's practice Nimbi kalan village, followed by 19.6 percent in Bhilal village,

Table 2: Yield gap analysis of cluster front line demonstrations on mustard crop 2023-2024 to 2024-25

Villages/Block	Variety	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
Kukanwali	DRMR-1165-40	14.60	2.10	48.67
Nagwara	DRMR-1165-40	15.20	2.00	50.67
Nimbi kalan	RH-725	17.80	3.17	49.44
Bhilal	RH-725	17.90	3.00	49.72
Bardwa	RH-725	18.10	3.20	50.28
Chavandiya	RH-725	18.20	3.30	50.56
Average	16.97	2.80	49.89	

Table 3: Technical impact of mustard crop demonstrations during 2023-2024 to 2024-25 in different blocks

Villages/Block	Variety	Area (ha)	No. of CFLDs	Potential yield (q/ha)	Avg. seed yield under demo. (IT) (q/ha)	Avg. straw yield under demo. (IT) (q/ha)	Avg. yield under farmer practices (q/ha)	Avg. straw yield under farmer practices (q/ha)	Increase in seed yield (%)
Kukanwali	DRMR-1165-40	10.0	25	30.00	15.4	38.9	13.3	34.8	15.77
Nagwara	DRMR-1165-40	20.0	25	30.00	14.8	39.1	12.8	33.9	16.19
Nimbi kalan	RH-725	20.0	50	36.00	18.2	40.2	15.03	37.0	21.1
Bhilal	RH-725	20.0	25	36.00	18.1	40.3	15.1	37	19.6
Bardwa	RH-725	20.0	25	36.00	17.9	40.6	14.7	36.3	21.7
Chavandiya	RH-725	20.0	25	36.00	17.8	40.3	14.5	36.1	22.5
Total/Avg	110	175	34	17.0	39.9	14.2	35.8	19.5	

21.7 percent in Bardwa village, 22.5 per cent in Chanvandiya village, 15.7 per cent in Kukanwali village and 16.1 percent in Nagwara villages, respectively with an additional returns of Rs 18151, 17258, 18631, 19197, 11690 and 11400 /ha, respectively with an average additional returns of Rs 16095/ ha. In case of straw yield is clearly shown that 8.65 percent yield increase over farmer's practice Nimbi kalan village, followed by 8.92 percent in Bhilal village, 11.85 percent in Bardwa village, 11.63 per cent in Chanvandiya village, 11.7 percent in Kukanwali village and 15.3 percent in Nagwara villages, respectively with an average of 11.4 percent. The average yield of DRMR-1165-40 ranged from 15.4 to 14.8 q/ha and as compared to farmer's practice 13.3 to 12.8 q/ha whereas, average yield of RH-0725 ranged from 17.8 to 18.2 q/ha and as compared to farmer's practice 14.5 to 15.1 q/ha of existing variety in all villages indicating suitability of variety in the district due to the use of HYVs, better quality inputs and scientific backup by KVK specialists time to time. The level of yield is considerably low under farmer's practice due to poor adoption of improved practices depending upon the amount of risk involved in terms of cost, skill, and knowledge about the improved practices. These findings conform to the results of a study carried out by Balai *et al.* (2012) in rapeseed and mustard FLDs.

Gap analysis: The present findings (Table 2) are also in accordance with the findings of Sharma (2014) who found that the yield levels under farmer's practices were

always lower than obtained under frontline demonstration. The results revealed that extension gap ranged from 2.00 to 3.30 q/ha in villages of Didwana-Kuchaman district and average figure comes out to be 2.80 q/ha, which indicated that farmers should be awarded for adoption of improved production technology in mustard. There is a vast gap between the farmer's yield and improved variety yield as per recommended practice through cluster frontline demonstrations on farmer's field. Technology gaps were also recorded of each village and these ranged from 14.60 to 18.20 q/ha and average technology gaps of 16.97 q/ha. These gaps may be attributed to the variation in soil fertility status. Similarly, technology index was ranged from 48.67 to 50.67 per cent and average figure comes out to be 49.89 per cent. The program of large scale frontline demonstration could be popularized for other oilseed crops also in order to increase farmer's income and attain self-sufficiency in oilseeds production.

Economics: Different variables like a seed, fertilizers, bio-fertilizers, and pesticides were considered as cash input for the demonstrations as well as farmer's practice, and the (Table 4) indicated that on average additional investment of Rs. 749 per ha was made under demonstrations. The economics of improved technology over farmer's practices were calculated depending upon the prevailing market prices of input and output for the particular year. It was observed that the cost of cultivation of mustard varied from

Table 4: Economic analysis of CFLDs on mustard crop

Village/ Block	Average Cost of Cultivation (Rs./ha)		Additional cost in demo. (Rs./ha)	Average Gross Return (Rs./ha)		Average Net Return (Rs./ha)		Additional returns in demo. (Rs./ha)	Benefit- Cost Ratio	
	IT/ CFLDs plot	FP/ Local check plot		IT/ CFLDs plot	FP/ Local check plot	IT/ CFLDs plot	FP/ Local check plot		IT/ CFLDs plot	FP/ Local check plot
Kukanwali	25900	24700	1200	96735	83845	70835	59145	11690	3.73	3.39
Nagwara	25900	24700	1200	93395	80795	67495	56095	11400	3.61	3.27
Nimbikalan	37310	36751	559	112880	94169.5	75570	57418.5	18151.5	3.03	2.56
Bhilal	37232	36715	517	112340	94565	75108	57850	17258	3.02	2.58
Bardwa	37200	36676	524	111285	92130	74085	55454	18631	2.99	2.51
Chavandiya	37110	36612	498	110645	90950	73535	54338	19197	2.98	2.48
Avg	33442	32692	749	106025	89180	72583	56488	16095	3.17	2.73

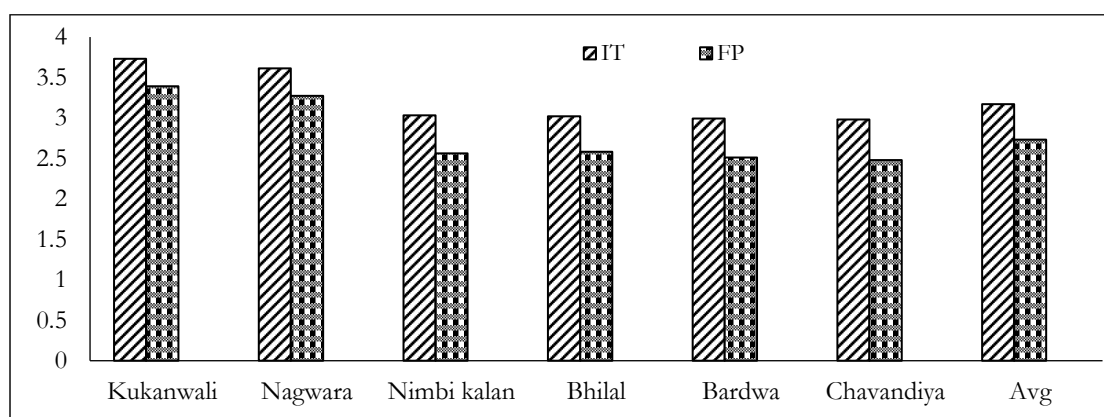
Table 5: Observation on farmers feedback on improved technologies of CFLDs on mustard crop

Particulars	Percentage
Adaptability	75
Level of improved technology acceptance to the farmers	70.83
Suitability to the existing farming system	75
Compatibility to household internal resources	70
Affordability	81.66

Rs. 25900 to 37310/ha with an average of Rs. 33442/ha under improved technologies. Whereas, the cost of cultivation of mustard varied from Rs. 24700 to 36751/ha with an average of Rs. 32692/ha under farmer's practices. Improved technology have also higher net returns varying from Rs. 67495 to 75570/ha with an average of Rs. 72583/ha under improved technologies. Whereas, the net returns of mustard varied from Rs. 56095 to 57850/ha with an average of Rs. 56488/ha (Table 4) recorded under farmer's practices. The average additional cost and net returns of Rs. 749 and 16095/ha, respectively were recorded with the

incremental cost-benefit-cost ratio of 21.48 (Figure 1). On average, the benefit-cost ratio (BCR) under improved technologies and farmer's practices were 3.17 and 2.73, respectively. Higher additional returns and effective gains obtained through demonstrations may be attributed to improved technology, non-monetary factors, timely crop cultivation operations, and scientific monitoring. The higher benefit-cost ratio proved the economic viability of the technology interventions and motivated the farmers to the adoption of improved technologies (Figure 2). These findings corroborate with that reported by Kumawat *et al.* (2017).

The farmers' feedback were collected on improved technology after conducted CFLDs for two years in different villages and blocks and its mentioned in Table 5. These observation find out that 75 per cent adaptability, 70.83 per cent level of improved technology acceptance to the farmers, 75 per cent suitability to farming system, 70 per cent compatibility to household internal resources and 81.66 per cent affordability on farmers reactions on improved technology.

**Figure 1: BCR of mustard demonstration in Didwana-Kuchaman district of Rajasthan****Figure 2: Performance of mustard variety RH-0725 under demonstration in Didwana-Kuchaman district of Rajasthan**

CONCLUSION

It is concluded that CFLDs were effective tools for increasing the productivity of mustard. The demonstrations conducted on mustard at the farmer's field revealed that the adoption of improved technologies significantly increased the yield as well as the net returns to the farmers. On average, gross return (Rs. 106025), net returns (Rs. 72583), ICBR (21.48), and benefit-cost ratio (3.17) were fetched under improved technologies over farmer's practices. So, there is a need to disseminate the improved technologies among the farmers with effective extension methods like on and off campus trainings, Kisan ghosthies, field days, field as well as exposure visits, and demonstrations. This created greater curiosity and motivation among other farmers who do not adopt improved practices of mustard cultivation. These demonstrations also strengthened the relationship and trust between farmers and KVK scientists. It was also concluded that besides other practices of weed management, insectpest management, and water stress are to be given due to attention to enhancing mustard production in the area. This will subsequently increase the income as well as the livelihood of the farming community of the district.

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REFERENCES

- Badhala, B.S. and L.S. Bareth. 2013. Constraints of mothbean production technology in the arid region of Rajasthan. *Agriculture Update*, 8(1/2): 93-97.
- Balai, C.M.; R.P. Meena; B.L. Meena and R.K. Bairwa. 2012. Impact of frontline demonstrations on rapeseed and mustard yield improvement. *Indian Research Journal of Extension Education*, 12(2): 113-116.
- Das, P.K. and R.W. Willey. 1991. A farmer participatory approach to the development of improved sustainable technologies for resource-poor rainfed areas of the western plateau of India. Extension strategies for Rainfed Agriculture. Ed: *Indian Society of Extension Education*, New Delhi. 199-205.
- DOA. 2024. Production and productivity of *rabi* pulses in the Agro-climatic zone of Rajasthan. 2024.
- GOI, Statistics. 2020-21. Directorate of Economics and Statistics, DAC and FW, GOI, New Delhi: pp. 85-86.
- GOR. 2023-24. Vital Agricultural Statistics, Govt. of Rajasthan, Pant Krishi Bhawan, Jaipur, pp 4-5.
- GOR. 2024-25. Vital Agricultural Statistics, Govt. of Rajasthan, Pant Krishi Bhawan, Jaipur, pp 4-5.
- Kadian, K.S.; R. Sharma and A.K. Sharma. 1997. Evaluation of Frontline Demonstrations trials on oilseeds in Kangra valley of Himachal Pradesh. *Annals of Agricultural Research*, 18(1): 40-43.
- Kumawat, S.; M.K. Yadav and I.P. Singh. 2017. Singh. Economic analysis of yield gap and constraints inhibiting the attainment of higher yield of mothbean in Rajasthan. *International Journal of Agriculture Sciences*, 9(34): 4501-4503.
- Meena, H.S.; A. Kumar; B. Rain; V.V. Singh; B.K. Singh; P.D. Meena and D. Singh. 2015. Combining ability and heterosis for seed yield and its components in Indian mustard (*B. juncea*). *Journal of Agricultural Science and Technology*, 17: 1861-1871.
- Prakash, S. 1980. Cruciferous oilseeds in India. p. 151–163. In: S. Tsunoda, K. Hinata, and C. Gomez-Campo (eds.), Brassica crops and wild allies. Biology and Breeding. Japan Science Soc. Press, Tokyo.
- Sharma, V.P. 2014. Problems and prospects of oilseeds production in India, Centre for Management in Agriculture (CMA), Indian Institute of Management (IIM), Ahmedabad, November, 2014.
- Shivani, K.S. 2002. Response of Indian mustard (*B. juncea*) to sowing date and row spacing in midhills of Sikkim under rainfed conditions. *Indian Journal of Agronomy*, 47: 405- 410.
- Singh, G.; N.S. Dhaliwal; J. Sing and K. Shama. 2011. Effect of frontline demonstrations on enhancing productivity of mustard. *Asian Journal of Soil Science*, 6: 230-233.
- Thakur, M. and B.S. Sohal. 2014. Effect of elicitors on physio morphological and biochemical parameters of Indian mustard (*B. juncea*) and rapeseed (*B. napus*). *Journal of Natural and Applied Sciences*, 6: 41-46.
- Yadav, D.B.; B.K. Kamboj and R.B. Garg. 2004. Increasing the productivity and profitability of sunflower through frontline demonstrations in irrigated agro-ecosystem of eastern Haryana. *Journal of Agronomy*, 20: 33-35.
- Yan, Z. 1990. Overview of rapeseed production and research in China. In: Proceedings of International Canola Conference held at Potash and Phosphate Institute, Atlanta. pp. 29–35.



Research Article

Productivity and Economics of Maize Cultivation after Wheat Crop by Different Sowing Methods under Rain Fed Conditions in Samba District of J&K

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ABSTRACT

Maize is cultivated manually which is time consuming, labour intensive and costly. Availability of a multi crop planter with replaceable metering plate is crucial to meet the seed rate requirements and to reduce the cost involved in machinery management. Seed metering device is a heart of seed sowing machine which is evaluated for seed distance. The tractor operated multi crop planter was used for line sowing of seed and fertilizer at proper depth to achieve increased productivity. The use of precise planter for seeds could save the seed in the require 15 to 20 per cent. Multi crop planter helped in efficient conduct of intercultural operation to reduce the weeds and use of other inputs. The present study was conducted with the specific objective i.e. to analyze the economic impact of multi crop planter as compared to the conventional practices on maize cultivation in the district. Twenty front line demonstrations each year were conducted during kharif season of 2019-20 and 2020-21, to evaluate for maize sowing with an objective to improve farm productivity and efficiency in Samba district of Union territory of Jammu and Kashmir. The results of the study revealed that the average yield of demonstration plots and farmers plot (check) were 31.50 q/ha and 22.70 q/ha in the year 2019-2020 and 2020-2021 respectively. On overall average basis, 38.77percent higher grain yield was recorded under demonstration plots as compared to the farmers plot. The net returns in Multi crop Planter of maize production was higher by 37.22 percent as compared to the conventional method. B:C ratio under Multi crop planter was 3.14 while under conventional method it reduced to 2.01. Therefore, Multi crop planter was economically feasible. The yield gap analysis emphasizes the need to educate the farmers for adoption of the resource conservation technologies to revert the trend of wide extension gap.

Keywords: Multi crop planter, Benefit cost ratio, Cultivator, Rotavator, Tractor, Yield

INTRODUCTION

Food and Agriculture Organization (FAO) projections in food demand suggest that cereal demand will increase by almost 50% towards 2050 (FAO, 2003). This is in line with the expected increase in population over time, the past 100 years have seen the world's human population increasing by nearly fourfold (UN population Division, 2007) and it is projected to increase

from 6.7 billion (2006) to 9.2 billion by 2050. Maize is one of the important crop of rain fed agriculture is grown in low, mid and high hill altitudes in all three seasons namely rainy (kharif), winter (rabi) and summer. Of these three seasons, nearly 90 per cent of the production came from kharif season, 7-8 per cent during rabi season and remaining 1-2 per cent during summer season. Jammu and Kashmir contribute 2.48 per cent to the total Indian maize production. The

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sowing of maize crop is mainly by broadcasting after three to four tillage operations resulting in high labour requirements and drudgery. Because of the seasonality of rain fed farming, maize planting is often late resulting in considerable losses in crop yield. A need exists for improved maize planting machine that allow farmers to plant in a timely manner in order to increase yield and reduce drudgery. Early planting is one of the most basic requirements for good crop production due to benefits from the higher soil fertility present at the beginning of the rainy season. As the season progresses, nutrients leach below the root zone and are therefore no longer available for uptake. Early planting also benefits from more days of sunshine. Unfortunately, farmers are reluctant to see the long-term effect of maize cultivation during spring season. Further, Manan *et al.* (2016) indicated that adequate plant spacing coupled with plant population per unit area gives a good yield. The number of rows per cob, cobgirth, grain weight and cob length were the factors which contribute to increase in cob yield and grain yield. Besides these factors, number of plants per unit area or plant density is also one of the main factors which ultimately led to increase in cob yield or grain yield only per unit area. The selections of suitable sowing methods play an important role in placement of seed and fertilizer at proper depth and maintain row to row and plant to plant spacing which ensures better yield. In Samba district, maize is sown through broadcasting on a large area after wheat harvesting. Broadcasting not only requires higher seed and fertilizer rate but also poor yield. Farmers prefer this technology due to the farm labour shortage and rising fuel prices. To boost the production and productivity of maize crop in the district, Krishi Vigyan Kendra (KVK) Samba conducted front line demonstrations (FLDs) on Multi crop planter technology in maize crop. The present study was undertaken with the objective of comparing the economics of maize production with Multi crop planter and conventional method and quantifying the contribution of technology and inputs into the estimated productivity differences due to Multi crop planter.

MATERIALS AND METHODS

Multi crop planter has been interpreted here as the process of planting maize seed after the harvest of

wheat with one time use of tractor operated rotavator. The conventional practice refers broadcasting of seed sowing after four times use of tractor drawn cultivator to accomplish land preparation for maize sowing. Multi crop planter cultivation of maize reduces the number of field operation from an average of four times use of tractor drawn cultivator to one time use of tractor operated rotavator over conventional maize cultivation.

The five furrows tractor mounted multi crop planter was tested in laboratory before taking to actual field conditions. The seed were passed through the inclined plate planter to check the regularity of flow and damage. The inclined plate of multi crop planter was fitted for line sowing at 60 cm. The parameters recorded were sowing time and operational energy, depth of sowing, labour requirement, man-h/ha, population of established plant in unit area, fuel requirement, cost of operation, cost of production and grain yield (q/ha). The primary data on grain yield and farmers' practices were collected from the FLD beneficiary and farmers of check plots through random crop methodology followed by personal interviews so that further research and extension activities can be improved.

Farmers in Samba district, are rapidly adopting Multi crop planter technology for maize sowing. For this study, twenty front line demonstrations (FLDs) on maize were conducted at farmers' field in the district, to assess its performance during kharif seasons for two consecutive years 2019-20 and 2020-2021. The area under each demonstration was 0.2 ha. In FLDs' plot, Multi crop planter for maize sowing practice was adopted whereas, in the adjoining farmers' fields, crop was grown as per the practices followed by the farmers which served as control/local check.

The cost of human labour and diesel were taken on actual expenditure basis. Gross income included the total value of main crop and by-product. Net income was calculated as the difference between gross income and cost of production.

The cost concept was considered for the estimation of cost of maize production. The cost was taken into account in this study to calculate net income and benefit cost ratio. The cost included all directly expenses paid in cash for crop production such as hired human

labour, seeds, fertilizers, plant protection measure, overhead charges and input value of family labour. All input and output parameters pertaining to the maize production were based on average values of two years with a view to minimize seasonal fluctuations in the variables. The gross income included the total value of main crop and by-product. Net income was calculated as the difference between gross income and cost of production.

Estimation of technology gap, extension gap and technology index: Technology gap refers to the difference between the potential yield and actual farm yield. The potential yield refers to that which is obtained in the experiment station. The yield is considered to be the absolute maximum production of the crop possible in the given environment, which is attained by the best available methods and with the maximum inputs in trials on the experiment station in a given season. Demonstration yield is the yield obtained on the demonstration plots on the farmers' fields in the study area. The conditions on demonstration plots closely approximate the conditions on the cultivators' fields with respect to infrastructural facilities and environmental conditions. Actual yield refers to the yield realized by the farmers on their farms under their management practices. The data output were collected both in FLDs as well as control plots and finally the extension gap, technology gap, technology index (%) were worked out (Samui *et al.*, 2000) as given below:

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Farmers yield

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

The regular visits by KVK scientists to FLD plots were made so as to ensure timely application of critical inputs and to solve other crop related problems.

RESULTS AND DISCUSSION

The machine was field evaluated at farmers' fields for raising maize crop after wheat in comparison to conventional method of broadcasting. The primary data were collected during the years 2019-20 and 2020-21 from 20 farmers each year. All input and output parameters pertaining to the maize production were based on average values of two years. The results obtained from the present study are discussed in detail under following heads:

Data related to machine performance, crop growth and yield of different treatments are presented in Table 1.

Sowing time and operational energy: The results showed that multi crop planter was the most time and energy effective for 68.4 and 65.6 per cent, respectively over the conventional practice. The time taken with conventional practices and multi crop planter method was 11.40 h/ha and 3.60h/ha respectively (Table 1).

Labour requirement: Labour requirement for sowing of maize with multi crop planter was much less as compared to the broadcasting method. The study showed that the multi crop planter saved 57.14 percent labour requirement as compared to the farmers'

Table 1: Field performance for different treatments for sowing of maize

Particular	Conventional method	Multi crop planter method
Sowing time, hr/ha	11.40	3.60 (68.4)
Operational energy, MJ/ha	1986.34	682.57(65.6)
Depth of sowing, cm	Top surface of the soil	5 cm
Labour requirement, man-hr/ha	7.0	3.0
Fuel requirement, l/ha	35.70	18.10
Cost of operation, Rs/ha	5900	3100
cost of production, Rs/ha	22500	19800
Grain yield, q/ha	22.70	31.50
Net return, Rs/ha	45400	62300
Benefit–cost ratio	2.01	3.14

practice. Similar result was reported by Murumkar *et al.* (2015) (Table 1).

Depth of sowing: The depth of sowing of multi crop planter was found to be 5 cm compared to broadcasting method in which seed remains on top surface of the soil.

Plant population: The plant population in unit area was much more by multi crop planter compared to broadcasting method. The plant population was found to be 7.8 per metre square in multi crop planter whereas 5.4 plant by broadcasting method. Similar result was reported by Abbas *et al.* (2009). The study have indicated 72 per cent reduced incidence of weeds in maize in long run resulting into reduced use of weedicides.

Fuel requirement: Fuel used by multi crop planter was less as compared to broadcasting method as reduced tillage operations. The study showed that fuel used by multi crop planter was 18.10 l/ha whereas 35.70 l/ha in conventional method. Multi crop planter was saved 49.16 per cent fuel as compared to broadcasting method.

Cost of operation and cost of production: The study showed that cost of operation were Rs 5900 and Rs 3100 Rs/ha in the conventional and multi crop planter method respectively. Multi crop planter saved 47.45 per cent cost of operation as compared to the broadcasting method. The cost of production were Rs 22500 and Rs 19800 /ha, in the conventional and multi crop planter method respectively.

Grain yield: The grain yield was estimated by measuring the plot cutting yield. This was done by measuring the grain yield production/plot area under a particular method. The harvesting of crop for each plot and measuring the yield in each method.

In conventional and multi crop planter method, average yield was found to be 22.70 and 31.50 kg/ha

respectively. Benefit cost ratio was 3.14 in multi crop planter whereas 2.01 in farmers' practice. Therefore, yield of grain as well as benefit cost ratio increased in the multi crop planter method.

Technology yield gaps: The technological gap during the study period varied to the extent of 18.20 to 18.80q/ha (Table 2). The overall average technological gap was 18.50. The technology gap observed may be attributed to dissimilarity in the soil fertility status, agriculture practices and local climatic situation.

Extension yield gaps: The extension yield gap during the study period varied to the extent of 8.70 to 8.90 q/ha (Table 2). The overall average extension gap was observed as 8.80 q/ha, which emphasized the need to educate the farmers through various extension means like FLD, for adoption resource conservation technologies, to regress the trend of wide extension gap. Generally, the technological gaps appear even if the FLDs' are conducted under the close supervision of farm scientists on the farmers' fields. This may be attributed mainly to the lack of irrigation infrastructure, untimely rainfall, and variation in soil fertility and cultivation on marginal lands, non-congenial weather conditions and local specific crop management problems faced in order to harness the yield potential of specific crop cultivars under demonstration plots.

Technology index: The technology index showed the feasibility of the evolved technology at the farmers' fields. The lower the value of technology index, the more is feasibility of the technology. Fluctuation in the technology index (ranging between 36.40 to 37.60 per cent and overall average technology index was observed as 37.0 per cent (Table 2) during the two years of FLD, may be attributed to the dissimilarity in soil fertility status, weather conditions (low or untimely rainfall), insect-pests, and diseases. Our results are also in conformity with the findings of Shashikumar (2015) on maize crop and Gaddi *et al.* (2002b) on cotton.

Table 2: Technology gap, Extension gap and Technology index in Wheat crop

Year	Crop	No. of Demonstrations	Area (ha)	Potential Yield (q/ha)	Average yield of demo. Plot (q/ha)	Average yield of farmers plot (q/ha)	% age increase over farmers plot	Technology Gap (q/ha)	Extension Gap (q/ha)	Technology Index
2019-20	Maize	20	4.00	50.00	31.20	22.50	38.66	18.80	8.70	37.60
2020-21	Maize	20	4.00	50.00	31.80	22.90	38.86	18.20	8.90	36.40

Some feedbacks were also recorded by interviewing the farmers about low productivity of maize.

CONCLUSION

It can be concluded that maize sowing by multi crop planter was very encouraging besides a net saving of Rs. 16900/ha as compared to farmers' method of maize establishment. This was mainly because of saving of fuel, labour and other inputs. The tractor operated multi crop planter can be acceptable machine for the farmers for sowing of maize after wheat harvesting since it gave maximum plant population, less requirement of labour, reduce cost of cultivation and higher yield compared to farmers' practice methods. Multi crop planter has been proved to be more beneficial in terms of saving of numbers of operations required for maize sowing, saving of tractor hour, saving of diesel fuel and reduce incidence of weeds infestation. Sowing with multi crop planter has advantage of better inter-culturing operation, management of insect, pest and disease and mechanical harvesting.

REFERENCES

- Abbas, G.; M.A. Ali; G. Abbas; M. Azam and I. Hussain. 2009. Impact of planting methods on wheat grain yield and yield contributing parameters. *The Journal of Animal and Plant Science*, 19(1): 30-33.
- Anonymous. 2011a. Annual Report 2011-12, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.
- Chandra, S. and D. Prasad. 2014a. Farm machine banks and its impact on mechanization process and socio-economic condition of member farmers. *Agricultural Engineering Today*, 38(2): 33-38.
- FAO. 2011. Crop Prospects and Food Situation. Global Information and Early Warning System, Trade and Markets Division, FAO, Rome.
- Ismail, W.I.W. 1998. Cost analysis model for crop production machinery system.
- Manan, J.; G. Singh; M. Sharma and G. Singh. 2016. Effect of plant spacing on yield and yield attributes of maize hybrids. *Journal of Krishi Vigyan*, 5(1): 41-45.
- Moitzi, G.; T. Szalay; M. Schüller; H. Wagentristsl; K. Refenner; H. Weingartmann; P. Liebhard; J. Boxberger and A. Gronauer. 2013. Effects of tillage systems and mechanization on work time, fuel and energy consumption for cereal cropping in Austria. *Agricultural Engineering International: CIGR Journal*, 15(4): 94-101.
- Murukumar, R.P.; R. Usha; D.S. Dongarwar; D.S. Phad and P.S. Pisalkar. 2015. Assessment of seed cum fertilizer drill for wheat sowing after paddy harvest. *International Journal of Innovative Studies in Sciences and Engineering Technology*, 2(6): 760-765.
- Shahare, P.U. 2012. Agricultural Mechanization in Konkan Region of Maharashtra. *Agri Engineer Today*, 36(2): 6-9.
- Sharma, M.; O. Singh; G. Singh and G. Kaur. 2014. A snap shot of spring maize cultivation in Kapurthala and Jalandhar district under Central Plain Zone of Punjab. *Journal of Krishi Vigyan*, 3(1): 1-4.
- Singh, S. 2007. Hill agricultural mechanization in Himachal Pradesh - A case study in two selected districts. *AM4*, 38(4): 18-25.
- Singh, S.P. and H.N. Verma. 2001. Scope of farm mechanization in Shivalik hills of India. *AM4*, 32(1): 59-64.
- Thierfelder, C. and P.C. Wall. 2009. Effects of conservation agriculture techniques on infiltration and soil water content in Zambia and Zimbabwe. *Soil and Tillage Research*, 105: 217-227.
- Vatsa, D.K. and D.C. Saraswat. 2003. Agricultural Mechanization in hills of Himachal Pradesh: A case study. *AM4*, 34(1): 66-70.

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Research Article

Quantum Social Science : Exploring Possibility and Insights for New Genre of Social Science Research (QSS)

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ABSTRACT

Quantum social science (QSS) is the latest and the swashbuckling progress in the genre of social science research which got off to a start since 2013 only. This is basically an extrapolation of Heisenberg's and Schrodinger's empirical researches on quantum mechanics harboring on entanglement and complementarity principles. The present paper delves deeper into the possibility of its application in studying extension science the realm of behavioral dynamics of technology response, networking and socialization across the planks of entanglement, complementarity and multiple reality. It also focuses lights on Schrodinger's empiricism on Super positioning of single truth with dual expression and possibilities as well. This is going to be a breakthrough conceptual revolution for elucidating technology-behavior duality in drawing upon policy implications for both extension methods and strategy in the light of most advanced physics of present-day civilization.

Keywords: Complementarity, Entanglement, Social science, Superposition and Contextuality, Technology socialization, Quantum social science, Wave-particle duality

INTRODUCTION

In the 17th century, the word 'Quantum' comes from the Latin word 'Quantus' which means 'How much' or 'An amount'. Quanta refers to the smallest possible discrete unit of a physical property or entity such as energy or matter. Founders of this great quantum theory are Max Planck, Niels Bohr and Albert Einstein. In 1901, Max Plank used the phrase to convey the notion that heat, gas, and electricity are only found in this form. Additionally, Albert Einstein proposed in 1905 that radiation was composed of spatially defined packets known as "quanta of light."

The multidisciplinary discipline of social physics analyses social systems and human behaviour by utilizing ideas and methods from physics, especially statistical mechanics and network research. Drawing comparisons between quantum physics and the social sciences, quantum social science is a new multidisciplinary area that investigates if quantum ideas might

provide fresh perspectives on social phenomena and human behaviour.

The interaction between matter and energy is the subject of physics. It is a basic idea that explains how nature behaves both at and below the atomic level. Many situations that classical physics is unable to describe can be described by quantum mechanics. Many features of nature may be described by classical physics at conventional (macroscopic + optical microscopic) dimensions, but not at extremely small sub microscopic (atomic + subatomic) scales. Unlike classical systems, where energy, momentum, angular momentum, and other quantities may be measured continuously, quantum systems have bound states that are quantized to discrete values.

It is better to say that QSS is bridging the gap between Quantum mechanics and social theory and here we are observing social science through the lens of quantum mechanics and quantum theory. Quantum

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social science examines the connections between quantum physics and social sciences, potentially providing fresh insights into social phenomena and decision-making, whereas social physics, also known as sociophysics, applies mathematical methods from physics to comprehend human behaviour and crowds.

From the standpoint of philosophy of science, there is a fundamental distinction between realist and anti-realist perspectives in quantum social science, just as there is in the interpretations of quantum theory itself. Realist viewpoints use the presumption that the social is quantum mechanical as justification for demanding a fundamental re-examination of our social practices, beliefs, and approaches. In contrast, instrumental accounts employ metaphors, analogies, and mathematical formalisms to provide more practical descriptions of social issues without committing to any ontological positions.

Questions about disciplinary boundaries, as well as the standing, reach, and methodologies of IR (International Relations) and the social sciences, are invariably brought up by quantum social science. The social science field of international relations (IR) examines how nations engage with other players in the global arena, such as multinational businesses, international organizations, and non-governmental organizations and it is based on some theoretical approaches viz. Realism, Liberalism, Constructivism, Marxism.

Sometimes, these discussions are presented as a choice between the humanities and the “hard” sciences, with the social sciences holding an uncomfortable middle ground among them. Other methods, however, expressly disagree with this exact dichotomy.

Beyond traditional, mechanical models of social interactions, quantum social science aims to create models that take into account key ideas from quantum theory, such as Complementarity and Entanglement. Measurement of QSS is based on wave-particle duality of The Uncertainty principle or Heisenberg’s indeterminacy principle. Classical probability theory and rational choice models are the foundation of traditional social science. Superposition and Contextuality are introduced by quantum models to help explain decision-making paradoxes such inconsistent decisions and

cognitive biases. Quantum social science has the promise of a whole new approach to social science for researchers who employ quantum concepts to reconsider social interactions and agency.

Objectives

- i. To understand the process of Decision-Making beyond classical Newtonian frameworks and develop better models of intricate social relationships.
- ii. To highlight the improvement of computational and AI models for social phenomena and use of Entanglement to simulate social interactions in order to investigate quantum probability in human behaviour.
- iii. To highlight the importance of redeeming social ontology and epistemology
- iv. To configure Policy Implications for developing quantum-like models for Economics and Finance with the help of the bridge between Science and Philosophy.

MATERIAL AND METHODS

- i. Generation information from digital repository and knowledge sources on.
- ii. Processing, filtering and editing of downloaded materials.
- iii. Objective wise presentation of procured citation, concepts and interpretation innovation.
- iv. Use of Delphi technique for isolating unique concepts from pool of homogeneous echelon of conglomeration. The Delphi Method is an organized method for getting a collection of experts’ perspectives in order to get to an agreement. Business, healthcare, education, and environmental science all often utilize it.

Key Principles of QSS

I. Challenging classical Newtonian assumptions:

Materialism, determinism, and mechanism are considered to be incompatible with the results of quantum physics, and quantum social science aims to go beyond these assumptions. To sum up, quantum theory questions the philosophical presumptions that underlie the classical worldview, including materialism,

determinism, the separation between subject and object, the function of consciousness, and the absoluteness of space and time (Wendt, 2006, 2015). Social scientists, especially economists, will quickly recognize the significance of these discoveries for human decision-making processes if they examine the function of consciousness interpretation from the perspective of quantum physics.

For example, Schrödinger (1944); Hameroff and Penrose (1996); Ho (1997); Glymour *et al.* (2001); Manousakis (2006); Aerts *et al.* (2010) and Igamberdiev (2012) discuss quantum physics, which talks about a quantum consciousness that can be extended to all social life, while classical physics views consciousness as something material. The underlying principles of choice theory (including cognitive biases) and the relationship between consciousness, quantum physics, social science, and decision-making theory are therefore examined and reinterpreted.

II. Two-slit experiment and collapse of the wave function: With the Two-slit experiment in 1924 and 1926, De Broglie provided both theoretical and experimental evidence that matter can behave like a wave and that electrons are both tiny objects and waves. This was in addition to Planck and Einstein's findings that light can be both waves and particles, which appears to go against Newton's traditional either-or physics (De Broglie, 1924; and more general Zukav, 1979; Herbert, 1985; Greene, 2011; Susskind, 2014). A type of particle gun directs an electron mass at a two-slit screen in these tests. As these electrons go through the slits, a photographic screen shows where they strike (Davisson and Germer, 1927; Nadeau and Kafatos, 1999).

The hits are distributed in front of the open slit if one slit is closed. A similar outcome across the second slit happens if the conditions are reversed (the open slit is closed and the other one is opened), as could be predicted if the electrons were particles. Therefore, one may presume that the outcome is a sum of the distributions when both slits are open. It turns out that's not the case. A normal wave interference pattern instead emerges. As a result, it seems like every electron moves through both slits at the same time and acts like a wave (Wheeler, 1978; Greene, 2011).

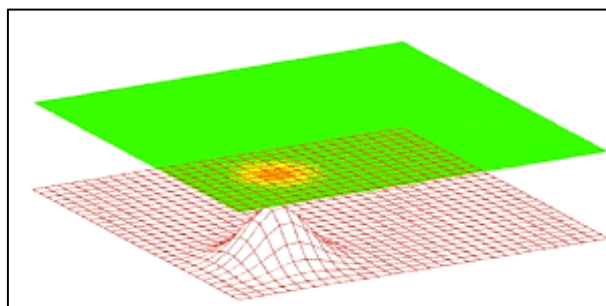


Figure 1: Red grid is a 3-D graph representing the wave function of the photon. Green film represents the photon as a particle, as a collapsed wave function. [Image source: Stills from Dr. Don Lincoln's "Quantum Field Theory" Fermilab film (public domain) from January 14, 2016; <https://www.youtube.com/watch?v=FBeALt3rxEA&feature=youtu.be>.]

To put it another way, measuring or viewing the electrons at the slits produces a different outcome than not measuring; that is, the electron acts like a wave while it is not being watched and as a particle once it is (Weinberg, 1995). This suggests that, in contrast to the classical world, where matter or objects are viewed as distinct from one another, in the quantum realm, the observer and the observed create their own unique system (Malin, 2001).

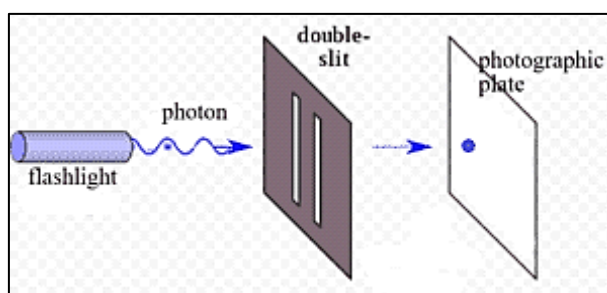


Figure 2: Double Slit Experiment shooting one photon at a time. [Image source: modification of https://en.wikipedia.org/wiki/Double-slit_experiment]

Applications in Social Science

We can say in the field of agriculture farmers are trying to go through the slits of uncertainty by adopting different enterprises, changing crop cultivation and cropping pattern also through Trial and Error methods as some crops cannot hit the expected productivity as well as the economic outcome.

III. Uncertainty principle: It is impossible to measure a particle's momentum and position at the

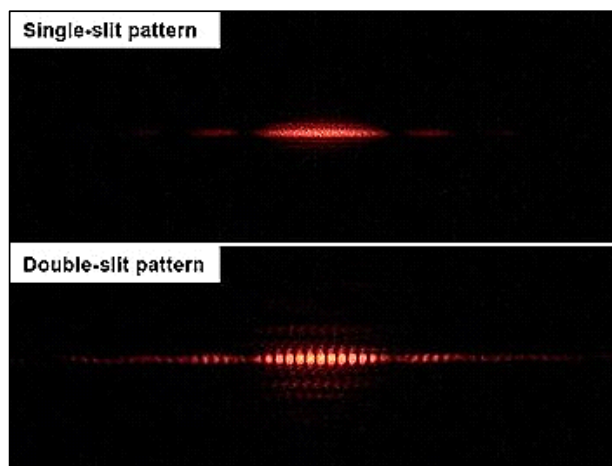


Figure 3: One slit is closed in the top picture of the same double-slit assembly (0.7 mm between slits). In the picture with only one slit, a diffraction pattern (The nonzero width of the slit causes the formation of (the faint spots on each side of the main band)). The double-slit picture displays this diffraction pattern as well, but with several smaller interference

same time, according to Heisenberg's uncertainty principle, commonly known as the unsharpness relation (Heisenberg, 1925). This implies that a particle's position becomes less accurate the more accurately its momentum is measured, and vice versa. The particle therefore possesses either a precisely specified location or a precisely defined momentum, but not both simultaneously (Malin, 2001). The uncertainty principle articulates the wave nature of matter in conjunction with the wave function.

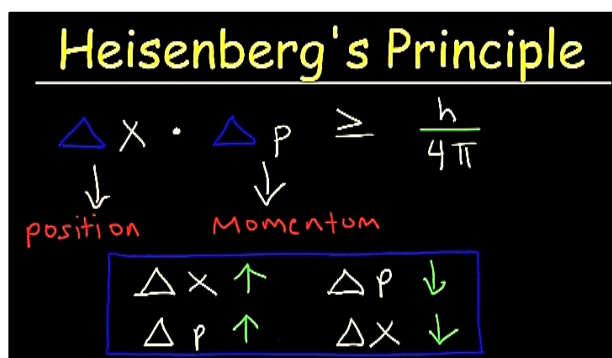


Figure 4:

Heisenberg's uncertainty principle is expressed by this connection. It restricts the amount of information that can be gleaned about a particle from simultaneous location and momentum measurements. Δp is little if Δx is big, and vice versa.

The instrumentalist and realist schools of thought are the two that are highlighted by a deeper examination of the interpretative literature (for an excellent summary, see Wendt, 2015). Instrumentalism, also known as the Copenhagen interpretation (see Howard, 2004), has its roots mainly in Bohr's 1927 work, which was based on a discussion with Heisenberg. Bohr believed that the question of what the quantum world actually is could not be answered, so he concentrated on what could be learned about it (Honner, 1987).

According to Shimony (1978), instrumentalism is concerned with the depiction of reality rather than reality itself. According to Bohr, unlike macroscopic things, quantum systems cannot verify that particular qualities are inherent without a description of the full experimental setup, including the observer and measuring apparatus (D'Espagnat, 1995).

Bohm's Mind-Matter Theory (1990) states that the movement of the quantum particles is organized by active information in the quantum field, which functions similarly to information in the macroscopic world but is more objective and not a measure of our knowledge (Pylkkänen, 2007).

Applications in Social Science

Farmers are the best or worst example of uncertain entity or human entity. Accordingly, the Uncertainty Principle of the Social Sciences mainly addresses the breadth and bounds of any interactions we find in social systems, both in terms of forecast accuracy and popularity.

"Curse of Dimensionality"

The Heisenberg Uncertainty Principle, commonly known as the "curse of dimensionality," in social science modelling states that the more variables or factors taken into account, the less correctly a social phenomenon may be modelled.

Example- Farmers have diversified different types of markets and technologies which are easily available to them but having no exact knowledge while they are having too many options here so we can set here - market and technology uncertainty as an example.

Research Implications

This idea affects how social scientists conduct their

studies by advising them to use caution when making generalizations and to be mindful of the limits of their models.

Emphasis on Context and Nuance

Rather than depending on excessively broad or simplified models, the idea urges academics to concentrate on comprehending the particular context and subtleties of social phenomena.

Examples: a) For a particular person or subgroup, a commonly held opinion of the behaviour of a certain group may not be correct; b) Due to the complexity of actual voting behaviour, a model that tries to forecast election results based on a small number of crucial elements may not be accurate.

IV. Superposition/Multiple reality

Quantum Superposition: A physical system's capacity to exist in several states simultaneously depending on certain solutions is known as superposition. One of the most well-known concepts in quantum mechanics, it is a fundamental quantum principle.

The law of superposition states that any two or more quantum states may be "superposed," or combined together, and yet result in a different, legitimate quantum state. According to the quantum superposition principle, a physical system can exist in a variety of configurations, which are arrangements of particles or fields. The most general state of a system is a combination of all these configurations, with the quantity in each configuration being determined by a complex number.

Analogy/Quantum states: A coin that has been flipped might simultaneously be in the heads and tails states in the quantum universe. In sharp contrast to our daily assumption that the coin must fall as either heads or tails, this event is a direct application of quantum superposition.

Collision: In more detail, a quantum particle can exist in all of its theoretically potential states concurrently until it is measured according to the concept of superposition. The particle collapses into one of the possible states when it is measured.

This concept is essential to quantum mechanics and gives birth to remarkable phenomena like quantum

entanglement and quantum interference. It serves as the foundation for the intriguing behaviours of the quantum world, that we may begin to comprehend by learning the fundamentals of quantum computing.

Probability waves: Probability waves are used in quantum mechanics to characterize particle states. Particles are considered to be in a state of quantum superposition when their actions follow these waves.

Superposition and Measurement: The particle exists in a superposition of every conceivable state up until a measurement is taken. The superposition vanishes when the particle "collapses" into one of those states after being measured.

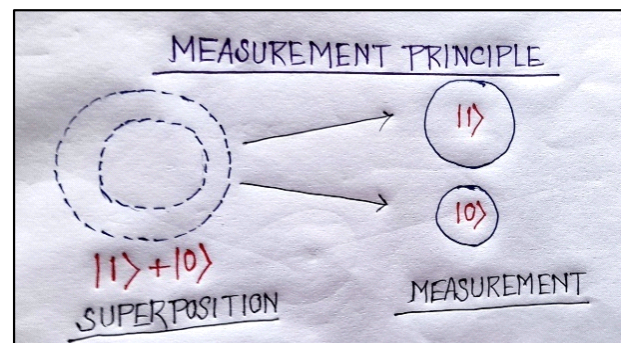


Figure 5:

Examples:

i. *Schrödinger's Cat:* This idea is shown with a well-known thought experiment. Until the box is opened and examined, a cat in a box is both living and dead.

$$|\text{cat}\rangle = \frac{1}{\sqrt{2}}(|\text{alive}\rangle + |\text{dead}\rangle)$$

Figure 6: An example of the Schrödinger's Cat mathematical concept

The most often used collection of solutions for superposition is Hilbert space, or all possible solutions. The superposition of two states is only represented mathematically by this equation. Until we open the box and examine the cat, there is a 50/50 chance that it is either dead or alive. The absolute value of the square of the amplitude in the equation represents the likelihood of any situation. Both states have the same amplitude of $1/\sqrt{2}$ in the cat equation. The absolute square will give us half, or fifty percent, if we compute it. The Hilbert space's dimension is shown in the equation by the 2 under the square root.

ii. *Double-Slit Experiment*: An interference pattern is produced when electrons behave as though they are passing through both slits simultaneously due to superposition.

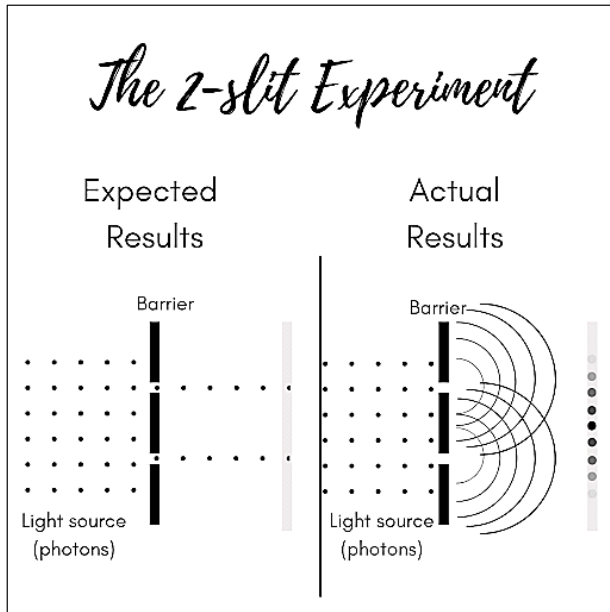


Figure 7:

Quantum computing

A fundamental idea in quantum computing is superposition, which allows for parallel processing and perhaps quicker computations by enabling qubits (quantum bits) to be in a superposition of 0 and 1.

Applications in Social Science

In QSS, particles can exist in multiple states. Similar to this, people can simultaneously possess several identities, viewpoints, and attitudes inside social systems. Some scholars look into the possibility of using quantum ideas like superposition to comprehend social phenomena, arguing that social systems and human behaviour may share traits of existing in several states at once until an action or interaction triggers a “collapse” into a single state.

Examples:

i. *Social Identity*: A person’s identity is a combination of several roles and affiliations that are “collapsed” when they come into contact with one another in certain social settings.

ii. *Decision-Making*: The final option “collapses” the system into a single response, even if a person may be

in a superposition of “yes” and “no” regarding a decision.

V. Bohr and his concept of complementarity: The term ‘complementarity’ was first used by Niels Bohr to describe one of the most basic concepts in quantum theory: that we cannot measure a particle’s position and velocity at the exact same time; the more we know about one, the less we may know about the other though the aspects are not mutually exclusive. We refer to our understanding of the two quantities as complimentary in this context. However, since location and velocity (or momentum) are not the only pairings of “conjugate observables,” the concept may be widely generalized. A fundamental tenet of quantum physics, Niels Bohr’s complementarity principle, asserts that although some pairings of attributes, such as wave and particle, cannot be experienced simultaneously, both descriptions are required for a thorough comprehension of occurrences.

This important point, which was to become a major theme of the conversations detailed below, suggests that there can never be a clear distinction

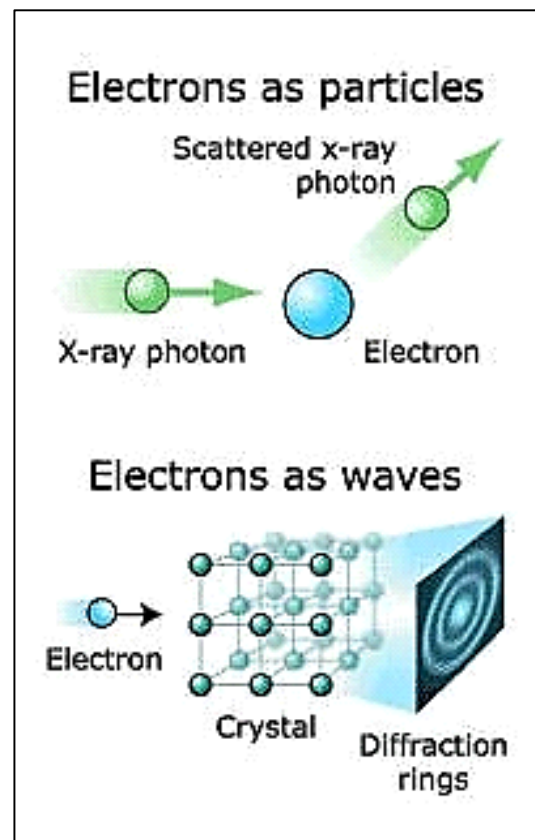


Figure 8:

between how atomic objects behave and how they interact with the measuring devices that define the circumstances under which the phenomenon manifests (Bohr, 1949).

Wave-Particle Duality: According to the concept, depending on the experimental configuration, quantum objects (such as electrons or photons) can behave both like waves and like particles.

Complementary Properties: Certain pairings of attributes, like the position and momentum, are said to as “complementary” because the accuracy with which one can be known restricts the accuracy with which the other can be known.

Experimental environment: The experimental environment affects how a quantum system behaves, therefore the measurement method used can disclose either the particle or wave nature, but not both at once.

Full Description: Since the wave and particle components of a quantum system are complimentary rather than antagonistic, both must be taken into account in order to properly comprehend it.

Examples:

i. Position and Momentum: You can determine a particle’s momentum less precisely the more you know about its position, and vice versa.

ii. Frequency and lifespan: You can determine a photon’s lifespan with more precision if you know less about its frequency, and vice versa.

iii. Optical Phase and Photon Number: How much precisely the optical phase of photon is known to us, the photon number can be less precisely known and vice versa.

iv. Single-photon Mach-Zehnder interferometer: the inference pattern behaves like wave aspect of quantum when the interferometer is closed and when it is open then it behaves like the particle aspect of the quantum.

Applications in Social Science

i. Avoiding Dichotomies: Complementarity pushes us to adopt a “both/and” perspective rather than the binary “either/or” one. We may accept that there are both good and bad sides to a situation rather than only seeing it as either positive or negative.

ii. Multiple Perspectives: When researching a conflict, one may take into account both the personal motivations of the individual and the larger social structures that impact the conflict (a systemic perspective).

iii. Insight Complexity: By accepting complementarity, we may get a more nuanced and thorough knowledge of complicated social situations and personal experiences.

Examples:

i. Education and Experience: Rather of seeing formal education and real-world experience as mutually incompatible, we may acknowledge that both are beneficial for both professional and personal growth.

ii. Politics: Instead of seeing social welfare and individual rights as mutually exclusive, we might appreciate their significance in politics.

iii. Tradition and Innovation: Rather than seeing tradition and innovation as mutually exclusive, we may appreciate their respective merits.

iv. Work and leisure: Rather than seeing work and leisure as mutually incompatible, we might acknowledge that both are essential for a happy existence.

v. Agriculture: If any farmer accepts any crop cultivation or technology then someone else also rejects that one or vice versa as a complement.

vi. Business: Instead of seeing innovation and stability as mutually exclusive, we may acknowledge their necessity in the economic world.

VI. Entanglement: The Nobel Prize in Physics 2022 acknowledged and emphasized the quantum physics notion of entanglement (see Nobel Committee, 2022). According to Bengtsson and Zyczkowski (2006), it indicates that a composite physical system, as a system with many particles, adopts a well-defined state when considered as a whole, without being able to provide each of the subsystems a unique state of its own.

The terminology and way of thinking about relational entanglement offered by quantum social theory is nuanced, reflective, and draws clear of what Zanotti (2019) calls the “Newtonian substantialism” of current IR theory, both positivist and non-positivist. According to Murphy (2021), this is a “physical imaginary” that restricts the theoretical potential of

current IR, especially critical IR. An ontology that rejects the restricted character of subjects, blurs the lines between humans and nonhumans, and defies conventional notions of choice is the starting point for quantum entanglement. Instead of focusing on the revelatory or critical elements of knowledge creation in space and time, it highlights its creative features (Barad 2007; Murphy 2021).

According to quantum social science, which examines the use of quantum ideas like entanglement to comprehend social phenomena, people and societies are interrelated and have an impact on one another, much like entangled particles.

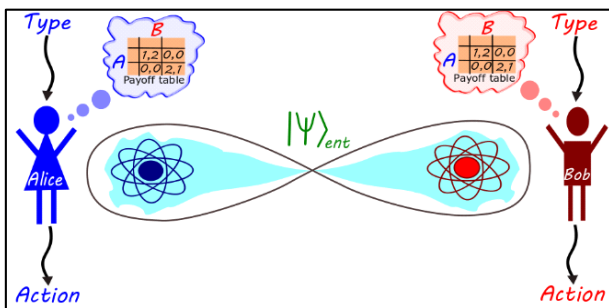


Figure 9: Two-Qubit Pure Entanglement as Optimal Social Welfare Resource in Bayesian Game

Interconnectedness/Shared Quantum State: Even if two entangled particles are located far apart, you may immediately determine their related properties if you measure one of them, such as its spin.

Thinking in holistic systems: Entanglement implies relational realism as opposed to perceiving people as separate entities, as social phenomena arise from the interactions rather than the components alone.

Agents' reluctance to be separated: People in closely connected social networks are impossible to model

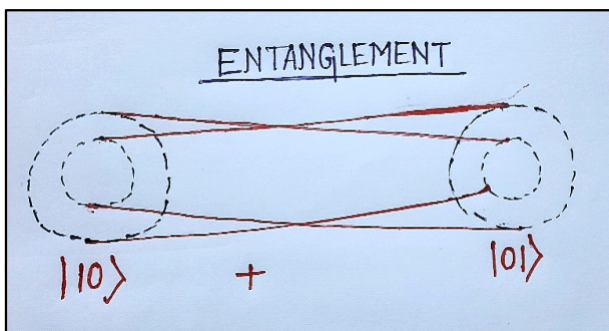


Figure 10: Connecting similar particles on opposite movement over space

separately, much like entangled particles. Shared meaning, culture, or emotion entangles their identities, mental states, or choices.

Not Classical: Compared to classical physics, where things have distinct qualities that can be measured on their own, this behaviour is essentially different.

Applications in Social Science

Researchers in quantum social science utilize “entanglement” both technically and symbolically to describe phenomena like as-

- i. Decision-making that is interdependent
- ii. Behaviour context
- iii. Unbreakable social bonds
- iv. Shared identity or collective awareness
- v. Classical logic is broken in human judgments.

This topic makes the assumption that traditional models-such as rational choice theory or utility theory-cannot adequately describe how people act in situations that are intricate, unclear, or intricately linked.

Examples:

i. Understanding Complex Systems: The concept of quantum entanglement, which occurs when two particles become connected despite their distance from one another, may be used as a metaphor to explain how several aspects of agriculture, including crop genetics, soil health, climate, and farmer practices, are intertwined.

ii. Sustainability and Quantum Entanglement: By optimizing resource usage and minimizing environmental effect, quantum-inspired methods may result in more environmentally friendly farming methods.

iii. Intuitive Farming: New study on intuitive farming, in which farmers base their decisions on their observations and intuition, may be explained by quantum notions.

iv. Understanding Farmer Behaviour: Recognizing the significance of subjectivity and agency, a quantum viewpoint may aid academics in comprehending how farmers make decisions and adjust to shifting circumstances.

v. Quantum Game and Marketing: Understanding the dynamics of agricultural markets and the actions of

various participants may be possible through the use of quantum game theory, which studies decision-making under uncertainty.

vi. Sustainable Farming Methods: Farmers may embrace more sustainable methods, such using less pesticide and fertilizer and enhancing soil health, with the use of quantum-inspired techniques.

vii. SWA: Every pure entangled state of a two-qubit system has been shown to be capable of acting as a quantum social welfare advise (SWA) in a certain Bayesian game. A quantum state that generates a quantum social welfare solution (SWS) is known as a quantum social welfare advice (SWA).

VII. Social positioning theory as a quantum social theory: Some contend that social positioning theory, which examines how people are positioned within social systems, corresponds to the paralleling conception between social positioning and quantum superposition. One example of a quantum social theory is social positioning theory, which describes the human being it grounds. In the study, I support and explain this assessment.

In order to better understand how people and groups dynamically construct and negotiate social identities, roles, and power relations in discourse and action, a new and interdisciplinary approach called Social Positioning Theory as a Quantum Social Theory combines aspects of social psychology, discourse analysis, and quantum theory.

Rom Harré and associates' work is the main source of Social Positioning Theory (SPT). It emphasizes:

Positions: the obligations and privileges given to people during a discussion or social encounter.

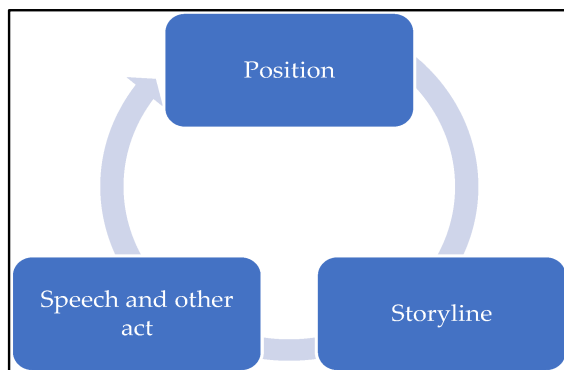


Figure 11:

Storylines: the more general societal narratives or trends that provide context for particular stances.

Acts: These are the words or actions used to carry out viewpoints and plots.

SPT essentially describes how people often and dynamically change and negotiate their social identities and duties within various circumstances.

It means-

- i. Social roles are unpredictable and contextual rather than set.
- ii. Because interactions are emergent and non-linear, placing one person in a certain way might affect other people.
- iii. Identity is a wave function of possibilities rather than a fixed "particle," and it collapses into distinct roles throughout the contact.

Similar to how physics defines the attributes of particles via observation, social reality is created by measurement (i.e., speech acts, interactions).

Applications in Social Science

i. Conflict resolution: Modelling how shifting plots might move people into cooperative positions is one way to resolve conflicts.

ii. AI & social robotics: Understanding dynamic social roles in human-machine interaction through AI and social robotics.

iii. Education: It is managing the dynamic and co-constructed power relations between teachers and students.

iv. Sociolinguistics: It is the study of discourse analysis with a focus on identity and power dynamics.

v. Pattern of land ownership and access: Social Positioning Theory may be used to examine the pattern of land ownership and access, showing how some groups-such as big landowners or particular ethnic groups-are positioned to dominate resources while others are sidelined.

vi. Tariffs and Subsidies: The theory may be applied to examine how agricultural policies, including tariffs and subsidies, impact various farmer and consumer groups,

demonstrating how some are positioned to gain from these policies while others suffer.

vii. Gender Roles: The division of labour within farming families, decision-making authority, and access to agricultural resources are all impacted by gender roles and expectations, which may be better understood using social positioning theory.

Case study example

Haringhata Farm (West Bengal): By analysing the various farmer groups' positions within the local agricultural system—such as smallholder farmers, large-scale farmers, and tenant farmers—and looking at their access to land, credit, and market opportunities, Haringhata Farm could be examined using the Social Positioning Theory.

VIII. Decision making, social science, and quantum physics: The following will reframe the phrases “social science,” “consciousness,” and “decision theory” in the context of quantum physics. In the 1930s, Bohr developed the initial concepts for a so-called quantum social science (see Haven and Khrennikov, 2013) in the form of quantum vitalism (Bohr, 1933). Despite their apparent differences, there are some remarkable parallels between the three subjects of quantum physics, social science, and decision-making.

By examining similarities between quantum physics and the social sciences, quantum social science challenges conventional beliefs about materialism and determinism and suggests that cognition and decision-making processes may be represented using quantum principles.

Quantum Decision Theory (QDT): A decision-maker's choice is described by quantum decision theory (QDT)

as a stochastic event with a probability equal to the sum of an objective utility factor and a subjective attraction component.

Quantum Physics and Social Sciences: A Potential Bridge:

i. Modelling Cognitive Processes: By seeing the brain as a quantum system, quantum models may be utilized to simulate cognitive processes like decision-making.

ii. Enhancing Decision-Making Models: More realistic and accurate models of human decision-making can be produced by integrating quantum principles.

iii. Understanding Cognitive Biases: By taking into account the influence of probability and subjective preferences, quantum principles can assist in explaining why humans make judgments that appear prejudiced or unreasonable.

Applications in Social Science

i. Quantum sensor: According to Farmonaut, quantum sensors can record fine-grained spectral data, exposing crop health problems before they become apparent to the human eye.

i. Understanding farmers' perspective: Gaining an understanding of farmers' varied motives, attitudes, and decision-making processes via social science research can result in more effective policy interventions and extension services.

ii. Adoption of New Technologies: Promoting the adoption of new technologies, like quantum-enhanced precision agricultural instruments, requires an understanding of the social and cultural context in which farmers work.

iii. Quantum-like Models: To depict and forecast the behaviour of complex systems, including agricultural

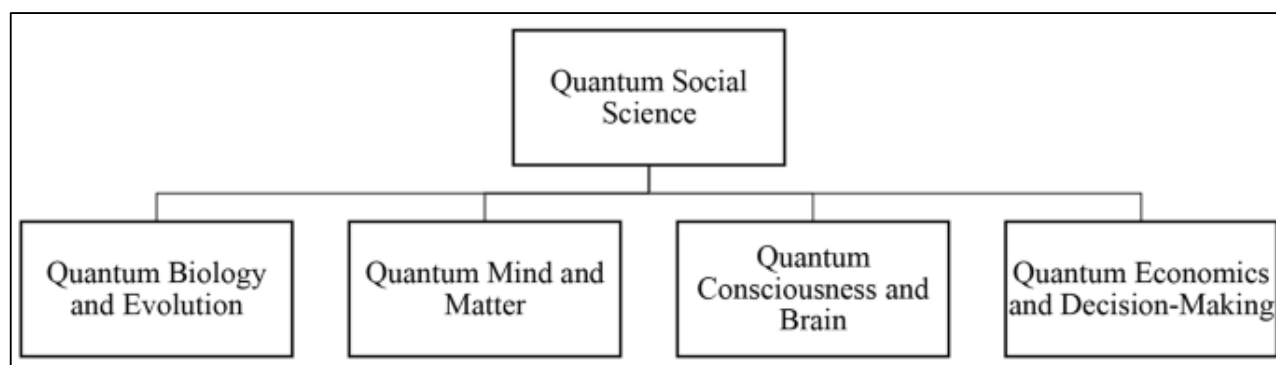


Figure 12: Summarization of quantum social science study areas

ecosystems, some researchers are investigating the use of quantum-like models.

For instance, MDPI proposes that decision-making processes in a variety of domains, including agriculture, may be represented using quantum-like models.

iv. Genetic examination: By speeding up the examination of plant genomes, quantum computing might help create more robust and fruitful crops.

Examples:

i. Finance and Economics: Market dynamics and investor behaviour may be comprehended through the application of quantum models.

ii. Psychology: The “availability heuristic” and the “gambler’s fallacy” are two examples of phenomena that can be explained using quantum principles.

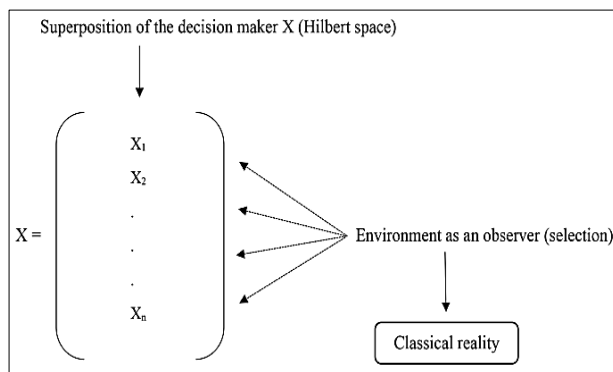


Figure 13: Darwinian perspective of quantum decision theory

Breakdown of the potential policy implications:

i. Better Risk Assessment: Quantum models may provide fresh opportunities to improve macro analysis, optimize portfolio management, and strengthen risk assessment.

ii. Quantum-Resistant Cryptography: To safeguard financial systems, the emergence of quantum computing also calls for the creation and application of quantum-resistant cryptographic protocols.

iii. Predictive Accuracy: Compared to classical models, quantum models may provide a competitive advantage in accuracy. This advantage might be used to real-world financial modelling, decision-making procedures, and economic trend forecasting.

iv. Quantum Game Theory: This theory helps explain intricate strategic relationships in economic contexts.

v. Frameworks for Regulation: It could be necessary for policymakers to modify current regulatory frameworks in order to take into consideration the possible influence of quantum-like models on the stability of the financial system.

Challenges and criticisms of QSS:

Quantum social science has its sceptics despite the fact that it presents intriguing opportunities. Some contend that the comparisons between social processes and quantum physics are just symbolic and lack empirical support (Bohr, 2014). Others warn against making too many generalizations about quantum principles since social systems are more context-dependent and complicated by nature than physical ones. Furthermore, for social scientists who might not have the requisite knowledge, the mathematical complexity of quantum physics presents a problem. More precisely we can say the challenges are regarding to-

- i. Interpretability and Complexity
- ii. Information Needed
- iii. Moral Aspects to Take into Account
- iv. Infrastructure and Hardware for Quantum

Future Opportunities

Quantum social science has enormous promise to improve our comprehension of intricate social processes in spite of these obstacles. Creating reliable empirical techniques to evaluate quantum models in social settings may be the main goal of future studies. In order to improve these models and overcome their shortcomings, interdisciplinary cooperation between mathematicians, social scientists, and physicists will be essential. Furthermore, the use of quantum computing to social science research may pave the way for novel approaches to the analysis and simulation of extensive social phenomena.

CONCLUSION

The entire discourse offer a kaleidoscopic vision of quantum social science for perceiving and responding to possibilities of application of quantum mechanics in extension sciences. After the USA and western

countries this is perhaps the maiden endeavour in India to conceptually and theoretically conceive quantum mechanics in the genre of social science researches including extension science. In case one rejects a technology, the other must be there elsewhere to adopt the same technology with an alternative set of logic called Complementarity. Logic and counter-logic, when coupled, the most empirical reality can be attained and entangled. The research has got huge applicability to cover robust area of social science researches.

REFERENCES

- Aerts, D.; B. D'Hooghe and E. Haven. 2010. Quantum Experimental Data in psychology and Economics. *International Journal of Theoretical Physics*, 49(2): 2971–2990.
- Barad, K. (n.d.). Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning. United Kingdom: Duke University Press.
- Bengtsson, I. and K. Życzkowski. 2006. Geometry of Quantum States – An introduction to Quantum Entanglement. Cambridge: Cambridge University Press.
- Bohm, D. 1990. A New Theory of the relation of mind and matter. *Philosophical Psychology*, 3(2): 271–286.
- Bohr, N. 1933. Light and life. *Nature*, 131: 421–423.
- Bohr, N. 1949. Discussion with Einstein on epistemological problems in atomic physics. In: P.A. Schilpp (Ed.), *Albert Einstein Philosopher-Scientist*. The Library of Living Philosophers (Vol. II, pp. 201–241). Evanston.
- Christopher McIntosh, From Policy Relevance to Present Relevance: Entanglement, Scholarly Responsibility, and the Ethics of Quantum Social Theory, *Global Studies Quarterly*, Volume 2, Issue 3, July 2022, ksac052, <https://doi.org/10.1093/isagsq/ksac052>
- D'Espagnat, B. 1995. *Veiled reality: An analysis of Present-Day Quantum mechanics concepts*. Reading, MA: Addison-Wesley.
- Davisson, C. and L. Germer. 1927. Diffraction of Electrons by a crystal of Nickel. *The Physical Review*, 30: 705–740.
- De Broglie, L. 1924. *Recherches sur la Theorie de Quanta*, PhD Thesis, Faculté de Sciences de Paris, Université de Paris.
- Favre, M.; A. Wittwer; H.R. Heinimann; V.I. Yukalov and D. Sornette. 2016. Quantum Decision Theory in Simple Risky Choices. *PLoS One*, 11(12): e0168045.
- Glymour, B.; M. Sabates and A. Wayne. 2001. Quantum Java: The upwards percolation of Quantum Indeterminacy. *Philosophical Studies*, 103(3): 271–283.
- Greene, B. 2011. *The hidden reality: Parallel Universes and the deep laws of the Cosmos*. New York: Vintage Books.
- Hameroff, S. and R. Penrose. 1996. Conscious events as Orchestrated Space-Time selections. *Journal of Consciousness Studies*, 3(1): 36–53.
- Haven, E. and A. Khrennikov. 2013. *Quantum Social Science*. Cambridge: Cambridge University Press.
- Heisenberg, W. 1925. Überquantentheoretische Umdeutung kinematischer und mechanischer Beziehungen' *Zeitschrift für Physik*.
- Herbert, N. 1985. *Quantum reality*. New York: Anchor Books.
- Ho, M. 1997. Quantum Coherence and conscious experience. *Kybernetes*, 26(3): 265–276.
- Holtfort, T. and A. Horsch. 2023. Social science goes quantum: explaining human decision-making, cognitive biases and Darwinian selection from a quantum perspective. *J Bioecon*, 25: 99–116.
- Höne, Katharina E. 2017. Quantum Social Science. *obo in International Relations*.
- Honner, J. 1987. *The description of Nature: Niels Bohr and the philosophy of Quantum Physics*. Oxford: Clarendon Press.
- Howard, D. 2004. Who invented the “Copenhagen Interpretation”? A study in mythology. *Philosophy of Science*, 71(5): 669–682.
- Igamberdiev, A. 2012. *Physics and logic of life*. New York: Nova Science Publishers.
- King-Kong Shake-Sphere, Ravi Kashyap. 2014. The Uncertainty Principle of the Social Sciences. SSRN Electronic Journal.
- Lawson, T. 2023. Social positioning theory and quantum mechanics. *Journal for the Theory of Social Behaviour*, 53(4): 583–619. <https://doi.org/10.1111/jtsb.12390>
- Malin, S. 2001. *Nature loves to hide: Quantum Physics and the nature of reality, a western perspective*. Oxford: Oxford University Press.
- Manousakis, E. 2006. Founding Quantum Theory on the basis of consciousness. *Foundations of Physics*, 36(6): 795–838.
- Murphy, M.P.A. 2020. Quantum Social Theory for Critical International Relations Theorists: Quantizing Critique. Germany: Springer International Publishing.
- Nadeau, R. and M. Kafatos. 1999. *The Non-Local Universe: The New Physics and Matter of the mind*. Oxford: Oxford University Press.
- Nobel Committee 2022. The Nobel Prize in Physics 2022. <https://www.nobelprize.org/uploads/2022/10/press-physicsprize2022-2.pdf>, Accessed 04 March 2023.
- Pylkkänen, P. 2007. *Mind, Matter and the Implicate Order*. Berlin: Springer.
- Schrödinger, E. 1944. *What is life?* Cambridge: Cambridge University Press.

- Shimony, A. 1978. Metaphysical problems in the Foundations of Quantum mechanics. *International Philosophical Quarterly*, 18(1): 2–17.
- Significance of Complementarity in Physics : Dialectica. *Nature*, 163: 435 (1949). <https://doi.org/10.1038/163435c0>
- Susskind, L. 2014. *Quantum mechanics: The theoretical Minimum*. London: Allen Lane.
- Two-Qubit Pure Entanglement as Optimal Social Welfare Resource in Bayesian Game
- Weinberg, S. 1995. *The Quantum Theory of Fields: Volume I, foundations*. Cambridge: Cambridge University Press.
- Wendt, A. 2006. Social theory as cartesian science: An auto-critique from a Quantum Perspective. In: S. Guzzini, & A. Leander (Eds.), *Constructivism in International Relations* (pp. 181–219). London: Routledge.
- Wendt, A. 2015. *Quantum mind and Social Science: Unifying Physical and Social Ontology*. Cambridge: Cambridge University Press.
- Wheeler, J. 1978. The past and the delayed choice double slit experiment. In: A. Marlow (Ed.): *Mathematical Foundation of Quantum Theory* (pp. 9–48). New York: Academic Press.
- Zanotti, L. 2018. Ontological Entanglements, Agency and Ethics in International Relations: Exploring the Crossroads (1st ed.). Routledge. <https://doi.org/10.4324/9781315227764>
- Zukav, G. 1979. *The Dancing Wu Li Masters: An overview of the New Physics*. New York: Morrow.

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Research Article

The Role of Social Support and Digital Addiction in Fostering Purpose in Life among Adolescents

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ABSTRACT

This study investigates the influence of social support and digital addiction in the development of purpose in life (PIL) among adolescents aged 16-18 years. Utilizing a descriptive cross-sectional design, data was collected from 500 adolescents (250 males and 250 females) attending rural and urban government senior secondary schools in Punjab. The study employed three validated instruments: the Child and Adolescent Social Support Scale (CASSS) to measure perceived social support, the Internet Addiction Test (IAT) to assess digital addiction, and the Youth Purpose in Life Scale to evaluate PIL. Descriptive statistics, bivariate correlations, and multiple regression analyses were used to explore the relationships between the key variables. Results indicate significant gender differences, with females reporting higher levels of social support and purpose in life, while males exhibited higher levels of digital addiction. Social support, particularly from teachers, parents, and close friends, was positively associated with PIL. Conversely, digital addiction, particularly excessive use, neglect of work, and social life, was negatively associated with PIL. The regression model explained 31.7% of the variance in PIL, underscoring the crucial role of supportive relationships and the detrimental impact of digital addiction on adolescents' sense of purpose. The study highlights the need for interventions that promote healthy social support networks and address digital addiction to foster a meaningful life purpose among adolescents.

Keywords: Adolescents, Social support, Digital addiction, Purpose in life, Gender differences

INTRODUCTION

One of the most fundamental probes of mankind is to comprehend the rationale of our existence; the purpose in life. It is the most essential and strenuous question humans have ever asked. Discussion about Purpose in life (PIL) has existed as long as the presence of any religion or philosophy. From Aristotle and Chanakya to Friedrich Nietzsche and Swami Vivekananda, philosophers have pondered why we exist and what makes life most worthwhile. Damon (2008) suggests PIL as a stable and consistent intention that includes one's search for meaning which is significant to both oneself and others, which all youngsters are competent to discover (Benson 2008).

Adolescence, usually defined as the period between 10 and 19 years (WHO 1986) is critical for identity development and exploration of one's life goals and aspirations. From Erikson (1968) to Loevinger (1976), identity theorists have referred to adolescence as the time in a person's life when they first devote themselves to modes of thought representing intriguing ends. Erikson proposed that people experience a crisis called "Identity versus Identity Confusion" during adolescence. A basic task beginning during this time is the formation of an *adult identity*. People with established identities understand who they are, what they are competent of, and what functions they play. They identify occupational goals and reflect on what makes life meaningful during this time. Certainly, Erikson

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(1968) emphasises that overcoming this dilemma frequently entails determining one's life purpose.

In adolescent years, purpose can be supported by people who are significant to adolescents, including parents (Moran *et al.*, 2013), teachers (Damon, 2008), and friends (Mariano *et al.*, 2011). Social support, which describes practical, emotional and informational aid from one's social surroundings, notably parents, friends, and other significant individuals, is a strong predictor of one's accessible interpersonal resources (Thoits, 2010). It is the viewpoint that one is cared for, and it cultivates a sense of belongingness and attachment (Tian *et al.*, 2016) which is a primary psychological need that adds to a person's well-being. Adolescence is marked by social shifts, including a greater degree of parental independence and tighter peer ties.

As the proverb goes, "Internet has brought a globe in a single room, and even the palm of one's hand" (Shek *et al.*, 2022). Internet usage in India has increased significantly in recent years. A report from Statista (2022) reported that India had more than 749 million internet users. By 2040, it was estimated that this number will increase to over 1.5 billion users. A 2019 McKinsey Global Institute survey stated that Indians were spending the most time on social media platforms such as Facebook, Instagram, Twitter, Whatsapp, and others. Indians are the world's biggest users of social media, spending 17 hours a week on them. This usage is getting dangerously close to addiction and dependence. Since 2019, the emergence of COVID-19 has had a wide-reaching influence on humanity, threatening not only the state of our education, finances, healthcare system, and environmental protection but completely changing the way we live. This highly contagious virus has driven many people to rely more heavily on the internet in their day-to-day lives, leading to an increasing number of individuals displaying symptoms of digital addiction (Geng *et al.*, 2022; Lebni *et al.*, 2020).

Clinical observations by Erikson and his followers show that when youngsters have nothing to devote themselves to while growing up, it becomes progressively hard for them to develop compelling value systems later down the line (Erikson, 1968; Marcia, 1980). As a consequence, there is a sensation of "drift," which can cause both personal and social problems. Problematic use of digital platforms has been linked

to reduced socialisation as well as relationship issues (Kuss and Griffiths, 2011). On the other hand, supportive social interactions provide not just material and emotional aid, but also a loving environment in which individuals can explore their life's purpose and meaning Feeney and Collins (2015). Keeping this scenario insight, we aim to examine adolescent's purpose in life. Additionally, the relationship and association between purpose in life, social support, and digital addiction are found through the use of multiple regression models, bidirectional associations, and descriptive statistics. We have also included analyses by gender since prior research revealed gender disparities in the dependent and independent variables.

MATERIALS AND METHODS

Participants and study characteristics: A cross-sectional, descriptive design was created for the data collection in 2023. This research and study procedures were approved by the Synopsis Approval Committee (Dean Postgraduate Studies) and the Ethical Committee of the Department of Human Development and Family Studies at the Punjab Agricultural University, Ludhiana. The inclusion criteria: (1) Age range between 16-18 years, (2) voluntary participation in the study (3) students attending Government Schools (4) signing informed consent. An equal number (n=250) of adolescents studying in 10th, 11th and 12th grades were selected from rural and urban senior secondary government schools which were further classified into 125 boys and 125 girls comprising a total sample of 500 adolescents (16-18 years).

Measurements: A general information sheet was constructed to gather the demographic information of the youngsters. The sheet comprised 12 statements regarding the school name, name of the respondent, gender, age, education and occupation of parents, size and type of family, number of siblings and birth order. The respondents were asked to fill in the information correctly. The statement regarding the name of the respondents was kept optional.

Child and Adolescent Social Support Scale (CASSS) by Malecki and Demaray (2002) was used to assess the social support perceived by adolescents from multiple sources. The scale consists of 60 items to be ranked on a 5-point Likert scale representing five

sources of social support namely, parent support, teacher support, classmate support, close friend support and people in my school support. The scale ranges from 1 which indicates low levels of perceived support to 5 which infers high levels of perceived support for each item.

Adolescent digital addiction was measured using Young's (1995) Internet Addiction Test (IAT). Twenty items make up the scale, which has a 5-point Likert scale for each topic. These items cover the six elements of online compulsion: excessive use, salience, lack of control, neglecting work, anticipating, and ignore social life. The sum of the scores of 20 items represents digital addiction.

The Youth Purpose in Life Scale by Chaddha and Bano (2018) was used to assess the purpose in life among adolescents. The scale comprised 30 items, constructed per the theoretically proposed dimensions of purpose in life by Damon (2008) namely goal-directedness, goal clarity, commitment towards goals, and beyond self-orientation (family and society-oriented goals). The reliability of the scale was found to be 0.89.

All the tools used in the study were administered to 20 non-sampled adolescents to check the relevancy of the tests. It was found that all the items were responded to without any complications. All scales were translated into the Punjabi language for the comfort and clear understanding of the statements among adolescents.

Study procedure: In the selected schools, adolescents were approached with the authorization of the principals through a letter of request which elucidated the motive of the study. The questionnaires were filled during the working days and working hours of the school. They were provided with the scale individually in the classroom setting and they had to fill it in a given time on the spot.

Important instructions were given to the respondents concerning how to respond to each scale. The motive of the investigation was made clear to them. They were guaranteed that their identity would not be disclosed and data provided by them would be used solely for research purposes only.

Statistical analysis: The statistical program IBM SPSS Statistics version 26 was used to analyze the data. The

study demographics were characterized using descriptive statistics, presenting frequencies (n) and percentages (%). Relationships between the key variables were assessed using bivariate correlations. Subsequently, a multiple linear regression analysis was conducted using the stepwise method, involving the elimination of variables with the weakest correlations. This process aimed to effectively select predictor variables from the available options.

RESULTS

Means and standard deviations: Results of descriptive statistics for social support, digital addiction and purpose in life variables by gender appear in Table 1. Relative to males, higher levels of social support from parents ($t=2.85$, $p\leq 0.01$), social support from teachers ($t=3.23$, $p\leq 0.01$), social support from classmates ($t=3.03$, $p\leq 0.01$), and social support from close friends ($t=3.17$, $p\leq 0.01$) were reported by female respondents. On the other hand, males reported elevated levels of salience ($t=2.95$; $p\leq 0.01$), excessive use ($t=2.90$; $p\leq 0.01$), neglect work ($t=1.64$, $p\leq 0.10$), anticipation ($t=1.74$, $p\leq 0.10$) and lack of control ($t=2.32$; $p\leq 0.05$) in comparison to their counterparts. Furthermore, females indicated a notably higher sense of purpose in life ($t=3.49$, $p\leq 0.01$) compared to males.

Relationships between social support, digital addiction and purpose in life: The results of the correlation analysis for the entire sample are shown in Table 2. All forms of social support showed a positive link with life purpose, but the highest correlation was observed with teacher support ($r = .439$, $p < 0.01$), indicating that a stronger sense of purpose in life is positively associated with higher levels of support from parents, teachers, classmates, close friends and support from people within the school environment. Further, purpose in life was negatively related to salience ($r = -.515$, $p < 0.01$), neglect work ($r = -.519$, $p < 0.01$), anticipation ($r = -.466$, $p < 0.01$), lack of control ($r = -.351$, $p < 0.01$), and neglect social life ($r = -.214$, $p < 0.01$) and the strongest correlation was found with excessive use ($r = -.556$, $p < 0.01$). This suggests that adolescents with greater levels of these digital addiction factors also have a weaker sense of purpose in life.

In Table 3, correlation coefficients for boys and girls are displayed individually. These results demonstrate that having a purpose in life was positively

Table 1: Descriptive statistics for variables of Social Support, Digital Addiction and Purpose in Life by gender (N=500)

	Females (Mean, SD)	Males (Mean, SD)	t-value
Parent Support	28.6 (5.39)	27.21 (5.50)	2.85***
Teacher Support	27.14 (5.58)	25.52 (5.63)	3.23***
Classmate Support	25.44 (5.57)	23.94 (5.50)	3.03***
Close Friend Support	28.72 (4.86)	27.29 (5.20)	3.17***
People in my School Support	24.90 (5.26)	24.99 (5.70)	0.18
Salience	9.944 (2.67)	10.664 (2.76)	2.95***
Excessive Use	9.92 (2.97)	10.688 (2.94)	2.90***
Neglect Work	6.112 (1.63)	6.356 (1.67)	1.64*
Anticipation	4.268 (1.29)	4.472 (1.32)	1.74*
Lack of Control	6.028 (1.59)	6.364 (1.64)	2.32**
Neglect social life	4.232 (1.13)	4.316 (1.13)	0.83
Purpose in Life	65.28 (11.71)	61.56 (12.086)	3.49***

***Significant at the 0.01 level (2-tailed); **Significant at the 0.05 level (2-tailed); *Significant at the 0.10 level (2-tailed).

Table 2: Correlation matrix for bivariate relationships in the whole sample (N=250)

	1	2	3	4	5	6	7	8	9	10	11	12
1. PS	-											
2. TS	.808**	-										
3. CS	.653**	.714**	-									
4. CFS	.619**	.617**	.668**	-								
5. PSS	.602**	.569**	.573**	.683**	-							
6. S	-.493**	-.340**	-.371**	-.139**	-.195**	-						
7. EU	-.509**	-.372**	-.308**	-.112*	-.196**	.673**	-					
8. NW	-.511**	-.360**	-.365**	-.156**	-.281**	.534**	.444**	-				
9. A	-.495**	-.481**	-.362**	-.178**	-.302**	.668**	.538**	.617**	-			
10. LOC	-.570**	-.375**	-.382**	-.273**	-.229**	.349**	.373**	.428**	.381**	-		
11. NSL	-.605**	-.451**	-.410**	-.208**	-.285**	.348**	.138**	.445**	.387**	.327**	-	
12. PIL	.424**	.439**	.397**	.427**	.421**	-.515**	-.556**	-.519**	-.466**	-.351**	-.214**	-

* $p < 0.05$, ** $p < 0.01$

Note: PS = parent support, TS = teacher support, CS = classmate support, CFS = close friend support, PSS = people in my school support, S = salience, EU = excessive use, NW = neglect work, A = anticipation, LOC = lack of control, NSL = neglect social life, PIL = purpose in life

correlated with all forms of social support. The strongest link was discovered between the support of parents for girls ($r = .622$; $p < 0.01$) and close friends for boys ($r = .507$; $p < 0.01$). In terms of digital addiction, all variables were negatively associated with purpose in life, although the strongest correlation was discovered with excessive use in both girls and boys ($r = -.616$; $p < 0.01$) and boys ($r = -.665$; $p < 0.01$). These findings underscore the noteworthy role of close

friends and parents in boys' and girls' senses of purpose, respectively, while also emphasizing the considerable adverse impact of excessive digital use on the overall PIL for both genders.

In Table 4, multiple regression analysis for purpose in life with social support variables is shown for the whole sample and then for girls and boys separately. The following variables were included in the models: social support from parents, teachers, classmates, close

Table 3: Correlation matrix for bivariate relationships by gender (N=250)

	1	2	3	4	5	6	7	8	9	10	11	12
1. PS	—	.820**	.646**	.619**	.672**	-.494**	-.523**	-.535**	-.511**	-.653**	-.623**	.622**
2. TS	.789**	—	.728**	.629**	.635**	-.336**	-.358**	-.356**	-.520**	-.367**	-.446**	.560**
3. CS	.638**	.685**	—	.679**	.585**	-.343**	-.275**	-.349**	-.368**	-.369**	-.376**	.531**
4. CFS	.592**	.576**	.646**	—	.630**	-.232**	-.158*	-.227**	-.264**	-.413**	-.304**	.555**
5. PSS	.560**	.523**	.572**	.732**	—	-.173**	-.186**	-.264**	-.316**	-.198**	-.273**	.543**
6. S	-.332**	-.387**	-0.027	-.210**	-.470**	—	.651**	.520**	.620**	.421**	.349**	-.552**
7. EU	-.374**	-.325**	-0.041	-.199**	-.446**	.671**	—	.430**	.503**	.484**	0.134	-.616**
8. NW	-.352**	-.369**	-0.064	-.294**	-.463**	.529**	.444**	—	.597**	.553**	.430**	-.602**
9. A	-.385**	-.398**	-.152*	-.259**	-.541**	.685**	.551**	.623**	—	.469**	.396**	-.499**
10. LOC	-.447**	-.433**	-0.093	-.294**	-.581**	.207**	.248**	.299**	.284**	—	.453**	-.521**
11. NSL	.529**	.685**	.207**	.301**	.860**	.301**	0.094	.450**	.373**	.193**	—	-.285**
12. PIL	.471**	.458**	.420**	.507**	.466**	-.610**	-.665**	-.617**	-.545**	-.385**	-.295**	—

Correlation coefficients. Girls above diagonal and boys below. * $p < 0.05$, ** $p < 0.01$

Note: PS = parent support, TS = teacher support, CS = classmate support, CFS = close friend support, PSS = people in my school support, S = salience, EU = excessive use, NW = neglect work, A = anticipation, LOC = lack of control, NSL = neglect social life, PIL = purpose in life

friends and people in the school. In this model, purpose in life is associated with support from parents and teachers for the girls. On the other hand, purpose in life has a strong association with social support from close friends and teachers for boys. For the whole sample, the regression model explains 31.7% of the variability in adolescents' sense of purpose. This implies that 31% of the difference in purpose in life scores among adolescents can be attributed to variations in the levels of support they receive from teachers, close friends, and parents.

Table 5 displays the results of multiple regression analysis examining the relationship between purpose in life and digital addiction variables. This analysis is presented for the entire sample, as well as separately for both boys and girls. Variables included in models: salience, excessive use, neglect work, anticipation, lack of control and neglect social life. In this model, purpose in life has a strong negative association with excessive use, neglect work and neglect social life across all three subgroups (whole sample, girls, boys). On the other hand, salience, anticipation and lack of control were not significantly related to purpose in life; therefore, we eliminated these variables from the final model. Higher levels of digital addiction, as indicated by EU, NW, and NSL, were associated with a lower sense of

purpose. These three variables accounted for 39% of the variance in boys' life purpose.

DISCUSSION

In the present study, female adolescents perceived higher support as compared to their male counterparts. The results are in concordance with the findings of the previous studies which also reported that girls perceived more peer support than boys (Furman and Buhrmester, 1992; Cheng and Chan, 2004). Girls also displayed a notably superior ability to perceive overall social support as compared to boys (Zhang *et al.*, 2016; Nakash *et al.*, 2022). One reason for this divergence can be attributed to the contrasting psychological development of the two groups. In particular, females tend to be more sensitive during adolescence and are more inclined to notice the presence of support from others as compared to males. Additionally, the dissimilarity can be attributed to the societal expectations placed on each gender, which are formed by cultural norms. When compared to girls, boys are generally more inclined towards personal growth, prefer to abide by their set standards, and are less affected by judgments from society (Rose and Karen, 2006).

Further, the findings of the present research align with those of previous studies which have backed the digital addiction bias towards males (Madell *et al.*, 2004;

Table 4: The role of social support in adolescents' purpose in life. Multiple linear regression (stepwise method)

Whole sample						Girls				Boys							
Variable	B	β	SE	t	p-value	Variable	B	β	SE	t	p-value	Variable	B	β	SE	t	p-value
Teachers	.54	.25	.14	3.73	<.001	Parents	.54	.25	.22	2.42	.016	Close Friend	.78	.36	.13	5.49	<.001
Close Friend	.36	.15	.11	3.29	.001	Teachers	.49	.23	.22	2.22	.027	Teachers	.56	.26	.13	4.27	<.001
Parents	.46	.21	.14	3.17	.002												
R ²	.317					R ²	.227					R ²	.309				
Constant	25.853		2.68	9.63	<.001	Constant	36.323		3.46	10.47	<.001	Constant	34.689		2.97	11.67	<.001

Note: B = unstandardized regression coefficients, β = standardized regression coefficients, SE = Standard error, t = t-statistic, p-value = probability value

Table 5: The role of digital addiction in adolescents' purpose in life: Multiple linear regression (stepwise method).

Whole sample						Girls				Boys							
Variable	B	β	SE	t	p-value	Variable	B	β	SE	t	p-value	Variable	B	β	SE	t	p-value
EU	-1.51	-.37	.15	-9.84	<.001	EU	-1.12	-.28	.24	-4.70	<.001	EU	-1.51	-.37	.18	-8.23	<.001
NW	-1.77	-.24	.29	-5.96	<.001	NW	-1.26	-.17	.48	-2.59	.010	NW	-1.65	-.23	.35	-4.70	<.001
NSL	-1.96	-.22	.34	-5.63	<.001	NSL	-1.66	-.199	.54	-3.07	.002	NSL	-1.91	-.20	.42	-4.46	<.001
R ²	.43					R ²	.27					R ²	.39				
Constant	97.710		1.810	53.969	<.001	Constant	90.373		2.768	32.652	<.001	Constant	97.134		2.228	43.606	<.001

Note: B = unstandardized regression coefficients, $\hat{\alpha}$ = standardized regression coefficients, SE = Standard error, t = t-statistic, p-value = probability value. EU = excessive use, NW = neglect work, NSL = neglect social life

Nachimas *et al.*, 2004; Dhok *et al.*, 2016). Sharma *et al.* (2014) revealed that more males in comparison to females, felt sleeplessness because of late-night digital logins; experienced more decline in outdoor activities; preferred using the web over going out with family and friends, and had fear of life becoming empty without the internet. There are two possible explanations for these results. Firstly, men and women have different objectives when it comes to their usage of digital platforms. Men tend to spend more time online compared to women, and they primarily utilize it for activities such as gaming, sexual content, entertainment, and social networking, while placing less emphasis on academic pursuits (Chou *et al.*, 2005; Durkee *et al.*, 2012). Secondly, online behaviour is perceived as more socially acceptable for males than females. This can be attributed to social norms, sociocultural attitudes, and the lower level of digital engagement among females, which act as significant protective factors (Su *et al.*, 2019). Nonetheless, there is evidence of females being susceptible to digital addiction as well (Shehata and Abdeldaim, 2021).

The results also revealed that females had a higher purpose in life. The same is reported by other studies that found that females showed a higher inclination to assist family members, friends, and individuals on a global scale (Patel *et al.*, 2009; Xi *et al.*, 2022). It has been suggested that females in general have a greater sense of purpose in life due to their tendency to care about others' needs and provide help. They generally have a stronger inclination towards social connections and are selfless, while men tend to be more concerned with individual pursuits and self-interest (Xi *et al.*, 2022).

Bivariate correlations revealed that purpose in life correlated positively with all types of social support and adversely with all indications of digital addiction among both boys and girls. These findings are consistent with those of earlier studies (Moran *et al.*, 2013; Liang *et al.*, 2017; Cheng and Li, 2014; Angulo *et al.*, 2021). The results, however, suggest that the relationships between one's life purpose and the social support one receives from friends, family, and other social support sources may vary depending on the kind and source of that support. First, the most relevant important finding is that, for girls, support from parents and teachers is the most significant factor in determining their purpose in life whereas, for boys,

support from close friends is also important. Previous studies also found that purpose can be supported by people who are significant to adolescents, including parents (Moran *et al.*, 2013), teachers (Damon, 2008), and friends (Mariano *et al.*, 2011). Molasso (2006) revealed that spending time with friends, attending social events and connecting with teachers outside of the classroom had a significant positive association with youngsters' life purpose. Teachers are important individuals in one's life and can serve as role models and mentors in helping students develop strong values and life goals (Bundick and Tirri, 2014). More recent findings proposed that the presence of supportive adults catalyzes initial interest in a particular purpose (Liang *et al.*, 2017).

Further, the results showed a strong negative correlation between dimensions of digital addiction and purpose in life. These results are supported by earlier research done by Molasso (2006) who demonstrated that confining activities like playing video games and watching television have a negative impact on the quest for meaning and self-contentment among adolescents. The present results of regression analysis revealed that excessive use of the internet, neglect of work and neglect social life contribute negatively towards purpose in life among adolescents. Harren and Walburg (2023) indicated that problematic Internet use was significantly impacted by the scores of meaning confusion. The displacement hypothesis (Neuman, 1988) posits that excessive internet use takes away time that could be devoted to meaningful activities like academics, extracurriculars, and in-person socializing. As adolescents immerse themselves in online realms, they might miss chances for personal growth in real life, resulting in a reduced sense of purpose. Some researchers also found that PIL appears to play a protective role against digital addiction (Brassai *et al.*, 2011; Zhang *et al.*, 2015).

CONCLUSION

In conclusion, our results highlight the significance and efficacious function of digital addiction and social support, particularly from family, friends and teachers, in shaping adolescents' purpose in life, whether in a favourable or negative way. These findings also highlight cultural concerns, such as gender disparities in digital addiction (e.g., males exhibiting greater levels

of addiction) and inequalities in the functions of social networks (e.g., family, peers) during adolescence. Furthermore, policymakers may wish to take into consideration paying more attention to the significance of the home and school environment, especially with regard to adolescent development as well as overall health and well-being, in light of these findings.

Availability of data and materials: The authors are unable to share raw data because ethical approval was not obtained for data sharing of this nature.

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REFERENCES

- Angulo, P.G.; J.S. Mendoza; E.C. Contreras; J.U.C. Martínez; C.B.E. Hernández and M.E.C. Hernández. 2021. The meaning of life as a mediator between self-esteem and Internet addiction in adolescents. *Enfermería Global*, 20: 519-31.
- Benson, P.L. 2008. *Sparks: How Parents Can Ignite the Hidden Strengths of Teenagers*. pp. 132-46. Jossey-Bass, San Francisco.
- Brassai, L.; B.F. Piko and M.F. Steger. 2011. Meaning in life: Is it a protective factor for adolescents' psychological health? *International Journal of Behavioral Medicine*, 18: 44-51.
- Bundick, M.J. and K. Tirri. 2014. Student perceptions of teacher support and competencies for fostering youth purpose and positive youth development: Perspectives from two countries. *Application Development Science*, 18: 148-162.
- Chaddha, U. and B. Bano. 2018. *Exploring the role of religiosity and parental support in fostering purpose in life among college students*. Ph.D. dissertation. Jamia Islamia University, Delhi, India.
- Cheng, S. and A.C.M. Chan. 2004. The multidimensional scale of perceived social support: Dimensionality and age and gender differences in adolescents. *Personality and Individual Differences*, 37: 1359-1369.
- Cheng, C. and A.Y. Li. 2014. Internet addiction prevalence and quality of (real) life: A meta-analysis of 31 nations across seven world regions. *Cyberpsychology, Behavior and Social Networking*, 17: 755-60.
- Chou, C.; L. Condrón and J.C. Belland. 2005. A review of the research on internet addiction. *Educational Psychology Review*, 17: 363-388.
- Damon, W. 2008. *The Path to Purpose: How Young People Find their Calling in Life*. pp. 142-56. Free Press, New York.
- Dhok, R.S.; K.S. Kadarkar and M.K. Doibale. 2016. Exploring levels of internet addiction among medical interns: A cross-sectional study. *International Journal of Medical Science and Public Health*, 5: 2341-2345.
- Durkee, T.; M. Kaess and V. Carli. 2012. Prevalence of pathological internet use among adolescents in Europe: Demographic and social factors. *Addiction*, 107: 2210-2222.
- Erikson, E.H. 1968. *Identity: Youth and Crisis*. pp. 54-63. Norton, New York.
- Feeney, B.C. and N.L. Collins. 2015. A new look at social support: A theoretical perspective on thriving through relationships. *Personality and Social Psychology Review*, 19: 113-147.
- Furman, W. and D. Buhrmester. 1992. Age and sex differences in perceptions of networks of personal relationships. *Child Development*, 63: 103-115.
- Geng, J.; S.U. Haq; J. Abbas; H. Ye; P. Shahbaz; A. Abbas and Y. Cai. 2022. Survival in pandemic times: Managing energy efficiency, food diversity, and sustainable practices of nutrient intake amid COVID-19 crisis. *Frontiers in Environmental Science*, 10: 945774.
- Harren, N. and V. Walburg. 2023. Studying the relationship between addictive beliefs about internet use, meaning in life, and problematic social media use. *Journal of Technology in Behavioral Science*, 8: 10-26.
- Kuss, D.J. and M.D. Griffiths. 2011. Online social networking and addiction – A review of the psychological literature. *International Journal of Environmental Research and Public Health*, 8: 3528-3552.
- Lebni, J.Y.; R. Toghroli; J. Abbas; N. Jhaddadgar; M.R. Salahshoor; M. Mansourian; H. Gilan; N. Kianipour; F. Chaboksavar; S. Azizi and A. Ziapour. 2020. A study of internet addiction and its effects on mental health: A study based on Iranian University Students. *Journal of Education and Health Promotion*, 9: 205.
- Liang, B.; A. White; A.M.D. Mousseau; A. Hasse; L. Knight; D. Berado and T.J. Lund. 2017. The four P's of

- purpose among college bound students: People, propensity, passion, prosocial benefits. *The Journal of Positive Psychology*, 12: 281-294.
- Loevinger, J. 1976. *Ego development: Conceptions and theories*. pp. 143-57. Jossey Bass, San Francisco.
- Madell, M.A.; Muneer and Sheman. 2004 Situating gender: Students' perceptions of information work. *Peo Information Technologies*, 17: 71-86.
- Malecki, C.K. and M.K. Demaray. 2002. Measuring perceived social support: Development of the Child and Adolescent Social Support Scale (CASSS). *Psychol Schools*, 39: 1-18.
- Marcia, J.E. 1980. Identity in adolescence. In: Adelson J (ed) *Handbook of Adolescent Psychology*. pp 159-187. Wiley, New York. (Original not seen. Cited by Marcia J E, 2009. *Policy Futures in Education* 7: 670-77.
- Mariano, J.M.; J. Going; K. Schrock and K. Sweeting. 2011. Youth purpose and the perception of social supports among African-American girls. *Journal of Youth Studies* 14: 921-937.
- McKinsey Global Institute. 2019. Digital India: Technology to transform a connected nation. Retrieved from <https://www.mckinsey.com>
- Molasso, W.R. 2006. Exploring Frankl's purpose in life with college students. *Journal of College Character*, 7: 1-10.
- Moran, S.; M.J. Bundick; H. Malin and T.S. Reilly. 2013. How supportive of their specific purposes do youth believe their family and friends are? *Journal of Adolescent Research*, 28: 348-377.
- Nachimas, Mioduser and Sheman. 2004. Gender issues in the career development of computer science staff. *Human Perspectives in the Internet Society: Culture, Psychology and Gender* 165-172. (Original not seen cited by Bhatnagar A, Mishra S, Sameen A (2011) *Psycho-Lingua* 41: 115-18.
- Nakash, O.; S. Arnon; T. Hayat and S. Abu Kaf. 2022. Strength of social ties and perceived tangible support: distinct characteristics and gender differences of older adults' social circles. *Journal of Women & Aging*, 34: 719-730.
- Neuman, S.B. 1988. The displacement effect: Assessing the relation between television viewing and reading performance. *Reading Research Quarterly*, 23: 414-440.
- Patel, C.J.; S. Ramgoon and Z. Paruk. 2009. Exploring religion, race and gender as factors in the life satisfaction and religiosity of young South African adults. *South African Journal of Psychology*, 39: 266-274.
- Rose, A.J.R. and D. Karen. 2006. A review of sex differences in peer relationship processes: potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin*, 132: 98-131.
- Sharma, A.; R. Sahu; P.K. Kasar and R. Sharma. 2014. Internet addiction among professional courses students: a study from central India. *International Journal of Medical Science and Public Health*, 3: 1069-1073.
- Shehata, W.M. and D.E. Abdeldaim. 2021. Internet addiction among medical and non-medical students during COVID-19 pandemic, Tanta University, Egypt. *Environmental Science and Pollution Research International*, 28: 59945-59952.
- Shek, D.T.L.; L. Yu; R.C.F. Sun and Y. Fan. 2022. Internet Addiction In: Pfaff, D W, Volkow, N D, Rubenstein, J (eds) *Neuroscience in the 21st Century*. Springer, New York, NY.
- Statista. 2022. <https://www.statista.com/statistics/255146/number-of-internet-users-in-india/>
- Su, W.; X. Han; C. Jin; Y. Yan and M.N. Potenza. 2019. Are males more likely to be addicted to the internet than females? A meta-analysis involving 34 global jurisdictions. *Computers in Human Behavior*, 99: 86-100.
- Tian, L.L.; Q.Q. Tian and E.S. Huebner. 2016. School-related social support and adolescents' school-related subjective well-being: The mediating role of basic psychological needs satisfaction at school. *Social Indicators Research*, 128: 105-129.
- Thoits, P.A. 2010. Stress and health: Major findings and policy implications. *Journal of Health and Social Behavior*, 51: 41-53.
- World Health Organization. 1986. Young people's health-a challenge for society: Report of a WHO Study Group on Young People and "Health for All by the Year 2000" (Technical Report Series). Switzerland.
- Xi, J.; M.T. Lee; J.R. Carter and D. Delgado. 2022. Gender differences in purpose in life: The mediation effect of altruism. *Journal of Human Psychology*, 62: 352-376.
- Young, K.S. 1995. *Caught in the net: How to recognize the signs of internet addiction and a winning strategy for recovery*. John Wiley and sons, New York.
- Zhang, Y.; S.L. Mei; L. Li; J.X. Chai; J.M. Li and H.Y. Du. 2015. The relationship between impulsivity and internet addiction in Chinese college students: A moderated mediation analysis of meaning in life and self-esteem. *PLoS One*, 10: e0131597.
- Zhang, C.; C. Wang and L. Zhai. 2016. The effect of college students' self-control ability on academic procrastination: with moderating mediating effects. *Psychology Technique Application*, 4: 209-214.

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