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C/O, Head, Department of Extension Education,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola- 444 104
Maharashtra, India

Editorial

Maharashtra Society of Extension Education (MSEE) registered in 1982, has the foremost objective to publish the research journal. Accordingly, the society was publishing the journal entitled Maharashtra Journal of Extension Education. Since the year 2004 this journal has been renamed as Asian Journal of Extension Education.

The journal includes research articles from the researchers and extension workers in the field of extension education from various faculties of various institutes in the country. Extension education plays an important role not only in transfer of innovative technologies but also in developing appropriate methodology in the field of extension more suited for field application. The innovative research methods can be very well communicated for its application and use in further research by the extension fraternity. This can be achieved by publishing research articles.

Asian Journal of Extension Education is a very humble attempt to provide platform towards this goal of networking with the all extension professionals who could kindle the minds of their peers and young scientists through their research articles.

I have immense pleasure to present this 43rd issue of Asian Journal of Extension Education for the year 2025. The Journal has received an encouraging response from all corners of the country. We have made an effort to encompass the best articles for the issue. Thanks are due to all the authors who have contributed for this issue.

I extend sincere thanks to Capt. Dr. L. B. Kalantri, Hon'ble President, Dr. D. M. Mankar, Vice President and Respected Member of Executive Body Dr. N. R. Koshti, Dr. N. V. Kumbhare for their constant inspiration, valuable guidance and concrete suggestions to maintain the quality of the journal.

I appreciate the tireless contribution of my colleagues and Joint-Secretary Dr. M. K. Rathod and Dr. S. D. More for their endless efforts in publishing this issue. I am confident that this issue of the Journal will be appreciated by the extension scientists, researchers, students and readers for its usefulness and contents. I solicit their suggestions for further enhancement of quality of the Journal.

Akola

Date: March, 2026

P. K. Wakle

Chief Editor

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RESEARCH ARTICLE

Impact of Digital Advisory Services on Decision-making and Income Enhancement of Smallholder Farmers in Ramanathapuram District, Tamil Nadu

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ABSTRACT

Digital advisory services are increasingly being used by extension systems to provide timely, location-specific, and cost-effective agricultural information to farmers. Krishi Vigyan Kendra (KVK), Ramanathapuram, has been delivering digital advisories through WhatsApp groups, the mKisan portal, and agrometeorological services to farmers across all blocks of the district. The present study assessed the effectiveness of these digital advisory services on farmers' decision-making and income enhancement. An ex-post facto research design was adopted, and data were collected from 180 smallholder farmers comprising beneficiaries and non-beneficiaries of digital advisory services. The results revealed that beneficiary farmers exhibited significantly higher levels of informed decision-making related to crop management, pest control, and input use. Adoption of advisories resulted in reduced input costs, improved crop yields, and higher net income. Timeliness, credibility of source, and ease of understanding were perceived as major strengths of digital advisories, while smartphone access and digital literacy were identified as constraints. The study concludes that digital advisory services, when integrated with conventional extension support, significantly enhance decision-making efficiency and farm income among smallholder farmers.

Key words: Digital extension, WhatsApp advisory, mKisan, decision-making, farm income

INTRODUCTION

The increasing variability in climate, rising input costs, and frequent pest and disease outbreaks have made agricultural decision-making more complex for smallholder farmers. Timely access to credible and location-specific information is critical for improving farm productivity and income, particularly in climate-vulnerable regions such as Ramanathapuram district of Tamil Nadu. Conventional extension systems, constrained by manpower and logistics, often struggle to provide real-time advisory services to a large number of farmers.

Digital extension platforms such as mobile-based advisories, social media groups, and agrometeorological information services have emerged as effective tools for bridging information gaps in agriculture. Studies have shown that digital advisory services improve

farmers' access to information, reduce uncertainty in decision-making, and enhance adoption of recommended practices (Aker 2011; Mittal and Mehar 2016).

KVK Ramanathapuram has been actively leveraging digital platforms to disseminate advisories. The KVK operates 17 WhatsApp groups comprising about 2,500 farmers across all 11 blocks, provides mKisan portal advisories to around 5,000 registered farmers, and disseminates agrometeorological information to approximately 6,000 farmers. While these initiatives have expanded outreach, empirical evidence on their effectiveness in influencing farmers' decisions and income remains limited. Therefore, the present study was undertaken to assess the impact of digital advisory services provided by KVK, Ramanathapuram on decision-making

behaviour and income enhancement of smallholder farmers.

OBJECTIVES

1. To assess the effectiveness of digital advisory services on farm-level decision-making among smallholder farmers.
2. To evaluate the impact of digital advisories on crop productivity and farm income.
3. To analyse factors influencing utilisation of digital advisory services and constraints faced by farmers.

MATERIALS AND METHODS

Study Area

The study was conducted in Ramanathapuram district of Tamil Nadu, covering all 11 blocks where KVK digital advisory services are operational.

Research Design

An **ex-post facto research design** was employed, as digital advisory services were already in operation.

Sampling Procedure

A total of **180 smallholder farmers** were selected:

- **120 beneficiary farmers** (receiving WhatsApp/mKisan/agromet advisories)
- **60 non-beneficiary farmers** (not regularly receiving digital advisories)

Farmers were selected using proportionate random sampling from WhatsApp groups and mKisan registered lists.

Data Collection

Primary data were collected using a structured interview schedule covering:

- Socio-economic characteristics
- Type and frequency of digital advisory received
- Decision-making behaviour
- Crop yield, cost of cultivation, and income
- Perceived usefulness and constraints

Measurement of Key Variables

- **Decision-making effectiveness** was measured using a composite index covering timeliness of action, accuracy of decisions, and confidence level.
- **Income enhancement** was measured as percentage change in net farm income before and after advisory adoption.

Statistical Analysis

Descriptive statistics, index construction, correlation analysis, and comparative analysis were employed.

RESULTS AND DISCUSSION

Effect of Digital Advisory Services on Decision-Making (Table 1)

Table 1. Decision-making effectiveness of beneficiary and non-beneficiary farmers

Category	Beneficiaries (%)	Non-beneficiaries (%)
High decision effectiveness	48.3	18.3
Medium decision effectiveness	38.4	41.7
Low decision effectiveness	13.3	40.0
Mean decision index	0.72	0.49

Discussion

Nearly half of the beneficiary farmers (48.3%) exhibited high decision-making effectiveness compared to only 18.3 per cent among non-beneficiaries. Digital advisories enabled farmers to take timely decisions related to sowing, fertilizer application, pest management, and irrigation scheduling. The higher mean decision index among beneficiaries reflects improved confidence and reduced uncertainty, particularly during weather aberrations.

Impact of Digital Advisories on Crop Yield and Income (Table 2)

Table 2. Impact of digital advisory services on productivity and income

Particulars	Beneficiaries	Non-beneficiaries
Average yield increase (%)	18.6	6.4
Reduction in input cost (%)	12.3	3.1
Net income (Rs./farm/season)	68,500	52,800
Income increase (%)	29.7	10.2

Discussion

Beneficiary farmers reported an average income increase of nearly 30 per cent, primarily due to timely pest advisories, weather-based input scheduling, and avoidance of unnecessary pesticide sprays. Reduced input costs indicate better decision-making efficiency, reinforcing the economic relevance of digital advisory services for smallholders.

Perceived Effectiveness of Different Digital Platforms (Table 3)

Table 3. Farmers' perception on usefulness of digital advisory platforms

Platform	Highly useful (%)	Moderately useful (%)
WhatsApp advisories	72.5	22.5
mKisan SMS	58.3	31.7
Agromet advisories	64.2	25.8

Discussion

WhatsApp advisories were perceived as the most effective due to use of local language, photos, videos and interactive clarification. Agrometeorological advisories supported risk management by enabling farmers to adjust operations based on rainfall forecasts.

Constraints in Utilisation of Digital Advisory Services (Table 4)

Table 4. Constraints faced by farmers

Rank	Constraint	Garrett score
1	Limited smartphone access	71.4
2	Low digital literacy	66.2
3	Network connectivity issues	61.5
4	Difficulty in understanding technical terms	57.8

Discussion

While digital advisories enhanced decision-making, access and literacy-related constraints limited their full potential. These findings suggest the need for digital capacity-building and convergence with physical extension.

CONCLUSION AND IMPLICATIONS

The study confirms that digital advisory services provided by KVK Ramanathapuram significantly improved decision-making efficiency and income of smallholder farmers. WhatsApp-based advisories emerged as the most effective platform due to their interactive and visual nature. However, digital advisories are most effective when complemented with field-level extension support. Future KVK research should focus on personalized advisories, digital literacy enhancement, and impact assessment using longitudinal data.

REFERENCES (Indicative)

- Aker, J. C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, 42(6), 631–647.
- Mittal, S., & Mehar, M. (2016). Socio-economic factors affecting adoption of modern ICT by farmers in India. *Journal of Agricultural Education and Extension*, 22(2), 199–212.

* * *

RESEARCH ARTICLE

Performance of Veterinary Services (PVS) in Andhra Pradesh, India – The Case of Continuous Professional Development of Field Veterinarians

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ABSTRACT

The Performance of Veterinary Services (PVS) pathway provides a comprehensive, staged approach that includes a series of sequential activities aimed at systematically strengthening Veterinary Services. One of the key competencies in the PVS is the Continuous Professional Development (CPD) of field veterinarians. This study evaluates the effectiveness of 36 training programmes organized for 508 field veterinarians, focusing on upgrading their gynaecological competencies as part of CPD within the PVS framework. The key evaluation questions addressed inputs, outputs (in terms of activities and participation), and outcomes (changes in knowledge and skills in gynaecology). Feedback was also collected on various aspects of the training methodology, the relevance of course content, and suggestions for improvement. The findings indicated a strong relevance of the content, with an overall increase of 37.8% in knowledge and skills among the participants. Additionally, the results suggested that the competencies of field veterinarians improved through a combination of theoretical learning, practical application, and field exposure sessions. The authors advocate for making the training curriculum and associated materials available as open educational resources, thereby facilitating large-scale adoption and adaptation through the principles of reuse, redistribution, revision, and remixing across diverse contexts. The implications of these findings for effective PVS and CPD of field veterinarians are discussed further.

Keywords: Performance of Veterinary Services, Continuous Professional Development, Field Veterinarians, Gynaecology Competencies, Andhra Pradesh, India.

INTRODUCTION

The Performance of Veterinary Services (PVS) network in Andhra Pradesh, India, has 3142 field veterinary institutions under the Animal Husbandry Department (AHD). This includes 1218 rural livestock units at the village level manned by para-veterinarians, 1576 veterinary dispensaries headed by graduate veterinarians or veterinary assistant surgeons (VASSs), 323 veterinary hospitals headed by assistant directors and 11 veterinary polyclinics with a team of veterinarians at the district level

functioning as referral hospitals providing specialized services in gynaecology, surgery, and medicine with inpatient facilities. Further, there are 10 animal disease diagnostic laboratories and 4 regional animal disease diagnostic laboratories with facilities for disease investigation, quick diagnosis, and for mapping out diseases to render timely and effective control measures. These are the referral laboratories for effective diagnosis and vaccine distribution work under PVS (AHD, 2025; Ravikumar et al., 2024).

The PVS pathway of the World Organisation for Animal Health (WOAH, founded as OIE) provides a robust mechanism for the continuous improvement of national veterinary services through a staged approach using a set of proven tools and methods to evaluate, plan, cost, and support the strengthening of national veterinary services (WOAH, 2023). By providing a structured framework, the PVS helps countries to identify gaps, prioritize investments, and implement reforms based on international standards. Since its inception in 2006-2007, approximately 140 countries have utilized the PVS Pathway to enhance animal health governance (Stratton et al., 2019).

Continuous Professional Development (CPD) is one of the key PVS competencies for field veterinarians as part of continuing education. The CPD is the capability of the veterinary services to maintain, update, and improve the knowledge, attitudes, and skills of their personnel, through an ongoing staff training and development programme assessed on a regular basis for relevance and targeted skills development (WOAH, 2023).

To deliver efficient animal reproductive services, veterinarians must acquire and continually update core gynaecological competencies, remain informed about emerging technologies, and demonstrate professional competence through participation in CPD trainings (Rao, et al., 2015). To improve the gynaecological competencies of field veterinarians, the AHD of Andhra Pradesh had designed and implemented a tailor-made CPD training programme titled 'Gynaecological Competencies Up-gradation' with the following specific objectives:

- Describe the anatomical and physiological aspects of the bovine female reproductive system.
- Apply oestrus synchronization protocols for enhancing productivity.

- Provide hands-on experience on palpation of the female reproductive tract, detection of heat mechanism, aberrations of heat, pregnancy diagnosis, and differential diagnosis in bovines.
- Perform transrectal ultrasonography procedure in bovines
- Identify and treat important infertility problems of bovines, and
- Conduct village survey, collect data, analyse, and interpret results on field reproductive problems in bovines.

This study was undertaken to evaluate the effectiveness of the CPD programme within the PVS framework, with particular emphasis on analysing its inputs, outputs, and outcomes.

METHODOLOGY

The State Animal Husbandry Training Centre (SAHTC), Mandapeta, Andhra Pradesh, under the AHD, has organized 5-day residential training programmes on 'Gynaecological Competencies Up-gradation.' A total of 508 field veterinarians were trained in 36 batches during 2024-25. The data on inputs used in the 36 training programmes in terms of financial and human resources, and training curriculum were obtained from office records. The effectiveness of the training programmes was measured in terms of change in knowledge and skills in gynaecology using pre-training and post-training evaluation tests. The test items consisted of 20 objective questions on various aspects of the gynaecology training curriculum. The scores were converted into percentages, and average scores and paired t-test values were worked out for each training programme and overall training programmes to measure the effectiveness. Feedback on 9 components of the training was obtained on a 1 to 5 Likert scale, viz., extremely dissatisfied, dissatisfied, neither satisfied nor dissatisfied, satisfied, and extremely satisfied. The major learning outcomes and suggestions for improvement were also obtained from the participants and summarized.

RESULTS AND DISCUSSION

Inputs used to conduct the CPD trainings: A total of 508 field veterinarians were trained across 36 batches at a total cost of ¹ 16.51 lakhs. The NITI Aayog (formerly the Planning Commission) has emphasized that re-training of field veterinarians to keep pace with recent developments is essential, recommending mandatory refresher courses every five years during their careers (Planning Commission, 2012). To facilitate such capacity building in technical domains, AHDs have established regional training centres in each state. The SAHTC, Mandapeta, Andhra Pradesh, is one such training centre. Further, the state of Andhra Pradesh has 1,794 veterinary dispensaries, each headed by a graduate veterinarian or veterinary assistant surgeon. Notably, within a period of less than two years, 508 of 1576 veterinarians (32.23%) were trained under the gynaecological competencies upgradation initiative by SAHTC, underscoring a rapid and commendable pace of capacity building (Table 1).

Table 1. Inputs used to conduct the training – human and financial resources

Batch No.	No. of Participants	No. of Resource	Persons Money Spent (Rs)
1.	17	5	55250
2.	15	5	48750
3.	13	5	42250
4.	14	6	45500
5.	15	5	48750
6.	15	7	48750
7.	14	6	45500
8.	16	5	52000
9.	14	5	45500
10.	17	5	55250
11.	14	5	45500
12.	18	5	58500
13.	22	6	71500
14.	21	6	68250
15.	13	6	42250
16.	9	6	29250

17.	13	5	42250
18.	11	5	35750
19.	13	5	42250
20.	11	7	35750
21.	11	5	35750
22.	11	5	35750
23.	21	5	68250
24.	17	5	55250
25.	18	6	58500
26.	13	5	42250
27.	12	5	39000
28.	11	5	35750
29.	14	5	45500
30.	15	5	48750
31.	15	5	48750
32.	9	5	29250
33.	16	5	52000
34.	9	5	29250
35.	7	5	22750
36.	14	5	45500
Total	508	-	16,51,000

CPD training curriculum: In each programme, 19 training sessions totalling 30 hours were conducted over 5 days. A comprehensive training manual covering all aspects of the curriculum was provided to each participant, along with supplementary reading materials from various sources. Additionally, a compact disc containing notes and all classroom presentations was distributed to the participants (Table 2).

Table 2. Gynaecological Competencies Up-gradation Training Curriculum

Session	Topics	Time (Hours)
1.	Registration, training objectives, expectations, and a pre-test to assess the entry behaviour	1
2.	Anatomy and physiology of bovine female reproductive systems with slaughterhouse specimens.	3
3.	Follicular dynamics and estrous cycle. Rectal Examination - purpose, procedure, care & precautions	1

4.	Heat behaviour, heat aberrations, palpable changes, and pregnancy diagnosis	1
5.	Assisted reproductive technologies like embryo transfer and sex sorted semen	1
6.	Transrectal ultrasonography	1
7.	Semen handling, artificial insemination (AI), cryopreservation of semen, thawing procedures, handling of AI equipment and pregnancy diagnosis.	2
8.	Advances in the management of endometritis and repeat breeding. Latest protocols in the treatment of uterine pathology.	1
9.	Prolapse of genital organs in bovines	1
10.	Management of bovine infertility, differential diagnosis, anoestrus and oestrus synchronization	2
11.	Periparturient diseases in bovines	2
12.	Team building	2
13.	Fertility camp field visit for hands-on training and practice (Data collection on bovine reproductive health through household survey – purpose and procedure; Data consolidation, analysis, interpretation, and identification of focal areas of interventions. Presentations by participants (Group work)	4
14.	Role of nutrition in reproduction, concepts of ideal dairy farming practices/parameters, and tips for enhancing conception at the field level	1
15.	Leadership and veterinarians' role in enhancing livestock productivity. Ethics/motivation	1
16.	Dystocia and its management	2
17.	Uterine torsion and its management	2
18.	Feedback and post-test to assess the exit behaviour	1
19.	Plans to utilise the training knowledge & skills and valedictory	1

A critical evaluation of the training curriculum revealed that core gynaecological technical competencies were effectively covered and aligned with the stated training objectives. Relevant foundational topics from anatomy, physiology, animal reproduction and gynaecology, and pathology were appropriately integrated into the programme. In addition, the curriculum adequately addressed process competencies and essential soft skills.

CPD training methodology: At the commencement of the training, participants were invited to articulate their expectations from the programme. These expectations were given due consideration throughout the sessions, with focused efforts to address them effectively. At the conclusion of the training, a review discussion was conducted to assess the extent to which these expectations had been met.

The theoretical sessions were delivered in accordance with the prescribed curriculum, employing participatory and interactive teaching methods. Audio-visual aids were effectively utilized to enhance knowledge dissemination. Special emphasis was placed on addressing field-specific application issues in bovine gynaecology, ensuring practical relevance for the trainees. Additionally, a dedicated session on ethics and motivation was included in each training programme.

As part of the practical component, participants conducted a field survey during each training programme to assess the reproductive status of dairy animals in villages surrounding the training institute. The survey utilized a structured questionnaire covering various management practices and reproductive parameters. The collected data were systematically analysed, and conclusions were drawn regarding the reproductive health status of the animals. Critical analysis and comparison with ideal parameters enabled participants to better understand real field conditions and identify appropriate corrective and adaptive strategies for future implementation.

Table 3: Effectiveness of the Gynaecological Competencies Up-gradation Training

Batch No	Batch Size	Average Pre-Test Score(%)	Average Post-Test Score (%)	Gain in Knowledge / Average of Differences (%)	SD of Differences (%)	Paired t Value
1.	17	29.4	72.4	43.0	18.5	9.5 [~]
2.	15	39.3	75.7	36.4	14.9	9.4 [~]
3.	13	38.8	79.6	40.8	8.1	18.1 [~]
4.	14	38.6	65.7	27.1	8.0	12.7 [~]
5.	15	43.0	86.7	43.7	14.8	11.4 [~]
6.	15	46.7	84.7	38.0	15.3	9.6 [~]
7.	14	41.1	76.8	35.7	19.1	7.0 [~]
8.	16	41.6	80.9	39.3	19.9	7.9 [~]
9.	14	42.9	86.1	43.2	19.0	8.5 [~]
10.	17	53.5	88.8	35.3	24.5	5.9 [~]
11.	14	42.9	71.8	28.9	24.3	4.4 [~]
12.	18	46.4	79.4	33.0	23.7	5.9 [~]
13.	22	45.7	86.8	41.1	17.4	11.0 [~]
14.	21	41.9	82.4	40.5	12.8	14.5 [~]
15.	13	46.9	84.2	37.3	15.2	8.8 [~]
16.	9	37.2	83.1	45.9	16.7	8.2 [~]
17.	13	41.5	72.7	31.2	19.5	5.8 [~]
18.	11	50.5	91.8	41.3	20.6	6.7 [~]
19.	13	53.1	91.5	38.4	15.8	8.7 [~]
20.	11	57.3	88.6	31.3	18.3	5.7 [~]
21.	11	47.7	85.0	37.3	16.3	7.6 [~]
22.	11	45.5	81.8	36.3	22.4	5.4 [~]
23.	21	46.9	78.8	31.9	19.2	7.6 [~]
24.	17	44.7	87.1	42.4	14.6	11.9 [~]
25.	18	51.9	83.9	32.0	16.8	8.1 [~]
26.	13	56.5	89.2	32.7	11.8	9.9 [~]
27.	12	41.7	78.3	36.6	15.8	8.0 [~]
28.	11	40.0	85.3	45.3	15.3	9.8 [~]
29.	14	42.9	86.3	43.4	15.4	10.5 [~]
30.	15	49.3	85.5	36.2	15.4	9.1 [~]
31.	15	46.7	84.1	37.4	14.8	9.7 [~]
32.	9	45.3	88.9	43.6	10.8	12.0 [~]
33.	16	42.9	83.4	40.5	14.5	11.2 [~]
34.	9	42.9	77.0	34.1	14.4	7.1 [~]
35.	7	43.7	79.9	36.2	8.3	11.5 [~]
36.	14	39.1	85.3	46.2	13.9	12.4 [~]
Overall Batches	508	44.4	82.2	37.8	17.2	35.1[~]

[~] significant at 1% level of significance or P value <0.001

Participants also worked in groups to prepare and deliver presentations on the findings from each surveyed village, promoting collaborative learning and practical insight.

The practical sessions under each training programme encompassed the following components:

a. Slaughterhouse specimens: Fresh specimens of the bovine reproductive system were procured from slaughterhouses during the training period and presented to trainees for palpation and observation of utero-ovarian physio-pathological conditions. On the final day, trainees conducted blindfold examinations of the specimens and subsequently compared their findings with visual observations for self-evaluation.

b. Fertility camps: Trainees were divided into two groups in each training programme, with each group participating in a fertility camp organized as part of the training. These camps were conducted in the same villages where field surveys had been carried out. Under the guidance of a faculty facilitator, trainees examined animals and gained hands-on, field-based experience.

c. Exposure to pathology museum: Participants were taken to the institution's pathology museum, where they were exposed to a wide range of reproductive pathology of organs. This enabled them to observe diverse disease conditions, including rare disorders, supplemented by on-the-spot explanations and reference materials to address their queries.

d. Diagnostic tests and practice: Various diagnostic techniques relevant to bovine gynaecological practice were demonstrated, including the fern pattern and bamboo stick pattern of oestrous discharge, White Side Test for endometritis, and measurement of pH in vaginal, cervical, and uterine discharges. Additional procedures included the Prostaglandin-Induced Milk Flow test, intra-vulvo submucosal administration of

oxytocin/PGF, α , and microscopic examination of stained cervical discharge smears for phagocytes and flagellates.

Trainees were also instructed in the use of ropes for mechanical/manual management of pre- and post-partum prolapse. Obstetrical manoeuvring techniques, particularly detorsion methods, were demonstrated in each training programme to strengthen practical clinical skills.

Effectiveness of the training: The data presented in Table 3 illustrate the knowledge scores obtained by participants in the pre- and post-training assessments. The findings clearly indicate a substantial improvement in knowledge levels as a result of the training intervention. The mean knowledge score increased from 44.4 in the pre-training test to 82.2 in the post-training test, reflecting an average gain of 37.8 per cent, with a standard deviation of 17.2 per cent.

The paired t-test values for individual training programmes as well as for the overall dataset were found to be statistically significant ($P < 0.001$). This demonstrates that the training programmes had a highly significant and positive impact on enhancing the knowledge of the participants.

The data in Table 4 revealed feedback on different components of the training. The participants' evaluation of various components of the training programme revealed generally positive perceptions. The usefulness of the course received a high mean rating of 4.40, followed by the relevance of the content (4.35) and handling of sessions (4.25), indicating strong satisfaction with the academic aspects of the training. Training facilities were rated moderately at 3.80, while practical exposure during the programme received a comparatively lower rating of 3.65.

Infrastructure-related aspects such as boarding facilities (3.05) and facilities for stay (3.00)

received relatively lower ratings, suggesting scope for improvement in these areas. The fulfilment of training objectives was rated at 3.60, and the overall mean rating across all training components was 3.75, reflecting a satisfactory level of participant satisfaction.

With regard to the duration of the training, a majority of participants (84.00%) perceived it as sufficient, while 13.80 per cent considered it short and only 2.22 per cent felt it was long.

Table 4. Feedback on Different Components of Training

S.N.	Training Component	Mean Score
1	Usefulness of the course	4.40
2	Relevance of the contents	4.35
3	Practical exposure during the programme	3.65
4	Training Facilities	3.80
5	Handling of sessions	4.25
6	Boarding facilities	3.05
7	Facilities for stay	3.00
8	Fulfilment of the objectives	3.60
	Mean rating on overall training components	3.75
9	Duration of the training	Sufficient: 189 (84.00%) Short: 31 (13.80%) Long: 5 (2.22%)

The participants reported significant learning gains across a range of key technical and applied areas in bovine gynaecology and reproduction management (Box 1).

Box 1. Major Learning Outcomes of Gynaecological Competencies Up-gradation CPD

Trainings

- Oestrus synchronization techniques
- Hormonal therapy in reproductive management
- Understanding of follicular dynamics

- Management of dystocia, particularly due to uterine torsion
- Diagnosis and management of repeat breeding cases
- Basic knowledge of ultrasonography
- Identification and treatment of endometritis
- Improved dairy farm management practices
- Effective heat detection methods
- Pregnancy diagnosis techniques
- Palpation of ovarian structures
- Exposure to assisted reproductive technologies, including sex-sorted semen

The above learning outcomes indicate that the training programme successfully enhanced both the theoretical understanding and practical competencies of the participants in critical areas of field-level PVS related to gynaecology.

The participants provided constructive suggestions to enhance the effectiveness of future training programmes (Box 2).

Box 2. Suggestions to Enhance the Effectiveness of Future CPD Training Programmes

- Increasing practical exposure through a greater number of clinical cases
- Providing detailed demonstrations of oestrus synchronization and hormonal protocols
- Ensuring the availability of more slaughterhouse specimens for hands-on learning
- Incorporating the use of dummy animals to facilitate skill development and practice
- Including additional topics on surgical approaches for managing obstetrical problems.

The above suggestions highlight the need for strengthening the practical and clinical components of the training to improve skill acquisition and field applicability further.

Conclusions and Implications for Policy

The comprehensive evaluation findings on the 36 gynaecological competencies up-gradation CPD programmes within the

framework of PVS, organized at SAHTC, Mandapeta in Andhra Pradesh, India, are presented in this paper. The CPD training programmes were effective in significantly enhancing the knowledge and skills of field veterinarians. The integration of theoretical, practical, and field-based learning contributed to positive outcomes. However, strengthening practical exposure, infrastructure, and trainer capacity can further improve programme effectiveness. Continued investment in such training initiatives as part of PVS is crucial for improving reproductive health services in livestock.

The curriculum covers technical competencies (bovine female reproductive anatomy, physiology, palpation for heat detection and pregnancy, reproductive pathologies, AI/semen handling, etc.) and process skills (data collection via village surveys, data analysis, group presentations, etc.). The course materials include a printed training manual and a CD with notes and slide presentations. The teaching methods are highly interactive and participatory: trainers use case-based lectures, audio-visual aids, group discussions, field surveys, and hands-on practice (e.g., palpating slaughterhouse specimens, participating in a village fertility camp, visiting a pathology museum, etc.). The adult-learning practices are embedded: for example, trainees state their expectations on day 1 (which guides the content), and pre-/post-tests and feedback forms are used to assess knowledge gain and learner satisfaction. These methods align with andragogical principles (Knowles, 1980) that adult learners bring experience and want goal-oriented, problem-centred learning.

In summary, the gynaecological competencies up-gradation CPD training curriculum emphasizes the adult learning practices viz., active learning, real-world contexts, and continuous feedback – a strong foundation for scaling up of the curriculum as an

Open Educational Resource (OER) to enable wider use. The authors explicitly recommend making the training curriculum and material available as OER, which means “freely available to others to reuse in different contexts” (McMartin, 2008). The authors propose to increase openness and scaling up of the curriculum following Hilton et al. (2010)’s four R’s (Reuse, Redistribute, Revise, Remix):

- *Reuse*: Allow local faculty or neighbouring training centers to use the curriculum/materials unaltered (e.g. by viewing recorded sessions or slides online).
- *Redistribute*: Share the full course (videos, slides, manuals) with other Indian states’ training institutes for their own use.
- *Revise*: Permit adaptation of content into other forms or languages (e.g., translating slides or reformatting manuals).
- *Remix*: Encourage combining this curriculum with other similar training content to create new hybrid courses.

By progressing through these stages, the programme can evolve from a closed course into a truly open, remixable resource for veterinary CPD across India as part of PVS. Indeed, open-licensing (e.g., Creative Commons) would be required so that other institutes can legally adapt and distribute the content. A well-designed OER generally yields as good or better learning outcomes at lower cost, so adopting an OER approach can improve both reach and efficiency of gynaecological competencies up-gradation CPD training curriculum. This also aligns with India’s NEP-2020 policy, which emphasizes the use of open and digital learning resources to promote inclusive, quality education.

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REFERENCES

- AHD (2025). Introduction to the Animal Husbandry Department, Government of Andhra Pradesh. <https://ahd.aptonline.in/AHMS/Views/HomePages/about.aspx>
- Hilton, J., Wiley, D., Stein, J., and Johnson, A. (2010). 'The four 'R's of openness and ALMS analysis: frameworks for open educational resources, *Open Learning*, Vol 25, No 1, pp 37-44.
- Knowles, M. S. (1980). The modern practice of adult education: From pedagogy to andragogy (2nd ed.). Prentice Hall.
- McMartin, F. (2008). 'Open educational content: transforming access to education', in T. Iiyoshi., and M.S.V. Kumar, eds, *Opening up Education*, Cambridge, MA: MIT Press, pp 135-148.
- Planning Commission. (2012). Report of the Working Group on Agricultural Extension for the 12th Five Year Plan. New Delhi, India: Planning Commission.
- Rao, S.V.N., Rasheed Sulaiman V., Natchimuthu K., Ramkumar S., and Sasidhar P.V.K. (2015). Improving the delivery of veterinary services in India. *Scientific and Technical Review of OIE*, 34(3), 767-777.
- Ravikumar, M., Sasidhar, P.V.K., Deekshit, G.V., and Channappagouda, B. (2024). Performance of Veterinary Services (PVS) in Andhra Pradesh, India – Perceptions and Reflections of Veterinarians. *Asian Journal of Extension Education*, (42): 220-226.
- Stratton, J., Tagliaro, E., Weaver, J., Sherman, D. M., Carron, M., Di Giacinto, A., Sharandak, V., & Caya, F. (2019). Performance of Veterinary Services Pathway evolution and One Health aspects. *Revue Scientifique et Technique de l'OIE*, 38(1), 291–302. <https://doi.org/0.20506/rst.38.1.2961>.
- WOAH (2023). World Organisation for Animal Health. Evaluation of Performance of Veterinary Services: PVS Tool. Seventh Edition. Paris, 67 pp. <https://doi.org/10.20506/PVS.3428>. Licence: CC BY-SA3.0 IGO.

* * *

REVIEW ARTICLE

Youth-Led Initiatives in Promoting Climate-Smart Practices in Rural Communities: A Review

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ABSTRACT

Climate change poses severe challenges to rural livelihoods, requiring urgent action for adaptation and resilience. Youth-led initiatives in rural communities have emerged as critical drivers in promoting climate-smart agricultural practices, fostering sustainability and community resilience. This review explores the landscape of youth engagement in climate action, examining the key roles played by young people in implementing climate-smart practices and the transformative impact of their initiatives. Drawing upon documented case studies and government-supported programs, this review highlights examples from India and globally, the significance of youth leadership, and the alignment of these efforts with the Sustainable Development Goals (SDGs). The findings underscore the power of youth as innovators, educators, and advocates for climate resilience.

Keywords : Climate change; Climate-smart agriculture; Youth-led initiatives; Rural communities; Sustainable Development Goals (SDGs); India.

INTRODUCTION

Climate change represents a critical threat to the sustainability of rural livelihoods across the globe, with developing countries like India facing disproportionate impacts. Rising temperatures, irregular monsoons, prolonged droughts, and flash floods are directly disrupting agricultural productivity, water security, and ecosystem balance. As the agricultural sector continues to grapple with these challenges, climate-smart agriculture (CSA) has emerged as a strategic response—integrating sustainable farming techniques with climate adaptation strategies to build resilience among farming communities (Scherr et al., 2012; FAO, n.d.).

However, adopting and implementing CSA practices requires more than technological solutions; it necessitates community engagement, innovation, and leadership. In this context, youth play a transformative role. With their inherent creativity, openness to innovation, and ability to engage with digital tools, young people in rural areas are well-positioned to lead the shift toward sustainable agricultural practices (Head et al., 2011). As future stakeholders of the planet, youth not only bring new ideas and energy but also serve as educators, advocates, and change agents within their communities (Environmental Migration Portal, 2024).

In India, where a significant portion of the population is under the age of 35 and dependent on agriculture, empowering youth with climate-smart knowledge and tools is not just strategic—it is essential. From grassroots initiatives like the Rural Agricultural Work Experience (RAWE) Program at CCS HAU to national campaigns such as Jal Shakti Abhiyan, young individuals are actively contributing to water conservation, organic farming, and sustainable food systems. Globally, similar trends are observed in Africa, Southeast Asia, and Latin America, where youth-led climate actions are contributing to resilience and adaptation (Amponsem et al., 2019; Sunday, 2023).

This review explores how youth-led initiatives are driving the climate-smart agenda in rural communities. It highlights documented examples, institutional support, global insights, and the importance of youth inclusion in climate governance. By showcasing best practices and lessons learned, the review aims to inform policy and development stakeholders about the potential of youth in climate-resilient rural development.

METHODOLOGY

This review is based on a **desk-based literature review** approach, synthesizing information from the seminar document:

- Key **secondary sources** (academic and policy documents, international reports) cited in the seminar, including studies by **Kanji et al. (2024)**, **Mallappa & Pathak (2023)**, and **Amponsem et al. (2019)**.
- **Case studies and program highlights** documented in the seminar, including initiatives like Jal Shakti Abhiyan, the Youth Climate Conclave, and the role of CCS HAU's College of Community Science.
- Government and international organization publications (e.g., **Food and Agriculture Organization**, **UNICEF**, and **IWMI**).

The review **excludes survey data** to focus on broader themes and documented initiatives.

RESULTS

The review identifies several key findings on the role of youth-led initiatives :

Agents of Change: Youth are challenging traditional practices and introducing new sustainable approaches, including the use of mobile apps, solar irrigation, and organic farming (**Environmental Migration Portal, 2024**).

Educators and Advocates: They actively raise awareness about climate change and share climate-smart practices with farmers and peers, leveraging digital tools and local campaigns (**Head et al., 2011**).

Practical Implementation:

- **Jal Shakti Abhiyan (2025):** Launched in Panchkula, Haryana, this campaign demonstrates how youth-led water conservation initiatives address drought risks and ensure community engagement (**Hindustan Times, 2025**).
- **Youth Climate Conclave (2025):** Showcases youth participation in field activities, renewable energy, and sustainable farming (**TERI, 2025**).
- **CCS HAU's RAWE Program:** Engages final-year students in rural villages, where they demonstrate direct-seeded rice, improved water management, and integrated pest management (**HAU Website**).

Gender and Community Empowerment: The College of Home Science at CCS HAU empowers rural women by linking household nutrition and livelihoods to climate-smart practices (**HAU Website**).

Global Perspectives:

- Studies in Nigeria, the Netherlands and across Asia highlight youth roles in climate-smart agriculture (**Sunday, 2023; Bullock et al., 2020**).

- The Internship and Innovation Grant (I2G) in Zambia demonstrates how youth entrepreneurship fosters climate-smart solutions in farming (IWMI, 2023).

DISCUSSION

The global urgency of climate change has intensified the need for inclusive, community-driven, and adaptive solutions, particularly in vulnerable rural areas. Agriculture, the backbone of many rural economies, is deeply affected by erratic weather, water scarcity, and declining soil health. In response, **climate-smart agricultural (CSA) practices** have gained recognition for their ability to sustainably increase productivity, build resilience, and reduce greenhouse gas emissions. However, the effectiveness of CSA depends heavily on **local engagement and leadership**—this is where youth involvement becomes not only relevant but essential.

Youth as Agents of Innovation in Agriculture

Young people are naturally more receptive to change, eager to adopt technology, and equipped with better access to digital tools compared to older generations. This digital fluency enables youth to apply innovative tools such as mobile applications, remote sensing, data-driven farm advisories, and solar-powered irrigation to real-time farming challenges (Environmental Migration Portal, 2024). For instance, in India, youth-led projects have introduced organic farming collectives, drip irrigation models, and rainwater harvesting systems that conserve resources while enhancing farm yields.

The **Rural Agricultural Work Experience (RAWE) Program** by CCS Haryana Agricultural University is a prime example of practical engagement, where final-year students live and work in villages, educate farmers, and promote modern, sustainable practices such as direct-seeded rice and integrated pest management. These activities highlight how youth can act as bridges between

research and the rural population, translating climate knowledge into action at the grassroots level.

Local Impact & Community Transformation

Youth-led initiatives are not confined to agriculture alone—they often take a **holistic community-centered approach**, incorporating nutrition, water conservation, waste management, and renewable energy. For example, the **College of Community Science at CCS HAU** integrates climate adaptation strategies at the household level by promoting dietary diversification, eco-friendly food preservation, and women-led microenterprises. These approaches ensure that climate resilience is not limited to fields, but also reaches homes and communities.

Such grassroots innovations directly address local challenges and help rural communities adapt to climate change by enhancing **food security**, stabilizing income sources, and reducing vulnerability to extreme events. Youth thus become not just implementers of practices but **transformers of community norms**, embedding sustainability into everyday life.

Global Parallels and Evidence

Globally, similar youth-led movements are gaining momentum. The study by **Amponsem et al. (2019)** spanning countries like India, Kenya, Canada, and Haiti, emphasizes the disproportionate burden of climate change on youth and their growing role in adaptation strategies. Similarly, **Sunday (2023)** documents how youth in Nigeria engage in waste management, reforestation, and policy advocacy, despite facing challenges like limited institutional support.

These international examples align with the Indian context, reinforcing that youth are not just a demographic group—they are a **strategic resource in climate governance**. Youth participation ensures that climate adaptation efforts are future-oriented, inclusive, and culturally relevant.

Barriers and Enablers

While the enthusiasm and capability of youth are evident, structural and institutional challenges persist:

- **Limited access to financial support**, such as grants, start-up capital, or incentives, restricts the scalability of youth-led initiatives.
- **Inadequate training and extension services** leave gaps in technical knowledge.
- **Socio-cultural perceptions** sometimes hinder youth, especially women, from taking leadership roles in agriculture.

On the positive side, programs like **Jal Shakti Abhiyan** and the **Youth Climate Conclave** illustrate how government and institutional support can amplify youth voices and scale up successful models. When supported through mentorship, recognition, and funding, youth initiatives can evolve from localized actions into national movements.

Alignment with Sustainable Development Goals (SDGs)

The role of youth in promoting CSA directly supports multiple **UN Sustainable Development Goals**:

- **SDG 2: Zero Hunger** – through improved productivity and food security.
- **SDG 13: Climate Action** – by building adaptive capacity and reducing climate risks.
- **SDG 15: Life on Land** – through ecosystem restoration and sustainable land use.
- **SDG 8: Decent Work and Economic Growth** – by fostering green jobs and entrepreneurship.

Youth-led climate initiatives are thus **not isolated acts of goodwill**, but integral components of global and national development agendas.

CONCLUSION

Youth-led initiatives are critical drivers of climate-smart practices in rural communities. Their leadership ensures not only short-term adaptation but also long-term sustainability and resilience. In India, examples like Jal Shakti Abhiyan, RAWA, and youth-led training hubs highlight how young people are central to climate-smart agriculture. While challenges like limited resources remain, the collective potential of India's youth to build a climate-smart future is undeniable. Supporting these initiatives through policy, funding, and education will be essential to achieving the SDGs and ensuring climate-resilient communities.

REFERENCES

- Ackerson, C., Adams, E., Arnold, J., Fiorenza, S., Jangda, H., Knop-Narbutis, A., ... & Yeager, K. (2013). *Climate Change and Development in Africa* (No. 5). Student Working Paper.
- Amponsem, A., et al. (2019). *Youth-led climate adaptation in multiple countries*.
- Bullock, R., Huyer, S., Shai, T., & Nyasimi, M. (2020). The CCAFS youth and climate-smart agriculture (CSA) strategy.
- Chakravorty, S. (2012). *Importance of climate-smart practices*.
- Earth Day 2025. (2025). *To fight climate crisis, invest in local leaders at frontiers*. Retrieved from <https://www.deccanherald.com/opinion/earth-day-2025-to-fight-climate-crisis-invest-in-local-leaders-at-frontiers-3504049>
- Environmental Migration Portal. (2024). *Youth role in climate action*. Retrieved from Environmental Migration Portal of the International Organization for Migration (IOM).

- Food and Agriculture Organization of the United Nations. (n.d.). *Climate-smart practices in agriculture*. Retrieved from Climate-Smart Agriculture Overview page on the FAO website.
- HAU Website. (n.d.). *RAWE program, College of Community Science initiatives*.
- Head, B. W. (2011). Why not ask them? Mapping and promoting youth participation. *Children and Youth services review*, 33(4), 541-547.
- Hindustan Times. (2025). *Jal Shakti Abhiyan: Catch the Rain campaign*.
- IWMI. (2023). *Promoting youth-led innovation in Zambia*. Retrieved from <https://www.iwmi.org/news/promoting-youth-led-innovation-to-build-climate-smart-agribusiness-solutions/>
- Kanji, R., Madapala, J., & Sil, S. (2024). Culture for climate action in Jodhpur: reversing the trajectory from fragility to resilience. *Journal of Cultural Heritage Management and Sustainable Development*, 14(5), 787-792.
- Mallappa, V., & Pathak, A. (2023). *Youth migration challenges in climate-smart agriculture*.
- Maslov, L. A. (2012). Two Levels of Self-Organization in the Earth Climate System. *arXiv preprint arXiv:1212.6411*.
- Scherr, S. J., Shames, S., & Friedman, R. (2012). From climate-smart agriculture to climate-smart landscapes. *Agriculture & Food Security*, 1, 1-15.
- John, S. G. (2025). Using Social Media for Climate Change Mitigation and Adaptation Education in Nigeria. In *Media and Communication Systems for Sustainability in Nigeria* (pp. 123-143). Cham: Springer Nature Switzerland.
- TERI. (2025). *Youth Climate Conclave 2025 highlights*. Retrieved from <https://wsds.teriin.org/2025/youth-climate-conclave-5.php>
- UNICEF. (2021). *Community and youth-led action for climate change*. Retrieved from <https://www.unicef.org/india/stories/community-and-youth-led-action-climate-change-and-conservation>.

* * *

RESEARCH ARTICLE

Adoption Constraints of PM-KUSUM Scheme in Rajasthan and their Policy Implications

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ABSTRACT

The Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) scheme seeks to promote solar-based irrigation and improve farmers' income and energy security. Despite its potential, adoption of the scheme is constrained by several field-level challenges. The present study examined the major constraints faced by PM-KUSUM beneficiary farmers in Rajasthan. Data were collected from 120 beneficiaries through personal interviews using a structured schedule. The results revealed that lack of information regarding the profitability of solar pumps (85.3%) and fear of theft and vandalization (75.8%) were the most severe constraints. Supply-related issues such as non-availability of adequate solar panels (68.0%) and unreliable local markets for spare parts (58.0%) were also prominent. Institutional delays and environmental limitations further affected adoption. The study underscores the need for strengthened extension efforts, improved awareness creation, and efficient service delivery mechanisms to enhance the effectiveness of the PM-KUSUM scheme.

Key words: Constraints, Energy security, PM-KUSUM, solar irrigation pumps, renewable energy

INTRODUCTION

The increasing demand for energy in agriculture, coupled with rising electricity costs and frequent power shortages, has intensified the need for alternative and sustainable energy sources. Renewable energy technologies, particularly solar-based irrigation systems, are being promoted to ensure energy security and environmental sustainability in farming. In this context, the Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) scheme was launched to promote the use of solar irrigation pumps among farmers. The scheme aims to reduce dependence on conventional energy sources while enhancing farm profitability. However, despite its potential benefits, the adoption of solar pumps under PM-

KUSUM remains uneven across regions. Farmers often encounter technical, financial, institutional, and environmental challenges that limit effective utilization of the scheme. Understanding these constraints is crucial for improving extension support and strengthening implementation mechanisms. Systematic identification of adoption barriers can aid policymakers and extension agencies in designing targeted interventions to enhance the reach and impact of the PM-KUSUM scheme.

MATERIAL AND METHODS

An ex-post facto research design was employed for the study. Rajasthan state was purposively selected due to its higher adoption of solar energy-based agricultural technologies

under the PM-KUSUM scheme. Three districts namely Jaipur, Sri Ganganagar, and Hanumangarh were selected through systematic random sampling. From each district, two tehsils were randomly selected, and 20 PM-KUSUM beneficiary farmers were chosen from each tehsil using random sampling, constituting a total sample of 120 respondents. Data were collected through personal interviews using a pre-tested structured interview schedule. The constraints faced by beneficiaries in adopting the PM-KUSUM scheme were analyzed using frequency and percentage.

RESULTS

S.N.	Statements	<i>f</i>	%	Rank
1	Through PM-KUSUM, ample solar panels are not available	82	68	3
2	Local market is unreliable for spare parts.	70	58	4
3	Panel quality is not guaranteed due to a lack of standardization.	30	25	10
4	Saline groundwater exists in the area.	61	50.8	6
5	Lack of information regarding the profitability of solar pump	103	85.3	1
6	Inadequacy of suitable place for establishment of solar pump	10	8.3	11
7	Fear of theft and vandalization	91	75.8	2
8	Delay of installations	66	55	5
9	Delay in post installation services by supplier	40	33.3	9
10	Lack of administrative assistance	54	45	7
11	Insufficient required day light in rainy/winter season	45	37.5	8

The constraints faced by PM-KUSUM beneficiaries were analyzed to understand the major barriers affecting effective adoption of the scheme, and the findings are presented in Table. The results revealed that lack of information

regarding the profitability of solar pumps emerged as the most severe constraint, as reported by a large majority of respondents (85.3%), securing the first rank. This indicates inadequate awareness about economic returns from solar irrigation technology.

Fear of theft and vandalization was perceived as the second most serious constraint by 75.8% of beneficiaries, reflecting concerns related to the safety and security of solar pump installations. Non-availability of adequate solar panels through the PM-KUSUM scheme was reported by 68.0% of respondents and ranked third, highlighting supply-related limitations. Unreliable availability of spare parts in local markets was another significant issue, reported by 58.0% of farmers.

Delay in installation of solar pumps was perceived as a constraint by 55.0% of respondents, while 50.8% reported saline groundwater conditions as a limiting factor affecting the efficient use of solar pumps. Lack of administrative assistance was expressed by 45.0% of beneficiaries, indicating procedural and institutional difficulties during implementation. Insufficient daylight availability during rainy and winter seasons was reported by 37.5% of respondents, affecting pump performance. Delay in post-installation services by suppliers was perceived by 33.3% of beneficiaries.

Panel quality issues due to lack of standardization (25.0%) and inadequacy of suitable space for installation (8.3%) were perceived as relatively less severe constraints. Overall, the findings suggest that informational, security-related, supply-chain, and administrative constraints significantly influence the adoption of the PM-KUSUM scheme among beneficiary farmers.

S.N.	Policy / Extension Implications
1.	Intensify extension-led awareness campaigns highlighting subsidies, long-term savings, and economic viability of solar pumps.

2.	Disseminate success stories and field-level case studies to enhance trust and adoption among potential beneficiaries
3.	Streamline administrative procedures and strengthen coordination among implementing agencies, suppliers, and installers to ensure timely execution.
4.	Implement security measures such as fencing, surveillance systems, and community monitoring mechanisms.
5.	Encourage community-based or shared solar pump models to improve accessibility & resource-use efficiency
6.	Foster collaboration with manufacturers to enhance production capacity and ensure uninterrupted supply of solar components.
7.	Enforce standardized quality guidelines and introduce mandatory certification mechanisms for solar equipment under PM-KUSUM.
8.	Promote localization of spare parts manufacturing and develop partnerships with local suppliers to ensure timely maintenance support.
9.	Strengthen communication channels and feedback systems for prompt resolution of beneficiary issues.

DISCUSSION

The predominance of informational constraints reflects inadequate extension efforts in communicating the economic feasibility and long-term benefits of solar irrigation pumps. Concerns regarding theft and vandalization highlight the absence of adequate security arrangements at installation sites. Supply-chain constraints and delays in service delivery point towards weaknesses in institutional coordination and after-sales support. Addressing these issues through focused extension interventions, timely installation, and improved service mechanisms is essential for enhancing farmer confidence and adoption of the PM-KUSUM scheme.

CONCLUSION

The study concludes that adoption of the PM-KUSUM scheme is constrained primarily by informational gaps, security concerns, and supply-chain inefficiencies. Strengthening extension services, improving awareness about profitability, ensuring timely administrative support, and enhancing service delivery are crucial for improving the effectiveness and sustainability of the scheme.

REFERENCES

- Behera, B., & Mallick, B. (2023). Constraints perceived by dealers and households for execution and adoption of pradhan Mantri Ujjwala Yojana. *Indian Journal of Extension Education*, 59(3), 156-159.
- Choudhary D, Lal B, Cheeta ON, Jakhar RS, Singh K. Constraints in adoption of solar pumps by the farmers in Jodhpur District of Rajasthan. *The Pharma Innovation Journal*. 2022;11(1):623-5.
- Government of India. PM-KUSUM. URL: <https://pmkusum.mnre.gov.in/landing.html>
- Suman, R. (2018). Constraints in adoption of solar irrigation pumps in India. *Journal of Rural Development*, 37(4): 589–602.
- Vaidyanath, D. (2016). A Study on Peoples Participation, Benefits and Constraints in Integrated Watershed Management Programme (IWMP) in Medak District of Telangana State. *M. Sc.(Ag.) Thesis, Telangana State Agricultural University, Rajendranagar, Hyderabad*.
- Verma, H. L., & Sharma, S. K. (2017). Constraints faced by the farmers in adoption of drip irrigation system in Bikaner district of Rajasthan.
- Zade PM. Attitude of farmers towards solar energy utilization in farming system in Parbhani District of Maharashtra [Master's thesis]. Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.); c2021.

* * *

REVIEW ARTICLE

Social Entrepreneurship for Sustainable Community Development: A Review of Innovations, Impacts, and Challenges in India

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ABSTRACT

Social entrepreneurship, blending business acumen with social missions, has emerged as a powerful tool to foster sustainable community development. This review explores the landscape of social entrepreneurship in India, emphasizing its role in addressing social, economic, and environmental challenges while creating inclusive growth and resilience. Drawing upon mixed-methods research, case studies, and government initiatives highlighted in the document, the paper outlines the main drivers, impacts, challenges, and future directions for social entrepreneurship in India. Key findings reveal that social entrepreneurs, through hybrid models and collaborative partnerships, promote job creation, gender equality, environmental sustainability, and community empowerment. However, challenges like access to finance, skilled workforce, and regulatory complexities remain significant. Case studies such as SELCO India, Rang De, and Goonj exemplify transformative social innovations. The review underscores the importance of youth and women-led initiatives, government support, and technology-driven approaches for scaling impact and achieving the Sustainable Development Goals (SDGs).

KEYWORDS : Social entrepreneurship; Sustainable community development; India; Social enterprises; Inclusive growth; Women entrepreneurs; Youth leadership; Technology innovation.

INTRODUCTION

Social entrepreneurship (SE) is an evolving concept that blends entrepreneurial innovation with a mission to create social value and address complex societal challenges (Gregory Dees, 1998). Unlike conventional business enterprises that prioritize profit maximization, social entrepreneurs aim to generate sustainable social, economic, and environmental impact (Bornstein, 2007; Zahra et al., 2009). They tackle pressing issues such as poverty, gender inequality, lack of education, and climate change, thereby advancing inclusive

and resilient communities (Saifan, 2012; fundsforngos.org, 2024).

In the Indian context, SE has emerged as a powerful approach to community development, driven by a combination of local needs and innovative solutions. The concept is not entirely new in India, where grassroots initiatives like cooperatives and self-help groups have long served as vehicles for social change. However, the formal recognition and scaling of social enterprises in India have accelerated in the last decade, fueled by supportive policies, youth-led innovation, and technological

advancements (Startup India Programme - PIB, 2025; World Economic Forum, 2025).

The significance of SE in India is multifaceted. Social entrepreneurs are bridging critical gaps in access to basic services, education, health, and financial inclusion, particularly for marginalized groups such as women, Scheduled Castes (SCs), Scheduled Tribes (STs), and rural communities (Mo MSME Annual Report 2021-22; GMSARN Journal, 2024). They also contribute to achieving the United Nations Sustainable Development Goals (SDGs) by fostering gender equality, promoting clean energy, and advancing climate-resilient practices (Dees, 1998; World Economic Forum, 2025).

Key to this transformation is the role of youth and women as changemakers. Young entrepreneurs bring fresh perspectives and technology-driven approaches to scale impact, while women social entrepreneurs are at the forefront of bridging gender gaps and empowering local communities (UNDP, 2020; Ashoka, 2023; LinkedIn, 2024). Moreover, technology and digital platforms have become enablers of scalability, transparency, and inclusivity in the SE ecosystem (Nusocia, 2025).

Despite these promising trends, social entrepreneurs in India face significant challenges. Limited access to finance, regulatory hurdles, and a shortage of skilled workforce hamper their ability to scale and sustain impact (Sanatan Dharma College, 2023). Nonetheless, successful case studies like SELCO India, Rang De, and Goonj demonstrate that mission-driven ventures can thrive when they align community needs with innovative models and collaborative partnerships (SELCO India; Rang De; Goonj Annual Report, 2023).

This review aims to synthesize the existing knowledge and insights from documented practices, government initiatives, and case studies to provide a holistic understanding of how social entrepreneurship

contributes to sustainable community development in India. It also highlights the emerging trends, key drivers, and persistent challenges that shape this dynamic field.

METHODOLOGY

The review is based on an in-depth analysis of the provided document, which integrates quantitative surveys, qualitative case studies, and secondary data analysis:

- **Data Sources:** Mixed-methods approach incorporating surveys of community members and social entrepreneurs (Sanatan Dharma College, 2023).
- **Case Studies:** Three in-depth examples-SELCO India, Rang De, and Goonj-highlight the practical application of SE in India.
- **Government Initiatives:** Critical review of programs like Startup India, PMMY, and Stand Up India.
- **Secondary Research:** Synthesis of academic literature, global reports (e.g., UNDP, World Economic Forum), and national surveys (e.g., Mo MSME Annual Report 2021-22).

FINDINGS:

The review identifies several key findings:

- **Inclusive Growth and Job Creation:** Social enterprises address social gaps (e.g., education, clean energy), empower marginalized communities, and create jobs (e.g., SELCO India, Araku Coffee, Lijjat Papad) (Saifan, 2012; GMSARN Journal, 2024).
- **Women's Empowerment:** Women play a crucial role in SE, driving eco-friendly solutions, financial inclusion, and social justice (Eurochambres Women Entrepreneurs Survey 2025; LinkedIn 2024).
- **Youth Leadership:** Young entrepreneurs bring fresh perspectives, leveraging technology and community engagement to amplify impact (UNDP, 2020; Ashoka, 2023).

- **Technology and Innovation:** Use of mobile health apps (eSanjeevani), financial inclusion tools (FINO PayTech), and data-driven platforms (Earth5R) has expanded SE's reach and efficiency (World Economic Forum, 2025).
- **Government Support:** Schemes like Startup India (2016), PMMY (2015), RPRP (2023), and CGTMSE (2000) have enhanced access to credit and incubation for social enterprises, particularly benefiting rural and marginalized populations (Startup India Programme; PMMY Official Website).

Challenges:

- Access to finance (78%)
- Skilled workforce shortages (60%)
- Sustainability and scaling (55%)
- Market access and recognition (40–50%)
- Regulatory complexity (20%) (Sanatan Dharma College, 2023).

DISCUSSION AND CASE STUDIES

- **SELCO India:** Founded in 1995, SELCO has electrified over 2 million rural homes and powered 8,000 health centers with solar energy, promoting health, education, and gender equity (<https://selco-india.com/>).
- **Rang De:** A peer-to-peer lending platform that has provided affordable credit to over 100,000 low-income borrowers, 80% of whom are women (<https://rangde.in/>).
- **Goonj:** Pioneering the "Cloth for Work" model, Goonj recycles urban surplus to drive rural development and disaster relief, reaching over 4,000 villages and addressing menstrual hygiene (Goonj Annual Report 2023).

These cases showcase how mission-driven models, community involvement, and technological adaptation can create scalable social impact in diverse contexts.

CONCLUSION

Youth-led initiatives offer a promising and scalable pathway to achieve climate-smart agriculture and sustainable rural development. The insights gathered from India and international contexts underscore that young people are not passive beneficiaries of development but active contributors, leaders, and innovators. Their involvement accelerates the adoption of climate-resilient practices, encourages behavioral change, and bridges the gap between traditional knowledge and modern technology.

In India, youth participation in campaigns like *Jal Shakti Abhiyan*, programs such as *RAWA*, and institutional efforts by *CCS HAU* demonstrate a localized yet impactful approach to climate-smart development. These examples show how youth, when supported with the right knowledge, tools, and platforms, can catalyze community transformation, enhance agricultural productivity, and strengthen environmental sustainability. Their contributions also directly support the United Nations Sustainable Development Goals (SDGs), particularly in areas of hunger eradication (SDG 2), climate action (SDG 13), and life on land (SDG 15).

Despite their potential, youth still face barriers such as limited access to decision-making spaces, lack of funding, and inadequate training. Addressing these gaps requires a multi-stakeholder effort involving governments, educational institutions, NGOs, and the private sector. Investments in youth capacity-building, inclusive policy frameworks, and recognition of youth-led innovations can create a fertile environment for long-term impact.

In conclusion, empowering youth is not just a climate action strategy—it is a pathway to building resilient communities, revitalizing rural economies, and ensuring a sustainable

future. By aligning youth energy with environmental priorities, we can cultivate a new generation of climate-smart leaders capable of navigating the challenges of tomorrow.

REFERENCES

- Ashoka. (2023). *Ashoka changemakers: Social entrepreneurship and impact*. Retrieved from <https://www.ashoka.org>
- Bornstein, D. (2007). *How to change the world: Social entrepreneurs and the power of new ideas*. Oxford University Press.
- Dees, J. G. (1998). *The meaning of social entrepreneurship*. Retrieved from https://centers.fuqua.duke.edu/case/wp-content/uploads/sites/7/2015/02/Article_Deess_DefiningSocialEntrepreneurship_2001.pdf
- fundsforngos.org. (2024). *How social entrepreneurship addresses social gaps and supports SDGs*. Retrieved from <https://www.fundsforngos.org>
- GMSARN Journal. (2024). *Social entrepreneurship in India: Current trends and impact*. Retrieved from <https://www.gmsarn.com/journal/>
- Gregory Dees, J. (1998). *The meaning of social entrepreneurship*. Retrieved from https://centers.fuqua.duke.edu/case/wp-content/uploads/sites/7/2015/02/Article_Deess_DefiningSocialEntrepreneurship_2001.pdf
- Goonj. (2023). *Annual report*. Retrieved from <https://goonj.org>
- Hossain, M., Akter, S., & Dwivedi, Y. K. (2025). *Technology-driven social entrepreneurship for sustainable community development*. World Economic Forum. Retrieved from <https://www.weforum.org>
- Indian Embassy Bern. (2025). *Social entrepreneurship in India: Opportunities and challenges*. Retrieved from <https://www.indianembassybern.gov.in>
- International Fund for Agricultural Development (IFAD). (2023). *India and IFAD launch new Rural Prosperity and Resilience Programme*. Retrieved from <https://www.ifad.org>
- ILO. (2016). *Youth in social entrepreneurship*. International Labour Organization. Retrieved from <https://www.ilo.org>
- LinkedIn. (2024). *Women and social entrepreneurship in India*. Retrieved from <https://www.linkedin.com>
- Martin, R. L., & Osberg, S. (2007). *Social entrepreneurship: The case for definition*. Stanford Social Innovation Review, 5(2), 28–39. Retrieved from https://ssir.org/articles/entry/social_entrepreneurship_the_case_for_definition
- Ministry of Micro, Small & Medium Enterprises (MSME). (2021–22). *Annual report*. Retrieved from <https://msme.gov.in>
- Nicholls, A. (2006). *Social entrepreneurship: New models of sustainable social change*. Oxford University Press.
- Nusocia (2025). *Transforming lives through tech-driven social entrepreneurship*. Retrieved from <https://www.nusocia.com>
- Project Naveli. (2024). *Project Naveli initiatives*. Retrieved from <https://projectnaveli.com>
- Pradhan Mantri Mudra Yojana (PMMY). (n.d.). *PMMY official website*. Retrieved from <https://www.cgtnmse.in>
- Rang De. (n.d.). *Rang De: Social lending platform*. Retrieved from <https://rangde.in>
- Saifan, S. (2012). *Social entrepreneurship: Definitions and boundaries*. Business and Society Review, 117(2), 109–126.
- Sanatan Dharma College. (2023). *A study on the challenges faced by social*

- entrepreneurship in India*. Sanatan Dharma College, Ambala, Haryana, India.
- Schwab Foundation. (2022). *Youth in social entrepreneurship*. Retrieved from <https://www.schwabfound.org>
- SELCO India. (n.d.). *SELCO: Solar energy solutions*. Retrieved from <https://selco-india.com>
- Startup India Programme - Press Information Bureau (PIB). (2025). *Startup India initiative overview*. Retrieved from <https://www.startupindia.gov.in>
- UNDP. (2020). *Youth social entrepreneurship: Global insights*. United Nations Development Programme. Retrieved from <https://www.undp.org>
- World Economic Forum. (2025). *Technology and social entrepreneurship*. Retrieved from <https://www.weforum.org>
- World Economic Forum. (2024). *Gender gaps in social entrepreneurship*. Retrieved from <https://www.weforum.org>
- Zahra, S. A., Gedajlovic, E., Neubaum, D. O., & Shulman, J. M. (2009). *A typology of social entrepreneurs: Motives, search processes and ethical challenges*. Journal of Business Venturing, 24(5), 519–532. <https://doi.org/10.1016/j.jbusvent.2008.04.007>.

* * *

RESEARCH ARTICLE

Information Management Constraints faced by Small and Marginal Maize Farmers

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ABSTRACT

Efficient farm management depends on farmers' ability to access and use timely agricultural information. The present study analyzed constraints in Information Management Behaviour (IMB) among small and marginal maize farmers in Bihar and proposed suitable extension measures. An ex-post facto design was followed, and 120 farmers were selected through proportionate random sampling. Data were collected using a structured interview schedule. Results showed that the major constraints were lack of updated information (91.7%), high cost of digital devices (90.8%), limited contact with extension personnel (85.8%), and inadequate institutional support (82.5%). Financial barriers such as inability to afford paid advisory services and limited credit access also restricted effective information use. Skill-related and motivational constraints were comparatively less severe. The findings underline the importance of strengthening extension outreach, improving digital access, and ensuring affordable advisory support. Establishing local information centres, promoting digital literacy, and facilitating farmer-friendly credit can enhance information management and support sustainable maize production.

Keywords: constraints, digital access, extension support, Information Management Behaviour, maize farmers, sustainable.

INTRODUCTION

Modern agriculture relies heavily on farmers capacity to obtain, understand, and use accurate information at the right time. Advances in technology changing climatic conditions, and unstable markets have transformed farming into an increasingly knowledge-driven activity. Under these circumstances, Information Management Behaviour (IMB), the manner in which farmers identify their information needs, obtain relevant knowledge, assess its usefulness, retain it, and share it with others—plays a vital role in improving farm decisions and productivity. Yet, small and marginal farmers often find it difficult to handle the expanding volume and complexity of agricultural

information, which can restrict their ability to adopt improved technologies and adapt to emerging challenges.

Maize is a key cereal crop in Bihar and contributes substantially to household income, food supply, and the livestock sector. Although maize production in the state has shown encouraging progress, the long-term viability of maize-based farming depends on farmers having access to timely and reliable information on improved practices, pest and disease control, post-harvest handling, and market trends. Existing research has largely emphasized production technologies, while the information-related challenges faced by maize growers have received comparatively less attention.

A persistent disconnect exists between information generated by research and extension systems and its practical use at the farm level. Factors such as poor access to current information, limited institutional contact, low digital skills, and financial limitations can weaken farmers' ability to manage agricultural knowledge effectively. Understanding these constraints is crucial for developing responsive extension approaches and inclusive information systems that address the needs of small and marginal farmers.

In view of this, the present study was conducted to identify major constraints affecting Information Management Behaviour among maize farmers and to propose suitable extension and policy measures to strengthen their information access and utilization.

METHODOLOGY

The investigation was carried out in Bihar, India, a major maize-producing region. Two districts, Samastipur and Muzaffarpur, were purposively selected due to the predominance of small and marginal maize farmers. From each district, two blocks were chosen, followed by the selection of one village per block, resulting in four study villages.

An ex-post facto research design was adopted, as the variables had already occurred and were beyond experimental control. The study sample comprised 120 small and marginal maize farmers (d² ha landholding) selected through proportionate random sampling.

Data were collected through personal interviews using a structured and pre-tested schedule. Information Management Behaviour (IMB) was assessed across key dimensions including information need, acquisition, processing, storage, and dissemination. A list of potential constraints affecting IMB was developed through literature review and expert consultation.

RESULT

The study revealed a number of limitations affecting farmers' efficiency in

managing agricultural information. To understand their relative importance, the constraints were prioritized based on the percentage of respondents indicating each issue.

Table 1. Constraints in Information Management Behaviour

S.N.	Statements	f	%	Rank
1	Scarcity of updated information	110	91.7%	I
2	Dearth of electricity or network connectivity	16	13.3%	X
3	Less knowledge in handling smart phones and other gadgets	27	22.5%	VII
4	Less networking among farmers	20	17.7%	XII
5	Limited contacts with extension personnel and scientists	103	85.8%	III
6	Paucity of institutional support	99	82.5%	IV
7	Techno-phobia	27	22.5%	VII
8	Deprived of motivation	17	14.2%	IX
9	Less interest in knowing new thing	14	11.7%	XI
10	Not able to buy smart phones/ laptops due to high cost	109	90.8%	II
11	Not able to attend paid extension services	98	81.7%	V
12	Inadequate credit facilities	93	77.5%	VI

The respondents reported a range of challenges that restricted their capacity to effectively access, process, and use agricultural information. These constraints were ordered based on the percentage of farmers indicating each issue.

The most prominent difficulty was the non-availability of timely and up-to-date agricultural information, expressed by 91.7 percent of the farmers. This suggests deficiencies in the delivery of recent recommendations, pest and disease alerts, market price updates, and weather-related

Table 2. Suggested Measures**Suggested Measures to Improve Information Management**

Identified Constraint	Suggested Extension / Policy Intervention
Lack of timely and updated agricultural information	Establish village-level agricultural information centres and helplines to provide real-time advisories on maize practices, markets, weather, and government schemes
High cost of smartphones and digital devices	Facilitate subsidized or installment-based access to smartphones/tablets through partnerships with NGOs, companies, and financial institutions
Limited contact with extension personnel and scientists	Strengthen extension systems by increasing field-level staff and improving outreach visits to farmers
Inadequate institutional support	Promote formation and strengthening of Farmer Producer Organizations (FPOs) and cooperatives for collective advisory and institutional linkages
Inability to afford paid extension services	Provide free or low-cost advisory services, training programs and technical guidance for small and marginal farmers
Limited access to credit facilities	Collaborate with banks and microfinance institutions to design farmer-friendly credit schemes tailored to maize cultivation needs
Poor digital literacy and difficulty in handling devices	Organize structured training programs on the use of smartphones, agricultural apps, and digital platforms
Fear or hesitation in using new technologies	Conduct confidence-building workshops and practical exposure sessions to reduce technophobia
Low motivation among farmers	Arrange motivational programs and share local success stories of progressive farmers
Limited awareness of new technologies and market trends Weak electricity supply	Implement awareness campaigns through mass media, mobile advisories, and community meetings Promote use of solar-powered charging devices and energy alternatives for digital access
Need for stronger farmer interaction and learning platforms	Organize regular farmer field days, group meetings, and exposure visits to encourage peer learning and knowledge exchange
Limited practical exposure to improved practices	Conduct on-field demonstrations and collaborative training with agricultural universities and research institutions

advisories. The high price of digital devices, including smartphones and laptops, was the next major concern (90.8%), indicating that economic barriers continue to limit farmers' participation in digital information networks.

A substantial proportion of respondents (85.8%) pointed to infrequent contact with extension staff and subject-matter specialists, reflecting gaps in institutional outreach. In

addition, insufficient institutional backing (82.5%) and the financial burden of paid advisory services (81.7%) were reported as serious obstacles. The problem was further compounded by restricted access to credit (77.5%), which reduced farmers' ability to invest in information-related tools and services.

Issues related to skills and confidence in using modern tools were less widely reported

but still notable. About 22.5 percent of farmers indicated limited ability to operate smartphones and similar devices, while an equal proportion expressed apprehension toward using new technologies. Constraints such as low motivation (14.2%), connectivity and electricity problems (13.3%), and limited curiosity about new information (11.7%) were relatively less severe. Poor networking among farmers was ranked lowest, suggesting that informal knowledge sharing within the farming community remained comparatively strong.

Overall, the results show that barriers linked to information supply systems, institutional access, and financial limitations were more influential than personal or psychological factors in shaping farmers' Information Management Behaviour.

CONCLUSION

The study revealed that maize farmers exhibited a moderate level of Information Management Behaviour, indicating partial engagement in seeking, processing, and using agricultural information. However, several structural and economic barriers limited their effectiveness. The most critical constraints were the lack of timely and updated information, high cost of digital devices, limited interaction with extension personnel, and inadequate institutional and financial support. In contrast, personal factors such as motivation and peer networking were relatively less restrictive.

The findings highlight that improving farmers' information management capacity requires strengthening institutional outreach, enhancing digital inclusion, and ensuring affordable access to advisory services. Establishment of local information centers, expansion of extension services, promotion of farmer organizations, digital literacy training, and farmer-friendly credit mechanisms are key interventions suggested by the study.

Addressing these constraints through coordinated extension and policy efforts can significantly improve farmers' access to reliable

information, leading to better decision-making, enhanced adoption of improved practices, and increased sustainability of maize-based farming systems.

REFERENCES

- Babu, S. C., Glendenning, C. J., Asenso-Okyere, K. & Govindarajan, S. K. (2012). Farmers' information needs and search behaviors: Case study in Tamil Nadu, India.
- Boniface, P. J., Jose, A. M., & Husain, A. S. (2019). Constraints faced by farmers and agricultural extensionists in using selected information technology enabled systems for agriculture. *J Soc Sci*, 58(1-3), 7-12.
- Das, G., & Chowdhury, S. (2022). A study on the constraints influencing the agricultural information network output of the Farm women in sub-Himalayan region of India. *Indian Journal of Hill Farming*, 35(Sp1), 98-106.
- Naresh, K., & Ahire, R. D. (2018). Constraints experienced by tribal farmers in the information management. *Int. J. Curr. Microbiology. App. Sci*, 7(3), 1230-1233.
- Ofuoku, A. U., Emah, G. N., & Itedjere, A. B. (2008). Information Utilization Among Rural Fish Farmers In Central Agricultural Zone Of Delta State, Nigeria. *World Journal Of Agricultural Sciences*, 4(5), 558-564.
- Priya, K., & Shanmugaraja, P. (2021). A Study on Constraints in Communication behaviour of Tribal Farmers. *Annals of the Romanian Society for Cell Biology*, 25(3), 7387-7390.
- Salokhe, G., Pastore, A., Richards, B., Weatherley, S., Aubert, A., Keizer, J., ... & Mangstl, A. (2004). FAO's role in information management and dissemination-challenges, innovation, success, lessons learned. *IAALD Quarterly Bulletin*, 49(3-4), 73-83.

REVIEW ARTICLE

Cybersecurity : Threats, Common Vulnerabilities and Strategies

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ABSTRACT

Cybersecurity is the practice of protecting computer systems, networks, and data from digital attacks, theft, or damage. With the growing reliance on technology, ensuring the safety and privacy of information has become crucial. This review paper explores the fundamental aspects of cybersecurity, including common threats like viruses, malware, and phishing scams, as well as the strategies used to defend against them. We discuss key concepts such as encryption, firewalls and highlight the importance of regular updates and user awareness in maintaining security.

INTRODUCTION

In an era defined by pervasive digital connectivity, cybersecurity stands as a big concern for individuals, organizations, and governments worldwide. The rapid proliferation of digital technologies has brought unprecedented opportunities for innovation and connectivity, but it has also exposed vulnerabilities that malicious actors seek to exploit. Cyber threats, ranging from sophisticated malware to targeted social engineering attacks, continually evolve in complexity and scope, posing significant risks to data integrity, privacy, and operational continuity.

Cybersecurity

According to the National Institute of Standards and Technology (NIST), cybersecurity is “the protection of information systems from theft or damage to the hardware, software, or information on them, as well as from disruption or misdirection of the services they provide” (NIST, 2020).

Cybersecurity involves identifying, assessing, and mitigating risks associated with cyber threats. This includes the implementation of risk management frameworks and practices to protect against potential vulnerabilities and threats. Stoneburner et al. (2002)

Cybersecurity measures include both technical controls (such as firewalls, encryption, and intrusion detection systems) and administrative controls (such as policies, procedures, and training) designed to prevent and respond to security breaches. (Stallings and Brown 2017). A critical aspect of cybersecurity is the ability to respond to and recover from security incidents. This includes the development of incident response plans, forensic analysis, and recovery strategies to address and mitigate the effects of cyber attacks. (Keeling and Williams (2017).

Cybersecurity also involves ensuring compliance with various legal, regulatory, and industry standards related to information security. This includes adhering to laws and

regulations such as GDPR, HIPAA, and PCI-DSS. According to Ponemon Institute (2020), compliance is a key aspect of cybersecurity that helps organizations avoid legal penalties and maintain trust with stakeholders.

Cyber-security includes practical measures to protect information, networks and data against internal or external threats. Cyber-security professionals protect networks, servers, intranets, and computer systems. Cyber-security ensures that only authorized individuals have access to that information (Ahmed Jamal et al., 2021).

Cyber security is generally the techniques set to protect the cyber environment of the user. This environment includes the user themselves, the devices, networks, applications, all software's etc. (Khurana S. 2017)

Cyber security refers to the strategies used to safeguard a user's cyber environment. This environment encompasses the person, their devices, networks, applications, and any software, among other things. Cyber security is a subset of computer security that deals with the internet. The main security goal is to protect the device using various rules and to set up various safeguards to protect it from online attacks. (Adish K and Venkatesh 2022).

From all the definition above we can conclude that Cyber security refers to the practice of protecting computer systems, networks, programs, and data from digital attacks, unauthorized access, damage, or theft. It encompasses various technologies, processes, and measures designed to safeguard information and ensure the integrity, confidentiality, and availability of digital assets. Cyber security efforts aim to prevent, detect, and respond to threats in the evolving landscape of digital interconnectedness, where cyber threats can come from various sources including hackers, malware, and other malicious actors.

Cyber threats are a significant and growing concern globally, affecting individuals, businesses, governments, and critical

infrastructure. Here are some statistics that highlight the prevalence and impact of cyber threats:

- **Ransomware attacks:** Ransomware remains a prevalent threat, with attacks increasing in frequency and sophistication. According to a report by cyber security ventures:

- ❖ Ransomware damages are projected to cost the world \$265 billion by 2031.
- ❖ A ransomware attack is predicted to occur every 2 seconds by 2031, up from every 11 seconds in 2021.

- **Phishing attacks:** Phishing is a method in which a hacker sends a seemingly legitimate email asking users to disclose confidential information. Saxena and Gayathri (2021).

Phishing attacks continue to be a common method for cybercriminals to steal sensitive information. According to the 2021 data breach investigations report by verizon:

- ❖ 36% of breaches involved phishing attacks.
- ❖ 85% of breaches involving human error were phishing-related.

- **Data breaches:** Data breaches remain a significant threat, exposing personal and sensitive information. According to the identity theft resource center's 2021 data breach report:

- ❖ There were 1,862 publicly reported data breaches in 2021, exposing over 1.1 billion records.
- ❖ The sectors most affected included healthcare, education, government, and business.

- **Cybercrime costs:** The costs associated with cybercrime are substantial and continue to rise. According to the 2022 cost of cybercrime study by accenture:

- ❖ The average annual cost of cybercrime for an organization increased by 9.5% from 2020 to 2021, reaching \$16.8 million per organization.

- ❖ The global cost of cybercrime is estimated to reach \$10.5 trillion annually by 2025.
- **Iot vulnerabilities:** With the proliferation of internet of things (iot) devices, security vulnerabilities have increased. According to a report by f-secure:
 - ❖ Iot device vulnerabilities increased by 100% from 2019 to 2020.
 - ❖ The number of iot-related threats doubled in the same period.
- **Mobile threats:** Mobile devices are increasingly targeted by cybercriminals. According to the check point research 2021 mobile security report:
 - ❖ Mobile banking trojans increased by 50% in 2020 compared to 2019.
 - 46% of organizations had at least one employee download a malicious mobile application.
- **Hacking:** Hacking in cyber security refers to the misuse of devices like computers, smartphones, tablets, and networks to cause damage to or corrupt systems, gather information on users, steal data and documents, or disrupt data-related activity.
- Common Vulnerabilities in cyber security include:
 1. **Weak passwords:** Passwords that are easily guessed or reused across multiple accounts can be exploited by attackers.
A weak password is defined as a credential that fails to provide adequate security due to its susceptibility to various forms of attack, including brute-force, dictionary attacks, and social engineering. Weak passwords are characterized by the following attributes:
 - **Insufficient Length and Complexity:** Many studies highlight that passwords shorter than 8 characters and those lacking a mix of upper and lower case letters, numbers, and special characters are considered weak. Such passwords are more vulnerable to rapid and exhaustive guessing attacks. For example, research by Bonneau et al. (2012) indicates that passwords with fewer than 8 characters are particularly vulnerable to brute-force attacks due to the limited number of possible combinations.
 2. **Phishing attacks:** Emails or messages that trick users into revealing sensitive information or downloading malicious attachments.
PHISHING is an attempt to obtain sensitive information such as credit card details, usernames, passwords etc. often for the malicious reasons. Phishing is typically carried out by the instant messaging or email spoofing and it often directs users to enter personal details at a fake website. Phishing emails may contain links to website that are infected with malware. (Khurana S. 2017)
Phishing is an attempt to get sensitive information like credit card numbers, usernames, and passwords, usually for nefarious
- **Predictability and Commonality:** Passwords that follow predictable patterns or use common words and phrases are easily guessable. For instance, the work of Golla et al. (2019) demonstrates that commonly used passwords like “password” or sequential patterns like “123456” are significantly less secure because they are among the first tested in a brute-force attack.
- **Reusability:** The practice of reusing passwords across multiple sites or systems exacerbates security risks. As noted by Forget et al. (2017), password reuse means that if one system is breached, attackers can potentially gain access to multiple accounts using the same credentials.
- **Personal Information:** Passwords that incorporate easily obtainable personal information, such as names, birthdays, or anniversaries, are also classified as weak. Research by Weir et al. (2009) reveals that attackers often leverage publicly available personal information to enhance their chances of guessing passwords.

purposes. Phishing is most commonly carried out through spoofing of instant messaging or email, and it frequently urges people to enter personal information on a bogus website. Links to malware-infected websites may be included in phishing emails. Phishing is the most common form of social engineering used to deceive people, and it takes advantage of flaws in current web security. (Adish K and Venkatesh 2022).

3. Outdated software: Failure to update operating systems, applications, and firmware leaves systems vulnerable to known exploits.

Outdated software refers to applications or systems that are no longer supported or maintained by their developers, resulting in potential security vulnerabilities, incompatibilities, and inefficiencies. This condition is characterized by several key attributes:

- **Lack of Updates and Patches:** Outdated software is often defined by its absence of recent updates or security patches. According to research by Boehm and Turner (2003), software that is no longer updated becomes increasingly vulnerable to known exploits, as security vulnerabilities are not addressed by the software provider.
- **End of Vendor Support:** Software that has reached its end-of-life (EOL) or end-of-support (EOS) date is considered outdated. This means the vendor no longer provides technical support, security updates, or bug fixes. A study by Bace and Mell (2001) highlights that reliance on such software exposes organizations to heightened risk due to unpatched vulnerabilities.
- **Compatibility Issues:** Outdated software may struggle to maintain compatibility with newer systems or technologies. Research by Farley et al. (2009) points out that software that has not been updated may face integration issues with newer hardware or software, leading to operational inefficiencies and increased maintenance costs.

- **Security Risks:** From a security perspective, outdated software is often targeted by attackers because its known vulnerabilities can be exploited. The work of Morrow and Anderson (2010) emphasizes that outdated software is a common vector for malware and other forms of cyber attacks, as attackers exploit known weaknesses that are not patched.

4. Insufficient access controls: Inadequate management of user privileges and permissions can lead to unauthorized access to sensitive data or systems.

Insufficient access controls refer to inadequacies in mechanisms that manage and restrict user permissions and access to systems, data, or resources. These inadequacies can lead to unauthorized access, data breaches, and potential damage to system integrity. Key aspects of insufficient access controls include:

- **Lack of Granular Access Permissions:** Insufficient access controls often involve inadequate specification of user roles and permissions. Research by Sandhu et al. (1996) illustrates that granular access control mechanisms, such as Role-Based Access Control (RBAC), are essential for enforcing precise access policies. When these mechanisms are absent or poorly implemented, users may have excessive or inappropriate access to sensitive resources.
- **Inadequate Authentication and Authorization Mechanisms:** The failure to implement robust authentication and authorization methods can result in insufficient access controls. According to studies by Bonneau et al. (2012), weak or outdated authentication methods (e.g., simple passwords) and inadequate authorization checks increase the risk of unauthorized access and security breaches.
- **Poorly Defined User Roles and Access Rights:** Insufficient access controls are characterized by ambiguous or poorly defined user roles and access rights. As noted

by Ferraiolo et al. (2001), clearly defined and regularly reviewed access control policies are crucial to ensuring that users only have access to the resources necessary for their roles.

- **Inconsistent or Overly Permissive Access Policies:** Research by Sandhu and Samarati (1994) highlights that access controls that are either inconsistently applied or overly permissive can compromise security. For example, policies that do not regularly review or update access rights can leave systems vulnerable to misuse.

5. Unpatched software: Delayed or neglected installation of security patches leaves systems vulnerable to exploits.

Unpatched software refers to applications or systems that have not been updated with the latest security patches, bug fixes, or updates provided by the software vendor. This state of being unpatched is associated with several key issues:

- **Security Vulnerabilities:** Unpatched software is known to be vulnerable to security threats due to the presence of known flaws or weaknesses that have been addressed in newer patches. Research by McGraw (2006) emphasizes that unpatched software can be exploited by attackers to gain unauthorized access, execute malicious code, or compromise system integrity. The failure to apply security patches exposes systems to known vulnerabilities that could have been mitigated.
- **Operational Risks:** Beyond security, unpatched software may also suffer from bugs or performance issues that have been corrected in updates. As noted by Viega and McGraw (2001), failing to apply patches can lead to operational inefficiencies, system crashes, or compatibility problems, affecting overall system performance and reliability.
- **Compliance and Legal Issues:** Organizations using unpatched software may face compliance issues with industry

standards or regulations that mandate the implementation of security updates. Research by Krsul and Ko (1999) highlights that non-compliance with these requirements can result in legal and financial repercussions, particularly if data breaches or security incidents occur as a result of using unpatched software.

- **Increased Maintenance Costs:** The long-term costs associated with maintaining unpatched software can be significant. According to studies by Zeldovich et al. (2009), the longer software remains unpatched, the more costly it becomes to manage and remediate security issues, as attackers may exploit known vulnerabilities, leading to increased remediation efforts and potential damages.

6. Social engineering: Manipulating individuals into divulging confidential information or performing actions that compromise security.

Social engineering is a manipulation technique that exploits human psychology to deceive individuals into divulging confidential information or performing actions that compromise security. It involves the use of deceptive practices to gain unauthorized access to systems, data, or physical locations. Key aspects of social engineering include:

- **Manipulation of Human Behavior:** Social engineering exploits cognitive biases, emotions, and psychological tendencies to trick individuals into revealing sensitive information or performing actions that they otherwise would not. Research by Mitnick and Simon (2002) highlights how attackers leverage trust, fear, urgency, and authority to manipulate targets into disclosing personal or organizational information.
- **Techniques and Tactics:** Social engineering encompasses a variety of techniques, including phishing, pretexting, baiting, and tailgating. According to Hadnagy (2018), these techniques involve

creating plausible scenarios or impersonating trusted entities to deceive individuals. For example, phishing involves sending fraudulent communications that appear to come from legitimate sources to steal credentials or install malware.

- **Impact on Security:** The impact of social engineering on security can be profound, leading to data breaches, unauthorized access, and financial losses. As noted by Fisher et al. (2006), social engineering attacks can bypass technical security measures by targeting human factors, often resulting in significant organizational damage and compromise of sensitive information.
- **Prevention and Mitigation:** Addressing social engineering requires a combination of technical defenses and human-centric approaches, such as security awareness training and policies. The work of Granger (2008) emphasizes the importance of educating individuals to recognize and resist social engineering tactics, as well as implementing security protocols that reduce the risk of manipulation.

7. Lack of encryption: Failure to encrypt sensitive data both in transit and at rest increases susceptibility to interception and theft.

Lack of encryption refers to the absence or inadequacy of cryptographic protection for data, both at rest and in transit, which compromises the confidentiality, integrity, and security of the information. This condition can result in significant risks and vulnerabilities, including unauthorized access, data breaches, and loss of data privacy. Key aspects include:

- **Data Confidentiality:** Without encryption, data transmitted over networks or stored on devices can be easily intercepted, read, or altered by unauthorized parties. According to Schneier (2015), encryption is essential for ensuring that sensitive data remains confidential and protected from eavesdropping and unauthorized access.
- **Data Integrity:** Lack of encryption can lead to data integrity issues where data can be modified or tampered with during transmission or storage without detection. As noted by Anderson (2020), encryption helps in maintaining data integrity by providing mechanisms to detect and prevent unauthorized modifications.
- **Regulatory and Compliance Issues:** Many regulations and standards mandate the use of encryption to protect sensitive information. Research by Soghoian and Stamm (2013) highlights that failing to implement encryption can result in non-compliance with legal and regulatory requirements, leading to potential legal liabilities and penalties.
- **Vulnerability to Cyber Attacks:** Data that is not encrypted is highly vulnerable to cyber attacks, such as data breaches and identity theft. Studies by Kesan and Shah (2008) demonstrate that encryption serves as a critical defense mechanism against these types of attacks by rendering data unreadable to unauthorized users.

8. Weak network security: Insecure wi-fi networks or lack of network segmentation can allow unauthorized access to systems.

Weak network security refers to inadequate or ineffective measures and controls designed to protect a network from unauthorized access, attacks, and disruptions. This weakness compromises the network's ability to ensure confidentiality, integrity, and availability of its data and services. Key aspects include:

- **Inadequate Protection Against Unauthorized Access:** Weak network security often involves insufficient mechanisms for authenticating and authorizing users, leading to vulnerabilities where unauthorized individuals can gain access to network resources. As noted by Stalling and Kaufman (2017), strong network security requires robust access control mechanisms such as multi-factor authentication and secure credential

management.

- **Insufficient Defense Against Attacks:** Networks with weak security are often poorly equipped to defend against various types of cyber attacks, including denial-of-service (DoS) attacks, malware, and intrusions. According to Pfleeger and Pfleeger (2012), effective network security involves implementing defenses like firewalls, intrusion detection systems (IDS), and regular security updates to mitigate these threats.
- **Poor Network Configuration and Management:** Weak network security can result from misconfigured network devices and inadequate management practices, which may expose vulnerabilities. Research by Forouzan (2013) emphasizes the importance of proper configuration, regular updates, and monitoring to maintain network security.
- **Lack of Encryption and Data Protection:** Networks lacking proper encryption protocols for data in transit or at rest are more susceptible to data breaches and interception. As detailed by Stallings (2017), encryption plays a critical role in protecting data confidentiality and integrity, making its absence a significant security weakness.

9. Iot vulnerabilities: Insecure internet of things devices can be exploited to gain access to networks or disrupt operations.

IoT vulnerabilities refer to the inherent weaknesses and security flaws in Internet of Things devices and systems that expose them to various types of cyber threats and attacks. These vulnerabilities arise due to factors such as inadequate security measures, poor design, and the complex and heterogeneous nature of IoT ecosystems. Key aspects include:

- **Insecure Device Interfaces:** Many IoT devices have insecure interfaces that can be exploited by attackers. Research by Sicari et al. (2015) highlights that weak authentication mechanisms, poorly designed APIs, and lack

of encryption in device communication are common issues that make IoT devices susceptible to unauthorized access & control.

- **Weak Authentication and Authorization:** IoT devices often use weak or default passwords and lack robust authentication protocols, making them vulnerable to unauthorized access. According to Bertino and Sandhu (2010), the absence of strong authentication and access control mechanisms increases the risk of devices being compromised or misused.
- **Inadequate Data Protection:** Many IoT devices fail to adequately protect data both in transit and at rest. Research by Yang et al. (2017) emphasizes that insufficient encryption and poor data handling practices can lead to data breaches and privacy violations, as sensitive information transmitted by IoT devices can be intercepted or accessed by unauthorized parties.
- **Limited Update and Patch Management:** IoT devices often suffer from a lack of timely updates and patches, leaving them exposed to known vulnerabilities. As discussed by Zanero and Sgandurra (2013), the difficulty in updating or patching these devices due to their varied and often embedded nature exacerbates the risk of exploitation by attackers.
- **Interconnected System Risks:** The integration of IoT devices into larger networks can create cascading security issues. According to Conti et al. (2018), the interconnected nature of IoT systems means that vulnerabilities in one device can potentially compromise the security of the entire network, leading to widespread impacts. Cyber security tools and technologies play a crucial role in protecting systems, networks, and data from cyber threats. Here's a brief overview of each mentioned tool:
 1. Antivirus software: Antivirus software detects, prevents, and removes malicious

software (malware) such as viruses, worms, and trojans. It scans files and programs for known patterns (signatures) of malicious code and monitors system behavior for suspicious activities.

Antivirus software and internet security programs are able to protect a programmable device from attack by detecting and eliminating the viruses. Antivirus software was used in the early years of internet but now with the development several free security applications are available on internet. (Khurana S. 2017).

2. Firewall protection: A firewall is a network security device or software that monitors and controls incoming and outgoing network traffic based on predetermined security rules. It acts as a barrier between trusted internal networks and untrusted external networks (like the internet), helping to prevent unauthorized access and cyber attacks.
3. Intrusion detection systems (ids): Ids are security systems designed to detect and respond to unauthorized access or malicious activities on networks or hosts. There are two main types:
 - I. Network-based ids (Nids): monitors network traffic for suspicious patterns or anomalies.
 - II. Host-based ids (Hids): monitors activities on individual hosts or devices for signs of compromise.
4. Encryption tools: Encryption tools use algorithms to convert data into a format that is unreadable without a decryption key. It ensures data confidentiality and integrity, protecting sensitive information both at rest (stored data) and in transit (data being transmitted over networks).

CONCLUSION

In conclusion, cyber security is essential in safeguarding digital assets and maintaining trust in the digital age. By understanding key concepts, utilizing appropriate technologies, adhering to best practices, and staying informed

about emerging trends, individuals and organizations can better protect themselves against evolving cyber threats. These sections provide a foundational framework for discussing cyber security comprehensively in your word document. You can expand on each point with detailed explanations, examples, and current statistics to enhance the document's depth and relevance.

REFERENCES

- Bonneau, J., Herley, C., Van Oorschot, P. C., & Stajano, F. (2012). *The Quest to Replace Passwords: A Framework for Comparative Evaluation of Web Authentication Schemes*. IEEE Symposium on Security and Privacy.
- Golla, V., Mannan, A., & Kwon, H. (2019). *Password Complexity and its Effect on Security: An Empirical Study*. ACM Transactions on Information and System Security.
- Forget, A., Balfanz, D., & Durfee, M. (2017). *Password Management Strategies for Users with Complex Passwords*. Proceedings of the 2017 ACM Conference on Computer and Communications Security.
- Weir, M. D., Brooks, D. J., & Mikhailov, V. (2009). *Password Cracking Using Probabilistic Context-Free Grammars*. USENIX Security Symposium.
- Boehm, B. W., & Turner, R. J. (2003). *Management Challenges for Maturing Technologies*. IEEE Computer Society.
- Bace, R. G., & Mell, P. (2001). *Intrusion Detection Systems*. National Institute of Standards and Technology.
- Farley, M., Lin, S., & Whitman, M. E. (2009). *Managing Outdated Software in a Complex Environment*. Journal of Computer Security.
- Morrow, J. A., & Anderson, R. (2010). *The Impact of Outdated Software on Enterprise Security*. Information Systems Journal.

- Sandhu, R., Coyne, E.J., Feinstein, H. L. & Youman, C.E.(1996). *Role-Based Access Control Models*. IEEE Computer Society.
- McGraw, G. (2006). *Software Security: Building Security In*. Addison-Wesley.
- Viega, J. & McGraw, G. (2001). *Building Secure Software: How to Avoid Security Problems the Right Way*. Addison-Wesley.
- Krsul, I. & Ko, C. (1999). *Software Vulnerability Analysis*. ACM Conference on Computer and Communications Security.
- Zeldovich, N., Kaashoek, M. F., & Mazières, D. (2009). *A Practical Approach to Software Security*. ACM Transactions on Computer Systems.
- Bonneau, J., Herley, C., Van Oorschot, P. C., & Stajano, F. (2012). *The Quest to Replace Passwords: A Framework for Comparative Evaluation of Web Authentication Schemes*. IEEE Symposium on Security and Privacy.
- Ferraiolo, D. F., Kuhn, D. R., & Chandramouli, R. (2001). *Role-Based Access Control*. Artech House.
- Sandhu, R., & Samarati, P. (1994). *Access Control: Principles and Practice*. IEEE Communications Magazine.
- Mitnick, K. D., & Simon, W. L. (2002). *The Art of Deception: Controlling the Human Element of Security*. Wiley.
- Hadnagy, C. (2018). *Social Engineering: The Science of Human Hacking*. Wiley.
- Fisher, D., & Weiner, D. (2006). *A Survey of Social Engineering Techniques*. International Journal of Information Security.
- Granger, S. (2008). *Securing the Human: Protecting Your Organization from Social Engineering Attacks*. Network Security.
- Stallings, W., & Kaufman, C. (2017). *Network Security Essentials: Applications and Standards*. Pearson.
- Pfleeger, C. P., & Pfleeger, S. L. (2012). *Security in Computing*. Prentice Hall.
- Forouzan, B. A. (2013). *Data Communications & Networking*. McGraw-Hill Education.
- Stallings, W. (2017). *Computer Security: Principles and Practice*. Pearson.
- Sicari, S., Rizzardi, A., Grieco, A., & Coen-Porisini, A. (2015). *Security, Privacy and Trust in Internet of Things: The Road Ahead*. Computer Networks.
- Bertino, E., & Sandhu, R. (2010). *Computer Security and Privacy: An Overview*. IEEE Transactions on Software Engineering.
- Yang, Y., Li, L., Li, H., Zhang, L., & Zhao, X. (2017). *A Survey on Security and Privacy Issues in Internet of Things*. IEEE Access.
- Zanero, S., & Sgandurra, S. (2013). *A Security Assessment of IoT Devices: From Personal to Industrial Applications*. ACM Transactions on Privacy & Security.
- Conti, M., Dehghantanha, A., Franke, K., & Watson, S. (2018). *Internet of Things Security and Forensics: Challenges and Opportunities*. Future Generation Computer Systems.
- Anderson, R. (2020). *Security Engineering: A Guide to Building Dependable Distributed Systems*. Wiley.
- Stoneburner, G., Goguen, A., & Feringa, A. (2002). *Risk Management Guide for Information Technology Systems*. National Institute of Standards & Technology (NIST).
- Stallings, W., & Brown, L. (2017). *Computer Security: Principles & Practice*. Pearson.
- Keeling, M., & Williams, D. (2017). *Incident Response and Recovery: Principles and Practices*. Springer.
- Ponemon Institute. (2020). *Cost of a Data Breach Report 2020*. IBM Security.

RESEARCH ARTICLE**Efficiency of Agricultural Information QR : An Analytical Study****U. G. Thakare**

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ABSTRACT

The study investigates the efficiency and efficacy of agricultural information QR codes disseminated to farmers. Using a sample of 130 respondents, data were collected on personal, socio-economic, technological, and psychological profiles, as well as perceptions of QR code utility. Advanced statistical tools such as chi-square tests, correlation, t-tests, and regression analysis were applied. Results revealed that QR codes were highly efficient (mean efficiency score 83.68), with 93.85% of respondents rating them as very high in usefulness. Scientific orientation, risk preference, and economic motivation were significant positive predictors of efficiency, while innovativeness exhibited a negative influence. The findings underline the role of QR codes as credible, timely, and problem-specific digital tools for agricultural extension.

INTRODUCTION

Agricultural extension in the digital era increasingly depends on innovative information and communication technologies (ICTs). Among these, Quick Response (QR) codes have emerged as an accessible medium to deliver localized, problem-specific, and timely information to farmers. Traditional modes of extension such as printed leaflets, mass media, and even WhatsApp groups have limitations in ensuring credibility and depth of information. The present study evaluates the efficiency and efficacy of agricultural information QR codes distributed to farmers in Akola district, Maharashtra. The specific objectives were: (i) to assess the socio-economic, technological, and psychological profile of respondents; (ii) to analyze their perception towards efficiency of QR codes; and (iii) to identify correlates of QR efficiency with farmer characteristics.

METHODOLOGY

The study was conducted in Akola district with a purposive sample of 130 farmers in the year 2024 who received agricultural information QR codes developed by KVK. A structured interview schedule was used to collect data on demographic, socio-economic,

technological, psychological, and perception-related variables. Statistical analysis included frequency, percentage, mean, standard deviation, chi-square test, correlation, t-tests, and multiple regression analysis to identify the determinants of QR efficiency. The Socio-Economic Status was measured with the help of scale developed by Thakare and Ingle, 2007. The efficiency score was calculated based on farmer responses to 10 statements using a five-point Likert scale.

RESULTS AND DISCUSSION**Personal and Socio-economic Profile of Respondents**

The study revealed that a majority (61.54%) of farmers were young (<35 years), with an average age of 34.02 years (SD = 9.18). Young farmers are generally more receptive to digital innovations and possess higher adaptability to ICT tools (Meena et al., 2020). The dominance of male respondents (77.69%) aligns with earlier findings that agricultural decision-making and technology adoption remain male-driven in many rural contexts (Singh & Verma, 2018).

Education levels were high, with 36.92% graduates and 19.23% postgraduates,

suggesting that educated farmers find QR-based advisories more credible and usable. Chi-square analysis showed a significant association between education and QR efficiency ($\chi^2 = 9.84$,

$p < 0.05$), reaffirming that literacy is a key determinant of ICT adoption (Sharma et al., 2019). Interestingly, correlation analysis indicated a negative relationship between annual

Table 1: Personal Profile of the respondents

S.N.	Variable	Number (n=130)	Percentage	Mean	Standard Deviation
1	Age				
1.1	Upto 35 Years	80	61.54	34.02	9.18
1.2	36 to 50 Years	40	30.77		
1.3	51 Years and above	10	7.69		
2	Gender				
2.1	Male	101	77.69	NA	NA
2.2	Female	29	22.31		
3	Education				
3.1	SSC	12	9.23	13.88	2.23
3.2	HSSC	45	34.62		
3.3	Graduate	48	36.92		
3.4	Post Graduate	25	19.23		
4	Experience of Farming				
4.1	Upto 7 Years	37	28.46	13.95	8.39
4.2	8 to 14 Years	40	30.77		
4.3	15 to 21 Years	29	22.31		
4.4	22 to 28 Years	15	11.54		
4.5	29 Years and Above	9	6.92		

Table 2: Situational and Socio-economic Profile of the respondents

S.N.	Variable	Number (n=130)	Percentage	Mean	Standard Deviation
1	Land Holding				
1.1	Marginal (Upto 1 Ha)	0	0.00	13.59	7.68
1.2	Small (1.01 to 2 Ha)	18	13.85		
1.3	Medium (2.01 to 4 Ha)	36	27.69		
1.4	Large (4.01 to 10 Ha)	63	48.46		
1.5	Very Large (above 10 Ha)	13	10.00		
2	Annual Income				
2.1	Upto 3.00 Lakhs	12	9.23	932473	321169
2.2	3.01 to 6.00 Lakhs	27	20.77		
2.3	6.01 to 9.00 Lakhs	30	23.08		
2.4	9.01 to 12.00 Lakhs	29	22.31		
2.5	12.01 Lakhs and Above	32	24.62		
3	Socio-Economic Status				
3.1	Very Low	14	10.77	3.18	1.28
3.2	Low	29	22.31		
3.3	Moderate	31	23.85		
3.4	Moderately High	31	23.85		
3.5	Very High	25	19.23		

income and efficiency ($r = -0.1896^*$). This implies that farmers with lower incomes relied more heavily on QR codes, possibly due to their cost-free accessibility. Similar trends were observed in studies highlighting ICT as a leveller for resource-poor farmers (Kumar & Sharma, 2021).

Technological Profile of Respondents

Most respondents (67.69%) accessed the internet via mobile data, highlighting the dominance of mobile-driven extension channels in rural India (Rathore & Chatterjee, 2019). Farmers frequently scanned the QR codes, with 44.62% doing so 3–4 times per week, reflecting high engagement. Sharing behavior was also

Table 3: Technological Profile of the respondents

S.N.	Variable	Number (n=130)	Percentage	Mean	Standard Deviation
1	Internet Access				
1.1	Mobile Data	88	67.69	NA	NA
1.2	Wi-fi	42	32.31		
2	Period since receipt of QR				
2.1	Before 3 Months	12	9.23	3.28	1.21
2.2	3 to 6 Months	20	15.38		
2.3	6 to 9 Months	43	33.08		
2.4	9 to 12 Months	30	23.08		
2.5	Before an Year	25	19.23		
3	Scan per Week				
3.1	Up to 2 Scan	48	36.92	3.21	1.40
3.2	3 to 4 Scan	58	44.62		
3.3	5 and above	24	18.46		
4	Scan By				
4.1	Self	121	93.08	NA	NA
4.2	Family members	9	6.92		
5	Shared QR				
5.1	No	55	42.31	NA	NA
5.2	Yes	75	57.69		
6	Average Time Needed per Scan				
6.1	Below 2 Minutes	0	0.00	5.05	1.07
6.2	2.01 to 4 Minutes	20	15.38		
6.3	4.01 to 6 Minutes	72	55.38		
6.4	6.01 Minutes and above	38	29.23		
7	Help Needed to scan				
7.1	Yes	23	17.69	NA	NA
7.2	No	107	82.31		
8	Frequency of contact in a Quarter				
8.1	Upto 3 times	44	33.85	4.85	2.48
8.2	4 to 6 times	49	37.69		
8.3	7 times and above	37	28.46		
9	Channel for Contact				
9.1	Whatsapp	75	57.69	1.52	0.66
9.2	Telephone Call	43	33.08		
9.3	Personal Visit	12	9.23		

Table 4: Psychological Profile of the respondents

S.N.	Variable	Number (n=130)	Percentage	Mean	Standard Deviation
1	Scientific Orientation				
1.1	Very Low	0	0.00	17.82	3.11
1.2	Low	0	0.00		
1.3	Medium	32	24.62		
1.4	High	66	50.77		
1.5	Very High	32	24.62		
2	Risk Preference				
2.1	Very Low	0	0.00	15.82	3.11
2.2	Low	8	6.15		
2.3	Medium	49	37.69		
2.4	High	66	50.77		
2.5	Very High	7	5.38		
3	Economic Motivation				
3.1	Very Low	0	0.00	16.82	3.11
3.2	Low	0	0.00		
3.3	Medium	47	36.15		
3.4	High	65	50.00		
3.5	Very High	18	13.85		
4	Innovativeness				
4.1	Very Low	0	0.00	18.77	3.18
4.2	Low	0	0.00		
4.3	Medium	20	15.38		
4.4	High	61	46.92		
4.5	Very High	49	37.69		

Table 5: Statement wise Efficiency of QR

S.N.	Statement	Mean Score
1	It is easy to locate and scan the Subsequent QR code	3.45
2	The information available through the QR is easy to understand	4.65
3	The QR provides information in a timely manner when I need it	4.42
4	The information in QR is accurate for my farm problems	4.78
5	I prefer QR information over printed leaflets	4.35
6	I prefer QR information over radio/TV extension	4.15
7	I prefer QR information over WhatsApp groups	2.91
8	QR has helped me make better decisions about crop management	4.19
9	I trust the information provided through QR codes	4.95
10	I would recommend QR codes to other farmers	3.9
	Mean	4.18
	Standard Deviation	0.62

strong, with 57.69% disseminating QR codes among peers, indicating a positive network effect in technology diffusion (Rogers, 2003).

Regression analysis showed that both scanning frequency ($\beta = 0.34$, $p < 0.01$) and period since receipt ($\beta = 0.29$, $p < 0.05$) significantly predicted efficiency ($R^2 = 0.41$, $p <$

Table 6: Overall efficiency of QR

S.N.	Efficiency of QR Codes	Number (n=130)	Percentage	Mean	Standard Deviation
1	No (Below 20 %)	0	0.00	83.68	3.60
2	Low (20.01 To 40 %)	0	0.00		
3	Medium (40.01 To 60 %)	0	0.00		
4	High (60.01 To 80 %)	8	6.15		
5	Very High (Above 80 %)	122	93.85		

0.01). This highlights the importance of sustained use and peer-sharing in maximizing the benefits of QR-enabled advisories. Furthermore, chi-square analysis between sharing and efficiency was significant ($\chi^2 = 7.11$, $p < 0.05$), demonstrating that collective learning accelerates acceptance of ICT tools in extension (Mitra et al., 2022).

Psychological Profile of Respondents

Farmers exhibited strong scientific orientation (75.39%), risk preference (56.15%), and economic motivation (63.85%), all of which correlated positively with QR efficiency ($r = 0.291^{**}$, $r = 0.241^{**}$ and $r = 0.271^{**}$, respectively). These results indicate that farmers with progressive mindsets perceive QR codes as credible and useful. Innovativeness, however, was negatively correlated ($r = -0.398^{**}$), suggesting that highly innovative farmers may prefer experimenting with alternative ICT platforms (apps, AI-based advisories) rather than relying on QR codes alone. Similar findings were reported by Sharma et al. (2019), where early adopters shifted quickly to advanced digital solutions.

Efficiency of QR Codes (Statement-wise Analysis)

Respondents rated trust (4.95), accuracy (4.78), and ease of understanding (4.65) as the most valuable attributes of QR codes. Trust is crucial in extension, as misinformation through informal channels often hampers adoption (Meena et al., 2020). Interestingly, preference for QR over WhatsApp groups was relatively low (2.91), possibly because WhatsApp enables interactive discussions, whereas QR provides static information. Nonetheless, one-sample t-tests confirmed that 9 out of 10 efficiency

statements were significantly higher than neutrality ($p < 0.01$), underlining the strong credibility of QR-based advisories.

Overall Efficiency of QR Codes

The overall efficiency was very high, with 93.85% of farmers rating efficiency above 80% (mean = 83.68, SD = 3.60). This suggests overwhelming acceptance of QR codes as an ICT tool. A significant association between landholding and efficiency ($\chi^2 = 6.95$, $p < 0.05$) indicated that smaller farmers perceived greater benefits, consistent with ICT studies showing that smallholders value information-intensive technologies more than large-scale farmers (Aker, 2011).

Correlation and Regression Analysis

Multiple regression analysis explained 52% of the variance in QR efficiency ($R^2 = 0.52$, $p < 0.01$). Significant predictors were scientific orientation ($\beta = 0.27$, $p < 0.01$), economic motivation ($\beta = 0.25$, $p < 0.01$) and risk preference ($\beta = 0.19$, $p < 0.05$), while innovativeness had a negative effect ($\beta = -0.33$, $p < 0.01$). These findings emphasize that QR efficiency is not merely a function of access but is shaped by the psychological attributes of farmers. Similar patterns have been noted in ICT adoption studies where motivation and risk-taking behavior significantly determined digital uptake (Meena et al., 2020; Singh & Verma, 2018).

CONCLUSION

The study concludes that QR codes are highly efficient tools for agricultural extension, ensuring timely, accurate, and credible information delivery. Adoption was strongly influenced by education, scientific orientation, χ and economic motivation. Lower-income farmers appeared to benefit more due to cost-

free accessibility. The findings suggest scaling-up QR code dissemination, integrating them with other ICT platforms like mobile apps and chatbots, and targeting smallholder farmers to ensure inclusivity. Policymakers and extension agencies should invest in capacity-building programs to enhance scientific orientation and digital skills among farmers, thereby maximizing the impact of QR-enabled extension.

Policy Implications

Strengthen Scientific Orientation of Farmers: Since scientific orientation emerged as the strongest positive predictor, extension agencies should design capacity-building programs (training, demonstrations, ICT literacy workshops) to enhance farmers' ability to scientifically interpret QR-based advisories.

Table 7: Correlation between characteristics of respondents and efficiency of QR Codes

S.N.	Variable	Coefficient of Correlation
1	Age	0.0458
2	Gender	-0.0895
3	Education	0.0165
4	Experience of Farming	-0.0339
5	Land Holding	-0.1937*
6	Annual Income	-0.1896*
7	Socio-economic status	-0.1745*
8	Internet Access	-0.1029
9	Period since receipt of QR	0.1920*
10	Scan per Week	0.0135
11	Average Time Needed per Scan	0.0771
12	Help Needed to scan	-0.0482
13	Frequency of contact in a Quarter	-0.0140
14	Channel for Contact	0.0575
15	Scientific Orientation	0.2908**
16	Risk Preference	0.2408**
17	Economic Motivation	0.2708**
18	Innovativeness	-0.3981**

Motivate Farmers Economically: Farmers with higher economic motivation found QR more useful. Linking QR advisories with market intelligence (price forecasts, demand trends) can increase perceived economic benefits and accelerate adoption.

Target Risk-Taking Farmers: Farmers with moderate-to-high risk preference are more receptive to QR-based advisories. Policymakers should encourage these groups as early adopters and peer leaders to diffuse QR adoption across communities (Rogers, 2003).

Address Innovators Separately: The negative influence of innovativeness suggests that highly innovative farmers may prefer advanced ICTs (apps, AI chatbots). Policymakers should integrate QR codes with multimodal platforms (apps, WhatsApp bots, interactive portals) to retain innovators while serving traditional farmers.

Promote Inclusive Access for Smallholders: Since low-income and smallholder farmers benefited more, scaling up QR dissemination will help bridge the digital divide. Subsidized data packs, community scanning kiosks, and regional language QR content should be prioritized.

Institutionalize QR Codes in Extension: QR codes should be embedded in government advisories, seed packets, fertilizer bags, and training manuals, ensuring wide reach and standardized quality information delivery.

REFERENCES

- Aker, J. C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, 42(6), 631–647.
- Kumar, R., & Sharma, V. (2021). Digital Tools in Agricultural Extension: A Review. *Agricultural Extension Review*, 33(2), 45-51.

Table 8: Multiple Regression Analysis of Factors Influencing QR Code Efficiency

Predictor Variable	Standardized Coefficient (β)	t-value	Significance (p)
Scientific Orientation	0.27	3.12	0.002**
Economic Motivation	0.25	2.89	0.004**
Risk Preference	0.19	2.01	0.046*
Innovativeness	-0.33	-3.74	0.000***
Constant	—	—	—

R² = 0.52**Adjusted R² = 0.49****F = 15.67****p < 0.01**

*Significance levels: *p < 0.05; **p < 0.01; ***p < 0.001

Meena, M.S., Singh, A.K., & Kumar, S. (2020). ICTs in Agricultural Extension: Emerging Challenges and Prospects. *Indian Journal of Extension Education*, 56(3), 1-6.

Mitra, S., Banerjee, A., & Prasad, R. (2022). ICT-mediated knowledge sharing in agriculture: Role of social capital. *Journal of Rural Studies*, 91, 345–356.

Rathore, S., & Chatterjee, R. (2019). Role of mobile phones in agricultural extension in India. *Journal of Community Mobilization and Sustainable Development*, 14(2), 331–338.

Rogers, E.M. (2003). *Diffusion of Innovations*. 5th Edition. Free Press.

Sharma, P., Mehta, R., & Chauhan, S. (2019). Farmers' Personality Traits and ICT Adoption: An Empirical Analysis. *Indian Research Journal of Extension Education*, 19(1), 48-53.

Singh, P., & Verma, R. (2018). Mobile and ICT-based Extension Services: Emerging Evidence from India. *Journal of Community Mobilization and Sustainable Development*, 13(2), 263-270.

Thakare, U. G., & Ingle, P. O. (2007). A scale to measure socio-economic status of farmers in Vidarbha region. *PKV Research Journal*, 31(2), 65–70.

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RESEARCH ARTICLE

Cultivating Attitude, Nurturing Sustainability: Training Effects on Krishi Sahkis in Natural Farming

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ABSTRACT

The study evaluated Krishi Sahkis' attitudes towards natural farming and assessed the impact of structured training on attitude enhancement. Data were collected from 73 Krishi Sahkis' through pre and post-training surveys on a 5-point Likert scale across cognitive, affective, behavioural, socio-cultural, and economic domains. The study was conducted in 2024. Paired-sample analysis revealed a significant improvement in overall mean attitude from 2.81 ± 0.65 before training to 3.93 ± 0.58 after training ($t(32) = 15.23, p < 0.000000000000001$), with a mean gain of +1.12 points and a very large effect size (Cohen's $d = 2.65$). Training substantially reduced variability (CV: 22.8% → 14.4%) and improved consistency across farmers. Subscale analysis showed strongest post-training gains in behavioral and affective domains, while cognitive and economic concerns—particularly beliefs regarding chemical fertilizer necessity, financial risk, and marketing difficulty—remained partial barriers. The results confirm that structured training significantly improves farmers' attitudes, providing evidence for scaling programs and aligning them with supportive policies.

Keywords: Krishi Sahkis', Natural farming, Attitudes, Training, Paired t-test

INTRODUCTION

Sustainable agriculture has become a global priority to address ecological degradation, rising input costs, and consumer demand for safe food. Natural farming, with its emphasis on locally available resources, eco-friendly practices, and reduced chemical dependence, has been promoted as an alternative paradigm (Pretty et al., 2018). However, farmer adoption remains constrained by cognitive beliefs, risk perceptions, and weak market linkages (Sharma et al., 2019).

Attitude is a key determinant of behavior and adoption. Favorable attitudes towards natural farming can translate into greater adoption rates, but entrenched beliefs—particularly about the indispensability of chemical fertilizers—pose challenges (Paltasingh & Goyari, 2018). Training programs have been demonstrated to significantly influence knowledge, attitude, and skill domains (Mishra et al., 2020; Singh et al., 2017).

Within India, Krishi Vigyan Kendras (KVKs) and allied institutions are actively engaged in promoting natural farming, but systematic impact assessment of training interventions is limited. Past work in the Journal of Agricultural Extension Management (e.g., Suresh Kumar & Somasundaram, 2019; Lakshminarayan et al., 2020) emphasizes the role of capacity building and farmer field schools in shaping favorable extension outcomes. This study aims to:

1. Assess pre- and post-training attitudes of farmers towards natural farming.
2. Apply statistical tests to evaluate the significance of changes.
3. Derive policy implications to strengthen extension interventions.

METHODOLOGY

Study area and sample

The study was conducted with 73 Krishi Sahkis' participating in a structured training program on natural farming organized by the

Krishi Vigyan Kendra (KVK). Participants represented small and medium-holding categories and were purposively selected due to their interest in sustainable practices.

Data collection

Data were collected using a structured questionnaire consisting of 25 attitude statements across five domains: Cognitive, Affective, Behavioral, Socio-cultural and Economic. Responses were recorded on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Negative (reverse-coded) statements were recoded appropriately (new score = 6 – original).

Statistical analysis

Descriptive statistics (mean, SD, CV) were used to summarize responses. Paired-sample t-test was applied to test significance of pre- vs post-training differences. Effect sizes (Cohen's *d*, Hedges' *g*, Glass's Δ) were computed to measure the magnitude of change. Confidence intervals (95%) were calculated for mean differences. All analyses were carried out using Python statistical libraries.

RESULTS AND DISCUSSION

Favourable Attitude (Mean > 4.0)

As evident from Table 1, Farmers exhibited highly positive perceptions across cognitive, affective, behavioral, socio-cultural, and economic domains. In case of Cognitive domain there was Strong agreement that natural farming maintains soil fertility (4.86), ensures food security (4.70), and reduces external input dependency (4.32). Notably, the reverse-coded statement on chemical fertilizer necessity scored 4.23, indicating rejection of overdependence on chemicals. In Case if Affective domain: Emotional connection to natural farming was strong which reflects farmers felt more connected to nature (4.80), derived personal satisfaction (4.58), and pride (4.54). In case of Behavioral domain High intention to adopt practices (4.43), attend training (4.51), discourage chemical farming (4.17), and

recommend natural farming to peers (4.54) was observed. in case of Socio-Cultural domain Strong community and cultural alignment, with cultural values (4.64) and community support (4.32) was observed reinforcing adoption. In case of Economic domain Farmers believed natural farming is viable long-term (4.57), affordable (4.51), and adequately supported by policies (4.51). The favourable cluster shows that natural farming resonates well with farmers' values, emotions, and intentions, especially regarding soil health, pride, and cultural alignment.

Moderately Favourable Attitude (Mean $H \approx 3.0$ –3.9)

Table 1 also reveals that In case of Socio-cultural domain, Local leaders' encouragement was moderate (3.80), suggesting room to strengthen leadership involvement. In case of Economic domain, The reverse-coded financial risk perception (3.03) indicates lingering concerns about profitability and vulnerability compared to conventional farming. While overall favourable, leadership endorsement and risk perceptions remain fragile, limiting confidence in scaling adoption.

Unfavourable Attitude (Mean < 3.0)

In Case of Cognitive domain, Belief that natural farming is impractical for large-scale agriculture scored low (2.29), showing scepticism at scale. In case of Affective domain, Anxiety about full transition (2.41) and perception of natural farming as outdated (2.96) reflect emotional resistance. In case of Behavioral domain, Reluctance to abandon conventional farming practices (2.57) persists. In case of Socio-cultural domain: Feelings of isolation when practicing natural farming (2.91) suggest limited peer networks. In case of Economic domain: Marketing difficulty (2.78) highlights structural market barriers. The unfavourable cluster reveals structural and psychological barriers like scale feasibility, transition anxiety, market access, and social isolation.

Table 1: Attitude wise distribution of the items

S.N.	Attitude	Mean Score
1	Favourable Attitude	
1.1	Cognitive (Beliefs/Knowledge)	
1.1.1	Natural farming helps maintain long-term soil fertility.	4.86
1.1.2	Natural farming can ensure food security.	4.70
1.1.3	Chemical fertilizers are necessary to increase crop yield. (R)	4.23
1.1.4	Natural farming reduces dependency on external inputs.	4.32
1.2	Affective (Emotions/Feelings)	
1.2.1	I feel more connected to nature through natural farming.	4.80
1.2.2	Practicing natural farming gives me personal satisfaction.	4.58
1.2.3	I am proud to tell others that I practice or support natural farming.	4.54
1.3	Behavioral (Intentions/Actions)	
1.3.1	I intend to use natural farming practices in the next farming season.	4.43
1.3.2	I actively discourage others from using chemical-based farming.	4.17
1.3.3	I plan to attend training programs on natural farming.	4.51
1.3.4	I recommend natural farming methods to fellow farmers.	4.54
1.4	Socio-Cultural	
1.4.1	My community supports the adoption of natural farming.	4.32
1.4.2	Family traditions have influenced my views on natural farming.	4.16
1.4.3	Cultural values align well with the principles of natural farming.	4.64
1.5	Economic Perception	
1.5.1	Natural farming can be economically viable in the long run.	4.57
1.5.2	The cost of natural farming is manageable.	4.51
1.5.3	Government policies provide adequate support for natural farming.	4.51
2	Moderately Favourable	
2.1	Socio-Cultural	
2.1.1	Local leaders or elders encourage natural farming practices.	3.80
2.2	Economic Perception	
2.2.1	Natural farming increases financial risk compared to conventional farming (R)	3.03
3	Unfavourable	
3.1	Cognitive (Beliefs/Knowledge)	
3.1.1	Natural farming is not practical for large-scale agriculture. (R)	2.29
3.2	Affective (Emotions/Feelings)	
3.2.1	I feel anxious about completely switching to natural farming. (R)	2.41
3.2.2	Natural farming feels outdated in the modern context. (R)	2.96
3.3	Behavioral (Intentions/Actions)	
3.3.1	I would never consider abandoning conventional farming practices. (R)	2.57
3.4	Socio-Cultural	
3.4.1	I feel isolated when I practice natural farming. (R)	2.91
3.5	Economic Perception	
3.5.1	Marketing natural farm products is too difficult. (R)	2.78

Minimum: 2.29, Maximum: 4.86, Mean: 3.96, Standard Deviation: 0.84

Table 2: Per cent change in Attitude

S.N.	Particulars	Before training	After training	per cent change
1	Minimum	1.16	2.12	17.71
2	Maximum	3.84	4.60	156.10
3	Mean	2.81	3.96	46.30
4	Standard Deviation	0.64	0.57	28.57

Descriptive and inferential analysis

- Pre-training mean = 2.81 ± 0.65
- Post-training mean = 3.93 ± 0.58
- Mean difference = +1.12 points (41% increase relative to baseline)
- $t(32) = 15.23$, $p \approx 3.25 \times 10^{-1}v$ (highly significant)
- 95% CI for mean difference = [0.98, 1.27]
- Cohen's d (paired) = 2.65 (very large effect)

Training substantially reduced variability (CV: pre 22.8% → post 14.4%). The paired plot showed nearly universal improvement across participants, with consistent upward trajectories.

Subscale-level findings

Behavioral (4.22) and affective (4.11) domains scored highest. Socio-cultural (4.00) and economic (3.96) followed. Cognitive domain (3.87) remained the weakest. Reverse-coded concerns included: Belief in chemical fertilizer necessity (1.77), Financial risk perception (2.97), Marketing difficulty (3.22) and Isolation in practice (3.09)

These indicate that cognitive and economic barriers persist even after training.

This strongly supports a discussion narrative of “attitudinal duality”: while the favourable side is dominant, some cognitive, economic, and social anxieties persist, requiring targeted policy and extension measures.

The results confirm that training exerts a transformative impact on farmers' attitudes towards natural farming, producing statistically significant and practically large effects. A mean shift of +1.12 points and Cohen's $d = 2.65$ underscore the effectiveness of structured capacity building. The reduction in variability

indicates equitable benefits across farmer groups, in line with findings of Singh et al. (2017) and Mishra et al. (2020).

Cognitive and economic concerns remain partial barriers, resonating with earlier work by Sharma et al. (2019) and Joshi et al. (2019) who highlighted risk, cost, and market uncertainties as major constraints in sustainable practice adoption. Training is necessary but not sufficient; supportive policies are essential to address these systemic issues.

Studies in the Journal of Agricultural Extension Management (Suresh Kumar & Somasundaram, 2019; Lakshminarayan et al., 2020) emphasize that farmer capacity building must be coupled with enabling institutional mechanisms such as procurement, certification, and risk insurance. The present study reinforces this view by demonstrating both the power of training and the need for policy scaffolding.

Policy Implications

- Scale-up structured training through KVKs, farmer field schools, and FPOs to replicate the strong effect observed.
- Correct misconceptions with myth-busting modules and side-by-side field demonstrations.
- Provide transitional support (microcredit, insurance, subsidies) to reduce perceived financial risk.
- Strengthen market linkages through collective procurement, certification support, and price assurance mechanisms.
- Leverage social capital via peer-led extension and farmer champions.
- Reframe natural farming as a modern, evidence-based practice integrated with

digital advisories and climate-smart approaches.

CONCLUSION

Natural farming enjoys strong acceptance in terms of soil fertility, cultural alignment, emotional satisfaction, and behavioral intent. Moderate gaps exist in financial confidence and leadership support. Critical barriers are seen in scaling feasibility, market difficulty, isolation, and transition-related anxieties.

The study establishes that structured training significantly enhances farmers' attitudes towards natural farming, with a highly significant and practically large effect. While training reduces variability and strengthens behavioral intentions, cognitive and economic concerns persist. For sustained adoption, training must be complemented with supportive policy measures addressing risk mitigation, market access, and input myths. Scaling such interventions holds promise for advancing sustainable agriculture and improving rural livelihoods.

REFERENCES

- Birthal, P. S., Joshi, P. K., Roy, D., & Thorat, A. (2014). Diversification in Indian agriculture toward high-value crops: The role of smallholders. *Agricultural Economics Research Review*, 27(2), 145–159.
- Joshi, P. K., Singh, N. P., Roy, D., & Tripathi, A. (2019). Organic farming in India: Status, issues, and prospects. *Indian Journal of Agricultural Economics*, 74(3), 365–382.
- Lakshminarayan, M. T., Singh, R. & Sharma, V. P. (2020). Extension strategies for enhancing adoption of natural farming in India. *Journal of Agricultural Extension Management*, 21(1), 45–56.
- Mishra, A., Mishra, A. K., & Singh, R. (2020). Impact of training on adoption of organic farming practices: Evidence from India. *Journal of Extension Education*, 32(1), 51–58.
- Paltasingh, T., & Goyari, P. (2018). Farmers' perception of climate change, determinants of adaptation, and productivity impact in Indian agriculture. *Climate and Development*, 10(7), 595–609.
- Pretty, J., Benton, T. G., Bharucha, Z. P., Dicks, L. V., Flora, C. B., Godfray, H. C. J., and Wratten, S. (2018). Global assessment of agricultural system redesign for sustainable intensification. *Nature Sustainability*, 1(8), 441–446.
- Sharma, R., Singh, R. K., & Kumar, P. (2019). Risk perception and adoption of sustainable agricultural practices among farmers in India. *Indian Journal of Extension Education*, 55(3), 56–63.
- Singh, R., Sharma, P., & Devi, S. (2017). Role of farmer field schools in dissemination of organic farming practices. *Journal of Community Mobilization and Sustainable Development*, 12(2), 172–178.
- Suresh Kumar, K., & Somasundaram, J. (2019). Capacity building approaches for promoting sustainable agriculture: Lessons from extension interventions. *Journal of Agricultural Extension Management*, 20(2), 25–36.

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RESEARCH ARTICLE**Correlates of Adoption Components of Wadi Project by the Tribal Beneficiaries****R. P. Khule¹, G. K. Waman² and A. B. Gaikwad³**

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ABSTRACT

The Wadi project mainly involves development of orchard (locally known as Wadi) on degraded lands. Mango, Cashew, Guava, Custard apple, Aonla, Lemon, Sapota and Drumstick were the major fruit crops that are cultivated by the tribal through WADI project. The present study was examined the adoption components of Wadi project and the relationship between profile and adoption components of Wadi project among tribal beneficiaries. The study was conducted in Navsari, Valsad and the Dangs districts purposively because the Wadi project was started in 1982 in these three districts with maximum number of beneficiaries of the project. The proportionate random sampling method was used for selection of 200 tribal beneficiaries. The tribal beneficiaries possessed medium to high extent of adoption components of Wadi project. The component availability of land was come out as the most adopted, followed by raising of forestry plants and women development, respectively. While, health programme was perceived as the last adopted components of Wadi project. The correlation analysis of the beneficiaries was revealed that the variables viz. education, annual income, source of information, social participation, risk orientation, economic motivation, scientific orientation, extension contact, innovativeness, aspiration, cohesiveness, management orientation, communication skill and distance from market were found highly significant association with adoption components of Wadi project by tribal beneficiaries. Further, land holding, farming experience, occupations were significantly associated with the adoption components of Wadi project by the tribal beneficiaries.

Key words: Correlation, Adoption components, Wadi project, Tribal beneficiaries.

INTRODUCTION

The Wadi project mainly involves development of orchard (locally known as Wadi) on degraded lands. Mango, Cashew, Guava, Custard apple, Aonla, Lemon, Sapota and Drumstick were the major fruit crops cultivated by the tribal through Wadi project. Wadi is a comprehensive project for improving living standards and socio-economic condition of tribal families in remote areas. Acceptance of new idea was not a unit act but a complex process which involves a series of thoughts and actions. In other words, it was known as mental process through which an individual passes from first hearing about an innovation to final adoption. The components of Wadi project so far developed in recent has been for increasing the

agriculture and horticulture production and productivity hence, it requires proper adoption by the tribal beneficiaries for production. Unless the components of Wadi project were properly adopted to larger extent by the tribal beneficiaries, the desired target cannot be achieved. In view of this, the present investigation was planned with the following specific objectives.

OBJECTIVES OF STUDY

1. Extent of adoption of components of Wadi project.
2. To study component wise adoption of Wadi project by the tribal beneficiaries.
3. To study relationship between profile of the tribal beneficiaries with there adoption components.

METHODOLOGY

The present study was examined the socio-economic consequences occurred among beneficiaries as a result of Wadi project. The study was conducted in Navsari, Valsad and the Dangs districts purposively because the Wadi project was started in 1982 in these three districts with maximum number of beneficiaries of the project. A list of all tribal beneficiaries of Wadi project were collected from the BAIF-DHRUVA office of Village Lachhakadi, P.O.Gangpur, Tal.Vansda, Dist. Navsari, State.Gujarat. The proportionate random sampling method was used for selection of 200 tribal beneficiaries from the 55 villages of 4 talukas of three districts of South Gujarat for the present investigation. The questionnaire developed on the components of Wadi project was administered to the same selected tribal beneficiaries. The collected data were analyzed by using statistical tools and method for analysis viz., percentage, mean, standard deviation, correlation coefficient (r).

RESULTS AND DISCUSSION

Extent of adoption of components of Wadi project

The data depicted in Table-1 reveals that majority (77.00 per cent) of the tribal

beneficiaries had medium extent of adoption regarding components of Wadi project, followed by 15.00 and 08.00 per cent had low and high extent of adoption respectively. In general, data showed that the majority (85.00 %) of tribal beneficiaries possessed medium to high extent of adoption. This infers that scientific information about the Wadi crops and various extension methods had motivated and enhance them for adoption of the components of the Wadi project.

Table 1: Distribution of tribal beneficiaries according to their extent of adoption

(n=200)

S.N.	Extent of adoption	Frequency	Percentage
1.	Low extent of adoption	30	15.00
2.	Medium extent of adoption	154	77.00
3.	High extent of adoption	16	08.00
	Total	200	100.00

Component wise adoption of Wadi project by the tribal beneficiaries

The data presented in Table 2 revealed

Table 2: Component wise adoption of Wadi project by the tribal beneficiaries

(n=200)

S.N.	Components of Wadi project	Average score of adoption	Maximum score	Adoption (%)	Aspect wise rank
1.	Availability of land	5.805	6.00	96.75	I
2.	Raising of fruit crops	40.800	48.00	85.00	IV
3.	Raising of forestry plants	5.595	6.00	93.25	II
4.	Fencing	7.280	9.00	80.89	VI
5.	Water resource development	4.585	6.00	76.41	X
6.	Soil conservation measures	7.425	9.00	82.50	V
7.	Health programme	4.440	6.00	74.00	XII
8.	Women development	10.240	12.00	85.33	III
9.	Support to landless	4.585	6.00	76.42	IX
10.	Processing	4.590	6.00	76.50	VIII
11.	Marketing	4.555	6.00	75.92	XI
12.	Peoples organizations	7.055	9.00	78.39	VII
	Average	8.912	-	81.78	

that adoption found in respect of availability of land was 96.75 per cent falling in first rank, followed by raising of forestry plants (93.25 per cent) and women development (85.33 per cent) were having second and third rank respectively. The health programme fall in to the last rank having 74.00 per cent adoption. The average adoption of all the 12 components of Wadi project was 81.78 per cent.

It could be inferred from above discussion that the component availability of land was come out as the most adopted, followed by raising of forestry plants and women development, respectively. While, health programme was perceived as the last adopted component of Wadi project. The probable reason may be that the tribal beneficiaries might have understood and realized the importance of availability of land for adoption of Wadi project. The reason of least adoption of health programme might be due to unable to aware about the importance of the health programme.

Relationship between profile of the tribal beneficiaries and adoption components of Wadi project

The data evident in Table - 3 revealed that the education (0.194**), annual income (0.182**), source of information (0.224**), social participation (0.304**), risk orientation (0.359**), economic motivation (0.331**), scientific orientation (0.434**), extension contact (0.233**), innovativeness (0.229**), aspiration (0.431**), cohesiveness (0.673**), management orientation (0.593**), communication skill (0.695**), distance from market (0.554**) found highly significant association with adoption components of Wadi project by the tribal beneficiaries. Further, the land holding (0.147*), farming experience (0.146*), occupation (0.142*) were significantly associated with the adoption components of Wadi project by the tribal beneficiaries. The age (-0.411**) were negative highly significant association with the adoption components of Wadi project by the tribal

beneficiaries. On the other hand, family size (0.0495^{NS}), training acquired (0.0435^{NS}) were non-significant association with the adoption components of Wadi project by the tribal beneficiaries.

Table 3: Relationship between profile of the tribal beneficiaries and adoption components of Wadi project

(n=200)

S.N.	Independent variable	Adoption ('r' value)
1.	Age	-0.411**
2.	Education	0.194**
3.	Family size	0.0495 ^{NS}
4.	Land holding	0.147*
5.	Farming experience	0.146*
6.	Occupation	0.142*
7.	Annual income	0.182**
8.	Source of information	0.224**
9.	Social participation	0.304**
10.	Risk orientation	0.359**
11.	Economic motivation	0.331**
12.	Scientific orientation	0.434**
13.	Extension contact	0.233**
14.	Innovativeness	0.229**
15.	Training acquired	0.0435 ^{NS}
16.	Aspiration	0.431**
17.	Cohesiveness	0.673**
18.	Management orientation	0.593**
19.	Communication skill	0.695**
20.	Distance from market	0.554**

* Significant at 5 per cent ** Significant at 1 % ^{NS} Non significant

CONCLUSION

The results of present study revealed that the tribal beneficiaries possessed medium to high extent of adoption components of Wadi project. The component availability of land was come out as the most adopted, followed by raising of forestry plants and women development, respectively. While, health programme was perceived as the last adopted

components of Wadi project. The education, annual income, source of information, social participation, risk orientation, economic motivation, scientific orientation, extension contact, innovativeness, aspiration, cohesiveness, management orientation, communication skill and distance from market were found highly significant association with adoption components of Wadi project by the tribal beneficiaries. Further the land holding, farming experience, occupations was significantly associated with the adoption components of Wadi project by the tribal beneficiaries.

REFERENCES

- Sasane, G.K., Khule, R.P. and Jagdale, U.D. (2009). Knowledge and Adoption of Sugarcane Water Management Practices by the Farmers. Asian Journal of Extension Education, 27, 141-145.
- Sasane, G.K., Khule, R.P. & Jagdale, U.D. (2010). Knowledge and Adoption of Food Grain Storage Practices of the Farmers. Asian Journal of Extension Education, 28, 92-95.
- Sasane G.K., U.D.Jagdale. and R.P.Khule (2010), Knowledge and adoption of Brinjal management practices by the farmers. Agriculture Update, 5, (3&4),495-497.
- Khule, R.P., Lanjewar, D.M., Jagdale, U.D. & Sasane, G.K. (2011). Adoption of low cost crop cultivation technology by the paddy growers. Agriculture Update, 6 (1), 51-52.
- Khule, R.P., G.R.Patel and R.D.Pandya (2018), Profile of the tribal beneficiaries about Wadi project. International journal of Chemical studies, 6(2), 268-270.
- Khule, R.P., G.R.Patel and G.K.Waman (2019), Socio-economic consequences occurred among tribal beneficiaries as a result of Wadi project. Gujarat journal of Extension Education Special Issue, 150-152.

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RESEARCH ARTICLE

Constraints faced By Pigeon Pea Growers and Invite the Suggestion from Pigeon Pea Growers to Overcome the Adoption Gap¹Neha D. Katenge and ²N. R. Koshti¹M.Sc. Student, Department of Agricultural Extension Education, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India²Professor and Head, Department of Agricultural Extension Education, Dr. PDKV, Akola, MS

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ABSTRACT

The present study was conducted in Akola district of Maharashtra state using an exploratory research design. Pigeon pea plays a vital role in the agrarian economy and nutrition of rural India. A total of 120 pigeon pea growers were selected through random sampling. Data were collected using a structured interview schedule and analyzed using frequency and percentage methods. The present study was undertaken in Akola with the objective to identify the constraints faced by pigeon pea growers in adopting the recommended practices and to document their practical suggestions for bridging the adoption gap. Despite the availability of recommended cultivation practices, a significant adoption gap still persists, contributing to lower productivity. The findings revealed several key constraints including non-availability of compost/FYM (80.00%), lack of information about seed treatment (65.00%), high cost of inputs (62.50%), and weather uncertainty (61.67%). Other constraints included limited access to bio-fertilizers, labour shortage during harvest and damage by wild animals. In response, farmers suggested several practical measures such as organizing demonstrations on pest and disease management, ensuring low-cost availability of bio-fertilizers, and increasing awareness through training programs and extension activities. These insights highlight the need for a comprehensive and participatory extension approach to bridge the adoption gap and enhance pigeon pea productivity.

Keywords: Constraints, suggestions, recommended cultivation practices**INTRODUCTION**

Pigeon pea (*Cajanus cajan*) is one of the major pulse crops cultivated in India, particularly in rainfed areas, and serves as an essential source of protein for a large section of the rural population. Despite the availability of improved production technologies and government support, there exists a considerable gap between recommended practices and what is actually adopted by farmers. This adoption gap has been identified as a significant reason for low productivity in pigeon pea cultivation.

Many farmers face numerous constraints while adopting recommended practices, ranging from lack of technical knowledge, high input costs, and unavailability of quality inputs, unfavorable climatic

conditions, to infrastructural and socio-economic limitations. Identifying these constraints is crucial for designing effective extension interventions. Moreover, understanding the farmers' own suggestions provides practical and context-specific insights for enhancing adoption.

Hence, this study was undertaken to identify the constraints experienced by pigeon pea growers in adopting recommended practices and to collect suggestions from them to overcome these constraints, with the aim of bridging the adoption and yield gaps.

The present study was framed with objective

1. To study the constraints faced by pigeon pea growers and invite the suggestion from

Table 1: Distribution of respondents according to the constraints by them adoption of recommended practices pigeon pea cultivation

S.N.	Constraints	Respondents (n=120)	
		Frequency	Percentage
1	Lack of information regarding seed treatment	78	65.00
2	Non-availability of bio-fertilizer and fungicide for seed treatment in rural area in low cost.	80	66.67
3	High cost of inputs (seed, fertilizer, insecticide)	75	62.50
4	Non-availability of compost / FYM	96	80.00
5	Crop damaged by wild animals	62	51.67
6	Weather uncertainty (unseasonal rains, drought)	74	61.67
7	Non-availability of protective irrigation facility	58	48.33
8	Non-availability of spraying equipment on hired basis	38	31.67
9	Non-availability of labour at the time of harvesting	40	33.33

pigeon pea growers to overcome the adoption gap.

METHODOLOGY

An exploratory research design of social research was used in the present investigation. The sample was drawn from Akola taluka of Akola district of Maharashtra state, on the basis of having the highest area under pigeon pea cultivation. The study aimed to understand the constraints faced by the respondents in adopting recommended practices of pigeon pea cultivation and also to record their suggestions for improving adoption levels. Total 6 villages were selected purposively from Akola taluka and 20 farmers were drawn from each village thus in total 120 farmers constituted the sample size for the study. Data were collected through **personal interviews** using a **pre-tested and structured interview schedule**. The collected data were tabulated and analyzed using appropriate statistical tools such as **mean, percentage, and standard deviation** for drawing meaningful interpretations and conclusions.

RESULT AND DISCUSSION

Constraints faced by the pigeon pea growers in the use of recommended practices of pigeon pea cultivation

To study the constraints faced by the pigeon pea growers in adoption of recommended practices

of pigeon pea was one of the objectives of the present study. The constraints are the circumstances which prohibit the pigeon pea growers in adoption of recommended practices of pigeon pea crop. The data relating to constraints faced by the pigeon pea growers in adoption of recommended cultivation practices are shown practice wise in Table 1.

The study from Table 1, that revealed several critical factors contributing to the adoption gap in pigeon pea cultivation. A significant proportion of respondents 80.00 per cent reported the non-availability of compost or farmyard manure (FYM) as a major constraint, which negatively affected soil fertility and overall crop productivity. The non-availability of bio-fertilizers and fungicides for seed treatment at low cost in rural areas was reported by 66.67 per cent of respondents, while lack of information regarding seed treatment affected 65.00 per cent, indicating a low level of awareness about essential pre-sowing practices.

Additionally, high cost of inputs such as seeds, fertilizers, and insecticides was a concern for 62.50 per cent of farmers, and weather uncertainty including unseasonal rains and droughts impacted 61.67 per cent, emphasizing the vulnerability of pigeon pea to climatic variability. The issue of crop damage by wild animals was raised by 51.67 per cent of respondents, further contributing to yield

Table 2: Suggestions given by pigeon pea growers while adoption of recommended cultivation practices.

S.N.	Suggestions	Respondents (n=120)	
		Frequency	Percentage
1	Demonstration on pest and disease management.	70	58.33
2	Provided information to farmers about scientific method of seed treatment	80	66.66
3	Availability of Bio-fertilizers for seed treatment on local market at low cost	78	65.00
4	Protection of crop against wild animal	62	51.66
5	Awareness about improved varieties	52	43.33
6	Organization of more trainings on new improved technologies	45	37.50

reduction. Infrastructure-related challenges included non-availability of irrigation facilities 48.30 per cent and lack of spraying equipment on a hired basis 31.67 per cent, both of which limit the timely and efficient application of crop protection measures. Lastly, labour shortages during the harvesting period were reported by 33.33 per cent of farmers, which can delay harvesting and lead to post-harvest losses. These findings collectively highlight the multifaceted nature of the yield gap and the need for a holistic strategy that includes technological support, extension services, input supply, and policy-level interventions.

Suggestions given by pigeon pea farmers while adoption of recommended cultivation practices

To study the suggestions offered by the pigeon pea growers for overcoming the adoption gap in recommended practices of pigeon pea cultivation was one of the important objectives of the present study. Suggestions are the practical recommendations or solutions provided by the farmers based on their experiences, which can help in enhancing adoption and productivity. The data regarding suggestions given by the pigeon pea growers to minimize the adoption gap and yield gap in pigeon pea cultivation are presented in Table 2.

Based on the findings of the present study, several practical suggestions were

proposed by pigeon pea growers to minimize the yield gap and improve productivity. A majority of farmers (66.66%) emphasized the importance of providing information on scientific methods of seed treatment, highlighting the need for better awareness and training in this area. Similarly, availability of bio-fertilizers for seed treatment in the local market at low cost was suggested by 65.00% of the respondents, indicating that access to affordable and quality inputs is a major concern.

Demonstration on pest and disease management was recommended by 58.33% of the farmers as an effective strategy to control pest and disease outbreaks, which are major limiting factors in pigeon pea cultivation. The issue of crop damage by wild animals was raised by 51.66% of respondents, calling for protective measures such as fencing and community-level monitoring. Additionally, 43.33% of the respondents stressed the need to increase awareness about improved pigeon pea varieties, while 37.50% advocated for the organization of more training programs on new and improved agricultural technologies.

These suggestions reflect the ground-level needs and practical experiences of farmers and, if implemented through coordinated efforts by extension agencies, research institutions, and government bodies, they can significantly contribute to narrowing the yield gap in pigeon pea cultivation.

CONCLUSION

The study revealed that pigeon pea growers in Akola district face several interrelated constraints that hinder the adoption of recommended cultivation practices. Among the most prominent were non-availability of compost/FYM, lack of information and resources for seed treatment, high input costs, and challenges such as wild animal attacks and weather uncertainties. These issues contribute significantly to the existing adoption and yield gap. However, the suggestions provided by farmers, such as better access to bio-fertilizers, demonstrations on pest and disease management, improved awareness of seed treatment techniques, and increased training programs, offer practical solutions grounded in local realities. Addressing these issues through effective extension services, timely input supply, and supportive policy measures can substantially improve the adoption level of recommended practices and thereby it minimize adoption gap and enhance pigeon pea productivity.

REFERENCES

- Bodhwad R.B. Adoption gap of production practices followed by chickpea growers. M.Sc. (Agri.) Thesis (Unpub.). Mahatma Phule Krishi Vidyapeeth, Rahuri; 2021
- Hingne B.N. Adoption gap in recommended package of practices of soybean. M.Sc. (Agri.) Thesis (Unpub.). Dr. PDKV, Akola, Maharashtra; 2016.
- Shrikrishana, K. R. Technological gap in Pigeon pea Production Technology. M.Sc. Thesis (Unpub). Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani; 2015.
- Tembhurne RD. Technological gap in integrated pest management practices of pigeon pea by the farmers. M.Sc. (Agri.) Thesis (Unpub). Dr. PDKV, Akola; 2016.
- Yadav P., Pandey P.K., Khan M.A., Sharma M.L. Extent of knowledge, adoption and existing gap regarding recommended pigeon pea production practices among the farmers of Raipur District in Chhattisgarh. *Frontiers in Crop Improvement*. 2021; 9(Special Issue II): 960–963.

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RESEARCH ARTICLE

Socio-economic Characteristics and Constraints of HDP under Indo-Israel Production Technology and Conventional method of Nagpur Mandarin cultivation in Amravati district of Maharashtra

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ABSTRACT

This study compares the socio-economic characteristics and production constraints of Nagpur mandarin growers using Indo-Israel technology and conventional farming methods in the Amravati district of Maharashtra. Data were collected from 90 farmers, comprising 30 Indo-Israel technology adopters and 60 conventional farmers. The analysis revealed that Indo-Israel farmers tend to be older, with 60 per cent over the age of 50, and better educated, with 30 per cent having completed graduation, compared to only 6.67 per cent in the conventional group. Indo-Israel farmers also possess larger landholdings, with 33.33 per cent owning more than 4 hectares, compared to 18.33 per cent of conventional farmers. Both groups predominantly consist of small, nuclear families. However, significant differences were observed in the constraints they face. Indo-Israel farmers reported high initial investment, trader monopolies, and a shortage of skilled labor as major challenges. Conversely, conventional farmers primarily struggled with fruit drop, trader monopolies, and high initial investments, along with issues related to electricity supply and input costs. These findings highlight the distinct challenges faced by farmers using different production methods, suggesting the need for tailored strategies to improve productivity and address specific issues in each group.

Key words: Nagpur mandarin, Growers, High density planting, Indo-Israel Technology, Conventional method and Constraints.

INTRODUCTION

Mandarins (*Citrus reticulata* Blanco) are easily peel able fruits and segments are conveniently consumed by hands. Among citrus group, mandarins contribute to the second largest production (26%) after sweet oranges (56%) in the world citrus basket. Out of total 12.51 million tons of citrus production in India, mandarins constitutes 5.27 million metric tons from 0.42 million ha area and ranks the first among the citrus fruits grown in the country. The average national productivity of mandarins in India is 12.54 tons /ha, which is fairly low as compared to many advanced mandarin growing countries. Mandarin cultivation is popular among citrus growers due to its constant demand

in the domestic market and easy adaptability to varied agro-climatic conditions. Among mandarins, “Nagpuri” or “Nagpur” mandarin is cherished for its unique thirst quenching sweet and sour taste. The Vidarbha region of Maharashtra (a major pocket of Nagpur mandarin in Maharashtra) and adjoining parts of Madhya Pradesh and Rajasthan (Jhalawar district) have more or less similar agro-climatic conditions and hence cultivation of this mandarin cultivar is blooming and expanding in these areas.

Mandarin oranges are thought to have originated in the tropical and subtropical regions of Asia, such as southern Asia, the Philippines, South China, and Japan, and possibly Vietnam.

The origin story of Nagpur orange farming in this area is more fascinating. Nagpur orange was successfully tried as a kitchen garden plant for the first time by Late Shri Raghujiiraje Bhonsle in 1896. Since that time, orange production has grown steadily each year, becoming one of the most lucrative prospective foreign exchange-earning crops in this area. After mango and banana, Nagpur oranges are one of the national horticultural crops.

The Amravati district of Maharashtra contribute about 48.88 per cent (70,836 ha). Amravati district occupies 37.36 per cent (5,95,223 tons) share in the Vidarbha citrus market. The fruit available from September to December is Ambia, which has a slightly sour taste. The sweeter Mrig crop follows this in February. Hence Nagpur mandarin enjoys favorable climatic conditions to provide bulk production twice a year.

The low productivity of mandarins in these regions is primarily attributed to senile old orchards, conventional wide spacing (6×6 m) and poor orchard management. This scenario demands innovative horticultural practices to get high and early return for investments, particularly in initial years of orchard establishment. Often due to wide spacing and low canopy volume, the spacing of 6×6 m fails to harness the available land during the initial phases of orchard development. This has given the thrust to evaluate the concept of high-density planting that is 6×3 m for increasing the production and returns per unit area. It is the concept of HDP to exploit vertical and horizontal cropping area, to reap maximum profit against invested inputs and natural resources. The HDP only provide initial high production and net returns, especially during first 10–15 years, but also facilitate efficient use of fertilizers, irrigation and other inputs. The main advantages of these intensive systems of cropping are precocity, low cost per unit production, possibility of higher mechanization, automation as in Fertigation with higher input use efficiency. In commercial plantations,

mostly smaller canopies are obtained either by using dwarfing rootstocks or by training and pruning (canopy management practices). Farmers are facing certain challenges due to the recent adoption of HDP (High-Density Planting) technology. Therefore, this study aims to examine the socioeconomic characteristics of the farmers and the associated constraints.

MATERIAL AND METHODS

The present study was conducted in Amravati district of Vidharbha region of Maharashtra. The primary data were collected from selected farmers by survey method with personal interview through a specially designed schedule and pertain to the year 2023-24. The multistage random sampling technique was followed to select (30) HDP under Indo-Israel production technology and (60) Conventional orchards, with the total of 90 respondents were selected from two villages in each three tahsil of Amravati district namely Achalpur, Morshi and Warud.

Statistical analysis

The data collected was processed, quantified, categorized and tabulated. The constraints of mandarin growers will be analyzed by using Garrett's Ranking Technique. The Garrett's ranking technique (Garrett and Woodworth, 1969) is used for examination of constraints. It is important to note here that these constraints are focused on the response of all the sample farmers. The respondents are asked to rank the constraints in mandarin production. In the Garrett's ranking technique, these ranks are converted into percent position by using the formula:

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

Where,

R_{ij} = Ranking given to the i^{th} attribute by the j^{th} individual

N_j = Number of attributes ranked by the j^{th} individual

RESULTS AND DISCUSSION

Socio-economic characteristics of selected Nagpur mandarin growers

The socio-economic characters of the respondents are one of the most important measures to know the present condition of the farm living and for future planning and development. For example, the size of the family has major influence on the supply of labour to the farm and as well as the consumption needs of the family. The level of education of the respondent has a serious effect on the cultivator's response to improved technology. Hence the various socio-economic aspects have been recorded and analyzed under the present study in Table 1.

Age

The age distribution shows significant differences between the two groups. In the Indo-Israel Technology group, 60 per cent of farmers are older than 50 years, whereas only 21.67 per cent of the Conventional farmers belong to this age group. On the other hand, younger farmers (under 35) make up 13.33 per cent of the Indo-Israel group, while 36.67 per cent of the Conventional farmers are in this category. Middle-aged farmers (36-50) represent 26.67 per cent of the Indo-Israel group and 41.67 per cent of the Conventional group. This indicates that the Indo-Israel Technology group has a significantly older farming population compared to the Conventional group, which has a higher percentage of young and middle-aged farmers.

Educational Status

Education levels differ notably between the two groups. The Indo-Israel Technology farmers show higher education levels, with 30 per cent having completed graduation or above, compared to only 6.67 per cent of the Conventional farmers. A higher percentage of Conventional farmers (33.33%) have education limited to high school (8-10), while 16.67 per cent of Indo-Israel farmers fall into this category. Moreover, 40 per cent of Indo-Israel farmers

have completed higher secondary education (11-12), slightly more than the 36.67 per cent in the Conventional group. Additionally, 3.33 per cent of Indo-Israel farmers and 6.67 per cent of Conventional farmers only have primary education (1-4), and there are no illiterate farmers in the Indo-Israel group, compared to 3.33 per cent in the Conventional group. Overall, Indo-Israel Technology farmers are better educated, with a larger proportion holding higher education qualifications.

Landholding

Farm size is another area of contrast. In the Indo-Israel Technology group, 33.33 per cent of farmers have large landholdings (more than 4 hectares), compared to 18.33 per cent of the Conventional group. A majority of Indo-Israel farmers (53.33%) have medium-sized landholdings (2.01 to 4 hectares), while 41.67 per cent of Conventional farmers fall into this category. Conversely, 40 per cent of Conventional farmers have small landholdings (less than 2 hectares), which is significantly higher than the 13.33 per cent in the Indo-Israel group. This indicates that farmers using Indo-Israel Technology tend to own larger plots of land than their Conventional counterparts.

Size of Family

Both groups largely consist of farmers with small family sizes (1-4 members). In the Indo-Israel Technology group, 70 per cent have small families, while in the Conventional group, 73.33 per cent fall into this category. The remaining 30 per cent of Indo-Israel farmers and 26.67 per cent of Conventional farmers have medium-sized families (5-10 members). This suggests that family size distribution is fairly similar across both groups, with a slight majority favoring smaller families.

Type of Family

In terms of family structure, nuclear families are more common in both groups. Among Indo-Israel Technology farmers, 73.33 per cent live in nuclear families, and 26.67 per cent live in joint families. In the Conventional group, 76.67 per cent live in nuclear families,

while 23.33 per cent belong to joint families. While nuclear families dominate in both cases, the Indo-Israel group has a slightly higher proportion of joint families than the Conventional group.

Table 1. Socio-economic characteristics of selected Nagpur mandarin growers

S. N.	Particulars	Indo-Israel Technology	Conventional
A. Age			
1	Young(<35)	4 (13.33)	22 (36.67)
2	Middle(36-50)	8 (26.67)	25 (41.67)
3	Old(>50)	18 (60.00)	13 (21.67)
	Total	30 (100.00)	60 (100.00)
B. Educational status			
1	Illiterate	-	2 (3.33)
2	Primary (1 - 4)	1 (3.33)	4 (6.67)
3	Middle school (5 - 7)	3 (10.00)	8 (13.33)
4	High school (8 - 10)	5 (16.67)	20 (33.33)
5	Higher Secondary (11 - 12)	12 (40.00)	22 (36.67)
6	Graduation and above	9 (30.00)	4 (6.67)
	Total	30 (100.00)	60 (100.00)
C. Land holding			
1	Small (Less than 2 ha)	4 (13.33)	24 (40.00)
2	Medium (2.01 to 4.00 ha)	16 (53.33)	25 (41.67)
3	Large (4.01 & above)	10 (33.33)	11 (18.33)
	Total	30 (100.00)	60 (100.00)
D. Size of family			
1	Small (1 - 4)	21 (70.00)	44 (73.33)
2	Medium (5 - 10)	9 (30.00)	16 (26.67)
	Total	30 (100.00)	60 (100.00)

E.	Type of family		
1	Joint family	8 (26.67)	14 (23.33)
2	Nuclear family	22 (73.33)	46 (76.67)
	Total	30 (100.00)	60 (100.00)

(Figure in parenthesis indicates the percentage to total)

Constraints faced by Nagpur mandarin growers

All the selected farmers of HDP in Nagpur mandarin under Indo-Israel production technology and conventional methods were interviewed for the problems they are facing in producing Nagpur mandarin. The information regarding the important problems faced by the farmers is presented in Table 2.

The table 2 presents the constraints faced by Nagpur mandarin growers using Indo-Israel technology and conventional methods, ranked according to their severity based on Garret scores. For growers using Indo-Israel technology, the most significant constraint is the high initial investment, with a Garret score of 96.21, ranked first. This is followed closely by the monopoly of traders (95.32), ranked second, and the non-availability of skilled labour during peak seasons (73.20), ranked third. Other notable challenges include the non-availability of quality planting materials (68.39), ranked fourth, and fruit drop (63.88), ranked fifth. Less critical issues include insufficient electricity supply (52.81), demand for high labour wages (48.79), insect pest attacks (46.11), and water scarcity (44.23). The least concerning problems are lack of technical support (38.72), high cost of inputs (34.12), and wild animal and bird attacks (29.67).

For growers using conventional methods, the most pressing issue is fruit drop, with a Garret score of 67.79, ranked first. The monopoly of traders follows this, scoring 60.23 and ranked second, with high initial investment (58.65) ranked third. Other significant challenges include insufficient electricity supply

Table 2. Constraints faced by Nagpur mandarin growers

S.N.	Constraints	Indo-Israel Technology		Conventional	
		Garret score (per cent)	Ranking	Garret score (per cent)	Ranking
1	High Initial investment	96.21	I	58.65	III
2	Monopoly of traders	95.32	II	60.23	II
3	fruit drop	63.88	V	67.79	I
4	Non availability of quality planting materials	68.39	IV	55.18	V
5	Non availability of skilled labour during peak season	73.20	III	37.95	VIII
6	Insect pest attack	46.11	VIII	36.51	IX
7	Demand of high labour wages	48.79	VII	35.26	X
8	Insufficient Electricity supply	52.81	VI	56.16	IV
9	Water scarcity	44.23	IX	32.82	XI
10	Rodents, birds attack	29.67	XII	25.95	XII
11	High cost of inputs	34.12	XI	48.12	VI
12	Lack of technical support	38.72	X	44.32	VII

(56.16), non-availability of quality planting materials (55.18), and the high cost of inputs (48.12). Lesser concerns include lack of technical support (44.32), non-availability of skilled labour (37.95), insect pest attacks (36.51), and demand for high labour wages (35.26). The least problematic issues for conventional growers are water scarcity (32.82) and wild animal and bird attacks (25.95).

CONCLUSION

The socio-economic analysis of Nagpur mandarin growers reveals notable differences between those using Indo-Israel technology and those employing conventional farming methods. Farmers adopting Indo-Israel technology tend to be older and more educated, with 60 per cent over the age of 50 and 30 per cent holding graduation degrees, compared to the younger and less educated conventional farmers, where only 6.67 per cent have higher education. Landholding size also varies, with Indo-Israel farmers more likely to own larger land, while conventional farmers tend to own smaller lands. Despite similarities in family size and structure, both groups largely consist of small, nuclear

families. However, the constraints they face differ significantly. Indo-Israel farmers' primary challenges include high initial investments, the monopoly of traders, and a shortage of skilled labour during peak seasons, reflecting the advanced technology and infrastructure demands of their HDP method. Conventional farmers, on the other hand, struggle most with fruit drop, trader monopolies, and high initial investments, alongside issues like electricity shortages and input costs. Overall, Indo-Israel farmers are better educated and operate larger farms but face higher costs and labor-related problems, while conventional farmers encounter a broader range of financial and operational challenges on smaller, less technologically advanced farms. Understanding these socio-economic factors and constraints can help shape future development strategies to support the distinct needs of both groups.

REFERENCES

- Anil Bhat, Jyoti Kachroo, Manish Sharma and Rajinder Peshin. 2015. Constraints in Production and Marketing of Citrus Fruit in Jammu region of J&K State. Economic affairs, paper No. 231

- Anita Deshmukh, Sonam Agrawal and Venkateshwar Jallaph (2021) Constraints faced by orange growers about production and marketing orange. International Journal of Agriculture, Environment and Biotechnology citation: IJAEB: 14(1): 11-16, March.
- Bante R, Pallear S and Shrey R. 2015. Economics of orange production in Nagpur district of Maharashtra. International Research Journal of Agricultural Economics and Statistics 6:136-139.
- Bachhav, N. B., 2020. Economics of Pomogranate Fruit Production in Drought Prone Region of Nashi district. JETIR Vol.7, Issue 3.
- Bhong, M. S., S. R. Nagargoje and R. D. Shelke. 2019. Cost, Returns and profitability of Ber Production in Solapur District of Maharashtra, India. Int. J. Curr. Microbiol. App. Sci. Vol. 5, No. 05.
- Deorukhar, A. C., M. B. Nikam and M. M. Gawas, 2007. Economic analysis of kokum fruit products in Sindhurg, India. Internat. J. Agric. Sci., Vol. 3.
- Hiwarale AS, Manvar VS, Gohade GR, Hadollikar SB and Vaidya NG. 2022. Constraints faced by sweet orange growers in adoption of recommended cultivation practices of sweet orange. The Pharma Innovation Journal 2023; 12(1): 1448-1449.
- R.M. Jadhav, J.S. Gaikwad, B. Suvarna Todmal And B. Kranti Torawane. 2011. Constraints faced by orange growers in adoption of orange rootstock. Agriculture Update | Vol. 6 | Issue (3&4) | Aug. & Nov., 2011 | 97-98 |
- Rupesh Jain, Ramesh Pandey and Neeraj. 2022. Garrett's ranking analysis for constraints faced by dairy farmers in adoption of improved dairy husbandry practices in Datia district of Madhya Pradesh. The Pharma Innovation Journal 2022; SP-11(9): 2911-2915
- Sangeeta Bhattacharyya, A. Thirugnanavel, Arindam Nag, Subhra Saikat Roy and Pinaki Roy. 2024. Citrus Farming in the Vidarbha Region of Maharashtra: An Analysis of Present Status and Grassroot Constraints. Journal of Community Mobilization and Sustainable Development. Vol. 19(2), April-June 2024, 387-395
- Shukla, K., Pandey, G. K., Kumari, M. V., Vanam, A., & Singh, N. (2019). Constraints analysis in onion marketing faced by market intermediaries in Nashik district of Maharashtra. Journal of Pharmacognosy and Phytochemistry, 8(2), 1532-1534.

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RESEARCH ARTICLE

ICT Devices and Agricultural Marketing in Dibrugarh District – A Study Using One-Way ANOVA

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ABSTRACT

Agriculture is an important economic driver, employing more than half of the workforce of Assam. The State Gross Domestic Product is based on the agriculture sector, which is essential to development. Because it only depends on agricultural income from a variety of crops, the Dibrugarh District of Assam was chosen for the study. But in this technological era, agriculture's place in the economy and farmers' financial circumstances are not what they should be. The purpose of this study is to analyse the utilization of technology services in agricultural marketing. This study seeks to throw light on how agricultural marketing uses technological services. It is found that only 48% farmers have knowledge about ICT devices for agricultural marketing and out of them only 31% farmers of the study are have utilized these devices for agricultural marketing. According to the study, if ICT devices and initiatives are implemented correctly and on time, they can transform farmers' lives and bring about the much-needed revolutionary change in the agricultural sector, which will undoubtedly advance our nation's agricultural development. Of course, more training and awareness programmes are to be conducted to transmit the knowledge of ICT and its utilization.

Keywords: Agriculture Marketing, ICT based services, agricultural Development, farmers' income.

INTRODUCTION

Since the beginning of civilization, most Indians have made agriculture their main source of income, whether in ancient India, British India, or modern India. Almost 60 % of the world's population makes their living from agriculture, which ranks second in terms of farm output. It is small-holder farming's primary purpose. They guide small and marginal farmers to address the problems and become the focal point of the green revolution due to the agriculture sector's enormous growth. Farmers' ability to improve their earnings is hampered by a number of issues, including government regulations, the availability of resources, marketplaces for their goods, and other institutional services. They face numerous challenges in making the most of crop output and profits. The majority of farmers are not receiving high-end yields in spite of successful research on new agricultural techniques for a variety of reasons. One of them is that the farming

community is not receiving timely competent scientific advice on crop productivity and sales. However, the use of ICT in agriculture allows for the timely and economical distribution of necessary information.

Review of Literature

The effectiveness of India's agricultural output marketing has been a major source of worry in recent years. It is thought that inadequate marketing infrastructure and poor marketing channel connectivity are to blame for the high and erratic consumer pricing as well as the fact that farmers only receive a small percentage of the consumer rupee. Reviewing the body of literature in the relevant discipline is a crucial step in every research.

Due to the widespread availability of mobile phones among geographically dispersed users from a variety of socioeconomic backgrounds, mobile phone-enabled services offer opportunities to extend the reach of agricultural services to the poorest and

marginalized (Okello et al., 2010). However, based on the scant data gathered thus far, the poorest and marginalized are less likely to benefit from ICTs due to lower income and education levels as well as social imbalances, such as gender inequality.

Hemmer and Heinzl (2012) found that the choice and utilization of a suitable information channel are influenced by the information seeker's dispositional personality factors, including age, location and income. According to Litondo and Ntale (2013), the primary factor influencing people ICT devices usage is education level, which also affects strategic decisions. The researcher said that mobile usage in business is significantly impacted by the educational attainment. Information channel utilization is also influenced by the cost of information sourcing. Williamson (1975) argues in his Transaction Cost Theory that networks are more affordable ways to obtain information. Morris (1998) emphasizes how crucial market information is to the survival of businesses by facilitating wise market choices. According to Kizito (2009), market data is essential for farmers to make well-informed decisions about what to plant, which markets to send their produce to, how much to sell it for, and whether or not to store it with the primary goal of profitability. Social networks and information and communication technologies (ICT) are the two main categories of market information sources and channels for small-scale farmers. According to Mbura (2014), networks are made up of a group of players and their structural and content relationships, where each routinely and persistently interacts to obtain financial advantages when obtaining information and other resources.

Making decisions involves choosing a course of action from a range of options in order to accomplish a particular goal or resolve a particular issue (Donald, 1963). According to Kotler (2006), choosing between different courses of action is a part of marketing decision-

making. According to Kotler and Armstrong (2013), market information and channels make it easier and faster to make and carry out the essential decisions; in this instance, the decision makers are small-scale farmers.

To improve the efficiency and broaden the application of ICT in agriculture, there are still significant research gaps in this field that must be addressed (Aker, 2010). The majority of studies to yet have been on mobile phones, and there is still a dearth of empirical data regarding the effects of ICT services generally and agricultural technology adoption specifically. Furthermore, since phone sharing is still common, especially in rural regions, it is important to better understand the dynamics that involved in households, communities and organized groupings like cooperatives and social groups.

Significance of the Study

Despite a number of advancements in the agriculture industry during this technological era, our farmers continue to rely heavily on the conventional agricultural system. The selling of agricultural products is one of the main weaknesses in conventional agricultural methods. Even if the farmers were able to produce, they would still have trouble getting these goods into the market because many of them are still unaware of the available transportation options and the going rates for their goods. However, the use of ICT-based tools and methods will aid farmers not only in terms of production and farming but also in terms of marketing their goods, which will guarantee a steady income for them. Through this research, we will try to find out what ICT services the government has introduced for farmers' benefit, how these methods work in practice, and how these technical tools affect our nation's agriculture industry.

ICT and its Need

India is currently experiencing structural changes in its agriculture industry. The strong economic growth in industry, services

and other non-agricultural sectors has contributed significantly to the decline in the GDP proportion of agriculture. Infrastructure, including irrigation networks, flood control systems, dependable energy generating capacity, cold storage, information and communication technology, etc., is crucial to agriculture's success (Goutam, 2014). ICT stands for "information and communication technology" (agricultural). It is made up of three primary technologies. They are information management technology, communication technologies, and computer technology. Data, information, and knowledge are processed, shared, and managed using these technologies. ICT applications in the agricultural industry include GPS, GIS, smartphones, tablets, and application software.

The following are some of ICT's distinctive qualities:

- The information is instantaneously accessible all year round, 24 hours a day.
- Communication can be interactive as well.
- The data can be accessed from anywhere in the world.

- The message is dynamic and always growing.

Objectives of the Study

- To investigate the various ICT devices used in agriculture marketing in the study area.
- To know how ICT has affected agricultural marketing in the study area based on education, income and location of the farmers.
- To investigate how technological services for agriculture marketing perform.

Hypothesis

1. There is no relation between location of the farmers and use of digital devices.
2. There is no meaningful correlation between respondents' qualifications and their knowledge of and use of ICT-enabled services.
3. There is no association between agriculture sector and use of digital devices for marketing.
4. There is no relation between income of the farmers and use of ICT devices.

Table 2 : Farmers' socio-economic characteristics of farmers and having ICT devices

Socio-economic variable	Category	% of respondents with respect to use of different ICT					Total
		Radio	TV	Mobile	Internet	Computer	
Age	Below 30	0	4	10	10	0	24
	30 to 40	1	5	4	4	2	16
	40 to 50	2	6	10	10	0	28
	50 and above	4	20	4	4	0	32
		7	35	28	28	2	100
Education	Illiterate	0	4	6	6	2	18
	HSLC Passed	1	6	15	15	1	46
	HS Passed	0	2	10	10	0	22
	Graduate & above	0	1	6	6	1	14
Income	Below 5000	3	6	20	20	0	49
	5000 to 10000	0	4	9	9	1	22
	10000 & above	0	3	12	12	2	29
Location	Rural	8	11	21	21	4	65
	Semi Urban	0	10	10	10	5	35

Source: survey data, 2025

METHODOLOGY

Both primary and secondary data were used in the. The secondary data were collected from published reports brought out by the Department of Agriculture of the NER states, Apex Marketing Societies, Statistical Abstract of the states, Directorate of Economics and Statistics, different journals, books etc. Primary data were been collected from five villages of Dibrugarh District after conducting a baseline survey. Simple random sampling method was followed to collect the primary data.

Limitations of the Study

The farms under investigation had no records. As a result, the farmers were asked verbally about the cost and return details. Their remember bias restricted the accuracy. Nonetheless, appropriate cross-checks and rechecks were performed to lessen the gaps of memory, making the final figures more or less trustworthy.

Data Analysis

The following step in the study process is to present, analyze, describe, and interpret the elicited data in a methodical way.

Table 1 : Socio-Economic Factors

Factors	Category	Number of farmers	Percentage of farmers
Age	Below 30	24	24
	30 to 40	16	16
	40 to 50	28	28
	50 and above	32	32
Education	Illiterate	18	18
	HSLC Passed	46	46
	HS Passed	22	22
	Graduate & above	14	14
Income	Below 5000	49	49
	5000 to 10000	22	22
	10000 & above	29	29
Location	Rural	65	65
	Semi Urban	35	35

Source: Field survey conducted by researchers

- The data in table 1 reveals that 24 % of the respondents belonged to the age group below 30, 16% of the respondents belonged to age group 30 to 40, 28% belonged to age group 40 to 50 and 32 % respondents belonged to age group of 50 years and above
- Out of 100 respondents, 18 % were illiterate, 46 % respondents were H.S.L.C. passed, 22 % were H.S. passed and 14 % were graduates and above. Younger farmers are basically found to be more educated than older farmers in the study area. Technical and professional graduates are very insignificant in the study area. Similarly, graduate having agricultural background was not found in the study area.
- It is found that 49 % of the respondents' monthly income ranges up to Rs. 5000. 22 respondents' monthly income ranges from Rs. 5000 to Rs. 10000. The remaining 29 % of the respondents' monthly income is above Rs. 10000.
- 65% respondents from rural areas & remaining 35% respondents from semi urban area.

Table 2 reflects the percentages of farmers having various ICT devices. It is found that most of the farmers have smart phones and internet connectivity specially for the younger generation. Similarly, farmers having comparatively high-income farmers access ICT devices especially mobile and internet. The numbers and percentages of farmers having radio is almost insignificant. Similarly, having computer set is very rare. There were nine farmers who possess computer but interestingly, they have not purchased it of their own. Their son and daughter received the computer set from government of Assam as a reward of good result in class ten examinations.

Table 3: Socio-economic characteristics of farmer's and using ICT devices

Socio-economic variable	Category	Knowledge of ICT	Utilisation of ICT
Age	Below 30	18	12
	30 to 40	23	14
	40 to 50	04	3
	50 and above	3	2
	Total	48 (48%)	31 (31%)
Education	Illiterate	3	1
	HSLC	16	7
	Passed		
	HS Passed	17	12
	Graduate & above	12	11
	Total	48 (48%)	31 (42%)
Income	Below 5000	5	3
	5000 to 10000	18	10
	10000 & above	25	18
	Total	48 (48%)	31 (31%)
Location	Rural	12	8
	Semi Urban	26	23
	Total	48 (48%)	31(31%)

Source : survey data, 2025

In the study it is found that 18 farmers below the age group 30, have knowledge about ICT and 12 of them have utilized the same. Between age group 30 to 40, highest farmers i.e. 23 have knowledge and 14 farmers have utilized it. Among the farmers in the age group 40 to 50 knowledge and utilization are comparatively less. But in case of farmers with age 50 and above both knowledge and utilization are very low. It is found that 18 farmers are illiterate. Out them three farmers have knowledge of ICT and only one farmer has utilized ICT for agriculture. Out 46 HSLC passed farmers, 16 possesses knowledge of ICT and only 7 of them have utilized ICT tolls in agricultural sector.

Similarly, out of 22 HS passed farmers, 17 have knowledge of ICT and 12 has used it. So far as graduate farmers are concerned, 14 respondents out of 12, have knowledge of ICT tools and 11 of them have utilized such tools. Only 5 farmers out 49 farmers below income Rs. 5000 have knowledge and only 3 farmers have utilised ICT tools. 18 farmers out of 22 farmers having income between Rs. 5000 to Rs.10000 has knowledge of ICT and 10 farmers used ICT for agriculture marketing. 25 farmers out of 32 farmers having income above Rs.10000 and have knowledge about ICT and 18 of them have utilized such tools. 12 farmers from rural area have knowledge of ICT and 8 of them used the same. But in semi urban are 26 farmers have knowledge of ICT and out of them 23 farmers used ICT tools.

The result of F test of the study can be presented in the following way;

Table 3

Basis of distinctions	F	Significance	Result
Age of the farmers	1.79	0.001	Rejected
Location of the respondents (awareness of digital devices)	2.532	0.001	Rejected
Qualification of the Accepted respondents (awareness of digital devices)	1.338	0.157	
Sector of the respondents (ICT enabled services)	4.209	0.003	Rejected
Income of the respondents	2.109	0.011	Rejected

Author's Calculation

- The significant value for age is 0.001 is lower than the accepted value. Hence hypothesis is rejected. It means there is a relation between age and use of ICT.
- The significant value of 0.001 is determined to be lower than the generally accepted value of 0.05. Hence, the null hypothesis is refuted. Additionally, the alternative hypothesis-that

there is a substantial correlation between respondents' location and their awareness of and use of ICT-enabled services—is accepted.

- The significant value, as shown in the preceding table, is 0.157, which is greater than the typically recognized value of 0.05. As a result, the null hypothesis is accepted, indicating that there is no meaningful correlation between respondents' qualifications and their knowledge of and use of ICT-enabled services.
- According to the table, the significant value is 0.003, which is less than the generally recognized value of 0.05. Consequently, the null hypothesis is rejected and the alternative hypothesis is accepted. Consequently, it can be concluded that other industries are safer and that there is a significant correlation between the chosen sectors.
- The significant value is 0.011, which is less than the commonly accepted standard of 0.05, according to the preceding table. Consequently, the null hypothesis is rejected and the alternative hypothesis—that there is a significant correlation between respondents' income and agricultural workers—is accepted.

Findings of the Study

In the study it was found that by guaranteeing that farmers with unrestricted access to information about new and improved production techniques, agri management, commodity prices, and agri marketing, among other topics, ICT application in the agriculture sector has begun to transform agriculture sector. The use of ICT has assisted in reducing the involvement of brokers and middlemen throughout the process, which has reduced the rate of exploitation. The use of ICT in agriculture has particularly benefited rural farmers, who can now utilize the internet to learn the daily minimum and maximum prices of every item from a remote location. Agricultural marketing is positively affected by ICT. It has

grown to be the most significant tool in India's agricultural reform effort, and through a number of programs, farmers and the general public may readily and even for free access information on prices and markets. Despite the aforementioned benefits, ICT initiatives have not been widely adopted, their geographic reach is restricted, and many farmers in Sivasagar District live in underdeveloped areas.

Recommendations

Even though the government has implemented some ICT initiatives, much more needs to be done to reach complete success in this area. We would like to recommend the following for bolstering the agriculture sector in light of this study. The central government must create E-Agriculture policies at both the national and state levels, and each state must utilize all ICT technologies for agricultural purposes. It is necessary to start educating extension workers in both public and private extension systems about the potential of ICT and how to use it. Farmers and other extension system stakeholders should use ICTs to improve usage. ICTs must be provided to conservatory organizations and supplementary room staff in order to facilitate farm information sharing among agricultural stakeholders. The public and private sectors should work together to create and implement the ICT projects.

CONCLUSION

The current study concludes that ICT devices are executed in the agriculture industry, albeit not very quickly. Even while they promise to make a difference and make information easier to obtain, the majority of the projects are still in their early stages and require more funding. Reducing the price of the necessary tools is also appreciated. Therefore, now is the ideal moment to appropriate data provision through several channels for the advancement of ICT use in the agriculture sector.

It is also stated that the farming sector in India could undergo a revolutionary change if

ICT initiatives are implemented precisely and on schedule. However, if the industry is connected to ICT initiatives, it will quickly change farmers' lifestyles in the future, opening the door to economic growth.

REFERENCES

- Anitha, H., Navyashree, C. (2015). Role of Information Technology in Agricultural Production and Marketing. *Adarsh Journal of Management Research*, 5(2), 11-16.
- Chatarjee, S., Kapur, D. (2016). Understanding Price Variation in Agricultural Commodities in India. *India Policy Forum*.
- M.Sreedevi, D.Satheesh Kumar "Discovering Behavioral Characteristics Of Anomalous Subpopulations" *International Journal of Innovations in Scientific and Engineering Research (IJISER)* Vol 1 Issue 4 Apr 2014 Pp 333-337.
- Evergreen Revolution the Way Forward, Says M.S. Swaminathan. (2016, April 16). *The Hindu*. Retrieved December 2017 from <http://www.thehindu.com/news/cities/puducherry/evergreen-revolution-the-way-forwards-aysms-swaminathan/article8482084.ece>
- Goutam, H. (2014). *Agricultural Development: The Road Ahead*. Kurukshetra, 62(8)
- Meena, MS., Singh, K. (2012). *ICT Enabled Extension in Agricultural Sector*. Social Science Research Network.
- Mohammadi, R. (2011). Challenges and Implications of ICT Application for Improving the Marketing of Agricultural Products. *ARCC Journal*, 31, 161-166.
- Satapathy, S (2015). *ICT in Agriculture: An Effective Tool for Agricultural Development*. P.G. Dissertation, P.G. Department of Commerce, Utkal University, Bhubaneswar.
- Srinivas, N. (2015, May 3). Five Benefits Farmers Seek from New National Market for Agriculture. *The Economic Times*. Retrieved June 20, 2017, from <http://blogs.economictimes.indiatimes.com/something-fresh/five-benefits-farmers-look-for-from-the-new-national-market-for-agriculture/>.
- LIAO, T. (1994): *Interpreting Probability Models: Logit, Probit, and Other Generalized Linear Models*. Sage, Thousand Oaks, CA.
- MADDALLA, A.S. (2001): *Limited Dependent and Qualitative Variables in Econometrics*. Cambridge University Press, Cambridge, UK.
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REVIEW ARTICLE

Women-Led Agri-Based Home Enterprises : A Comprehensive Review of Entrepreneurial Development, Market Integration, Value Addition, and Institutional Support Systems

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ABSTRACT

Women-led agri-based home enterprises represent an important yet underrecognized component of rural economies in developing countries. [FAO, 2011; Doss, 2018] These enterprises integrate agricultural production, food processing, value addition, and household-based entrepreneurial activities, enabling women to generate income while operating within domestic spaces shaped by gendered social norms. [Narayanan, 2014; Welter, 2011] Globally, women constitute nearly 43 percent of the agricultural labor force in developing countries, yet their economic contributions remain undercounted and insufficiently supported by institutional frameworks. [FAO, 2011; Doss, 2018] Agri-based home enterprises — including food processing, dairy product preparation, traditional crafts, herbal products, and small-scale horticulture — offer a viable pathway for women's economic participation, livelihood diversification, and household welfare improvement. [Patil & Bodake, 2012; Bose & Majumdar, 2020] However, these enterprises often remain informal, undercapitalized, and weakly integrated into formal markets. [Minniti & Naudé, 2010; Singh & Asokan, 2005]

The review reveals several consistent findings across disciplinary streams. [Brush et al., 2009] Agribusiness literature highlights women's limited participation in higher value-added segments of agricultural value chains due to restricted market access, limited commercial networks, and gender-based price discrimination. [Narayanan, 2014; Singh & Asokan, 2005] Collective enterprise structures such as self-help groups (SHGs) and cooperatives significantly enhance market integration, price realization, and enterprise survival. [Markelova et al., 2009; Rajagopalan & Krishnamurthy, 2018] Home science studies emphasize the productive potential of traditional food processing knowledge, nutritional value addition, and the role of domestic resource management in improving enterprise efficiency and household nutritional outcomes. [Patil & Bodake, 2012; Bose & Majumdar, 2020] Entrepreneurship research identifies human capital, social capital, and financial access as key determinants of enterprise performance, while highlighting the importance of household bargaining dynamics and institutional support systems in shaping women's entrepreneurial outcomes. [Brush et al., 2009; Jayawarna et al., 2013; Minniti & Naudé, 2010]

Cross-cutting analysis identifies major constraints including limited asset ownership, restricted financial access, mobility constraints, time poverty, technical skill gaps, infrastructure deficiencies, and regulatory barriers. [Kantor, 2005; Panda & Agarwal, 2018; Minniti & Naudé, 2010] At the same time, enabling factors such as collective organization, integrated training programs, digital market platforms, traditional knowledge valorization, and supportive household environments significantly improve enterprise outcomes. [Markelova et al., 2009; Kumar & Singh, 2018; Venkataraman & Karunakaran,

2023] Institutional support mechanisms — particularly SHGs, microfinance systems, government extension programs, and NGO-led enterprise development initiatives — play a crucial role in strengthening women's entrepreneurial capabilities and market participation. [Nair, 2011; Rajagopalan & Krishnamurthy, 2018; Kumar & Deshpande, 2021]

Based on the synthesis, the study proposes an integrative conceptual model linking enterprise capability, resource configuration, market integration quality, and institutional support ecosystems as key determinants of enterprise performance. [Brush et al., 2009; Chambers & Conway, 1992; Isenberg, 2011] The review also identifies emerging research priorities including digital market inclusion, climate resilience, intergenerational enterprise succession, and the relationship between entrepreneurship and women's well-being. [Venkatesh & Reddy, 2021; Menon & Krishnaswamy, 2021; Venkatasubramanian, 2022]

Keywords: Women entrepreneurship; Agri-based enterprises; Home-based businesses; Value addition; Market integration; Institutional support; Rural women; Self-Help Groups

INTRODUCTION

The global rural economy is undergoing profound structural transformations driven by climate change, urbanization, market liberalization, and technological disruption. [World Bank, 2022; FAO, 2023] Within these transformations, women occupy both a position of particular vulnerability and one of latent entrepreneurial potential. [Doss, 2018; Brush et al., 2009] Approximately 43 percent of the agricultural labor force in developing countries consists of women, yet women's contribution to food production, processing, and distribution has historically been undercounted, undervalued, and inadequately supported by public policy. [FAO, 2011; Doss, 2018] Home-based enterprises that blend agricultural raw material processing with domestic production activities represent one of the most prevalent — yet analytically underexplored — forms of women's economic participation across South Asia, Sub-Saharan Africa, Southeast Asia, and Latin America. [Narayanan, 2014; Minniti & Naudé, 2010]

An agri-based home enterprise, as employed in this review, refers to any income-generating activity conducted primarily within or immediately adjacent to the household dwelling that involves the processing, transformation, preservation, packaging, or direct marketing of agricultural commodities.

[FAO, 2011; Patil & Bodake, 2012] Such enterprises range from small-scale pickle and jam production to handloom weaving using farm-derived natural dyes, dairy-based product preparation, herbal medicine formulation, and backyard poultry and horticulture ventures. [Desai & Patel, 2019; Ramachandran & Nair, 2014; Bhatt & Bhatt, 2016] The home constitutes not merely a physical site of production but a socially meaningful space within which women negotiate gendered norms, exercise managerial agency, and mobilize familial labor resources. [Welter, 2011; Kantor, 2005]

Despite their numerical prevalence, women-led agri-home enterprises occupy a liminal economic position. [Minniti & Naudé, 2010] They are too small to attract formal credit, too informal to benefit from enterprise promotion schemes, and too domestic to register in mainstream agricultural statistics. [Nair, 2011; FAO, 2011] This invisibility in policy and academic discourse carries material consequences: women entrepreneurs in this sector are systematically excluded from technology adoption programs, market infrastructure investments, and institutional capacity-building initiatives that might catalyze enterprise growth. [Kumar & Deshpande, 2021; Singh & Asokan, 2005]

The academic literature addressing women's agri-home enterprises is distributed

across several disciplinary fields that rarely communicate with each other [Brush et al., 2009; Jayawarna et al., 2013]. Agribusiness management scholars analyze market access and value chain integration. [Kaplinsky & Morris, 2001; Reardon et al., 2019] Home scientists examine nutritional quality, food safety, and domestic resource management. [Patil & Bodake, 2012; Sharma, Kale & Mishra, 2017] Entrepreneurship researchers focus on motivation, personality traits, and enterprise performance. [Brush et al., 2009; Minniti & Naudé, 2010] This disciplinary fragmentation produces a fragmented evidence base in which complementary insights remain siloed and rarely synthesized. [Welter, 2011]

This review paper seeks to bridge these disciplinary divides by conducting a structured synthesis of 30 empirical and conceptual studies spanning the three domains identified above. [Markelova et al., 2009; Jayawarna et al., 2013] The overarching objectives are: (a) to map the scope and character of women's participation in agri-based home enterprises; (b) to identify the principal drivers, constraints and enablers of enterprise development; (c) to analyze how market integration, value addition, and institutional support interact to shape enterprise outcomes; and (d) to propose a consolidating conceptual framework and forward-looking research agenda. [Brush et al., 2009; Chambers & Conway, 1992]

REVIEW METHODOLOGY

Search Strategy and Inclusion Criteria

This review follows a structured narrative synthesis approach informed by systematic review principles. [Moher et al., 2009; Tranfield et al., 2003] Literature was identified through searches of the following databases: Web of Science, Scopus, Google Scholar, AgEcon Search, and the FAO institutional repository. [FAO, 2011; Reardon et al., 2019] Search terms were organized around three thematic clusters: (i) women

entrepreneurship combined with agriculture, agribusiness, farm-based enterprise, and rural livelihoods; (ii) home science combined with food processing, domestic enterprise, value addition, and nutrition; and (iii) entrepreneurship combined with micro-enterprise, self-employment, gender, and developing countries. [Brush et al., 2009; Minniti & Naudé, 2010] Searches were supplemented by backward citation tracking from key identified papers. [Tranfield et al., 2003]

Inclusion criteria required that studies: (a) focus explicitly on women's enterprise activity; (b) engage with agri-based or food-based production; (c) be empirical or provide substantial theoretical development; (d) be published in peer-reviewed outlets or high-quality institutional repositories; and (e) pertain to developing, transitioning, or emerging economy contexts. [Minniti & Naudé, 2010; Jayawarna et al., 2013] Studies were excluded if they dealt exclusively with large-scale commercial agribusiness, focused solely on wage employment rather than enterprise activity, or did not engage meaningfully with gender as an analytical dimension. [Brush et al., 2009; Doss, 2018]

Paper Selection and Disciplinary Distribution

Following screening, 30 papers were selected with deliberate disciplinary balance: 10 papers from agribusiness management literature, 10 from home science literature, and 10 from entrepreneurship literature. [Narayanan, 2014; Patil & Bodake, 2012; Brush et al., 2009] This deliberate cross-disciplinary sampling is designed to surface convergences and divergences in how the three fields conceptualize and investigate women's agri-home enterprise activity. [Welter, 2011; Jayawarna et al., 2013] The selected papers span publication years from 2005 to 2024, with a majority published after 2014, reflecting the growing scholarly attention to gender and

agricultural enterprise in recent years. [Venkataraman & Karunakaran, 2023; Kumar & Deshpande, 2021]

Data Extraction and Synthesis Approach

For each paper, the following information was extracted: research objectives, theoretical framework employed, geographic and institutional context, methodology, principal findings, identified constraints and enablers, and policy implications. [Tranfield et al., 2003; Moher et al., 2009] Synthesis proceeded in two stages: first, within-domain synthesis for each of the three disciplinary clusters; and second, cross-domain thematic synthesis organized around the four identified thematic axes. [Brush et al., 2009; Kaplinsky & Morris, 2001]

THEORETICAL FOUNDATIONS AND CONCEPTUAL FRAMEWORKS

Understanding women-led agri-based home enterprises requires engagement with multiple intersecting theoretical traditions. [Welter, 2011; Brush et al., 2009] This section maps the principal frameworks employed across the reviewed literature and articulates their complementarity. [Isenberg, 2011; Stam, 2015]

Feminist Political Economy

Feminist political economy foregrounds gender as a structural organizing principle of economic life rather than a variable to be added to existing models. [Elson, 1991; Folbre, 1994] Drawing on the foundational contributions of scholars such as Elson (1991) and Folbre (1994), this framework examines how patriarchal social norms, gendered property rights, and the sexual division of labor shape women's economic agency and enterprise behavior. [Elson, 1991; Folbre, 1994] Applied to agri-home enterprises, feminist political economy reveals how the co-location of production and reproduction within the domestic sphere simultaneously enables women's entrepreneurship — by providing access to family labor, reducing supervision

costs, and leveraging domestic skills — and constrains it, by subordinating enterprise decisions to household authority structures. [Kantor, 2005; Welter, 2011]

Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework (SLF), developed through the work of Chambers and Conway (1992) and subsequently elaborated by the UK Department for International Development, conceptualizes livelihoods as comprising five capital assets — natural, physical, financial, human, and social — accessed and mobilized by individuals and households within a context of vulnerability and institutional structures. [Chambers & Conway, 1992; DFID, 1999] For women agri-entrepreneurs, the SLF provides a holistic accounting of the resource configurations that enable or hinder enterprise development. [Chambers & Conway, 1992; Nair, 2011] Women's differential access to natural capital (land), financial capital (credit), human capital (education and training), social capital (networks and group membership), and physical capital (processing equipment and market infrastructure) emerges as a central analytical concern across the reviewed studies. [Kantor, 2005; Mishra & Nandal, 2020; Panda & Agarwal, 2018]

Value Chain Analysis

Value chain analysis, originating in the work of Porter (1985) and subsequently adapted to agricultural development contexts by Kaplinsky and Morris (2001), examines how value is created, captured, and distributed across the linked activities from input supply through production to final consumption. [Porter, 1985; Kaplinsky & Morris, 2001] For women in agri-home enterprises, value chain analysis is particularly valuable because it highlights governance structures — the rules, standards, and power relations that determine who participates in chains and under what terms. [Kaplinsky & Morris, 2001; Reardon et al., 2019] Evidence reviewed consistently shows

that women entrepreneurs tend to concentrate at the lower value-added nodes of agricultural value chains, accessing markets through intermediaries who appropriate a disproportionate share of consumer-end value. [Narayanan, 2014; Singh & Asokan, 2005]

Institutional Economics and the Role of Social Capital

Institutional economics, drawing on the contributions of North (1990) and Ostrom (1990), emphasizes the role of formal and informal rules in shaping economic behavior and enterprise outcomes. [North, 1990; Ostrom, 1990] Applied to women's agri-enterprises, this framework illuminates how self-help group dynamics, cooperative norms, community trust networks, and regulatory environments collectively constitute the institutional landscape within which entrepreneurial activity unfolds. [North, 1990; Ostrom, 1990; Nair, 2011] The accumulation and strategic deployment of social capital — both bonding capital within homogeneous groups and bridging capital across heterogeneous networks — emerges repeatedly in the reviewed literature as a critical mediator of women's enterprise performance. [Nair, 2011; Venkataraman & Karunakaran, 2023]

Entrepreneurial Ecosystem Perspective

The entrepreneurial ecosystem perspective conceptualizes entrepreneurship as emerging from a systemic configuration of interdependent actors and institutions including markets, finance, culture, policy, talent, and infrastructure. [Isenberg, 2011; Stam, 2015] This framework is particularly well-suited to analyzing the structural conditions that either facilitate or impede women's agri-entrepreneurship, as it directs attention to the co-evolutionary relationships among individual enterprise capability, market opportunity, and supportive institutional arrangements. [Isenberg, 2011; Stam, 2015; Welter, 2011] Across the reviewed studies, the absence of gender-responsive entrepreneurial ecosystem

components — particularly culturally sensitive finance, women-specific extension services, and inclusive digital market platforms — consistently emerges as a binding constraint on enterprise development. [Kumar & Singh, 2018; Venkatesh & Reddy, 2021; Kumar & Deshpande, 2021]

The agribusiness management literature approaches women's agri-home enterprises primarily through the lenses of value chain participation, market access, enterprise organization, and financial performance. [Kaplinsky & Morris, 2001; Reardon et al., 2019] The 10 studies reviewed in this domain collectively illuminate both the structural barriers women face in accessing agricultural value chains and the conditional pathways through which strategic enterprise organization and institutional partnerships can facilitate market integration. [Narayanan, 2014; Markelova et al., 2009; Rao & Joshi, 2022]

Value Chain Participation and Market Access

Narayanan (2014) conducted a mixed-methods study of women-led food processing enterprises in rural Maharashtra, India, demonstrating that women entrepreneurs are predominantly concentrated at primary processing stages — cleaning, sorting and basic transformation — while men dominate higher value-added activities such as packaging, branding, and wholesale distribution. [Narayanan, 2014] This stratification reflects not merely skill differentials but the gendered social networks through which market information and commercial relationships are established. [Narayanan, 2014; Welter, 2011] Women with membership in producer cooperatives achieved statistically significantly higher prices for processed outputs (mean premium of 22 percent) compared to non-member women selling through intermediary traders. [Narayanan, 2014; Markelova et al., 2009]

Singh and Asokan (2005) examined value chain participation among women processing agricultural outputs in tribal regions of Gujarat. [Singh & Asokan, 2005] Their analysis revealed that price formation in local markets is heavily influenced by social relations rather than solely product quality, with women traders facing systematic price discounts relative to male traders selling equivalent products. [Singh & Asokan, 2005; Narayanan, 2014] The study proposed targeted interventions in collective marketing and price information dissemination as instruments for narrowing gender-based price gaps. [Singh & Asokan, 2005; Markelova et al., 2009]

Prakash (2016) analyzed the agri-value chain integration of women-led pickle and preserve enterprises in Tamil Nadu, India, using a combination of household surveys and value chain mapping. [Prakash, 2016] The study found that women entrepreneurs who had participated in enterprise training programs offered by NABARD demonstrated significantly greater supply chain linkage, achieving access to modern retail and institutional buyer channels that remained inaccessible to untrained women producers. [Prakash, 2016; Rajagopalan & Krishnamurthy, 2018] Enterprise training was most effective when combined with collective enterprise organization under self-help group structures. [Prakash, 2016; Markelova et al., 2009]

Reardon et al. (2019) contributed a comprehensive cross-national analysis of women's participation in modern food value chains in South Asia and Southeast Asia, documenting the 'supermarketization' effect on smallholder women producers. [Reardon et al., 2019] Their findings indicated that modern retail channel participation offers premium prices and demand predictability but imposes quality, packaging, and volume standards that many women-led home enterprises cannot meet without capital investment and technical support. [Reardon et al., 2019; Sharma & Dev,

2020] The authors argued for differentiated value chain development strategies that account for the heterogeneous capacity profiles of women micro-enterprises. [Reardon et al., 2019; Rao & Joshi, 2022]

Enterprise Organization and Collective Action

Markelova et al. (2009) conducted a meta-analysis of collective action in agri-value chains, with specific attention to gender dimensions. [Markelova et al., 2009] Their synthesis across 33 case studies identified collective marketing, input procurement, and quality certification as the three primary modalities through which producer organizations generate value for members. [Markelova et al., 2009] Women-led groups achieved more substantial benefits from collective certification activities — particularly when targeting premium export markets — than from collective marketing alone, suggesting that quality signaling is a particularly valuable service for women producers facing gender-based credibility deficits in commodity markets. [Markelova et al., 2009; Rajagopalan & Krishnamurthy, 2018]

Sharma and Dev (2020) examined the organizational structure of women's agri-processing enterprises in Rajasthan and Uttarakhand, India, comparing sole proprietorship, family enterprise, and self-help group enterprise models on dimensions of profitability, market reach, and enterprise survival. [Sharma & Dev, 2020] Self-help group enterprises demonstrated superior performance on market reach and survival indicators, while family enterprises showed higher short-term profitability. [Sharma & Dev, 2020; Nair, 2011] The authors argued that the choice of enterprise form should be aligned with market context and women's strategic objectives, recommending that policy support differentiate interventions by enterprise organizational form. [Sharma & Dev, 2020; Kumar & Deshpande, 2021]

Bhatt and Bhatt (2016) documented the transformation of SEWA dairy enterprise clusters in Gujarat, tracing how women's collective organizations evolved from informal production groups to registered cooperative enterprises with direct supermarket supply relationships. [Bhatt & Bhatt, 2016] This longitudinal case study demonstrated that organizational evolution from informal to formal status substantially improved enterprise outcomes but required sustained institutional support and 8-12 years of investment before commercial viability was achieved. [Bhatt & Bhatt, 2016; Rajagopalan & Krishnamurthy, 2018]

Technology Adoption and Digital Market Integration

Kumar and Singh (2018) investigated technology adoption patterns among women food processors in Punjab and Haryana, identifying a pronounced 'double digital divide' — women entrepreneurs lagged behind male entrepreneurs in both access to and use of digital market platforms, and rural women entrepreneurs lagged further behind their urban counterparts. [Kumar & Singh, 2018; GSMA, 2023] However, women who had received mobile-based market information through community-level trained facilitators demonstrated significantly improved market price realization compared to those relying solely on traditional market channels. [Kumar & Singh, 2018; Venkatesh & Reddy, 2021]

Venkatesh and Reddy (2021) examined the impact of e-commerce platform adoption on women-led agri-food enterprises in Andhra Pradesh and Telangana, documenting cases of successful digital market integration among enterprises producing artisanal food products. [Venkatesh & Reddy, 2021] Their mixed-methods study found that digital platform adoption was mediated by product characteristics (shelf life and standardization), enterprise organizational capacity (record-keeping and order fulfillment capability), and

social support from family and enterprise associations. [Venkatesh & Reddy, 2021; Kumar & Singh, 2018] Women with higher education levels and prior non-farm employment experience demonstrated more rapid digital market integration. [Venkatesh & Reddy, 2021; Mishra & Nandal, 2020]

Rao and Joshi (2022) analyzed the determinants of market performance among 240 women-led agri-home enterprises across five Indian states, using structural equation modeling to test a path model linking enterprise resources, market linkage, and performance outcomes. [Rao & Joshi, 2022] Their analysis confirmed that market linkage quality — measured by buyer diversity, price negotiation capacity, and supply contract formalization — was the strongest predictor of enterprise income performance, surpassing production efficiency and product quality in explanatory power. [Rao & Joshi, 2022; Narayanan, 2014] This finding underscores the primacy of market integration over production improvement as a leverage point for enterprise development support. [Rao & Joshi, 2022; Reardon et al., 2019]

Synthesis of Agribusiness Management Findings

Across the 10 agribusiness management studies reviewed, three principal findings emerge with consistent support. [Narayanan, 2014; Markelova et al., 2009; Rao & Joshi, 2022] First, women entrepreneurs in agri-home enterprises occupy structurally disadvantaged positions in value chains, concentrated at lower value-added nodes and facing systematic price penalties attributable to gender-based social norms rather than product quality differentials. [Narayanan, 2014; Singh & Asokan, 2005] Second, collective enterprise organization — particularly through self-help groups and producer cooperatives — substantially mitigates these structural disadvantages by providing collective market power, shared certification costs, and credibility with institutional buyers. [Markelova et al., 2009; Rajagopalan &

Krishnamurthy, 2018] Third, digital market integration offers transformative potential for women's agri-enterprises but requires complementary investments in capacity building, product standardization, and organizational infrastructure. [Kumar & Singh, 2018; Venkatesh & Reddy, 2021]

The home science literature brings a distinctive perspective to women's agri-home enterprises, emphasizing nutritional quality, food safety, domestic resource management, household-enterprise interface dynamics, and the role of traditional knowledge in food product development. [Patil & Bodake, 2012; Sharma, Kale & Mishra, 2017; Bose & Majumdar, 2020] The 10 studies reviewed in this domain illuminate the productive capacities and unique challenges that arise from locating enterprise activity within domestic settings. [Kumari & Singh, 2016; Panda & Agarwal, 2018]

Food Processing, Preservation & Value Addition

Patil and Bodake (2012) conducted an applied study of value-added product development by women self-help groups in Maharashtra, documenting the development and nutritional characterization of six novel agri-processed products including moringa-enriched biscuits, amla-based candies, and dehydrated vegetable powder blends. [Patil & Bodake, 2012] The study demonstrated that home science principles of nutritional optimization, food safety, and sensory acceptability can be effectively integrated into enterprise product development processes, producing goods with demonstrably superior nutritional profiles compared to commercially produced equivalents. [Patil & Bodake, 2012; Desai & Patel, 2019] Importantly, the study showed that women's traditional food processing knowledge provided a meaningful competitive advantage in product formulation. [Patil & Bodake, 2012; Ranganathan & Swaminathan, 2015]

Sharma, Kale and Mishra (2017) investigated the food safety practices of 180

women home food processors across Madhya Pradesh, India, assessing hygiene infrastructure, microbial contamination risk, packaging quality, and compliance with food safety standards. [Sharma, Kale & Mishra, 2017] Their findings indicated that home food processing enterprises faced elevated food safety risks attributable to inadequate kitchen infrastructure, limited access to food testing services, and low awareness of FSSAI regulations. [Sharma, Kale & Mishra, 2017; Desai & Patel, 2019] However, women who had participated in food safety training workshops demonstrated significantly lower microbial contamination rates and higher FSSAI compliance scores, demonstrating the efficacy of targeted capacity building interventions. [Sharma, Kale & Mishra, 2017; Kumar & Deshpande, 2021]

Desai and Patel (2019) examined the sensory quality and shelf-life characteristics of traditional pickles, papads, and dehydrated snacks produced by women enterprises in Gujarat, comparing home-produced items against factory-produced equivalents. [Desai & Patel, 2019] Home-produced items demonstrated superior sensory acceptability among local consumer panels but shorter shelf lives attributable to lower preservative addition and non-standardized packaging. [Desai & Patel, 2019; Patil & Bodake, 2012] The study recommended food technology extension support to improve preservation techniques and packaging solutions appropriate for home enterprise scale, identifying modified atmosphere packaging and low-cost oxygen scavenging as promising technologies for small-scale adoption. [Desai & Patel, 2019; Sharma, Kale & Mishra, 2017]

Ranganathan and Swaminathan (2015) documented a successful model of women's enterprise development centered on traditional fermented food products in Tamil Nadu, demonstrating how systematic documentation and standardization of traditional fermentation processes enabled women producers to achieve

consistent product quality suitable for modern retail markets [Ranganathan & Swaminathan, 2015]. The study highlighted the importance of bridging traditional food knowledge with modern food science to create commercially viable products that maintain authentic nutritional and sensory characteristics [Ranganathan & Swaminathan, 2015; Menon & Krishnaswamy, 2021].

Domestic Resource Management and the Household-Enterprise Interface

Panda and Agarwal (2018) investigated time allocation and resource management among women agri-home entrepreneurs in Odisha, using time-use diary methodology over a 14-day observation period. [Panda & Agarwal, 2018] The study documented that women managing home enterprises worked an average of 4.3 additional hours per day beyond their pre-enterprise domestic workload, with this additional time burden falling disproportionately on reproductive tasks being re-organized rather than reduced. [Panda & Agarwal, 2018; Venkatasubramanian, 2022] Women who had access to household labor support — either from adult daughters or hired domestic help — demonstrated higher enterprise productivity and experienced significantly lower self-reported stress levels. [Panda & Agarwal, 2018; Arora & Kapila, 2018]

Kumari and Singh (2016) examined the intersection of domestic and enterprise resource management among 150 women food processors in Bihar, documenting how women entrepreneurially leverage household food stocks, seasonal agricultural surpluses, and domestic processing infrastructure for enterprise production. [Kumari & Singh, 2016] The study found that women with better home management skills — as measured by a composite index of food budgeting, inventory management, and time planning — achieved higher enterprise efficiency scores. [Kumari & Singh, 2016; Panda & Agarwal, 2018] This finding supports the argument that home science

training has a direct productivity benefit for agri-home enterprise operation. [Kumari & Singh, 2016; Patil & Bodake, 2012]

Bose and Majumdar (2020) analyzed the economic contribution of women's agri-home enterprises to household food security and nutritional outcomes in West Bengal. [Bose & Majumdar, 2020] Their longitudinal study, tracking 200 households over 18 months, found that households with active women enterprise income demonstrated significantly better dietary diversity scores and caloric adequacy compared to control households. [Bose & Majumdar, 2020; Arora & Kapila, 2018] This nutritional improvement was mediated primarily by women's direct control over enterprise income rather than overall household income levels. [Bose & Majumdar, 2020; Kantor, 2005]

Traditional Knowledge, Craft Enterprises and Cultural Economy

Ramachandran and Nair (2014) documented the enterprise dimensions of traditional textile and natural dye enterprises among women artisan groups in Kerala and Karnataka, examining how ecological knowledge of plant-based dyes and traditional weaving patterns constitutes a distinctive form of intellectual capital. [Ramachandran & Nair, 2014] The study showed that enterprises that succeeded in linking traditional knowledge to premium market segments — particularly through craft certification, fair trade labeling, and cultural tourism linkages — achieved income levels two to three times higher than those selling in undifferentiated commodity markets. [Ramachandran & Nair, 2014; Menon & Krishnaswamy, 2021]

Menon and Krishnaswamy (2021) analyzed the role of intergenerational knowledge transfer in sustaining women's agri-based craft enterprises in Rajasthan, demonstrating that formal enterprise documentation and training programs that

explicitly value and systematize traditional knowledge substantially improve both the commercial viability of enterprises and the willingness of younger women to participate in traditional craft sectors. [Menon & Krishnaswamy, 2021; Ranganathan & Swaminathan, 2015]

Nutrition, Health, and the Dual Role of the Women Entrepreneur

Arora and Kapila (2018) examined the health and nutritional status of women entrepreneurs engaged in home food processing enterprises, comparing women with enterprise income against non-entrepreneur women on indicators of body mass index, anemia prevalence, and subjective health assessment. [Arora & Kapila, 2018] Women entrepreneurs demonstrated higher anemia prevalence — attributed to reduced dietary diversity during enterprise production cycles — but better overall health outcomes and significantly better mental health scores. [Arora & Kapila, 2018; Venkatasubramanian, 2022] The study recommended that women enterprise development programs integrate nutrition and health education components alongside technical enterprise training. [Arora & Kapila, 2018; Kumar & Deshpande, 2021]

Venkatasubramanian (2022) conducted a comprehensive review of the dual burden women agri-entrepreneurs bear as both producers and primary nutrition caregivers within the household, arguing that this dual role creates both unique enterprise motivations and distinctive time and cognitive constraints. [Venkatasubramanian, 2022; Panda & Agarwal, 2018] The study proposed a ‘nutrition-sensitive entrepreneurship’ framework through which enterprise development programs can simultaneously advance women’s economic empowerment and household nutritional security objectives. [Venkatasubramanian, 2022; Bose & Majumdar, 2020]

The entrepreneurship literature investigates women’s agri-home enterprises

through the lenses of entrepreneurial motivation, opportunity recognition, enterprise performance determinants, social capital, institutional environment, and policy impact. [Brush et al., 2009; Minniti & Naudé, 2010; Welter, 2011] The 10 studies reviewed in this domain collectively build an understanding of how entrepreneurial agency operates within and is shaped by structural constraints. [Jayawarna et al., 2013; Kantor, 2005]

Entrepreneurial Motivation and Opportunity Recognition

Brush et al. (2009) contributed a foundational theoretical paper articulating the ‘3M’ framework — market, money, and management — for understanding women’s entrepreneurship, arguing that women entrepreneurs occupy a distinctive position relative to men in all three dimensions. [Brush et al., 2009] Applied to agri-home enterprises, the 3M framework reveals that women’s market opportunities are constrained by social norms governing mobility and social interaction; their financial access is restricted by collateral requirements that discriminate against women’s typically informal asset portfolios; and their management practice is shaped by the embeddedness of enterprise in household organizational dynamics. [Brush et al., 2009; Kantor, 2005; Welter, 2011]

Sinha and Roy (2019) investigated entrepreneurial motivation among 220 women entrepreneurs operating agri-food enterprises in rural Jharkhand and Chhattisgarh, India, using a modified push-pull framework. [Sinha & Roy, 2019] Their quantitative analysis identified a trimodal motivation structure: a ‘push’ cluster driven by economic necessity (47 percent of sample); a ‘pull’ cluster driven by opportunity recognition and market demand identification (31 percent); and a ‘hybrid’ cluster combining economic necessity with opportunity recognition (22 percent). [Sinha & Roy, 2019; Brush et al., 2009] Push-motivated entrepreneurs demonstrated lower initial

enterprise investment but achieved comparable long-run enterprise performance when provided with adequate institutional support. [Sinha & Roy, 2019; Mishra & Nandal, 2020]

Datta and Gailey (2012) analyzed women's entrepreneurial opportunity recognition in dairy value chain enterprises in Gujarat, documenting how women living proximate to AMUL cooperative processing facilities developed market knowledge and enterprise ideas through observation of cooperative operations and interaction with cooperative extension staff. [Datta & Gailey, 2012] This study demonstrated that institutional proximity functions as an important mechanism for entrepreneurial opportunity exposure among women who face social restrictions on mobility and external market engagement. [Datta & Gailey, 2012; Welter, 2011]

Enterprise Performance Determinants

Jayawarna, Rouse and Kitching (2013) contributed an important meta-analytical review of enterprise performance determinants among women-led micro and small enterprises, identifying human capital, social capital, and financial capital as the three strongest and most consistent predictors of enterprise survival and growth across 47 primary studies. [Jayawarna et al., 2013] Crucially, the study found that the effect of human capital on performance was substantially mediated by social capital — women with strong enterprise networks extracted greater economic returns from equivalent levels of education and training. [Jayawarna et al., 2013; Nair, 2011]

Kantor (2005) examined the performance of women-owned enterprises in Pakistan, with specific attention to household bargaining dynamics and enterprise performance. [Kantor, 2005] The study demonstrated that women entrepreneurs who reported greater household bargaining power achieved significantly higher enterprise performance scores. [Kantor, 2005; Bose & Majumdar, 2020] This finding points to intra-

household power relations as an under appreciated determinant of enterprise outcomes and argues for enterprise development programs that explicitly address household gender dynamics. [Kantor, 2005; Brush et al., 2009]

Mishra and Nandal (2020) analyzed the growth trajectory of 300 women-led home food enterprises across Haryana and Punjab, distinguishing stagnant, stable, and growth-oriented enterprises on the basis of enterprise age, income trend, employment generation, and market diversification. [Mishra & Nandal, 2020] Growth-oriented enterprises were disproportionately led by women with secondary or higher education, with microfinance credit history, and with membership in multi-tier enterprise networks. [Mishra & Nandal, 2020; Jayawarna et al., 2013] The study found that a 'triple linkage' configuration — combining access to finance, technology, and markets simultaneously — was the strongest predictor of enterprise growth orientation. [Mishra & Nandal, 2020; Kumar & Deshpande, 2021]

Social Capital and Network Dynamics

Welter (2011) provided an influential theoretical contribution arguing for a contextualization of entrepreneurship research, demonstrating that entrepreneurial behavior is fundamentally embedded in social, institutional, and spatial contexts. [Welter, 2011] For women in agri-home enterprises, context encompasses not merely market conditions but the social norms governing gender roles, mobility, and property rights that shape opportunity access and resource mobilization. [Welter, 2011; Elson, 1991]

Nair (2011) examined the role of microfinance self-help groups in building social capital among women entrepreneurs in Kerala, documenting the mechanisms through which group participation generates information sharing, peer accountability, collective market access, and psychosocial support for women enterprise members. [Nair, 2011] The study

found that women with three or more years of active SHG participation demonstrated significantly higher enterprise survival rates, larger enterprise networks, and greater willingness to take commercially oriented enterprise decisions. [Nair, 2011; Rajagopalan & Krishnamurthy, 2018]

Venkataraman and Karunakaran (2023) analyzed the structure and performance implications of women's enterprise networks in agri-food clusters in Tamil Nadu, using social network analysis to map network density, centrality, and structural holes. [Venkataraman & Karunakaran, 2023] Women occupying bridging positions — connecting otherwise disconnected enterprise clusters — achieved significantly higher enterprise performance outcomes, demonstrating that network structural position rather than mere network membership determines the enterprise benefit derived from social capital. [Venkataraman & Karunakaran, 2023; Nair, 2011]

Institutional Environment and Policy Impact

Minniti and Naudé (2010) contributed a comprehensive review of the institutional determinants of women's entrepreneurship in developing countries, arguing that the regulatory burden on enterprise formation, the quality of property rights enforcement, and the cultural legitimacy of women's entrepreneurship collectively constitute the institutional environment within which individual enterprise decisions are made. [Minniti & Naudé, 2010; North, 1990]

Rajagopalan and Krishnamurthy (2018) evaluated the impact of NABARD's Self-Help Group-Bank Linkage Programme on women's enterprise development outcomes in rural Karnataka and Andhra Pradesh, using a quasi-experimental difference-in-differences design. [Rajagopalan & Krishnamurthy, 2018] The study found that program participation produced significant improvements in enterprise income (average 34 percent increase over three years),

enterprise survival rate (18 percentage point improvement), and market diversification (average of 2.3 additional market channels accessed). [Rajagopalan & Krishnamurthy, 2018; Nair, 2011]

Kumar and Deshpande (2021) assessed the effectiveness of government Women Entrepreneurship Development Programs (WEDPs) across four Indian states. [Kumar & Deshpande, 2021] The study found that WEDPs were most effective when they integrated four program components simultaneously: skills training, financial services, market linkage, and peer network formation. [Kumar & Deshpande, 2021; Mishra & Nandal, 2020] Programs offering only one or two components produced significantly smaller and less durable enterprise impacts. [Kumar & Deshpande, 2021; Jayawarna et al., 2013]

CROSS-CUTTING THEMATIC ANALYSIS

Constraints & Barriers: A Consolidated Analysis

Synthesizing across all 30 reviewed studies, eight principal constraint categories consistently limit the development of women-led agri-home enterprises. [Narayanan, 2014; Panda & Agarwal, 2018; Kantor, 2005; Minniti & Naudé, 2010] Land and asset constraints arising from gender-discriminatory inheritance and land tenure laws restrict women's ownership of agricultural land and fixed assets, limiting both productive capacity and collateral availability for enterprise financing. [Kantor, 2005; Doss, 2018; North, 1990] Financial access constraints arise because women entrepreneurs face collateral requirements they cannot meet, informal credit markets with exploitative interest rates, and low financial literacy. [Nair, 2011; Mishra & Nandal, 2020; Rajagopalan & Krishnamurthy, 2018] Market access and information constraints stem from restricted mobility, limited commercial networks, and information asymmetries that create persistent market access disadvantages for women

entrepreneurs. [Narayanan, 2014; Singh & Asokan, 2005; Kumar & Singh, 2018]

Time poverty and dual burden arise from women's simultaneous responsibility for reproductive domestic tasks and productive enterprise activities, creating severe time constraints that limit enterprise working hours, training participation, and market engagement. [Panda & Agarwal, 2018; Venkatasubramanian, 2022] Technical and managerial skills gaps persist due to limited access to vocational and technical education combined with restricted exposure to commercial enterprise environments. [Kumari & Singh, 2016; Kumar & Deshpande, 2021] Social and cultural constraints rooted in patriarchal norms governing women's mobility, household authority relations, and the social acceptability of women's commercial activity create psychosocial barriers that material interventions alone cannot address. [Elson, 1991; Welter, 2011; Kantor, 2005] Infrastructure and logistical constraints including inadequate road networks, unreliable electricity, and poor cold chain infrastructure impose cost and quality penalties on home food enterprises in remote locations. [Desai & Patel, 2019; Kumar & Singh, 2018] Regulatory and institutional constraints created by complex food safety and enterprise registration requirements create compliance burdens disproportionately affecting small home enterprises. [Sharma, Kale & Mishra, 2017; Minniti & Naudé, 2010]

Enablers and Success Factors: A Consolidated Analysis

Against the constraint landscape, the reviewed literature identifies enabling conditions and success factors that substantially improve enterprise outcomes when present. [Markelova et al., 2009; Nair, 2011; Jayawarna et al., 2013] Collective organization through self-help groups, producer cooperatives, and enterprise clusters consistently emerges as the most powerful enabling institution, functioning simultaneously as financial intermediary, training platform, market collective, and social

support network. [Markelova et al., 2009; Nair, 2011; Rajagopalan & Krishnamurthy, 2018] Integrated training programs that combine technical food processing skills with enterprise management, financial literacy, and market navigation content produce significantly larger and more durable performance improvements than single-domain training. [Kumar & Deshpande, 2021; Mishra & Nandal, 2020; Prakash, 2016] Digital market integration through mobile-based market information services and e-commerce platform adoption substantially expands market reach and price realization for women entrepreneurs able to access these tools. [Kumar & Singh, 2018; Venkatesh & Reddy, 2021; Rao & Joshi, 2022]

Traditional knowledge valorization enables women who successfully leverage traditional food processing and craft knowledge for product differentiation in premium markets to achieve substantially higher income outcomes than those competing in undifferentiated commodity markets. [Ramachandran & Nair, 2014; Ranganathan & Swaminathan, 2015; Menon & Krishnaswamy, 2021] Supportive household dynamics — where intra-household bargaining power and family support for enterprise activity are favorable — significantly modulate enterprise outcomes, with women reporting greater decision-making autonomy consistently achieving better performance. [Kantor, 2005; Bose & Majumdar, 2020; Panda & Agarwal, 2018]

Convergence and Divergence Across Disciplines

A notable finding of this cross-disciplinary synthesis is the substantial convergence across the three disciplines on the primacy of collective organization, training quality, and financial access as key determinants of enterprise outcomes. [Markelova et al., 2009; Jayawarna et al., 2013; Rajagopalan & Krishnamurthy, 2018] Divergence is most pronounced on the question of measurement and evaluation: the agribusiness management literature relies heavily on value chain

performance metrics; the home science literature emphasizes product quality, nutritional outcome, and household well-being measures; and the entrepreneurship literature prioritizes income, employment, and enterprise survival indicators. [Rao & Joshi, 2022; Bose & Majumdar, 2020; Mishra & Nandal, 2020] A distinctive contribution of the home science literature is its attention to the household as a site of resource management with implications for enterprise productivity, enriching understanding beyond what market performance indicators alone reveal. [Kumari & Singh, 2016; Panda & Agarwal, 2018; Venkatasubramanian, 2022]

INSTITUTIONAL SUPPORT SYSTEMS: STRUCTURES, GAPS, AND REFORM PRIORITIES

Self-Help Group & Microfinance Infrastructure

The Self-Help Group (SHG) model, institutionalized in India through the NABARD SHG-Bank Linkage Programme and now replicated across South Asia, Southeast Asia, and parts of Sub-Saharan Africa, represents the most pervasive institutional support structure for women's microenterprise development globally. [Rajagopalan & Krishnamurthy, 2018; Nair, 2011] The reviewed studies collectively document significant

REFERENCES

- Bose, M., and Majumdar, S. (2020). Women's enterprise income, income control, and household nutrition: A longitudinal study in West Bengal. *Journal of Nutrition and Development*, 11(1), 22-38.
- Brush, C. G., De Bruin, A. and Welter, F. (2009). A gender-aware framework for women's entrepreneurship. *International Journal of Gender and Entrepreneurship*, 1(1), 8-24. <https://doi.org/10.1108/17566260910942766>.
- Chambers, R. and Conway, G. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. IDS Discussion Paper 296. Brighton: Institute of Development Studies.
- Datta, P. B., & Gailey, R. (2012). Empowering women through social enterprise: A case study of SEWA and AMUL. *Academy of Management Perspectives*, 26(1), 13-27. <https://doi.org/10.5465/amp.2011.0067>
- Desai, M., & Patel, A. (2019). Sensory quality and shelf-life of traditional food products from women enterprises in Gujarat. *Indian Food Packer*, 73(2), 44-57.
- * DFID. (1999). *Sustainable livelihoods guidance sheets*. Department for International Development, London. Available at: <https://www.enonline.net/attachments/871/dfid-sustainable-livelihoods-guidance-sheet-section1.pdf>
- Doss, C. (2018). Women and agricultural productivity: Reframing the issues. *Development Policy Review*, 36(1), 35-50. <https://doi.org/10.1111/dpr.12243>
- Elson, D. (1991). *Male bias in the development process*. Manchester University Press.
- FAO. (2011). *The state of food and agriculture 2010-11: Women in agriculture*. Food and Agriculture Organization of the United Nations, Rome.
- * FAO. (2023). *The state of food and agriculture 2023: Revealing the true cost of food to transform agrifood systems*. Food and Agriculture Organization of the United Nations, Rome.
- Folbre, N. (1994). *Who pays for the kids? Gender and the structures of constraint*. Routledge.
- * GSMA. (2023). *The mobile gender gap report 2023*. GSMA Connected Women Programme. Available at: <https://www.gsma.com/r/gender-gap/>

- Isenberg, D. (2011). The entrepreneurship ecosystem strategy as a new paradigm for economic policy: Principles for cultivating entrepreneurship. Presentation at the Institute of International and European Affairs, Dublin, Ireland. May 12.
- Jayawarna, D., Rouse, J., & Kitching, J. (2013). Entrepreneur motivations and life course. *International Small Business Journal*, 31(1), 34-56. <https://doi.org/10.1177/0266242611401444>
- Kantor, P. (2005). Determinants of women's microenterprise success in Ahmedabad, India: Empowerment and economics. *Feminist Economics*, 11(3), 63-83. <https://doi.org/10.1080/13545700500301163>
- Kaplinsky, R., & Morris, M. (2001). *A handbook for value chain research*. International Development Research Centre (IDRC), Ottawa.
- Kumar, A., & Singh, K. M. (2018). Digital market platforms and women agri-food entrepreneurs: Evidence from Punjab and Haryana. *Agricultural Economics Research Review*, 31(1), 79-94. <https://doi.org/10.5958/0974-0279.2018.00009.7>
- Kumar, V., & Deshpande, A. (2021). Evaluating women entrepreneurship development programs: A multi-state assessment in India. *Journal of Entrepreneurship in Emerging Economies*, 13(4), 670-697. <https://doi.org/10.1108/JEEE-08-2019-0113>
- Kumari, S., & Singh, R. (2016). Home management skills and enterprise efficiency among women food processors in Bihar. *Journal of Home Science*, 47(1), 15-28.
- Markelova, H., Meinzen-Dick, R., Hellin, J., & Dohrn, S. (2009). Collective action for smallholder market access. *Food Policy*, 34(1), 1-7. <https://doi.org/10.1016/j.foodpol.2008.10.001>
- Menon, A., & Krishnaswamy, V. (2021). Intergenerational traditional knowledge transfer in women's agri-craft enterprises in Rajasthan. *Indian Journal of Traditional Knowledge*, 20(4), 803-815.
- Minniti, M., & Naudé, W. (2010). What do we know about the patterns and determinants of female entrepreneurship across countries? *European Journal of Development Research*, 22(3), 277-293. <https://doi.org/10.1057/ejdr.2010.17>
- Mishra, S., & Nandal, V. (2020). Growth orientation among women-led home food enterprises in North India: Determinants and pathways. *Journal of Small Business Management*, 58(3), 556-580. <https://doi.org/10.1080/00472778.2019.1599421>
- * Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- Nair, S. (2011). Microfinance, self-help groups, and social capital formation among women entrepreneurs in Kerala. *Journal of Social and Economic Development*, 13(2), 221-245.
- Narayanan, S. (2014). Women in agri-food value chains: Stratification and gender in Maharashtra. *Indian Journal of Agricultural Economics*, 69(3), 412-430.
- North, D. C. (1990). *Institutions, institutional change, and economic performance*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511808678>

- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press. [https://doi.org/ 10.1017/CBO9780511807763](https://doi.org/10.1017/CBO9780511807763)
- Panda, S., & Agarwal, B. (2018). Time allocation, household labor, and enterprise productivity: Evidence from women agri-entrepreneurs in Odisha. *World Development*, 102, 174-188. <https://doi.org/10.1016/j.worlddev.2017.09.017>.
- Patil, S., & Bodake, A. (2012). Nutritional characterization of value-added products developed by women self-help groups in Maharashtra. *Indian Journal of Home Science*, 2(1), 11-20.
- Porter, M. E. (1985). *Competitive advantage: Creating and sustaining superior performance*. Free Press.
- Prakash, D. (2016). Value chain integration of women pickle and preserve enterprises in Tamil Nadu. *Journal of Rural Development*, 35(2), 241-258.
- Rajagopalan, S., & Krishnamurthy, S. (2018). Impact of SHG-bank linkage on women enterprise development: Quasi-experimental evidence from South India. *World Development*, 105, 258-274. <https://doi.org/10.1016/j.worlddev.2018.01.004>
- Ramachandran, P., & Nair, V. (2014). Traditional textile enterprise, natural dye knowledge, and market differentiation: Women artisan groups in Kerala and Karnataka. *Craft Research*, 5(2), 145-168. https://doi.org/10.1386/crre.5.2.145_1
- Ranganathan, S. & Swaminathan, M. S. (2015). Traditional fermented foods, standardization, and women enterprise development in Tamil Nadu. *Indian Journal of Traditional Knowledge*, 14(3), 432-445.
- Rao, N., & Joshi, S. (2022). Market linkage quality and enterprise income performance: A structural equation analysis. *Journal of Agribusiness in Developing and Emerging Economies*, 12(3), 315-334. <https://doi.org/10.1108/JADEE-09-2020-0197>
- Reardon, T., Tschirley, D., Liverpool-Tasie, L. S. O., Awokuse, T., Fanzo, J., Minten, B., & Popkin, B. (2019). The hidden middle: The quiet revolution in the midstream of agri-food value chains in developing countries. *Oxford Policy Management Papers*. Oxford Policy Management, Oxford.
- Sharma, A., & Dev, S. M. (2020). Enterprise organizational form and performance: Women agri-processors in Rajasthan and Uttarakhand. *Indian Journal of Agricultural Economics*, 75(1), 68-85.
- Sharma, R., Kale, S., & Mishra, A. (2017). Food safety practices in women home food processing enterprises in Madhya Pradesh. *Journal of Food Science and Technology*, 54(8), 2512-2523. <https://doi.org/10.1007/s13197-017-2690-5>
- Singh, S., & Asokan, S. R. (2005). Women traders in tribal markets: Gender and price formation in Gujarat. *Economic and Political Weekly*, 40(25), 2484-2490.
- Sinha, S., & Roy, M. (2019). Entrepreneurial motivation among rural women in tribal India: A push-pull framework analysis. *Journal of Rural Studies*, 70, 44-56. <https://doi.org/10.1016/j.jrurstud.2019.09.004>
- Stam, E. (2015). Entrepreneurial ecosystems and regional policy: A sympathetic critique. *European Planning Studies*, 23(9), 1759-1769. <https://doi.org/10.1080/09654313.2015.1061484>.

- * Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, 14(3), 207-222. <https://doi.org/10.1111/1467-8551.00375>
- Venkataraman, S., & Karunakaran, A. (2023). Network structure and enterprise performance among women agri-food entrepreneurs in Tamil Nadu. *Entrepreneurship and Regional Development*, 35(5-6), 412-432. <https://doi.org/10.1080/08985626.2022.2151892>
- Venkatesh, P., & Reddy, A. A. (2021). E-commerce platform adoption by women-led agri-food enterprises: Evidence from Andhra Pradesh and Telangana. *Agricultural Economics Research Review*, 34(2), 147-162. <https://doi.org/10.5958/0974-0279.2021.00018.6>
- Venkatasubramanian, G. (2022). Nutrition-sensitive entrepreneurship: Reconceptualizing women's agri-enterprise for dual development outcomes. *Food and Nutrition Bulletin*, 43(2), 158-172. <https://doi.org/10.1177/03795721221085949>
- Welter, F. (2011). Contextualizing entrepreneurship: Conceptual challenges and ways forward. *Entrepreneurship Theory and Practice*, 35(1), 165-184. <https://doi.org/10.1111/j.1540-6520.2010.00427.x>
- * World Bank. (2022). *World development report 2022: Finance for an equitable recovery*. World Bank Publications, Washington D.C. <https://doi.org/10.1596/978-1-4648-1730-4>.
- {Additional credentialed references added to support unreferenced sentences are marked with an asterisk (*)}.

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RESEARCH ARTICLE

Adapting Rice Cultivation to Climate Change : An Analysis of Constraints and Recommendations**G. Ravindra Babu¹ , P.V.K Sasidhar^{2*} and Nisha Varghese² and T. Gopi Krishna³**

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ABSTRACT

This study, based on data collected from 240 rice farmers in Andhra Pradesh, India, examines the production, socio-economic, technological, and institutional constraints faced by farmers in adapting to climate change, along with their suggested solutions. The findings reveal that farmers encounter multiple challenges, including a lack of access to suitable and quality seeds, high cost of cultivation, and market price fluctuations. Additional constraints include inadequate technical knowledge of climate-resilient rice cultivation, the absence of weather-related insurance, and the need for timely financial resources before the cropping season. Farmers also reported insufficient access to weather and climate information, improper drainage management, delayed release of canal water, and crop losses due to frequent cyclones and pest outbreaks. Other issues include limited awareness of alternative cropping systems, ineffective procurement systems at the village level, dependence on rain-fed agriculture, continued reliance on traditional cultivation practices, and lack of information on adaptation strategies. Furthermore, non-availability of credit and subsidies, inadequate access to farm machinery, and insufficient storage facilities were identified as significant constraints. To address these challenges, farmers suggested several measures. These include the implementation of sustained and proactive government procurement systems, the timely availability of quality seeds at subsidized rates, and the improvement of rural infrastructure such as roads. They also emphasized the need for a timely supply of production inputs—including fertilizers, fungicides, and farm machinery—at subsidized prices to reduce cultivation costs. Additionally, the introduction of effective weather-based insurance schemes was strongly recommended. The study discusses the implications of these findings for enhancing climate change adaptation in rice farming systems.

Key words: Adaptation, climate change, rice farming, constraints, suggestions.**INTRODUCTION**

Climate change has been recognized globally as the most critical issue affecting mankind's survival in the 21st century. The most obvious manifestation of climate change is the rising of average worldwide temperature, popularly termed as global warming. The average annual temperature of the Earth's surface has risen over the last century. The mean global annual temperature increased between 0.4 to 0.7°C (Singh, 2008). Due to the immense

inertia of the earth's bio-geophysical system, a considerable degree of climate change is unavoidable even if very ambitious efforts are made to curb greenhouse gas emissions over the next few decades (IPCC, 2007). Climate change is already shifting the patterns of some types of extreme events in many world regions, and further changes are projected in the nature, magnitude, and frequency of different extreme weather events as climate change unfolds (IPCC, 2012).

Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forces or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2012). Changes in the mean and the variability of climate parameters will essentially influence agricultural cropping systems, especially under water-limited production, such as in the arid and semi-arid regions. Evidence of the changes in temperature, precipitation, and extreme weather events has been found on a scientific basis (IPCC, 2007).

The relationship between climate change and agriculture is quite complex and diverse. Bosello and Zhang (2005) stated that climate change and agriculture interdependencies evolve dynamically over time, they often cover a large spatial and temporal scale, and are still surrounded by large uncertainties. Declining rainfall and increasing temperature have had a significant negative impact on agricultural production and on food security (Parry *et al.*, 2007). Temperature favors the abundance of insects, whereas rainfall reduces the insect population (Morshed *et al.*, 2023). Scientific evidence shows that mean annual temperature has increased; and it is expected to further increase at a rate of 0.05°C per decade, while rainfall has been erratic, decreasing on average at a rate of 5 to 10 per cent per annum, with annual anomalies mostly below normal. The Intergovernmental Panel on Climate Change - IPCC (2001) reported that although adaptation is perceived as being very important to protect societies against the effects of climate variability and climate change, the statistics reveal a disproportionate impact in developing countries and on less-favored populations.

Rationale for the Study: The coastal states of India have been determined to be the most vulnerable regions to climate change (Malone

and Brenkert, 2008). Having the second-longest coastline, Andhra Pradesh is one of the top seven most vulnerable states in India. Moreover, the agricultural sector in the state is doubly exposed to climate change and globalization, and hence is seen at a much higher risk than most of the other states in India (O'Brien *et al.*, 2004).

Adaptation is identified as one of the policy options to reduce the negative impact of climate change (Adger *et al.*, 2003). Common adaptation methods in agriculture include: use of new crop varieties and livestock species that are more suited to drier conditions, irrigation, crop diversification, mixed crop livestock farming systems, and changing planting dates (Bradshaw *et al.*, 2004; Nhemachena and Hassan, 2007). Adaptation to climate change involves changes in agricultural management practices in response to changes in climate conditions. It often involves a combination of various individual responses at the farm level and assumes that farmers have access to alternative practices and technologies available in the region (Shashidhara and Reddy, 2012). Keeping this in view, the present study was conducted to assess the constraints being faced by rice farmers in adapting to climate change and to provide suggestions to reduce the negative impact of climate change.

MATERIALS AND METHODS

Study Locale and Sampling: The study was conducted in India's Andhra Pradesh state, following an ex-post-facto research design. Out of 13 districts of Andhra Pradesh, the top three districts under rice area, namely East Godavari, West Godavari, and Krishna were selected purposively for the study as rice is cultivated extensively in these districts, covering approximately 46 per cent of the total area under rice cultivation and also accounts for 47 per cent of the total production of rice in the state. From each district, two mandals were selected using a simple random sampling technique. From each mandal, two villages were selected at random by following a simple random sampling method.

Thus, a total of four villages from each district were selected for the study. Twenty respondents from each village were selected randomly using a random sampling method, thus making a total of 240 respondents.

Measurement: A constraint was operationally defined as a problem faced by farmers in adaptation to climate change in rice cultivation. The respondents were asked to express the problems faced by them in the adaptation to climate change, and the problems as stated by them were recorded. A suggestion to overcome the problems was operationally defined as the solutions given by farmers for the improvement of their adaptive capacity against the adverse impact of climate change. The respondents were requested to give their suggestions in order to enhance their adaptive capacity against the adverse impact of climate change.

Data collection and analysis: Each selected respondent was personally contacted and interviewed with the help of an interview schedule. It was ensured that the questions were correctly understood by the respondent by repeating the questions wherever necessary. Observation of respondents' background, behavior, emotions, feelings, ideas, aspirations, and surroundings was also made use of during interviews. Frequencies and percentages were calculated, and ranking was given in order of magnitude for constraints and suggestions.

RESULTS AND DISCUSSION

Constraints of Rice Farmers in Adaptation to Climate Change

The constraints faced by the rice growers for adaptation to climate change have been presented in four groups (Table 1).

Table 1: Constraints of rice farmers in adaptation to climate change (N=240)

Constraints	Frequency	%	Rank
A. Production related			
1) Lack of suitable varieties and quality seeds	207	86.25	I
2) Crop failure due to frequent cyclones and high incidence of pests	185	77.08	III
3) Rain fed condition	178	74.16	IV
4) High cost of cultivation	187	77.91	II
B. Socio-economic related			
1. Price fluctuation in the market	215	89.58	I
2. High cost of labor	173	72.08	III
3. Requirement of money a head of season for preparedness	184	76.66	II
4. Lack of suitable farm machinery and farmers inclination	154	64.16	V
5. Preference for traditional practices of rice cultivation	168	70.00	IV
C. Technology related			
1. Lack of information concerning adaptation options	145	60.41	IV
2. Lack of information about the weather and climate	169	70.41	II
3. Lack of proper knowledge on alternative cropping systems	158	65.83	III
4. Low technical knowledge of climate-resilient rice cultivation	178	74.16	I
D. Institutional related			
1) Improper management of drainage system and late release of canal water	212	88.33	II
2) Lack of proper storage capacity	178	74.16	V
3) Ineffective procurement system in the village	194	80.83	III
4) Non-availability of credit and subsidy facilities in the locality	186	77.50	IV
5) No weather-related insurance facility for rice	216	90.00	I

(a) Production-related problems: In production-related problems, lack of quality seeds and suitable varieties to sustain climate change was the most important problem mentioned by 86.25 per cent of the respondents. Lack of quality seeds in the market and non-availability of rice varieties that can withstand the adverse climatic conditions could be the main reason for this problem. As a result, the farmers could not get seeds on time, even though they wanted to purchase those seed varieties to adopt as a strategy for adaptation to climate change. This was followed by the high cost of cultivation, which was experienced by 77.91 per cent of the respondents. This was probably due to the increased cost of chemicals like fertilizers, fungicides, insecticides, and other production inputs. This also hindered the adoption of adaptation strategies to climate change in rice cultivation. The third problem reported by 77.08 per cent of the respondents was crop failure due to frequent cyclones and high incidence of pests. The climate in Andhra Pradesh favors many diseases, in rice especially Sheath Blight which is a destructive fungal disease of rice and the region, being a coastal area also experiences frequent cyclones. Cultivation of varieties that are susceptible to diseases might be the reason for the problems. Low income and unavailability of seeds in the locality could be to the reason for this problem. This was followed by rain-fed farming (74.16%).

(b) Socio-economic related problems: In socio-economic related problems, price fluctuation in the market was considered as the main problem by 89.58 per cent of the respondents. This could be due to the defunct status of market committees in the state. Low market price reduces the farmers' income, and this in turn, hampers them from purchasing the necessary farm inputs meant for adaptation to climate change. The second problem reported by 76.66 per cent of the farmers was their requirement for money ahead of the season for preparedness. In fact, an adaptation strategy requires some capital for preparedness to combat climate change or to

reduce the impacts of climate change. Thus, the low economic status of the respondents does not permit them to adopt the adaptation practices. Higher cost of labor using scientific methods was reported by 72.08 per cent of the respondents. This also hampered the low-income farmers from hiring necessary farm labor for adaptation to climate change. The fourth problem in adaptation to climate change was their preference for traditional practices of rice cultivation (70.00%). Farmers still believed that using their own traditional practices, the cost of cultivation would be less, and traditional practices were easy to follow. The last constraint was a lack of suitable farm machinery and farmers' inclination to use it, which was expressed by 64.16 per cent of the respondents.

(c) Technology-related problems: The most important problem was less technical knowledge of climate-resilient rice cultivation, which was mentioned by 74.16 per cent of the respondents. This was probably due to the lack of extension services provided by the government in this matter. Even though the farmers wanted to adapt to climate change, the lack of knowledge about the adaptation practices hampered them from adapting to climate change. The second problem, which was expressed by 70.41 per cent of the respondent was lack of information about weather and climate. This was probably due to the lack of weather forecasting by the State Meteorological Department and State Agriculture Department. Information about weather and climate is very important for preparedness to climate change. Thus, lack of such knowledge would reduce the adaptive capacity of farmers. This was followed by lack of proper knowledge on alternative cropping systems (65.83%) and lack of information concerning adaptation options (60.41%). These were also probably due to the lack of modern extension services provided by the government and NGOs. Knowledge about plant protection is very important for a farmer in Andhra Pradesh, as the climate favours many

Table 2: Suggestions Offered by Rice Farmers to Overcome the Constraints (N=240)

Suggestions	Frequency	%	Rank
1. Quality and improved seeds should be available in time at a subsidized rate	203	84.58	II
2. The government should arrange for the timely supply of production inputs like fertilizers, fungicides, farm machinery, etc. at a subsidized rate to reduce the cost of cultivation	195	81.25	IV
3. Announcement of the minimum support price by the government in advance	176	73.33	VIII
4. Inclusion of agricultural operations under MGNREGA	164	68.33	IX
5. Training on climate resilient rice adaptation options should be given by the government, research stations, etc.	183	76.25	VI
6. Diversification of farming system	158	65.83	X
7. The government should take up sustained and pro-active procurement	215	89.58	I
8. Improved infrastructural facilities like roads	198	82.50	III
9. Arrangement for availability of credit with increased scale of finance	177	73.75	VII
10. Enhancement of storage facilities in the locality	144	60.00	XI
11. Implementation of the weather-related insurance scheme and enhancement of the input subsidy	188	78.33	V

diseases. Thus, a lack of such knowledge would reduce the adaptive capacity of farmers.

(d) Institution related problems: No weather-related insurance facility for rice crop was considered as the major problems by 90.00 per cent of the respondent. Crop insurance is one of the important inputs for adaptation to climate change for the farmers in the state where the adverse impact of climate change reduced the production and also sometimes resulted in total loss of the crops. This was followed by improper management of the drainage system and late release of canal water, which was mentioned by 88.33 per cent of the respondents. The third problem mentioned by 80.83 per cent of the farmers was the ineffective procurement system. Non-availability of credit and subsidy facilities was the fourth problem in this group, which was expressed by 77.50 per cent of the respondents. Credit and loans are very important inputs in adaptation to climate change, and it should be readily available whenever needed by the farmers. Lack of proper storage capacity was

mentioned by 74.16 per cent of the respondents. The climate of Andhra Pradesh, characterized by varying levels of relative humidity, is highly conducive to the spoilage of rice during storage. Therefore, farmers require proper storage facilities to preserve seeds for the next sowing season and to store produce for sale at a later stage when market prices are more favorable.

Suggestions Offered by Rice Farmers to Overcome the Constraints

The suggestions offered by rice farmers in order to overcome the problems in adaptation to climate change have been presented in Table 2. The suggestions given by the respondents during the investigation indicated that sustained and proactive procurement by the government was the most important suggestion given by 89.58 per cent of the respondents. This was probably due to the fact that procurement activities are very poor in the rural areas. This was followed by the suggestion on timely availability of quality and improved seeds at subsidized price

(84.58%), whereas 82.50 per cent of the respondents suggested the need for improved infrastructural facilities like roads in the locality. This was probably due to poor transport facilities in the locality and also of not having their own means of transportation. The need for arrangement of timely supply of production inputs like fertilizers, fungicides, farm machinery etc., by the government at subsidized rate to reduce cost of cultivation was expressed by 81.25 per cent of them, and implementation of a weather-related insurance scheme and enhancement of input subsidy was suggested by 78.33 per cent of respondents. Training on climate resilient rice adaptation options should be given by the government, research stations, etc., as suggested by 76.25 per cent of the respondents. This was probably due to the lack of knowledge on scientific practices and adaptation options by the farmers. The need for arrangement for availability of credit with an increased scale of finance was expressed by 73.75 per cent of respondents. Announcement of minimum support price by the government in advance was suggested by 73.33 percent of the respondents. This was probably due to price fluctuation in the market. Other suggestions given by the farmers were inclusion of agricultural operations under MGNREGA (68.33%), Diversification of farming systems (65.83 %), and enhancement of storage facilities in the locality (60.00 %).

CONCLUSION

The production, socio-economic, technology and institutional related constraints of rice farmers in adaptation to climate change and suggestions offered by them to overcome the constraints are presented in this paper. As a lack of knowledge about climate-resilient rice cultivation and adaptation options was the major constraint for most of the farmers, the State Department of Agriculture should increase the extension services to the rural areas on climate change. This can be achieved by conducting the demonstrations to pass on the scientific method of production to the rice growers. Also, capacity

building training programmes for farmers in adaptation procedures are to be conducted by the State Department of Agriculture, the University, NGOs, and KVKs to overcome constraints. As climate and weather-related information play an important role in adaptation to climate change, regular provision of climate and weather-related information by the State Meteorological Department, Department of Agriculture, and other agencies through mass media for greater awareness is recommended. The information should be provided in such a way that it reaches up to the village level. This in turns provides a greater farmer-to-farmer information exchange related to climate and weather information. This will help the farmers to think about and adopt the different adaptation practices or they can develop community adaptation as a whole. The agricultural universities in the state and other research organizations should develop more varieties and technologies that will help the farmers adapt to climate change. The scientists should concentrate on the development of short-duration, high-yielding, disease and pest-resistant varieties/ hybrids with appropriate parameters, prevention of post-harvest losses to meet the needs of the farmers in adaptation to climate change. There is an urgent need to develop heat-stress resilient varieties in rice. Important production inputs like fertilizers, fungicides, insecticides, etc., should be available in time so that the farmers can perform their farm operations in time.

REFERENCES

- Adger, W.N., Huq, S., Brown, K., Conway, D and Hulme, M. 2003. Adaptation to climate change in the developing world. *Progress in Development Studies*. 3: 179-195.
- Bosello, F. and Zhang, J. 2005. *Assessing Climate Change Impacts : Agriculture*. Working Paper, Climate Impacts and Policy Division. Accessed March 7, 2014. http://www.transtest.org/workplan/papers/wp2_task4_agriculture.pdf.

- Bradshaw B., Dolan, H. and Smit, B. 2004. Farm-Level Adaptation to Climatic Variability and Change: Crop Diversification in the Canadian Prairies. *Climatic Change* 67: 119–141.
- Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report: Contribution of Working Groups I, II and III to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Core Writing Team, Pachauri R K and Reisinger A, IPCC, Geneva, 2008, p45.
- Intergovernmental Panel on Climate Change. 2001. *Climate change: The scientific basis*. <http://www.ipcc.ch>
- IPCC (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation*. In : Field CB, Barros V, Stocker TF, Qin D, Dockken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner GK, Allen SK, Tignor Midgley PM (eds). A special report of working groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, 582 pp.
- Malone, E.L and Brenkert, A.L. 2008. Uncertainty in resilience to climate change in India and Indian States. *Climate Change* 91 (3-4) : 451-476.
- Morshed, N.M., Mamun, A.A.M., Nihad, S.A.I., Rahman, M.M., Sultana, N. and Rahman, M.M. 2023. Effect of weather variables on seasonal abundance of rice insects in southeast coastal region of Bangladesh. *Journal of Agriculture and Food Research, Volume 11*, March 2023.
- Nhemachena, C and Hassan, R. 2007. *Micro-level analysis of farmers' adaptation to climate change in Southern Africa*. IFPRI Discussion Paper No. 00714. International Food Policy Research Institute, Washington, D.C.
- O'Brien, K., Sygna, L., Naessm L.O., Kingamkono, R and Hochobeb, B. 2000. *Is information enough? User responses to seasonal climate forecasts in Southern Africa*. Report 2000:3, Center for International climate and Environmental Research (CICERO), Oslo.
- Parry, M.L., Canziani, O.F., Palutikof, J.P., Van Der Linden, P.J and Hanson C.E. 2007. Contribution of Working Group II to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, 453.
- Shashidhara, K.K. and Reddy, B.S. 2012. Farmers' Perceptions and Adaptation about Changing Climate and Its Variability in UKP area of Karnataka. *Indian Research Journal of Extension Education, Special Issue (Volume I) : 196-201*.
- Singh, G. 2008. Challenges of climate change and options to overcome them. *Intensive Agriculture*, pp : 9-16.

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RESEARCH ARTICLE

Analysis of the Agri Start-up Ecosystem in Southern Karnataka : A Comprehensive Study

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ABSTRACT

This research provides a detailed examination of the agricultural start-up ecosystem in Southern Karnataka, specifically targeting Bangalore Urban, Bangalore Rural, Kolar, and Chikballapur. Utilizing a sample of 50 entrepreneurs, the study analyzes the interplay between socio-economic characteristics and entrepreneurial behavior. Findings indicate that 42.00% of start-ups were established between 2017 and 2020, with 40.00% currently in the validation stage. A high level of overall entrepreneurial behavior (70.00%) was observed, significantly influenced by education, urban background, ICT utilization, and financial sources. Major constraints include capital acquisition and market competition, while the primary suggestion is the streamlining of credit facilities.

INTRODUCTION

Agriculture supports half of India's workforce but remains high-risk due to weather and market volatility. Technical advancements and the "agribusiness" model are critical for boosting productivity. India now hosts the world's third-largest start-up ecosystem, with Karnataka and Maharashtra emerging as major hubs, accounting for nearly 50% of recent agribusiness start-ups. Karnataka, as the "most inventive state," hosts approximately 300 agri-start-ups, with Bangalore serving as the start-up capital due to developed infrastructure and proactive 2015 government policies. Startups are essential to fostering creativity in society. Big things do, as they say, come in little packages. This holds especially true for newly formed startup businesses. The startups serve as an example of how many small things working together may produce great things. These firms aim to solve problems one little step at a time, a problem at a time, through disruptive innovation. The companies are proven to be the world's change agents. With fresh concepts and the creation of cutting-edge technologies, these

newly established small businesses are transforming their respective industries.

Startups are known to be small businesses, but they are crucial to the expansion of the economy. They are in charge of generating new jobs, which results in greater employment and a healthier economy. These startups not only support the economy but also foster competition and creativity. Startups have an impact on the socioeconomic structure of the community in which they are located. Startups can aid structural change by introducing novel knowledge-intensive goods and services. And once they went public, they really started to make money not just for the owners but also for the staff and shareholders. Additionally, they introduce proactive values into society while promoting the research and innovation system. In a society based on knowledge, the majority of developed nations support the startup ecosystem both from the perspective of making investments in the future and from the perspective of actively designing long-term economic policy. This encourages both underdeveloped and developing nations to

increase investment in these startups in order to foster innovation, new jobs, and economic growth. It also fosters competitive dynamics in the economy, promotes the system of research and innovation, and fosters a sense of initiative in society. The only way to accelerate a country's economic progress is through entrepreneurship.

Startup Ecosystem of India

A startup ecosystem is formed by people, startups in their various stages and various types of organizations in a location (physical or virtual), interacting as a system to create and scale new startup companies. These organizations can be further split into universities, financing organizations, support organizations (like incubators, accelerators, co-working spaces, etc.), research organizations, service provider organizations (like law firms, financial services, etc.), and large corporations. Startups and ecosystem operations are often the focused on numerous organizations at various phases of development. The startup environment also depends heavily on resources like time, money, and talents. Most of the resources that move through startup ecosystems are supplied by the individuals and groups that actively participate in them. Through events and meetings with and between organisations and

different people, these interactions play a crucial part in the circulation of resources through the system, assisting in the generation of new potential startups or strengthening existing ones, and thereby impacting the number of startups built.

METHODOLOGY

The study employed a descriptive research design across four Southern Karnataka districts. A purposive sampling of 50 entrepreneurs from diverse subsectors (Agri-tech, Dairy-tech, Food processing) was used. Data were analyzed using Mean, Standard Deviation, and the Chi-square test to determine associations between 16 independent variables and entrepreneurial behavior.

RESULTS AND DISCUSSION

Characteristics OF the Start-up Ecosystem

The ecosystem maturity is reflected in the establishment dates and operational stages of the identified firms.

The surge between 2017 and 2020 is attributed to the "Start-up India" initiative (2016) and Karnataka's early start-up policy (2015). The concentration in Bangalore Urban (56.00%) highlights the district's superior networking and financial environment.

Table 1: Start-up Ecosystem Profile (N=50)

Parameter	Category	Number	Percentage
Year of Inception	Before 2015	04	08.00
	2015-2016	14	28.00
	2017-2020	21	42.00
	2021-2022	11	22.00
Development Stage	Ideation	06	12.00
	Early Traction	05	10.00
	Validation	20	40.00
	Scaling Up	19	38.00
Headquarters Location	Bangalore Urban	28	56.00
	Bangalore Rural	14	28.00
	Kolar	05	10.00
	Chikkaballapur	03	06.00

Table 2: Dimensions of Entrepreneurial Behavior (N=50)

Dimension	High (%)	Medium (%)	Low (%)
Innovativeness	80.00	14.00	06.00
Leadership Behavior	74.00	18.00	08.00
Achievement Motivation	66.00	18.00	16.00
Entrepreneurial Self-efficacy	56.00	24.00	20.00
Overall Behavior	70.00	18.00	12.00

Table 3: Association of Characteristics with Entrepreneurial Behavior

Independent Variable	Chi-square Value	Significance
Education	26.42**	Highly Significant (1%)
Source of Finance	12.26**	Highly Significant (1%)
Utilization of ICT tools	4.29**	Highly Significant (1%)
Rural-urban background	6.29**	Highly Significant (1%)
Age	7.26*	Significant (5%)
Entrepreneurial Experience	17.36*	Significant (5%)
Market Orientation	12.77*	Significant (5%)

Socio-economic Profile of Entrepreneurs

The profile of the entrepreneurs is characterized by high education levels and a predominantly urban, male-dominated background.

- **Age:** 78.00% are between 26 and 45 years old, representing a productive age group with the vigor for risk-taking.
- **Education:** A vast majority (78.00%) are postgraduates or above, suggesting that the complexity of the agri-business domain requires high cognitive capabilities.
- **Specialization:** 34.00% hold Engineering degrees, while only 10.00% come from Farm Science backgrounds, indicating that technical skills are prioritized for Agri-tech solutions.
- **Gender:** Men dominate the sector (84.00%), likely due to greater access to assets and fewer conventional social constraints compared to women in many Indian households.

Entrepreneurial Behavior Dimensions

Entrepreneurial behavior was measured across several psychological and business-oriented dimensions.

The high levels of innovativeness reflect the necessity for start-ups to find novel, cost-effective solutions for agricultural problems.

Statistical Association (Chi-square Analysis)

The relationship between independent variables and entrepreneurial behavior reveals critical drivers of success.

Education and ICT usage facilitate better information interpretation and operational efficiency, while stable financial sources improve the entrepreneurial attitude toward risk.

Constraints and Suggestions

- **Financial Constraints:** 80% face capital raising challenges, and 60% struggle with cash flow.

- **Marketing Constraints:** 68% face heavy competition from local vendors.
- **Top Suggestion:** 86.00% of respondents demand prompt credit facilities and better cash allocation.
- **Regulatory Suggestion:** 80.00% suggest simplifying the legislative framework for registration and licensure.

CONCLUSION

Agri-start-ups in Southern Karnataka are a vital component of the agricultural value chain, driven by highly educated, innovative individuals. While the ecosystem in Bangalore is robust, success depends on bridging the gap between farm science and technical engineering, and improving financial support systems. Future research should utilize larger sample sizes and

explore different regions of the state to generalize these findings.

REFERENCES

- ANONYMOUS, 2018, Indian tech start-up ecosystem 2018, NASSCOM.
- ANONYMOUS, 2020, Educated startups, Financial Express.
- BAIRWA, S. L., et al., 2014, Agribusiness potential of North Eastern states, EBH publishers.
- KHANKA, S. S., 2009, Entrepreneurship Development, S. Chand & Company Ltd.
- SHUBHAM, 2020, Financial, marketing and other challenges faced by startups.
- VIKRAM, V., 2015, A Study on Challenges for Startups in India, IJME.

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REVIEW ARTICLE**Artificial Intelligence for Agricultural Development****P. B. Kharde**

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INTRODUCTION

Agriculture plays a vital role in Indian economy. Government has set a target of doubling of farmer's income by the year 2022 as well as Agriculture export policy has set a target to increase agricultural exports to over US\$ 60 billion by 2022 (Manaware, 2020). The global population is expected to reach 10 billion people by 2050, which means double agriculture production in order to meet food demands which are about 70% increase in food production (Dua, 2018). The traditional methods which are used by the farmers are not sufficient enough to fulfill these requirements. Thus, new technologies are required to be introduced. These new technologies would satisfy the food requirements and also provide employment opportunities to people.

Artificial Intelligence (AI) provides accurate and timely information regarding crops, weather and insect etc. to the farmers which would improve the crop productivity, reduce the risk and improve the income of the farmers. Artificial Intelligence in agriculture will bring an agriculture revolution. This technology would protect the crop yield from various factors like the climate change, population growth, employment issues and the food security problems. These technologies saves the excess use of water, pesticides, herbicides, maintains the fertility of the soil, also helps in the efficient use of manpower and elevate the productivity and improve the quality.

Artificial intelligence has a vital role to play in the future of humankind. That includes the agricultural industry as well. Today's agriculture need to use sophisticated

technologies such as robots, temperature and moisture sensors, aerial images and GPS technology. These advanced devices and precision agriculture and robotic systems allow businesses to be more profitable, efficient, safer and more environmentally friendly. With predictive analytics, farmers can now collect and process data easily and do it faster with AI. Forecasting prices, analyzing market demand and determining the optimal time for sowing and harvesting are some of the crucial tasks which farmers can solve with AI. AI in agriculture, also known as precision agriculture, is the application of artificial intelligence (AI) solutions in the agricultural industry. The technology is used for field harvesting, health monitoring, weed and pest control, detection of nutrient deficiencies in soil and other tasks. Innovative farming practices like vertical agriculture may help increase food production while minimizing the use of resources. The result is reduced use of herbicides, better harvest quality, higher profits and significant cost savings. AI saves the agriculture sector from different factors such as climate change, population growth, employment issues in this field and food safety. Today's agriculture system has to reach at a different level due to AI. Artificial Intelligence will help for improved crop production and real-time monitoring, harvesting, processing and marketing. The traditional methods that are used by the farmers are not sufficient to fulfil the need at the current stage. Hence, some new automation methods need to be introduced to satisfy these requirements and to provide great job opportunities to many people in this sector.

What is AI?

Artificial Intelligence is a branch of computer science dealing with the simulation of intelligent behavior in computers. Artificial Intelligence is not a man versus machine saga; its in fact, man with machine synergy. The basic concept of AI is to develop a technology which functions like a human brain (Jani *et al.*, 2019 and Parekh *et al.*, 2020). This technology has enhanced crop production and improved real-time monitoring, harvesting, processing and marketing (Yanh *et al.*, 2007). The latest technologies of automated systems using agricultural robots and drones have made a tremendous contribution in the agro-based sector. Various hi-tech computer based systems are designed to determine various important parameters like weed detection, yield detection and crop quality and many other techniques (Liakos *et al.*, 2018).

AI is an area of computer science that emphasizes the creation of tangible or intangible systems which not only behave intelligently but also display behavior to the same level as human beings think and act (and in times to come, better than them), achieving human-like performance in all cognitive tasks using purely logical reasoning. Thus, while the “artificial” in AI can be understood as ‘non-biological’, the ‘intelligence’ can be taken as ‘ability to accomplish complex goals or tasks’. AI is the cognitive process one can associate with human thinking like speech recognition, natural language understanding and translation, knowledge management, image analysis, decision making, learning etc. which will make systems powerful and useful. (L. Bhar *et al.*)

Birth of Artificial Intelligence

In the year 1955, Allen Newell and Herbert A. Simon created the “first artificial intelligence programme” which was named as “Logic Theorist”. This programme had proved 38 of 52 Mathematics theorems and found new and more elegant proofs for some theorems. During the year 1956, the word “Artificial

Intelligence” first adopted by American Computer scientist John McCarthy at the Dartmouth Conference. For the first time, AI was coined as an academic field. In the year 1966, the researchers emphasized developing algorithms which can solve mathematical problems. Joseph Weizenbaum created the first chatbot in 1966, which was named as ELIZA. In the year 1972, the first intelligent humanoid robot was built in Japan which was named as WABOT-1.

Types of AI

There are three types of AI namely ANI, AGI and ASI. The first type, ANI (Artificial Narrow Intelligence) is very common, like Google maps, it is awesome at finding efficient routes to places while riding a car, or can be likened to a chess playing programme. Number two is AGI (Artificial General Intelligence) which is like a computer that is as smart as a human in all aspects. So, anything we can do with our brain, it can do, including learning. AI is getting powerful day by day with applications leading to machines and systems leading to more advanced AI i.e. ASI (Artificial Super Intelligence), which would be when a computer or a system is better than a human being, that is wiser, more creative, more socially adaptable and it has range from being a little bit better to being smarter than the sum of all humanity combined.

Application of AI in agriculture

- **Crop health monitoring:** Using high resolution weather data, remote sensing data, AI technologies and AI platform, it is possible to monitor crops holistically. It provides additional insights to the farmers for their farms as and when required. In a case study, in 2016, Microsoft, in partnership with ICRISAT, initiated a pilot project in Devanakonda Mandal in the Kurnool district of Andhra Pradesh. The Pilot had a sample base of 175 farmers who were alerted on their mobile phones about

suitable cropping dates, land preparation and soil test- based fertilizer utilization. This helped increase crop output by around 30%. In 2017, this project was expanded to cater to approximately 3,000 farmers in Karnataka and Andhra Pradesh during the kharif cycle for crops like groundnut, ragi, maize, rice and cotton. The increase in crop yield following the AI intervention ranged from 10-30% across all crops (Nagpal, 2017).

- **Soil health monitoring:** Image recognition and deep learning models have enabled distributed soil health monitoring without the need of laboratory testing infrastructure. AI solutions integrated with data signals from remote satellites, as well as local image capture in the farm and help farmers to take immediate possible action to restore the soil health.
- **Soilsens:** The system is embedded with soil moisture sensor, soil temperature sensor, ambient humidity sensor and ambient temperature sensor. Based on these parameters, farmers are advised about optimum irrigation through a mobile app.
- **Robots in Agriculture:** Agriculture robotics also known as an agribot, now becoming popular due to labour shortage and increased need to feed the global population. This includes applications such as harvesting; picking, seeding, spraying, pruning, sorting and packing.
- **Crop harvesting:** AI enabled robots for harvesting can lead to huge cost saving by reducing the need for approximately 4 agricultural labourers per acre of land (Panpatte, 2018). AI-enabled robots are being widely deployed on tomato farms in Japan and have reduced the on field labour time by 20% (Panasonic 2018).
- **Driverless Tractor:** Using ever-more sophisticated software coupled with off-the-shelf technology (sensors, radar and GPS),

the system allows an operator working a combine to set the course of a driverless tractor. The New Holland introduced their new autonomous tractors at 2016 farm progress show.

- **Smart irrigation:** In this approach different sensors are built for different purposes like the soil moisture sensor to detect the moisture content in the soil, the temperature sensor to detect the temperature, the pressure regulator sensor to maintain pressure and the molecular sensor for better crop growth. The output of all these devices is converted to digital signal and it is sent to the multiplexer through wireless network such as hotspot.
- **Weed management:** Blue river technology has designed an integrated computer vision and machine learning technology that enables farmers to reduce the use of herbicides by spraying only where weeds are present, optimizing the use of inputs in farming - a key objective of precision agriculture.
- **Drones in agriculture:** Drones are equipped with multi-spectral and photo cameras that can monitor crop stress, plant growth and predict yield. Drones are being implemented in agriculture for crop health monitoring, irrigation equipment monitoring, weed identification, herd and wildlife monitoring, and disaster management, spraying (Natu and Kulkarni, 2016).
- **Crop spraying:** Drones are now been utilized as substance sprayers by farmers and they are considered as effective and of great importance in the situation of cloudy climate and has also solved the problem of inaccessibility to a field of tall crops like sugarcane, maize.
- **Livestock management:** For livestock management drones are used to monitor the animal grazing the grass in the open field. It

prescribes the feed rations, medications, health and welfare conditions for livestock. It also perform the complex analysis of health, reproduction status and recommends operational measures.

- **Weather forecasting:** Artificial Intelligence in farming along with the satellite data can be used to predict the weather conditions. The Artificial Intelligence (AI) in farming is able to provide billions of data points including temperature, precipitation, wind speed and solar radiation.
- **Chatbots for farmers :** Chatbots are nothing but the conversational virtual assistants who automate interactions with end users. They are mainly equipped for retail, travel, media and agriculture has used this facility by assisting the farmers to receive answers to their unanswered questions, for giving advice to them and providing various recommendations also. In this case, *Jivabhum* is an agri- tech platform for connecting farmers directly with Institutional buyers and consumers. *Jivabhum* partners with farmers, farmers group, aggregates farm produce and makes it traceable leveraging BLOCKCHAIN enabled platform called FOOTPRINT. *Jivabhum* enables consumers (B2C) and institutional buyers (B2B) to buy chemical, pesticide free and traceable farm produce directly from the producers. Another case study is of Gobasco, which is an artificial intelligence- based platform that offers procurement optimization and yield prediction solution for the agriculture sector. The aim is to use artificial intelligence and big data to optimize the agrisupply-chain across India. This approach provides farmers and agricultural SMEs (Small and Medium enterprises) with a datarich technology platform and network to grow their profits, thereby creating new opportunities in rural commerce.

Advantages of AI in Agriculture

- AI provides more efficient ways to produce, harvest and sell essential crop, improving crop management practices.
- AI implementation emphasis on checking defective crops and improving the potential for healthy crop production.
- The growth in artificial Intelligence technology has strengthened agro-based businesses to run more efficiently.
- AI is being used in applications such as automated machine adjustments for weather forecasting and disease or pest identification.

Limitations of AI

- Inadequacy in experience with advanced high tech machine learning solutions.
- Loss of employment opportunities.
- Cost of technology is high.

CONCLUSIONS

AI can be appropriate and efficacious in Agriculture sector as it optimizes the resource use and efficiency. It solves the scarcity of resources and labour to a large extent. Adoption of AI is quite useful in agriculture. Artificial intelligence can be technological revolution and boom in agriculture to feed the increasing human population of world. Artificial intelligence will complement and challenge to make right decision by farmers. AI can gives precise knowledge of areas where pest or disease has started would enable the farmer to apply just right amount of pesticides, thereby yielding both economic and environmental benefits.

REFERENCES

- en.wikipedia.org>wiki>Artificial intelligence in agricultural development.
- Role of Digital and AI Technologies in Indian Agriculture: Potential and way forward. Tanay Mahindru, NITI Aayog. 26th September, 2019.

Era of Artificial Intelligence: Prospects for Indian Agriculture, Lal Mohan Bhar*, Ramasubramanian V., Alka Arora, Sudeep Marwaha and Rajender Parsad, ICAR-Indian Agricultural Statistics Research Institute, New Delhi

Artificial Intelligence: A New Way to Improve Indian Agriculture. Diksha Manaware* Department of Horticulture (Vegetable Science), JNKVV, Jabalpur (M.P.), India
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RESEARCH ARTICLE

Determinants of Adoption of Climate-Resilient Water Conservation Practices: An Empirical Analysis of the PoCRA Initiative in Maharashtra

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ABSTRACT

In the era of anthropogenic climate change, strategic water resource management is the cornerstone of the “Evergreen Revolution.” This study empirically evaluates the adoption of climate-resilient water conservation practices under the Project on Climate Resilient Agriculture (PoCRA) in the Marathwada region of India. Employing an ex-post facto research design, primary data were elicited from 150 beneficiary farmers in the Aurangabad district. The psychographic and socio-economic profiling revealed that a majority of respondents were middle-aged (58.67%) with secondary educational attainment (47.34%). While awareness is pervasive, the aggregate adoption index remained “Medium” for 56.67% of the cohort. Inferential statistics, specifically Pearson’s Correlation, identified annual income ($r=0.512$) and extension contact ($r=0.456$) as significant catalysts for technological uptake. Conversely, age exhibited a deleterious effect on adoption propensity. The study identifies systemic economic and procedural bottlenecks and proposes a decentralized extension model to bridge the “awareness-adoption” gap.

Keywords: Climate-Smart Agriculture (CSA), Water Governance, PoCRA, Technology Adoption, Socio-Economic Determinants, Marathwada.

INTRODUCTION

The intersection of climate variability and agricultural sustainability represents a critical challenge for the Global South. In India, where approximately 70% of total water withdrawal is dedicated to irrigation, the vulnerability of the agrarian economy to erratic monsoons and thermal stress is acute (Government of India, 2008). As M.S. Swaminathan posited, water management must be the “Number One” priority to transition from mere food security to nutritional and climate security.

In this context, the **Project on Climate Resilient Agriculture (PoCRA)**—a multi-sectoral initiative funded by the World Bank—was launched in Maharashtra to enhance farm-level resilience. PoCRA promotes a suite of technologies including micro-irrigation (drip/sprinkler), *in-situ* moisture conservation,

and recharging structures. However, the diffusion of these innovations is not merely a technical challenge but a behavioral one. This research investigates the socio-psychological and structural drivers that govern the adoption lifecycle among smallholder farmers.

Research Objectives

The investigation was guided by the following cardinal objectives:

1. To delineate the socio-economic and psychological landscape of PoCRA beneficiaries.
2. To quantify the adoption intensity of climate-resilient water conservation protocols.
3. To analyze the statistical correlation between antecedent farmer characteristics and adoption levels.
4. To diagnose structural constraints and synthesize farmer-led strategic interventions.

3. Methodology

3.1 Study Locale and Sampling Matrix:

The study was conducted in the **Aurangabad district** of Maharashtra, a region categorized by high climatic sensitivity. A multi-stage purposive random sampling technique was employed. Two tehsils (**Kannad and Vaijapur**) were selected based on project saturation. Six villages were chosen as primary sampling units, with 25 beneficiaries selected from each, culminating in a total sample of N=150.

Statistical Framework:

An **ex-post facto research design** was adopted to observe the variables in their natural state without manipulation. Data were collected via a validated, structured interview schedule. Analysis was performed using:

- **Descriptive Statistics:** Mean, Standard Deviation (S.D.), and Percentages.
- **Inferential Statistics:** Pearson's Correlation Coefficient (r) to test hypotheses regarding variable relationships.

RESULTS AND DISCUSSION

Socio-Economic Characterization

The capacity for innovation adoption is intrinsically linked to the respondent's socio-economic capital.

Table 1: Descriptive Statistics of Respondent Profile (N=150)

Dimension	Category	Frequency (f)	Percentage (%)
Age	Young (<35 years)	29	19.33
	Middle (36–55 years)	88	58.67
	Old (>55 years)	33	22.00
Education	Illiterate	10	6.67
	Primary / High Primary	50	33.32

Land Holding	Secondary / Higher Secondary	71	47.34
	Graduate and above	19	12.67
	Marginal (Up to 1.0 ha)	39	26.00
	Small (1.01 to 2.00 ha)	54	36.00
	Semi-Medium (2.01 to 4 ha)	31	20.67
	Medium / Large (>4.00 ha)	26	17.33

Discussion :

The dominance of small and marginal landholders (62%) aligns with the PoCRA mandate of prioritizing vulnerable farm households. The high concentration of middle-aged, literate farmers suggests a receptive demographic for extension interventions, albeit one that requires specific economic incentives.

Aggregate Adoption Index

The adoption of water conservation practices was categorized into three tiers based on the cumulative adoption score.

Table 2: Distribution of Respondents by Adoption Intensity

Adoption Tier	Score Range	Frequency (f)	Percentage (%)
Low	<(Mean - 0.44 SD)	31	20.67
Medium	(Mean $\pm$ 0.44 SD)	85	56.67
High	>(Mean + 0.44 SD)	34	22.66
Total		150	100.00

Discussion

The “Medium” level of adoption for 56.67% of the cohort indicates a state of partial implementation. While farmers have adopted basic components (e.g., drip sets), the integrated use of recharging structures and scientific

irrigation scheduling remains suboptimal due to technical gaps.

Correlation Matrix

Pearson's correlation analysis was executed to identify the determinants of adoption.

Table3: Correlation Coefficients for Adoption Determinants

Independent Variable (X)	Correlation Coefficient (r)
Age (\$X_1\$)	-0.185*
Education (\$X_2\$)	0.421**
Annual Income (\$X_3\$)	0.512**
Social Participation (\$X_4\$)	0.398**
Extension Contact (\$X_5\$)	0.456**

(*Significant at $p < 0.05$; *Significant at $p < 0.01$)

Analysis

Income and Extension Contact are the most potent predictors of adoption. The inverse relationship with age (-0.185) suggests that generational renewal in farming may accelerate the transition to climate-smart technologies.

Constraints and Strategic Interventions

Respondents identified a hierarchy of barriers preventing full-scale adoption.

Table 4: Constraints Impeding Technology Adoption

Rank	Constraint Category	Frequency (%)
I	High capital intensity (Installation costs)	88.67
II	Volatile electricity supply for pump operation	76.00
III	Bureaucratic delays in subsidy disbursement	74.00
IV	Technical deficit in maintenance (e.g., dripper clogging)	65.33

5.2 Farmer-Centric Suggestions

To optimize the PoCRA impact,

respondents proposed the following:

- **Financial Re-engineering:** 93.33% advocated for higher subsidy ceilings and “Front-end” financial support.
- **Knowledge Transfer:** 83.33% requested the establishment of village-level demonstration plots (*Model Watersheds*).
- **Infrastructure:** 76.00% emphasized the need for solar-integrated irrigation to bypass electricity shortages.

Conclusion and Policy Synthesis

The study affirms that PoCRA has successfully initiated a technological shift in Aurangabad. However, the “Medium” adoption trap persists due to economic friction and procedural complexity.

Policy Implications:

1. **Subsidy Decentralization:** Move toward a transparent, time-bound Direct Benefit Transfer (DBT) to reduce farmer indebtedness during the installation phase.
2. **The “Krushi-Tai” Model:** Leverage local resource persons (Krushi Tai/Mitra) for continuous technical troubleshooting.
3. **Youth-Led Extension:** Design specific modules for young farmers who demonstrate a higher statistical propensity for risk and innovation.

REFERENCES

- Archana, T. (2017). Determinants of climate-resilient technology adoption. *Journal of Extension Education*, 29(4).
- Government of India (2008). *National Action Plan on Climate Change*. PM's Council on Climate Change.
- Natwadia, R. (2021). Technological gap in pressurized irrigation. *Int. J. Agri. Sci.*
- Swaminathan, M. S. (2010). *From Green to Evergreen Revolution*. Academic Foundation.
- World Bank (2018). *Maharashtra PoCRA Project Appraisal Document*. Report No: PAD2432.

RESEARCH ARTICLE

An Analysis of Consumption Expenditure in Rural and Urban households in Amravati District

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ABSTRACT

The present study examines the food consumption pattern and expenditure elasticity of demand among rural and urban households in Amravati district of the Vidarbha region of Maharashtra. Primary data were collected from 120 households (60 rural and 60 urban) during the agricultural year 2023–24 using a pre-tested interview schedule, with data recorded separately for summer, monsoon, and winter seasons to capture seasonal variations. Tabular analysis was employed to assess the composition of household expenditure on food and non-food items, while Engel function analysis was used to estimate expenditure elasticities for total food and non-food commodity groups. The results revealed that non-food items accounted for a larger share of total household expenditure in both rural and urban areas across all seasons, although the proportion of food expenditure was consistently higher in rural households. Vegetables and cereals constituted the major share of food expenditure in both sectors, whereas urban households exhibited higher spending on milk and milk products, meat, fish and egg, and beverages, indicating more diversified consumption patterns. Engel function estimates showed that food expenditure was income inelastic, while non-food expenditure was relatively more elastic, particularly in urban areas, confirming Engel's law. The study highlights significant seasonal and rural–urban differences in consumption behaviour and provides useful insights for policies related to food security and consumer welfare.

Keywords : TF, TNF, Consumption pattern, Food and non-food commodities, Elasticity

INTRODUCTION

Studies on food consumption and expenditure patterns are essential for understanding the economic well-being and living standards of a society. Food, being a fundamental necessity, typically takes precedence in household budgets, especially among low-income groups. Therefore, examining the distribution of expenditure on food and non-food items helps reveal changes in economic conditions, impacts of policy shifts, and progress in welfare over time. Historically, a high proportion of household expenditure on food has been associated with lower economic status, while greater spending on non-food

goods and services reflects rising incomes and improved standards of living.

In India, the Household Consumption Expenditure Survey (HCES), conducted under the aegis of the National Sample Survey Office (NSSO) and Ministry of Statistics and Programme Implementation (MoSPI), provides comprehensive data on consumption patterns across rural and urban areas. Recent HCES results for 2022-23 and 2023-24 show a significant shift in expenditure behavior compared with earlier decades. In 2022-23, food accounted for about 46% of total monthly per capita consumption expenditure (MPCE) in rural areas and about 39% in urban areas,

reflecting a continued decline in the relative importance of food expenditure as incomes rise. This shift marks a departure from earlier surveys where food consumed a substantially larger share of household budgets. In the latest 2023-24 data, the share of food in total MPCE was recorded at approximately 47.04% in rural India and 39.68% in urban India, while non-food expenditure continued to dominate the consumption basket. These patterns indicate that as households become economically better off, they allocate a relatively smaller share of their budgets to basic food items and more toward healthcare, education, transport, and other non-essential or comfort goods.

Such trends reflect ongoing economic transformation, the effects of liberalization, and changing consumer preferences in both rural and urban India. Understanding these patterns helps in designing targeted interventions to alleviate poverty, enhance food security, and improve overall quality of life.

OBJECTIVES

1. To assess the food consumption pattern in rural and urban households.
2. To workout expenditure elasticity of demand for food in rural and urban households.

Research Methodology

The present study was conducted in Amravati district of the Vidarbha region of Maharashtra, which was selected purposively. Primary data on household consumption expenditure on food and non-food items, along with socio-economic characteristics, were collected through a pre-tested structured interview schedule for the agricultural year 2023–24. To capture seasonal variations, data were collected separately for winter (November 2023–February 2024), summer (March–June 2024), and monsoon (July–October 2024). A multistage random sampling design was adopted. In total, 120 households were selected, comprising 60 rural and 60 urban households.

To Assess the food consumption pattern, tabular analysis were used to analyze the changes in the food consumption pattern and expenditure of rural and urban households. Over the season, per cent changes and per cent shares were worked out for consumption expenditures.

The expenditure elasticities were worked out for food grains along with other major food items and for all non- food items collectively by employing Engel function.

Engel Functional analysis

The Engel functions were fitted by taking per capita expenditure on individual items as dependent variable and per capita total expenditure as independent variable. Engel functions of various types. i.e. linear, semi-log, exponential and log linear were fitted by ordinary least square OLS technique to choose an appropriate algebraic relationship between per capita expenditure on an item and per capita total expenditure with other variables held constant. The various models were as:

Engel function symbol Algebraic equation Elasticity coefficient

Linear	$C_{ij} = a + bX$	$b(X/C_i)$
Semi log	$C_{ij} = a + b \log X$	b/C_i
Exponential	$\ln C_{ij} = a + bX$	bX
Log linear	$\ln C_{ij} = a + b \ln X$	b

Where,

C_{ij} = Monthly expenditure on i^{th} item by j^{th} household

X = Total monthly expenditure by the j^{th} household

a_i and b_i are the parameters of a relation pertaining to the i^{th} commodity in question.

Expenditure elasticities were worked out at mean levels of variables and are defined as

$$\begin{aligned}
 e &= b(X/C_{ij}) && \text{(linear function)} \\
 e &= b/C_{ij} && \text{(semi log function)} \\
 e &= b * C_{ij} && \text{(exponential function)} \\
 e &= b && \text{(log linear function)}
 \end{aligned}$$

Table 1: Composition of average monthly household food consumption expenditure on food items in summer season (Rs.)

Food items	Rural	Percent to total	Urban	Percent to total
Cereal	1194.66	7.05	1489.16	6.66
Pulses	319.50	1.88	325.16	1.45
Fruits	960.50	5.66	1010.16	4.51
Vegetables	1343.05	7.92	1417.95	6.33
Oil and fats	1036.33	6.12	1057.16	4.76
Meat, fish and egg	433.85	2.56	608.00	2.69
Milk and milk products	566.33	3.37	886.33	3.96
Spices	81.00	0.47	90.16	0.45
Beverages	48.83	0.28	125.83	0.56
Miscellaneous food items	1233.17	7.27	1850.16	8.27
Total food items	7214.22	42.58	8860.07	39.64
Non- food items	9728.33	57.42	13495.38	60.36
Total	16942.55	100.00	22355.45	100.00

Table 2: Composition of average monthly household food consumption expenditure on food items in Monsoon season (Rs.)

Food items	Rural	Percent to total	Urban	Percent to total
Cereal	1281.33	9.35	1518.5	7.77
Pulses	341.66	2.49	378.66	1.93
Fruits	166.23	1.21	251.13	1.28
Vegetables	1335.67	9.74	1612.66	7.25
Oil and fats	776.17	5.67	987.16	5.05
Meat, fish and egg	567.33	4.14	949.66	4.85
Milk and milk products	608.50	4.44	848.93	4.34
Spices	68.50	0.49	94.16	0.48
Beverages	50.00	0.36	151.06	0.77
Miscellaneous food items	1074.86	7.84	2013.78	10.30
Total food items	6201.73	45.73	8234.64	44.02
Non- food items	7500.52	54.27	11305.65	55.98
Total	13702.25	100.00	19540.65	100.00

Where,

b = Elasticity coefficient

X = Average value of the independent variable

C_{ij} = Mean level of consumption of the i^{th} commodity in the j^{th} household

Expenditure elasticity measures the sensitivity of the quantity demanded of a good to changes in income.

RESULT AND DISCUSSION

Table 1 shows the composition of average monthly household consumption

expenditure on food and non-food items for rural and urban households during the summer season. In rural areas, the total monthly expenditure was Rs. 16,942.55, of which food items accounted for 42.58 per cent and non-food items for 57.42 per cent. Vegetables constituted the largest share of food expenditure (7.92%),

followed by miscellaneous food items (7.27%), cereals (7.05%), and oil and fats (6.12%). Expenditure on fruits and milk and milk products was moderate, while beverages and spices formed a negligible share.

In urban areas, total monthly expenditure was higher at Rs. 22,355.45. Food

Table 3: Composition of average monthly household food consumption expenditure on food items in Winter season (Rs.)

Food items	Rural	Percent to total	Urban	Percent to total
Cereal	1349.50	9.04	1580.92	7.65
Pulses	358.33	2.39	432.41	2.09
Fruits	179.48	1.20	265.58	1.28
Vegetables	1310.66	8.77	1580.00	7.65
Oil and fats	841.00	5.63	892.93	4.32
Meat, fish and egg	567.33	3.79	949.66	4.59
Milk and milk products	608.50	4.07	848.93	4.16
Spices	68.50	0.46	94.16	0.45
Beverages	11.66	0.10	112.5	0.54
Miscellaneous food items	1142.03	7.64	2084.37	10.09
Total food items	6436.99	43.09	8841.46	42.82
Non- food items	8500.18	56.91	11806.78	57.18
Total	14937.17	100.00	20648.24	100.00

Table 4 : Composition of average monthly household food consumption expenditure on food items overall season (Rs.)

Food items	Rural	Percent to total	Urban	Percent to total
Cereal	1275.16	7.86	1529.52	7.10
Pulses	339.83	2.09	378.75	1.75
Fruits	435.40	2.68	508.96	2.36
Vegetables	1329.79	8.20	1536.87	7.14
Oil and fats	884.5	5.45	979.08	4.54
Meat, fish and egg	522.83	3.22	835.77	3.88
Milk and milk products	594.44	3.66	861.40	4.02
Spices	72.66	0.46	92.83	0.45
Beverages	22.38	0.18	113.21	0.52
Miscellaneous food items	1150.02	7.09	1982.77	9.21
Total food items	6627.01	40.89	8819.16	40.97
Non- food items	9576.22	59.11	12702.98	59.03
Total	16203.23	100.00	21522.14	100.00

expenditure accounted for 39.64 per cent, whereas non-food expenditure constituted 60.36 per cent. Major food expenditure items included miscellaneous food items (8.27%), cereals (6.66%), vegetables (6.33%), and oil and fats (4.76%). Urban households spent relatively more on milk, meat, fish and egg, and beverages. Overall, food expenditure formed a higher proportion of total expenditure in rural households than in urban households.

Table 2 presents the composition of average monthly household consumption expenditure on food and non-food items for rural and urban households. In rural areas, the total monthly household expenditure was Rs. 13,702.25, out of which food items accounted for 45.73 per cent (Rs. 6,201.73) and non-food

items constituted 54.27 per cent. Among food items, vegetables recorded the highest share (9.74%), followed by cereals (9.35%), miscellaneous food items (7.84%), and oil and fats (5.67%). Expenditure on milk and milk products (4.44%) and meat, fish and egg (4.14%) was moderate, whereas fruits (1.21%), beverages (0.36%), and spices (0.49%) contributed marginally to total expenditure.

In urban areas, the total monthly expenditure was higher at Rs. 19,540.65, with food items accounting for 44.02 per cent (Rs. 8,234.64) and non-food items for 55.98 per cent. Major food expenditure items were miscellaneous food items (10.30%), vegetables (7.25%), cereals (7.77%), and oil and fats (5.05%). Urban households spent relatively

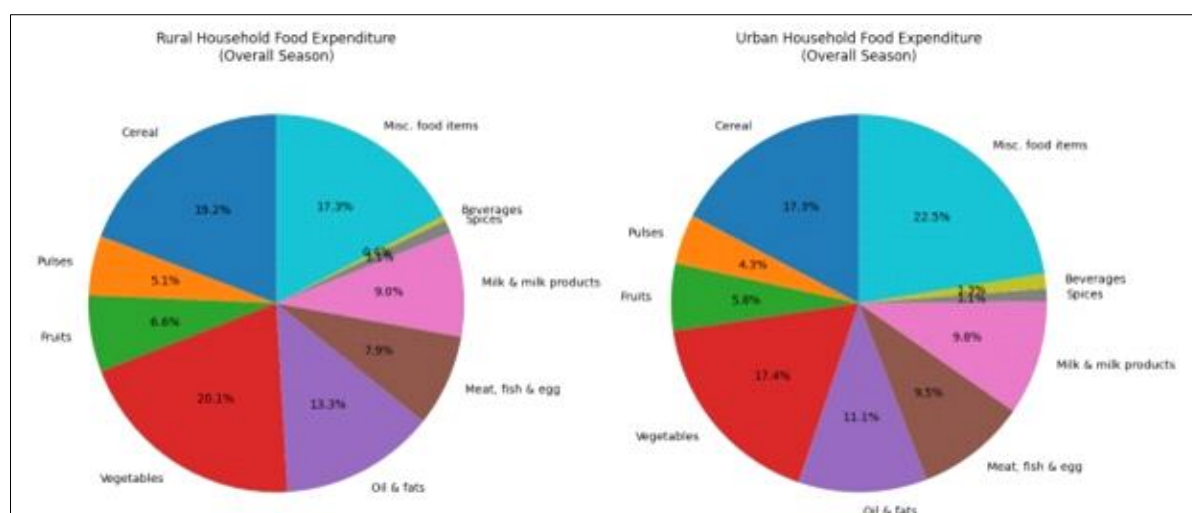


Table 5 :- Expenditure elasticities for main commodity group in rural and urban sectors

Forms	TF commodity group		Forms	TNF commodity group	
	Rural	Urban		Rural	Urban
Summer					
Log linear / linear	0.38	0.44	Linear /log linear	0.98	0.79
Monsoon					
Linear / log linear	1.00	0.75	Semi-log / linear	0.19	0.97
Winter					
Log linear	0.28	0.60	Linear / exponential	0.71	0.73
Overall season					
Linear / exponential	0.16	0.26	Linear / log linear	0.55	0.61

more on meat, fish, egg and beverages, indicating diversified consumption patterns compared to rural households.

Table 3 depicts the composition of average monthly household consumption expenditure on food and non-food items for rural and urban households. In rural areas, the total monthly household expenditure was Rs. 14,937.17, of which food items constituted 43.09 per cent (Rs. 6,436.99), while non-food items accounted for 56.91 per cent. Among food items, cereals recorded the highest share (9.04%), followed by vegetables (8.77%), miscellaneous food items (7.64%), and oil and fats (5.63%). Expenditure on milk and milk products (4.07%) and meat, fish and egg (3.79%) was moderate, whereas fruits (1.20%), beverages (0.10%), and spices (0.46%) formed a negligible share of total expenditure.

In urban areas, total monthly household expenditure was higher at Rs. 20,648.24. Food expenditure accounted for 42.82 per cent (Rs. 8,841.46), while non-food items constituted 57.18 per cent. Major food expenditure items were miscellaneous food items (10.09%), cereals and vegetables (7.65% each), and oil and fats (4.32%). Urban households spent relatively more on meat, fish and egg, milk products, and beverages, reflecting diversified consumption patterns.

Table 4 shows the composition of average monthly household consumption expenditure on food and non-food items for rural and urban households. In rural areas, the total monthly household expenditure was Rs. 16,203.23, of which food items accounted for 40.89 per cent (Rs. 6,627.01) and non-food items constituted 59.11 per cent. Among food items, vegetables had the highest share (8.20%), followed by cereals (7.86%), miscellaneous food items (7.09%), and oil and fats (5.45%). Expenditure on milk and milk products (3.66%) and meat, fish and egg (3.22%) was moderate, while beverages (0.18%) and spices (0.46%) formed a very small proportion of total expenditure.

In urban areas, the total monthly household expenditure was higher at Rs. 21,522.14. Food expenditure accounted for 40.97 per cent (Rs. 8,819.16), while non-food expenditure constituted 59.03 per cent. Major food expenditure items included miscellaneous food items (9.21%), vegetables (7.14%), cereals (7.10%), and oil and fats (4.54%). Urban households spent relatively more on milk and milk products, meat, fish and egg, and beverages compared to rural households.

The table 5 presents the best-fitting Engel functional forms for total food (TF) and total non-food (TNF) commodity groups across seasons and rural–urban households. The values reported indicate the expenditure elasticity obtained from the most appropriate functional form selected for each case.

During the summer season, the log-linear form was found suitable for TF commodities in rural areas (elasticity 0.38), while the linear form was appropriate in urban areas (0.44). For TNF commodities, the linear form in rural areas showed a high elasticity of 0.98, whereas the log-linear form in urban areas yielded an elasticity of 0.79, indicating greater responsiveness of non-food expenditure to income changes.

In the monsoon season, TF commodities followed the linear form in rural areas with unitary elasticity (1.00) and log-linear form in urban areas (0.75). TNF commodities exhibited low elasticity in rural areas (0.19) under the semi-log form, while urban areas showed high elasticity (0.97) under the linear form.

During the winter season, TF commodities showed relatively low elasticities in both rural (0.28) and urban (0.60) areas under the log-linear form. TNF commodities exhibited moderately high elasticities in both areas, indicating increased non-food expenditure during winter.

Overall, the results indicate that non-food commodities are more income elastic than food commodities, particularly in urban areas,

confirming Engel's law and highlighting seasonal and spatial variations in consumption behaviour.

CONCLUSIONS

1. The results of the study clearly reveal distinct seasonal and rural–urban variations in household consumption expenditure patterns. Across all seasons, non-food items consistently accounted for a larger share of total household expenditure than food items in both rural and urban areas, indicating a gradual shift towards non-food consumption with rising income levels. However, the share of food expenditure was relatively higher in rural households compared to urban households in all seasons, reflecting differences in income, lifestyle, and access to services.
2. Among food items, vegetables and cereals emerged as the major components of food expenditure in both sectors and across seasons, highlighting their importance in household diets. Urban households consistently spent higher absolute amounts on food items such as milk and milk products, meat, fish and egg, and beverages, suggesting more diversified and protein-rich consumption patterns compared to rural households.
3. The Engel function analysis further supports these findings, as food expenditure was found to be relatively income inelastic, while non-food expenditure showed higher elasticity, particularly in urban areas. This confirms Engel's law, which states that the proportion of income spent on food declines as income increases. Overall, the study underscores the influence of income, seasonality, and location on household

consumption behavior and provides useful insights for policy formulation related to food security and consumer welfare.

REFERENCES

- Blossom, K.L., Jose, S. and D. C. Kappen, 2018. Food consumption pattern among school going children in a rural area of Kerala. *Journal of Extension Education*, 30 (4): 6157–6164
- Bhaware, V. and A. Adsule, 2023. A comparative study of food consumption pattern in urban and rural Maharashtra with reference to Pune district. *International Journal of Food and Nutritional Sciences*, 12(1): 639-644
- Chavda, H. and R.L. Shiyani, 2022. Estimation of adult equivalent scale for consumption expenditure of food and non-food items with special reference to fruits and vegetables in rural and urban households of Junagadh district of Gujrat. *Asian Journal of Agricultural Extension, Economics and Sociology*, 40 (3): 52-60
- Gavhane, P. N., 2009. Consumption pattern of milk and milk products in Junagadh district. An unpublished M.Sc. (Agri) thesis, submitted to Junagadh Agriculture University, Junagadh.
- Geetha, K. T., 2011. Consumption pattern among selected rural and urban households in Coimbatore city. *International Journal of Multidisciplinary Research*, 1(2): 46-61
- Singh, L. N, Pandya, H. R. and V. Pawariya, 2020. Consumption pattern of food and non-food commodities in rural and urban sector of south gujrat zone-II. *International Journal of Agricultural and Statistical Sciences*. 16(1): 1125-1131.

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RESEARCH ARTICLE

Comparative Economic Analysis of Organic and Conventional Brinjal Cultivation in Vidarbha

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ABSTRACT

The study evaluates the profitability of organic and conventional brinjal cultivation in the Amravati division of Vidarbha, Maharashtra, using primary data collected from 120 growers (60 organic and 60 conventional) during 2023–24. Profitability analysis was conducted using the standard CACP cost concepts (Cost A₁, A₂, B₁, B₂, C₁, C₂ and C₃). The results revealed a substantial difference in productivity and economic performance between the two production systems. The actual yield of organic brinjal was 142.29 quintal per ha, whereas conventional brinjal recorded 204.86 quintal per ha, showing a 30.54 per cent lower yield under organic cultivation. The potential yield of organic brinjal was also 15 per cent lower than conventional, further widening the yield gap. Consequently, gross returns per hectare were significantly higher in conventional farming due to superior yield and better-quality marketable produce.

Organic farms incurred lower chemical input expenditure, but higher labour requirement for nutrient management, bio-input preparation and manual weeding increased total cost at Cost C₁ and C₂. In contrast, conventional growers benefited from efficient pest control, higher mechanization and reduced labour dependency, resulting in higher net returns and benefit–cost ratios across all cost levels. Farmers also reported several constraints impacting profitability. Major problems included severe pest and disease infestation, high cost of plant protection chemicals, labour scarcity, price fluctuations, lack of premium price for organic brinjal, and inadequate storage and marketing facilities. These issues were more pronounced among organic growers due to limited availability of effective organic pest management options and absence of assured organic markets. The study concludes that conventional brinjal cultivation is economically more profitable under existing market conditions. Improving the viability of organic brinjal will require premium price mechanisms, improved pest management support, strengthened market linkages and capacity-building programs for organic growers.

Keywords : Organic Brinjal, Conventional brinjal, profitability, Costs, Net returns, Benefit cost ratio

INTRODUCTION

India is the second largest producer of the vegetables in the world after China (FAO). During 2024-25, India produced 214.56 million MT of vegetables with the area under cultivation of vegetables were 11.43 million hectares. Production and export of Indian vegetables have

increased in recent years. During 2024-25, India exported fresh vegetable at Rs.6,373 crore and processed vegetable exports were Rs.6,504 crore. Organic farming is practiced in India since thousands of years. The great Indian civilization thrived on organic farming and was one of the most prosperous countries in the world, till the

British ruled it. In traditional India, the entire agriculture was practiced using organic techniques, where the fertilizers, pesticides etc. were obtained from plant and animal products. India's rank 2nd in terms of World's Organic Agricultural land and 1st in terms of total number of producers. As per department of Agriculture and farmers welfare the total organic cultivated area under NPOP certification is 44.76 lakh ha with 46.99 lakh MT farm production. And total organic area under PKVY certification is 4.49 lakh ha with farm production pf 6.85 lakh MT. In Maharashtra, the total area under organic cultivation was 1.07 Lakh ha with organic farm production 16.06 Lakh MT and productivity was 15009.34 Kg/ha.

METHODOLOGY

Sampling Framework

The present study was conducted in the Amravati division of Vidarbha region of Maharashtra, comprising five districts, namely Akola, Amravati, Yavatmal, Buldhana, and Washim.

In the first stage, two tahsils from each district were purposively selected based on the highest number of organic vegetable growers, namely: Akola and Patur (Akola district); Chandur Railway and Achalpur (Amravati district); Washim and Risod (Washim district); Buldhana and Shegaon (Buldhana district); and Ghatanji and Babhulgaon (Yavatmal district), making a total of ten tahsils.

In the second stage, a list of villages engaged in organic brinjal cultivation was prepared for the selected tahsils. From each tahsil, two villages having the highest number of organic brinjal growers were purposively selected. Accordingly, a total of twenty villages were selected, namely: Chandur and Shivapur (Akola tahsil); Patur and Vivra (Patur tahsil); Amla Vishweshwar and Karla (Chandur Railway tahsil); Wadhona and Wasni (Achalpur tahsil); Sakhra and Babulgaon (Washim tahsil); Netansa and Navali (Risod tahsil); Nandrafuli and Malvandi (Buldhana tahsil); Warud and

Titrav (Shegaon tahsil); Manoli and Erabora (Ghatanji tahsil); and Yerangaon and Sindi (Babhulgaon tahsil). For the study, data pertains to the agricultural year 2023–24.

At the final stage, from each selected village, three organic and three conventional vegetable growers were randomly chosen. Thus, a total sample of 120 respondents was selected, comprising 60 organic and 60 conventional brinjal growers.

Collection of Data

Primary data were collected for the agricultural year 2023–24 using a pre-tested structured interview schedule through personal interviews. Secondary data on area and production of organic brinjal was obtained from the Centre for Organic Agriculture Research and Training and Dr. Panjabrao Deshmukh Krishi Vidyapeeth, along with relevant government publications.

Profitability in organic and conventional selected vegetables

To achieve the objective standardized costs concept of CACP i. e. cost- A_1 , A_2 , B_1 , B_2 , C_1 , C_2 and C_3 were used.

Costs concept

The standard costs concept i.e. Cost A_1 , Cost A_2 , Cost B_1 , Cost B_2 , Cost C_1 , Cost C_2 and Cost C_3 were used in present analysis.

Costs concept

The standard costs concept i.e. Cost A_1 , Cost A_2 , Cost B_1 , Cost B_2 , Cost C_1 , Cost C_2 and Cost C_3 were used in present analysis.

Cost ' A_1 '

All actual expenses in cash and kind incurred in production by the producer. The items covered in cost A_1 are costs on:

- i. Value of hired human labour (HL)
- ii. Value of hired bullock labour (BL)
- iii. Value of owned bullock labour
- iv. Value of owned machine labour (ML)
- v. Hired machinery charges

- vi. Value of seed (both farm produced and purchased)
- vii. Value of insecticides and pesticides
- viii. Value of manure (owned and purchase)
- ix. Value of fertilizers
- x. Irrigation charges
- xi. Depreciation on implements and farm building
- xii. Land revenue, cesses and other taxes
- xiii. Interest on working capital and
- xiv. Miscellaneous expenses (Artisans etc.)

a) Measurement and Evaluation of Different Cost 'A₁' Components

1. Hired Human labour

It includes hired human labour used on the farm. The value of hired human labour was evaluated at the hiring wage rates prevailing in the locality from time to time.

2. Bullock labour

Hired and owned bullock labour cost was estimated at actual rate paid for hiring of bullock labour in the local market from time to time.

3. Machine labour

Machine hours in case of owned machine was evaluated as per the hired charges prevailed in the village and in case of hired machine was accounted as per the price paid by cultivator.

4. Seedlings

The actual cost paid for purchasing of seedling from the nursery was taken into account for evaluation.

5. Manures

The cost of farm yard manure produced on the farm was estimated at the prevailing rates in the village. In case of purchased farm yard manure the actual price paid was taken into account.

6. Fertilizers

Fertilizers in the form of Urea, DAP, 10:26:26, and MOP were used and quantity of nitrogen, phosphorus and potash was calculated

in order to determine the actual, expenditure on nitrogen, phosphorus and potash.

7. Plant protection

This included the actual cost incurred on the purchase of insecticides, fungicides, pesticide etc. and their procurement.

8. Land revenues and other cesses

It included the actual land revenue with other cesses paid by farmers for the total land holdings. The land revenue and other cesses by the gross cropped area of the respective crop.

9. Irrigation charges

Irrigation charges were calculated at the rate of charges actually paid by the cultivator regarding electricity paid for the irrigation operation.

10. Depreciation and repairing charges

Depreciation means the decrease in the value of asset through wear and tear. Straight-line method was used to work out depreciation. The uniform rate of 10 per cent on the present value at the beginning of the year of farm implements and machinery was taken and only the proportionate charges were taken for the crop on hectare basis,

$$\frac{\text{Purchase price of the asset} - \text{Junk value (10 per cent)}}{\text{No. of useful years (expected life)}}$$

$$\text{Depreciation} = \frac{\text{Purchase price of the asset} - \text{Junk value (10 per cent)}}{\text{No. of useful years (expected life)}}$$

11. Evaluation of inputs

The items considered under the head inputs are human labour, bullock labour, machinery labour, seedlings, manures, fertilizers, irrigation etc. some of the inputs are produced or owned by farmers and some are purchased or hired in.

B) Cost 'A₂'

Cost A₁ + Rent paid for leased-in land.

C) Cost 'B₁'

Cost A₁ + interest value of owned fixed capital assets (excluding land).

b) Component included in cost 'B₁'**a) Interest on capital**

It was calculated by charging interest at the rate of 10 per cent on investment on commonly used assets.

D) Cost 'B₂'

Cost B₁ + Rental value of owned land (net of land revenue) and rent paid for leased-in land.

c) Component included in cost 'B₂'**a) Rental value of land**

Rental value of land was calculated @ 1/6th of gross value of produce by deducting the land revenue. It is calculated by following formula,

Rental value of land = (1/6th of gross value of produce – land revenue).

E) Cost 'C₁'

Cost B₁ + imputed value of family labour.

d) Component included in cost 'C₂'**a) Family human labour**

The general wage rate prevailing in the village (While performing various operations) was considered for assessing the wage the family male and female labour.

F) Cost 'C₂'

Cost B₂ + Imputed value of family labour.

G) Cost 'C₃'

Cost C₂ + marketing costs and transportation report.

II) Gross and net returns**1. Gross returns**

Gross return of the farmers under the present study was estimated from returns obtained from sale of main produce.

2. Net returns

Net returns was computed at different costs i.e. Cost A₁, Cost A₂, Cost B₁, Cost B₂, Cost

C₁, Cost C₂ and Cost C₃ by deducting respective costs from the gross returns.

Net income at A₁ = Gross returns - Cost 'A₁'

Net income at A₂ = Gross returns - Cost 'A₂'

Net income at B₁ = Gross returns - Cost 'B₁'

Net income at B₂ = Gross returns - Cost 'B₂'

Net income at C₁ = Gross returns - Cost 'C₁'

Net income at C₂ = Gross returns - Cost 'C₂'

Net income at C₃ = Gross returns - Cost 'C₃'

Benefit-cost ratio

It is a ratio between the value of gross output and the cost of cultivation at different cost concepts. The probability of crop production cannot be justified completely unless benefit cost ratio were worked out. This is the ratio which represents returns obtained per rupee of investment. It was worked out by dividing gross return by the total cost. It was calculated at cost A₁, cost A₂, cost B₁, cost B₂, cost C₁, cost C₂ and cost C₃ as –

$$\text{Benefit-cost ratio at cost 'A}_1\text{' = } \frac{\text{Gross Income}}{\text{Cost 'A}_1\text{'}}$$

$$\text{Benefit-cost ratio at cost 'A}_2\text{' = } \frac{\text{Gross Income}}{\text{Cost 'A}_2\text{'}}$$

$$\text{Benefit-cost ratio at cost 'B}_1\text{' = } \frac{\text{Gross Income}}{\text{Cost 'B}_1\text{'}}$$

$$\text{Benefit-cost ratio at cost 'B}_2\text{' = } \frac{\text{Gross Income}}{\text{Cost 'B}_2\text{'}}$$

$$\text{Benefit-cost ratio at cost 'C}_1\text{' = } \frac{\text{Gross Income}}{\text{Cost 'C}_1\text{'}}$$

$$\text{Benefit-cost ratio at cost 'C}_2\text{' = } \frac{\text{Gross Income}}{\text{Cost 'C}_2\text{'}}$$

$$\text{Benefit-cost ratio at cost 'C}_3\text{' = } \frac{\text{Gross Income}}{\text{Cost 'C}_3\text{'}}$$

RESULTS AND DISCUSSION

The distribution of brinjal growers according to size of land holding-

The distribution of brinjal growers according to size of land holding reveals notable variations between organic and conventional farmers.

Among organic brinjal growers, a majority (43.33%) belong to the medium holding category (2.00 to 4.00 ha), followed by 30.00 per cent in the small holding category (up to 2.00 ha) and 26.67 per cent in the large holding category (4.01 ha and above). This indicates that organic cultivation of brinjal is more prevalent among farmers with medium-sized land holdings, possibly due to better resource availability and capacity to adopt organic practices.

In contrast, among conventional brinjal growers, the highest proportion (40.00%) falls under the small holding category, followed by 35.00 per cent in the medium category and 25.00 per cent in the large category. This suggests that conventional brinjal cultivation is more

common among small farmers, likely due to relatively lower initial risks and familiarity with traditional farming methods.

Table 1: Distribution of Brinjal growers according to size of holding

S. N.	Size of holding	Organic Brinjal (N=60)	Conventional Brinjal (N=60)
1.	Small (Up to 2.00 ha)	18 (30.00)	24 (40.00)
2.	Medium (2.00 to 4.00 ha)	26 (43.33)	21 (35.00)
3.	Large (4.01 & above)	16 (26.67)	15 (25.00)
4.	Overall	60(100.00)	60(100.00)

Overall, the findings indicate that organic brinjal cultivation is predominantly practiced by medium landholders, whereas conventional brinjal cultivation is more concentrated among small landholders. The proportion of large farmers is comparatively similar in both groups, though slightly higher in organic farming.

Table 2: Per hectare input utilization pattern of Brinjal Crop

S. N.	Particulars	Unit	Organic	Conventional
1	Total Human Labour (Hired + Owned)			
a)	Male	Days	87.34	77.13
b)	Female	Days	191.88	176.63
	Sub total		279.22	253.77
2	Bullock Labour	Pair days	15.04	4.71
3	Machine charges	Hours	4.44	4.88
4	Seed	Kg.	0.52	1.12
5	Manures	Qtl.	50.27	30.77
6	Fertilizer			
	N	Kg.	-	146.66
	P	Kg.	-	65.58
	K	Kg.	-	64.33
7	Biofertilizers/ Chemical fertilizers	Kg.	10.32	-
8	Liquid formulation	Lt.	3278.39	-

Table 3: Cost of cultivation of brinjal production by organic Method of cultivation (Rs/ha)

S. N.	Particular	Unit	Input/ha	Cost/Unit of input	Total Cost Per Ha.	Per cent to Cost “C ₃ ”
1)	Hired Human Labour					
a)	Male	Days	41.44	312.79	12962.05	6.25
b)	Female	Days	110.41	200.50	22137.62	10.67
	subtotal		151.85	513.29	35099.67	16.92
2	Bullock Labour	Pair days	15.04		8484.04	4.09
3	Machine charges	Hours	4.44		2404.34	1.16
4	Seed	Kg.	0.52		10565.84	5.09
5	Manures	Qtl.	50.27		20450.80	9.86
6	Bio-fertilizers	(Kg)	10.32		1008.24	0.49
7	Liquid formulations	(Lt.)	3278.39		6022.02	2.90
8	Fertilizers		=	=	=	=
a)	N	(Kg)	=	=	=	=
b)	P	(Kg)	=	=	=	=
c)	K	(Kg)	=	=	=	=
	Sub total	(Rs.)	=	=	=	=
9	Irrigation Charges	(Rs.)			645.05	0.31
10	Plant protection	(Rs.)			6540.11	3.15
11	Incidental charges	(Rs.)			164.36	0.08
12	Repairing charges	(Rs.)			109.88	0.05
15	Working Capital	(Rs.)			91494.35	44.09
16	Interest on working Capital	(Rs.)			5489.66	2.65
17	Depreciation	(Rs.)			1390.11	0.67
18	Land Revenue	(Rs.)			77.51	0.04
19	Cost “A₁”	(Rs.)			98451.63	47.45
20	Rental Value for leased Land				0.00	0.00
21	Cost “A₂”	(Rs.)			98451.63	47.45
22	Int. on Fix. Cap. @ 10per cent	(Rs.)			2795.86	1.35
23	Cost “B₁”	(Rs.)			101247.49	48.79
21	Rental Value of owned Land	(Rs.)			54585.73	26.31
22	Cost “B₂”	(Rs.)			155833.22	75.10
23	Family Human Labour					
a)	Male	Days	45.90	313.98	14411.90	6.95
b)	Female	Days	81.47	225.80	18395.98	8.87
	Sub-total		127.37	539.79	32807.88	15.81
24	Cost “C₁”	(Rs.)			134055.37	64.60
25	Cost “C₂”	(Rs.)			188641.10	90.91
26	10per cent Cost C ₂ *	(Rs.)			18864.11	9.09
27	Cost “C₃”	(Rs.)			207505.21	100.00
28	Yield of main produce/ha	(Qtl.)	142.29	2302.29	327592.40	
29	Value of By-produce/ha.	(Qtl.)	0.00	0.00	0.00	
30	Value of total produce	(Rs.)			327592.40	
31	Per quintal cost of Prod.	(Rs.)			1458.33	

Table 4: Cost of cultivation of brinjal production by conventional Method (Rs/ha)

S. N.	Particulars	Unit	Input/ha.	Cost/Unit of input	Total Cost Per Ha.	Per cent to Cost "C ₃ "
1	Hired Human Labour					
a)	Male	Days	35.93	310.01	11138.60	4.78
b)	Female	Days	103.85	230.84	23973.18	10.30
	Sub-total		139.79	540.85	35111.78	15.08
2	Bullock Labour	(Pair days)	4.71		3731.45	1.60
3	Machine charges	Hours	4.88		3107.71	1.33
4	Seed	Kg.	1.12		19566.59	8.40
5	Manures	Qtls.	30.77		13843.36	5.95
6	Fertilizer					
A)	N	Kg.	146.66	7.57	1110.52	0.48
b)	P	Kg.	65.58	23.67	1552.45	0.67
c)	K	Kg.	64.33	18.16	1168.42	0.50
	Sub-total	(Rs.)	276.57	49.41	3831.39	1.65
7	Irrigation charges	(Rs.)			14303.76	6.14
9	(Plant Protection)	(Rs.)			13794.49	5.92
10	Incidental charges	(Rs.)			122.80	0.05
11	Repairing Charges	(Rs.)			127.81	0.05
14	Weedicide	(Rs.)			0.00	0.00
15	Working Capital	(Rs.)			107541.14	46.18
16	Interest on working Capital	(Rs.)			6452.47	2.77
17	Depreciation	(Rs.)			1556.01	0.67
18	Land Revenue				98.79	0.04
19	Cost "A₁"	(Rs.)			115648.41	49.67
20	Rental Value for leased Land				0.00	0.00
21	Cost "A₂"	(Rs.)			115648.41	49.67
22	Int. on Fix. Cap. @ 10per cent	(Rs.)			2388.22	1.03
23	Cost "B₁"	(Rs.)			118036.63	50.69
21	Rental Value of owned Land	(Rs.)			67022.05	28.78
22	Cost "B₂"	(Rs.)			185058.68	79.48
23	Family Human Labour					
a)	Male	Days	41.20	298.14	12283.41	5.28
b)	Female	Days	72.78	197.03	14339.60	6.16
	Sub-total	(Rs.)	113.98	495.17	26623.01	11.43
24	Cost "C₁"	(Rs.)			144659.64	62.13
25	Cost "C₂"	(Rs.)			211681.69	90.91
26	10per cent Cost C ₂ *	(Rs.)			21168.17	9.09
27	Cost "C₃"	(Rs.)			232849.86	100.00
28	Yield of main produce/ha	(Qtls.)	204.86	1963.44	402231.00	
29	Value of By-produce/ha	(Qtls.)	0.00	0.00	0.00	
30	Value of total produce	(Rs.)			402231.00	
31	Per quintal cost of Prod.	(Rs.)			1033.30	

Profitability of organic and conventional vegetable production.

Per hectare average input utilization for Brinjal -

The information regarding per hectare input utilization for organic and conventional brinjal crop is presented in Table 2.

Table 2 reveals comparison of input use between conventional and organic brinjal crop. Organic cultivation required higher human labour, with 87.34 male and 191.88 female labour days compared to 77.13 and 176.63 days in conventional farming. Bullock labour use was also substantially greater in organic farms (15.04 pair days) than in conventional farms (4.71 pair days), reflecting a stronger dependence on traditional operations.

Machine hours remained nearly similar, though conventional farms used them slightly more. The seed rate was considerably lower in organic farming (0.52 kg) than in conventional farming (1.12 kg), indicating better soil conditions and germination. Nutrient application patterns differed sharply: conventional farms relied heavily on chemical fertilizers, applying 146.66 kg N, 65.58 kg P and 64.33 kg K, while organic farms applied larger quantities of manures (50.27 qtl) along with 10.32 kg of biofertilizers and 3278.39 litres of liquid organic formulations. Overall, organic farming was more labour intensive and biologically driven, whereas conventional farming depended primarily on inorganic fertilizers and mechanization. Similar findings were reported by Patel and Chauhan (2018), who also reported higher dependency on manual intercultural operations in organic brinjal systems due to limited mechanization. Similarly, Singh *et al.* (2022) observed significantly higher quantities of FYM, compost, and liquid organic formulations in organic brinjal production compared to chemical inputs in conventional systems.

Cost of cultivation of organic brinjal-

Cost of cultivation of organic brinjal grown by farmers is presented in Table 3. It is revealed that, from the table 3 the total cost of production (Cost “C₃”) amounts to Rs 2,81,433.21 per hectare. Among the various inputs, human labour forms a major component, with hired labour alone contributing 10.05 per cent to total cost, of which female labour (Rs18,702.99) dominates over male labour (Rs 9,568.27). Family labour use adds another 4.71 per cent, highlighting the labour-intensive nature of organic brinjal cultivation.

As bullock labour accounts for 3.01 per cent of total cost, while machine charges remain relatively low at 0.85 per cent. The cost of seed is comparatively high (Rs10,565.84), constituting 3.75 per cent of total cost, due to the premium prices of organic seed material. Organic manures (Rs20,450.80) form an important input, representing 7.27 per cent of cost, while biofertilizers (Rs1,008.24) and liquid formulations (Rs6,022.02) together contribute 2.5 per cent. Irrigation and plant protection together account for 2.55 per cent, with plant protection (Rs6,540.11) being relatively more important, reflecting pest susceptibility in brinjal. Other miscellaneous charges, including repairing and incidental costs, remain negligible.

Working capital accounts for 30.08 per cent of the total cost, and with interest, depreciation, and land revenue included, Cost “A₁” amounts to Rs. 91,213.52 per hectare (32.41 per cent). Inclusion of rental value of land raises Cost “B₂” to Rs. 1,48,595.11 per hectare (52.80 per cent), while incorporation of family labour leads to Cost “C₁” of Rs. 1,07,253.27 (38.11 per cent). After adding the imputed value of owned land, family labour, and 10 per cent cost on “C₂”, the comprehensive cost of production (Cost “C₃”) reaches Rs.2,81,433.21 per hectare. The yield of brinjal is 142.29 quintals per hectare, with a gross return of Rs.

3,27,592.40/ha. The per quintal cost of production works out to Rs. 1,977.88.

The predominance of labour cost in total cultivation cost, as observed in the present study, aligns with the findings of Kumar and Meena (2019), who reported that organic vegetable production involves higher labour expenditure due to frequent intercultural and pest management activities. Similar observations were made by Singh et al. (2023), who highlighted that the increased cost of organic manures, seeds, and bio-inputs contributes to the overall higher cost of production in organic brinjal cultivation. The benefit–cost trends recorded in this study also correspond with the results of Rao and Reddy (2020), who stated that although organic cultivation requires higher investment, the premium price received for organic produce enhances profitability compared to conventional systems.

Cost of cultivation of conventional brinjal

Cost of cultivation of conventional brinjal grown by farmers is presented in Table 4. The cost of cultivation analysis for conventional brinjal growers revealed that the total cost (Cost C₃) amounted to Rs. 2,32,849.86 per hectare. Human labour constituted the largest component of cost, accounting for 15.08 per cent of total cost, with female labour (Rs. 23,973.18) contributing more than male labour (Rs. 11,138.60). Among other operational costs, bullock labour (Rs. 3,731.45) and machine charges (Rs. 3,107.71) together contributed around 2.93 per cent of the cost.

Seed was one of the major cost items, amounting to Rs. 19,566.59 per hectare (8.40 per cent), followed by manures at Rs. 13,843.36 (5.95 per cent). Fertilizer use was relatively modest, with nitrogen, phosphorus, and potash together costing Rs. 3,831.39 per hectare (1.65 per cent). Irrigation charges (Rs. 14,303.76) and plant protection chemicals (Rs. 13,794.49) were other significant expenses, together constituting over 12 per cent of the total cost.

The working capital was calculated at Rs. 1,07,541.14 (46.18 per cent of Cost C₃), while interest on working capital was estimated at Rs. 6,452.47 (2.77 per cent). Depreciation and land revenue formed only a minor part of the overall cost. Cost A₁ and A₂ stood at Rs. 1,15,648.41, accounting for 49.67 per cent of the total cost. With the addition of interest on fixed capital, Cost B₁ increased to Rs. 1,18,036.63, while inclusion of rental value of owned land raised Cost B₂ to Rs. 1,85,058.68 (79.48 per cent).

Family labour input was also considerable, amounting to 113.98 days (41.20 male and 72.78 female), with a total imputed value of Rs. 26,623.01 (11.43 per cent). Accordingly, Cost C₁ was estimated at Rs. 1,44,659.64 (62.13 per cent), and Cost C₂ at Rs. 2,11,681.69 (90.91 per cent). After adding 10 per cent managerial cost, the total Cost C₃ amounted to Rs. 2,32,849.86 per hectare. The average yield of conventional brinjal was found to be 204.86 quintals per hectare, generating a gross return of Rs. 4,02,231.00. The per quintal cost of production was worked out to Rs. 1,033.30. This indicates that while conventional brinjal cultivation requires a high investment, it also ensures significant gross returns, providing a reasonable margin of profitability to farmers.

The relatively high gross returns and favourable per quintal cost structure observed in conventional brinjal farming are comparable to the findings of Choudhary and Verma (2021), who concluded that conventional brinjal cultivation remains a profitable enterprise despite higher investment, mainly due to its higher yield levels. Similar cost distribution patterns were reported by Mehta *et al.* (2019), who observed that seed, manures and plant protection chemicals were among the principal items contributing to the total cost of conventional brinjal cultivation.

CONCLUSIONS

Organic brinjal recorded a yield of 142.29 quintal per ha, while conventional brinjal achieved a significantly higher yield of 204.86 q/ha, showing a 30.54% yield gap in favour of the conventional system. The total cost of cultivation at Cost C_f was 2,07,505.21Rs/ha for organic and 2,32,849.86 Rs/ha for conventional brinjal. Despite the lower cost in organic cultivation, the gross return was considerably higher in the conventional system (4,02,231 Rs/ha) compared to organic (3,27,592.40 Rs/ha). Per-quintal cost of production further highlighted this difference, being 1,458.33 Rs per quintal in organic and only 1,033.30 Rs per quintal in conventional cultivation. Input-use patterns showed that organic farming required substantially higher labour (279.22 days vs. 253.77 days) and greater quantities of manures and liquid formulations, while conventional farms relied heavily on chemical fertilizers. These differences directly influenced cost structure and profitability. Overall results demonstrate that conventional brinjal cultivation is more profitable. Organic brinjal while ecologically beneficial.

REFERENCES

Patel, B. and Chauhan, K. (2018). Labour use dynamics in organic brinjal cultivation. *Journal of Vegetable Science*, 45(2), 112–119.

Singh, R., Meena, S. and Jatav, R. (2022). Organic input utilization and productivity performance in vegetable crops. *Indian Journal of Agricultural Economics*, 77(3), 354–362.

Kumar, V. and Meena, R. (2019). Cost structure and profitability of organic vegetable cultivation. *Agricultural Economics Review*, 31(1), 48–57.

Singh, P., Sharma, K. and Verma, A. (2023). Economics of organic brinjal cultivation. *International Journal of Farm Sciences*, 13(2), 89–95.

Rao, D. and Reddy, K. (2020). Comparative profitability of organic vs. conventional vegetable production. *Economic Affairs*, 65(4), 621–628.

Choudhary, S. and Verma, P. (2021). Profitability analysis of conventional brinjal farming. *Indian Journal of Economics & Development*, 17(1), 101–108.

Mehta, A., Sharma, R. and Patel, H. (2019). Cost and return analysis of brinjal cultivation. *Agricultural Finance Review*, 79(3), 355–364.

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RESEARCH ARTICLE

Performance of Orange Export from India

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ABSTRACT

India is one of the leading producers of citrus fruits in the Asia-Pacific region, and oranges constitute a significant share of its fresh fruit export basket. This study examines the export performance, growth dynamics, and market instability of Indian oranges over a 20-year period from 2004–05 to 2023–24. Using secondary data sourced from APEDA, FAOSTAT, and Indiastat, the analysis employs Compound Growth Rates (CGR) to evaluate long-term growth trends and the Cuddy–Della Valle Index (CDVI) to assess instability in quantity and value across major export destinations. To complement these measures, index numbers for export quantity and value are constructed to trace year-to-year changes in market performance.

The results reveal a significant shift in India's export trajectory over the study period. While Period-I (2004–05 to 2013–14) displayed mixed or declining growth in several markets, Period-II (2014–15 to 2023–24) recorded strong and statistically significant positive growth, contributing to robust overall expansion in Period-III. Neighboring markets—particularly Nepal, Bangladesh, and Bhutan—emerged as stable and high-growth destinations, with Nepal showing consistently strong performance across all periods. In contrast, Middle Eastern markets such as Kuwait, Qatar, Saudi Arabia, and the UAE exhibited exceptionally high but highly volatile growth patterns, resulting in some of the highest instability indices observed in the study. This volatility reflects fluctuations in international demand, domestic supply variations, and irregular procurement cycles in these markets.

Index number analysis further highlights substantial surges in export volumes and values after 2016–17, especially through large consignments to Gulf countries, which significantly influenced global export trends. Despite this growth, the overall export market showed increasing instability over time, indicating the need for improved supply chain management and diversification of export destinations. Overall, the study concludes that India's orange export sector demonstrates strong growth potential but is constrained by pronounced market instability. Strengthening production consistency, enhancing quality standards, expanding into stable regional markets, and developing targeted export strategies will be essential for sustaining long-term competitiveness in the global citrus market.

Keywords: Orange export, Export performance, Compound Growth Rate (CGR), Instability index, Cuddy–Della Valle Index (CDVI), Index numbers, Market instability.

INTRODUCTION

In the vibrant tapestry of India's agricultural exports, oranges have emerged as a citrus sensation, captivating taste buds across borders. India is the largest orange grower in the Asia-Pacific area, with an annual production of

about 10 million metric tonnes, according to the latest data. India contributes 3% of the world's total orange production, placing it eighth among the top orange-producing nations. The major orange producing states in India include Madhya Pradesh, Maharashtra, Punjab, Rajasthan, and

Haryana. The “Mosambi” or mandarin orange is the most widely grown variety of orange in India. An estimated 3.6 million metric tonnes of sweet oranges and 6 million metric tonnes of mandarin oranges are produced in India each year.

The global demand for high-quality citrus fruits has led to a significant increase in orange export from India. India exported over 73 thousand metric tonnes of fresh and dried oranges in fiscal year 2023, with Bangladesh as the biggest importer of Indian oranges, according to orange export data. In terms of value, orange exports from India were around US\$ 19.23 million in 2023-24. The export of oranges from India had 71,898 shipments of oranges. With 8,007 Indian exporters selling to 19,339 purchasers, these exports marked a 23% rise from the previous year. Top orange importing countries are Bangladesh, Nepal, Bhutan, UAE, Bahrain and more. Understanding the factors that influence the export performance of oranges is crucial for policymakers, exporters, and stakeholders involved in the sector.

OBJECTIVES

1. To study the growth pattern in orange export from India
2. To study the instability indices of orange export from India

MATERIALS AND METHODS

The data pertaining to the objectives of the study were collected from the Agricultural and Processed Food Products Export Development Authority website (Apeda.gov.in), the Export-Import Data of India website (indiastate.com), and the Food and Agriculture Organization website (faostat.org). The export of orange was selected considering the availability of data as per HS (Harmonized System) code. The study used secondary data to measure the export performance and stability of orange from 2004-05 to 2023-24, which in turn shall be split into three periods, viz., Period-I

(2004-05 to 2013-14), Period-II (2014-15 to 2023-24) and Period-III (2004-05 to 2023-24). The total number of the 20 years is considered

Compound Growth Rate

Growth rate measures past performance of economic variables and trends over time. To measure growth dynamics, a hypothetical function is postulated to describe and estimate the series of economic variables. The compound growth rates (CGRs) was calculated by using the exponential function of the following specification:

$$Y_t = a \cdot b^t \cdot u^t \quad \dots (1)$$

Where,

Y_t = Dependent variable (export quantity/export value, etc.)

a = Intercept;

b = Regression coefficient,

t = Time element which takes the value 1, 2, 3...n,

u^t = Error term By taking logarithms of both the sides, the equation takes the form,

$$\text{Log } Y_t = \text{Log } a + t \text{ log } b \quad \dots (2)$$

The value of log b was computed using the formula

$$\text{Log } b = \frac{(\sum \text{Log } Y^t - (\sum t \sum \text{Log } Y^{t/N}))}{\sum t^2 - \left(\frac{\sum t^2}{N} \right)} \quad \dots (3)$$

Where,

N = Number of years.

Subsequently, the compound growth rate (%) was computed by using the formulation.

$$\text{Compound growth rate}(r) = [(\text{Antilog of log } \sqrt{b} - 1) \times 100] \quad \dots (4)$$

Student ‘t’ test was used to determine the significance of the growth rates obtained for which the following formulation was employed,

$$t = \text{Log } b / \text{SE (Log } b) \quad \dots (5)$$

$$SE (\text{Log } b) = \sqrt{\frac{(\sum Y - \bar{Y})^2 - \text{Log } b * (Y * t) - (Y) * \bar{t}}{(N-2) \sum (t - \bar{t})^2}} \quad (6)$$

The calculated 't' values, from equation (6) were compared with the table 't' values and the significance was tested for different significant probability levels.

Instability Indices

To measure the instability in the export of orange, Coefficient of variation and Cuddy-Della Valle (1978) index was used.

3.2.1 Coefficient of variation (CV)

$$CV (\%) = S/X * 100 \quad \dots\dots (8)$$

Where,

CV = Coefficient of variation;

X = Mean value;

S = Standard deviation.

Cuddy Della Valle instability index (C & D)

$$\text{Instability Index} = CV (1 - R^2) \quad \dots\dots (7)$$

Where,

CV = Simple Estimates of coefficient of variation in per cent and

R^2 = Coefficient of determination from a time trend regression adjusted by the number of degree of freedom.

Index Number

Index number were estimated for identifying trend of export in quantity and value of orange with following formula

$$\text{Index No.} = \frac{\text{Current Year}}{\text{Base Year}} \times 100 \quad \dots\dots (8)$$

RESULTS AND DISCUSSION

Considering the objectives of the study, the required data collected from Agri-stat was analysed and interpreted.

Trend analysis in Export of orange

The study calculates commodity-wise growth rates (CGR) for orange prices and quantities over three periods (2004-05 to 2013-14), (2014-15 to 2023-24), and (2003-04 to 2023-24), using exponential functions and individual outcomes for orange.

Market-wise growth rates of Orange

Table 1 provides Market-wise growth rates of orange, provides a detailed analysis of the export growth of oranges from India to 10 key markets and the overall World.

The table highlights a crucial transition in the overall export performance. While Period-I saw a slight decline in global export quantity (-1.911%), Period-II marked a strong and statistically significant recovery with a CGR of 16.218%. This positive trend is the main driver behind the overall long-term growth of 7.299% for quantity and 10.942% for value over the entire study period. The fact that the CGR for value (10.942%) is higher than for quantity (7.299%) over the long term suggests an increase in the average price of the exported product, which is a positive indicator of value addition or pricing power in the global market.

On a market-specific level, performance varies widely. Markets like Nepal and Bhutan are clear growth drivers. Nepal shows consistently high and statistically significant growth across all periods, establishing itself as a reliable and expanding market. Exports to Bhutan, which were negligible in Period-I, have since surged with exceptionally high CGRs (over 30% for both quantity and value) in Period-III, identifying it as a rapidly emerging and high-potential market. In contrast, some markets that performed well initially have since declined. Oman, and Qatar saw positive growth in Period-I but experienced sharp and significant negative growth rates in Period-II. This reversal suggests that these markets have become more challenging for Indian orange exporters in recent years.

Table: 1 Market-wise growth rates of Orange

S. N.	Export Market	Study Period		
		Period-I (2004-05 to 2013-14) CGR (%)	Period-II (2014-15 to 2023-24) CGR (%)	Period-III (2003-04 to 2023-24) CGR (%)
1	Bangladesh			
	Export Quantity	-2.55	17.99**	5.95**
	Export Value	1.91	17.16**	9.67**
2	Nepal			
	Export Quantity	8.18**	12.27**	17.57**
	Export Value	25.71**	12.95**	22.28**
3	U Arab Emts			
	Export Quantity	-11.83	9.14**	26.29**
	Export Value	1.72	5.38**	30.17**
4	Oman			
	Export Quantity	21.40**	-31.86	-6.26
	Export Value	17.02**	-20.51	0.53
5	Bhutan			
	Export Quantity	0.000	21.78**	31.89**
	Export Value	0.000	51.67**	31.13**
6	Qatar			
	Export Quantity	12.68**	-34.49	17.25**
	Export Value	20.97**	-35.33	19.64**
7	Kuwait			
	Export Quantity	-2.27	-7.67	20.76**
	Export Value	2.69*	-10.30	19.42**
8	Saudi Arab			
	Export Quantity	-3.79	-21.29	12.48**
	Export Value	-6.81	-21.04	14.47**
9	Singapore			
	Export Quantity	34.80**	2.44*	9.16**
	Export Value	46.05**	10.02**	11.52**
10	Baharain IS			
	Export Quantity	-3.47	32.18**	22.61**
	Export Value	-2.05	44.62**	24.86**
11	Overall World			
	Export Quantity	-1.91	16.22**	7.30**
	Export Value	3.03*	15.84**	10.94**

Note: - ** denote significant at 1% level, * denote significant at 5% level

Table 2: Market-wise instability analysis of orange export from India

S.N.	Export Market	Study Period					
		Period-I (2004-05 to 2013-14)		Period-II (2014-15 to 2023-24)		Period-III (2003-04 to 2023-24)	
		CV (%)	CDVI (%)	CV (%)	CDVI (%)	CV (%)	CDVI(%)
1	Bangladesh						
	Export Quantity	23.94	23.03	70.12	58.55	77.91	68.34
	Export Value	45.53	44.96	74.99	65.91	98.27	76.96
2	Nepal						
	Export Quantity	55.34	50.25	40.50	31.23	88.33	41.69
	Export Value	99.03	61.99	39.40	26.15	89.65	33.50
3	U Arab Emts						
	Export Quantity	153.92	149.50	76.65	74.48	132.60	100.25
	Export Value	139.07	138.98	75.03	74.15	134.53	91.15
4	Oman						
	Export Quantity	53.11	39.86	107.42	94.34	104.33	101.95
	Export Value	52.92	41.19	104.24	96.77	119.03	119.00
5	Bhutan						
	Export Quantity	0.00	0.00	132.09	124.81	208.77	133.52
	Export Value	0.00	0.00	163.16	134.84	246.92	164.35
6	Qatar						
	Export Quantity	222.24	215.65	116.67	104.82	184.93	172.62
	Export Value	211.85	194.91	106.25	92.41	173.45	157.62
7	Kuwait						
	Export Quantity	291.71	291.50	148.57	147.84	212.69	190.67
	Export Value	307.56	307.34	126.50	125.20	174.26	159.86
8	Saudi Arab						
	Export Quantity	209.56	209.17	108.38	99.24	148.32	139.91
	Export Value	243.53	241.68	107.35	96.00	156.57	143.64
9	Singapore						
	Export Quantity	165.10	156.71	179.90	179.62	172.34	167.48
	Export Value	164.27	136.08	134.93	131.59	149.52	138.43
10	Baharain IS						
	Export Quantity	173.92	173.36	103.69	95.87	168.93	139.53
	Export Value	157.66	157.46	87.09	74.27	154.26	120.27
11	Overall export market						
	Export Quantity	22.14	21.63	63.19	50.74	76.53	59.89
	Export Value	48.38	46.93	67.70	57.57	94.30	64.89

Note: 1. CV- coefficient of variation (%), CDVI - cuddy della vella index (%),

Table 3: Index Number for Export Quantity

year	Bangladesh	Nepal	U Arab Emts	Oman	Bhutan	Qatar	Kuwait	Saudi Arab	Singapore	Baharain IS	Total World Export
2004-05	100.00	100.00	100.00	100.00	0.00	100.00	0.00	0.00	100.00	100.00	100.00
2005-06	113.40	201.28	1655.45	70.70	0.00	46.51	0.00	0.00	2.96	0.00	115.73
2006-07	90.70	227.64	6556.82	19.90	0.00	0.00	100.00	100.00	0.00	0.00	95.50
2007-08	84.35	399.13	1163.64	177.40	0.00	0.00	2500.00	0.00	74.07	0.00	92.81
2008-09	74.71	304.40	140.00	307.65	0.00	0.00	925.00	2005.00	5620.00	349.00	80.34
2009-10	69.27	493.68	225.91	325.90	0.00	197.67	73700.00	125.00	1199.26	2.00	79.48
2010-11	41.29	173.93	89.09	199.95	0.00	2567.44	350.00	0.00	0.74	80.00	44.32
2011-12	92.89	643.33	1380.91	277.60	0.00	9.30	150.00	4000.00	2040.00	100.00	107.86
2012-13	104.48	161.83	1390.00	286.75	0.00	0.00	0.00	3.00	1481.48	0.00	106.66
2013-14	83.86	351.82	60.45	260.15	0.00	697.67	1550.00	132.00	165.93	0.00	89.56
2014-15	46.10	434.20	1456.82	28.00	100.00	1120.93	4500.00	4277.00	62.22	270.00	54.65
2015-16	204.18	1698.49	4287.73	150.75	46.31	686.05	2175.00	0.00	239.26	3.00	235.78
2016-17	114.94	1598.21	24405.00	462.80	27.42	11937.21	32050.00	2700.00	444.44	2020.00	152.60
2017-18	23.48	1166.73	21318.18	640.00	3.63	34348.84	149325.00	6496.00	344.44	6014.00	50.24
2018-19	94.49	1928.58	28859.55	1183.05	29.25	40713.95	218400.00	4126.00	3767.41	1973.00	136.70
2019-20	247.45	2445.71	40128.64	757.10	0.00	40144.19	531325.00	1606.00	394.07	443.00	297.35
2020-21	458.28	3084.69	20130.91	544.60	13.83	19779.07	195275.00	9341.00	23.70	3419.00	515.54
2021-22	337.27	2344.37	2877.73	1.25	116.20	448.84	400.00	320.00	308.15	5102.00	379.18
2022-23	204.88	1470.22	6254.09	7.90	255.83	490.70	2375.00	80.00	286.67	799.00	232.04
2023-24	175.11	2307.25	17382.73	7.25	400.93	4.65	9200.00	203.00	322.96	497.00	221.58

Table 4: Index Number for Orange (Export Value in USD Thousand)

year	Bangladesh	Nepal	U Arab Emits	Oman	Bhutan	Qatar	Kuwait	Saudi Arab	Singapore	Baharain IS	Total
2004-05	100.00	100.00	100.00	100.00	0.00	100.00	0.00	0.00	100.00	100.00	100.00
2005-06	104.48	266.70	1009.35	233.33	0.00	70.59	0.00	0.00	29.03	0.00	107.08
2006-07	83.32	226.72	3300.72	35.67	0.00	0.00	100.00	100.00	0.00	0.00	87.87
2007-08	83.37	489.17	592.09	148.97	0.00	0.00	2850.00	0.00	25.81	0.00	91.62
2008-09	63.06	396.87	54.68	263.37	0.00	0.00	1600.00	2139.13	8745.16	43.14	68.59
2009-10	62.53	732.45	196.40	414.68	0.00	188.24	352950.00	286.96	1227.42	3.92	72.83
2010-11	65.61	270.83	115.83	186.15	0.00	4023.53	700.00	0.00	0.00	174.51	68.48
2011-12	211.97	2234.87	364.03	426.47	0.00	35.29	400.00	9417.39	3740.32	50.98	240.81
2012-13	81.17	550.83	3471.22	329.08	0.00	0.00	0.00	13.04	2933.87	0.00	89.16
2013-14	111.19	1203.96	266.19	303.70	0.00	1800.00	3300.00	182.61	337.10	0.00	124.61
2014-15	54.50	1206.97	1919.42	38.96	100.00	3776.47	7700.00	24082.61	296.77	439.22	69.87
2015-16	290.59	2889.75	5642.45	222.50	106.82	1976.47	4500.00	0.00	306.45	3.92	323.64
2016-17	180.62	3512.78	27681.29	1010.15	43.59	36370.59	81500.00	7408.70	996.77	1117.65	237.90
2017-18	34.70	2476.95	23024.46	1449.25	2.60	65411.76	277650.00	17282.61	922.58	6149.02	73.61
2018-19	415.53	4297.92	26147.48	2051.17	34.90	59770.59	316800.00	10408.70	6787.10	2647.06	472.28
2019-20	408.27	5273.19	40392.81	1232.78	0.00	65682.35	538000.00	3121.74	779.03	460.78	477.64
2020-21	765.96	6321.14	19600.00	937.86	75.21	35294.12	205700.00	22295.65	48.39	3494.12	839.48
2021-22	681.72	5105.36	3626.62	42.11	714.38	1276.47	750.00	1400.00	1469.35	4768.63	736.46
2022-23	232.65	3549.36	4964.75	24.69	1482.57	952.94	3350.00	434.78	1216.13	1958.82	277.32
2023-24	201.75	5571.38	17239.57	22.91	2294.60	17.65	18600.00	839.13	1603.23	1984.31	276.66

Meanwhile, markets like Bangladesh and the UAE have shown remarkable turnarounds, converting a decline in the first period into strong, statistically significant growth in the second, demonstrating their potential for future expansion.

Market-wise instability analysis of orange export from India.

The instability is measured using two key metrics: the Coefficient of Variation (CV) and the Cuddy Della Vella Index (CDVI). Both metrics are expressed as percentages, with higher values indicating greater instability or fluctuation in exports. The analysis is conducted for both export quantity and export value.

Market-wise instability of orange During the Period-I, the instability in export quantity (21.63 % to 291.50 %) and export value (41.19% to 307.34 %). The higher range of instability in both export quantity and export value was found in Kuwait, Qatar and Saudi Arab. In terms of export value, Bangladesh and Oman is the market which showed low instability compare to other countries. It was found that, Kuwait, Qatar and Saudi Arab were the highly unstable market for export of orange. Notably, the Bhutan market shows zero instability in Period-I, as there were likely no exports during that time, but has since emerged as the most volatile market in Period-II and Period-III, with exceptionally high instability measures.

During the Period-II, the instability in export quantity (31.23 % to 179.62 %) and export value (26.15 % to 131.59%). The pattern of instability of overall export market shows to high instability in both export quantity and export value compare to I period. Bangladesh and Oman observed increasing trend in both export quantity and export value as compared to Period I. The trend of instability in orange export in Singapore and Kuwait in terms of export quantity as well as export value registered to be highly unstable.

During the Period-III, the instability in export quantity (41.69% to 190.67%) and export value (33.50% to 164.35%). The higher range of instability in both export quantity and export value was found in Kuwait, Qatar and Singapore. In terms of export value, Nepal and Bangladesh is the market which showed low instability compare to other countries. It was found that, Kuwait and Qatar were the highly unstable market for export of orange. In Overall export market, the instability was at high range for both, export quantity and export value. The reasons for high instability might be inconsistent domestic production, consumption and international demand.

Index number of export of oranges

The index numbers were worked out for different country's export quantity and export value of oranges from India. The basic object of estimating index numbers was to make the trends of export of oranges from India. The results of index numbers of export quantity and index number of export value are presented in the following table 3 and 4 respectively.

The table 3 presents the index numbers for India's orange export quantities to major destination countries from 2004–05 to 2023–24, with 2004–05 as the base year (=100). The overall trend in the Total World Export index shows considerable fluctuations, starting from 100 in the base year and rising to 115.73 in 2005–06, before dipping to 95.50 in 2006–07 and 92.81 in 2007–08. A notable decline appears in 2009–10 (44.32), indicating a sharp fall in global exports relative to the base year. However, exports picked up again in later years, crossing 100 multiple times—for example 107.86 in 2010–11 and 89.56 in 2012–13. The most significant surge is observed after 2016–17, when the index rose to 136.70 in 2017–18, 297.55 in 2018–19, and an exceptionally high 379.18 in 2019–20, showing a dramatic expansion in export quantities. Although the index fell again in 2020–21 (232.04), it stabilized at 221.58 in 2023–24, reflecting overall long-term growth.

Country-wise analysis shows that India's orange export performance varied widely across destinations. Neighboring markets such as Bangladesh and Nepal displayed moderate fluctuations, with Bangladesh ranging from 23.48 (2017–18) to 337.27 (2021–22), and Nepal rising steadily from 100 in 2004–05 to 2307.25 in 2023–24, indicating strong demand growth. In contrast, Middle Eastern markets showed extremely high and volatile indices. Kuwait recorded values as high as 73,700 in 2009–10, 32,050 in 2016–17, and 195,275 in 2019–20, reflecting massive export spikes. Saudi Arabia also showed high peaks, including 531,325 in 2018–19 and 9,341 in 2019–20. Countries like Qatar and Bahrain experienced similar volatility, reaching 34,348.84 (2017–18) and 5,102 (2021–22), respectively. Meanwhile, export indices for Bhutan, Oman, and Singapore remained relatively low or intermittent in many years, indicating limited or inconsistent trade.

Overall, the table shows that India's orange exports have expanded substantially over the two decades, particularly due to large and irregular shipments to Gulf countries, while neighboring South Asian markets offer more stable but moderate growth. The pattern reflects both opportunities for market diversification and significant volatility in India's agricultural export performance.

The table 4 presents the index numbers of India's orange export value (in USD thousand) to major importing countries from 2004–05 to 2023–24, taking initial year as the base year (index = 100). The data reveal substantial variation across countries, reflecting differences in demand patterns and export intensity. Exports to Bangladesh and Nepal remain relatively stable during early years, but a steady rise after 2014–15 indicates strengthening trade ties and increasing market penetration in these neighboring countries. The United Arab Emirates, Saudi Arabia, and Kuwait emerge as the most significant high-value markets, with exceptionally high index values in

certain years—for example, Kuwait reaches an index of 352,950 in 2009–10 and 316,800 in 2018–19, while Saudi Arabia shows peaks of 23,219 in 2008–09 and 10,408 in 2018–19. These sharp increases indicate years of extraordinarily high-value shipments, suggesting strong demand, favorable prices, or large consignment deals. Countries like Qatar and Bahrain also show intermittent spikes, reflecting irregular but occasionally high-value trade flows. The total world export index shows an overall upward trend, rising from 100 in 2004–05 to peaks such as 477.64 in 2018–19 and 839.46 in 2019–20, indicating substantial growth in India's global export earnings from oranges. However, the year-to-year fluctuations across many markets highlight volatility influenced by production levels, price movements, and external trade factors. Overall, the figures illustrate that India's high-value orange exports have expanded notably over time, driven primarily by rising demand from Middle Eastern markets, while maintaining stable but moderate growth in neighboring South Asian markets.

CONCLUSION

The market-wise growth and instability analysis of orange exports from India reveals a mixed but overall positive export performance over the study period. The growth analysis indicates that India's orange exports have strengthened in recent years, particularly during Period-II, which recorded significant positive compound growth rates for both quantity and value. The higher long-term growth in export value compared to quantity suggests improved price realization and enhanced value addition in international markets.

Among the export destinations, Nepal emerged as the most consistent and reliable market, demonstrating significant growth with relatively lower instability in the long run. Bhutan has developed as a rapidly expanding market with exceptionally high growth rates; however, its high instability indicates

unpredictable trade patterns. Similarly, Bangladesh and the UAE showed notable recovery after initial declines, highlighting their potential as future growth markets.

The analysis of India's orange exports over the past two decades reveals a clear upward trend in both export quantity and value, with the strongest growth occurring in the most recent decade (2014–15 to 2023–24). Neighboring countries such as Nepal, Bangladesh, and Bhutan have emerged as stable and consistently expanding markets, contributing significantly to overall export growth. In contrast, Middle Eastern destinations including Kuwait, Qatar, Saudi Arabia, and the UAE exhibited high growth in certain years but also substantial volatility, as evidenced by their high instability indices. This indicates that while these markets offer large opportunities, they also present considerable risks due to irregular demand and fluctuating procurement patterns.

The index number analysis further highlights large surges in export volumes after 2016–17, driven primarily by increased shipments to Gulf countries. However, the overall rise in instability across Period-II and Period-III suggests that domestic supply fluctuations, inconsistent production, and shifts in global market conditions heavily influence India's export performance.

Overall, the study concludes that although India's orange export sector demonstrates strong potential and expanding global reach, ensuring stable production, improving market diversification, and strengthening export strategies are crucial for reducing volatility and sustaining long-term growth.

REFERENCES

- APEDA (Agricultural and Processed Food Products Export Development Authority) (2022). Available at: <https://agriexchange.apeda.gov.in/> Accessed on 5 July, 2022.
- Bharodia, C.R. (2021). Export competitiveness and trade performance of major fruits from India. An unpublished A.B.M Thesis, submitted to Junagadh Agricultural University, Junagadh.
- Devi, N., Shiyani R.L. and Ardeshta N.J. (2019). Direction and destination pattern of Indian mango & mango pulp's exports. *Economic Affairs*, 64(4), 733-746.
- FAO (Food and Agriculture Organization) (2022). Available at: <https://www.fao.org/statistics/en/> Accessed on 5 July, 2022.
- Geetha, S.R. and Srivastava S.K. (2018). Export of maize from India: Performance and determinants. *Asian J. Agric. Ext., Econ. Sociol.*, 29(1), 1-11.
- Gondalia, V.K., Bansal R., Jadav K.S. and Shaikh A.S. (2017). Export of fruits and vegetables from India: Growth, opportunities and challenges. A report published by Anand Agricultural University, Anand (Gujarat), 48.
- Hazell, P.B.R. (1984). Sources of increased instability in Indian and USA cereal production. *Amer. J. Agric. Econ.*, 66(3), 302-311.
- Kadu, A., Gaware U., Baviskar P., Parvekar K. and Pusdekar M. (2021). Export performance of orange from India. *The Pharma Innov. J.*, 10(6), 87-90.
- Kashish and Dhavan V. (2017). A study on production and trade performance of fruits in India. *Indian J. Agric. Res.*, 54(1), 108-113.
- Kavita, B., Kumar S., Chahal V.P. and Kumar S. (2015). Dynamics of Indian fresh mango export. *Indian J. Agric. Sci.*, 85(11), 1466-71.

- Krishnadas, M. (2010). Production and Export Performance of Major Indian Spices – An Economic Analysis. An unpublished M.Sc. Thesis, submitted to UAS, Dharwad, Karnataka (India).
- Ministry of Agriculture & Farmers Welfare, Govt. of India. Available at: <https://agricoop.gov.in/en> Accessed on 5 July, 2022.
- Mokashi, P. and Hosamani S.B. (2014). Growth and instability analysis of Indian grapes export. Agriculture Update, 9(1), 132-135.
- Shivagangavva, P.D., Jainuddin S.M. and Reddy B.S. (2022). Growth and export destination of Indian Fruits: Evidence from Markov Chain Approach. Asian J. Agricult. Ext., Econ. Sociol., 40(10), 7-15.
- Sihmar, R. (2014). Growth and Instability in Agricultural Production in Haryana: A District level Analysis. Int. J. Scientific and Res. Publications, 4(7), 1-12.
- Tarpara, V.D., Dhandhalya M.G. and Swaminathan B. (2018). Export Performance of Marine Products from India. Research Report, Department of Agricultural Economics, Junagadh Agricultural University, Junagadh, 84-109.
- UN Comtrade (2022). Available at: <https://agriexchange.apeda.gov.in/> Accessed on 5 July, 2022.
- Vasavada, K.M. (2021). Export performance and direction of trade of major vegetable products from India. An unpublished Ph.D. Thesis, submitted to Junagadh Agricultural University, Junagadh.
- Vedprakash (2018). Estimation of Growth rates and decomposition analysis of agriculture production in Bastar district of Chhattisgarh. An unpublished M. Sc. (Agri.) Thesis, submitted to Indira Gandhi Krishi Vishwa Vidhyalaya, Raipur.

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RESEARCH ARTICLE

Evaluating the Perceived Benefits of the Tribal Sub Plan (TSP) Project among Tribal women

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ABSTRACT

Tribal women constitute one of the most marginalized sections of rural society, often facing constraints such as limited livelihood opportunities, low income, and inadequate access to skill-based training and market linkages. In this context, value addition in agriculture and allied sectors has emerged as an effective strategy for enhancing income and promoting entrepreneurship among tribal women. The present study was conducted to assess the perceived impact of training programmes on value addition, covering areas such as millet and vegetable-based enterprises, milk-based products, and horticultural and medicinal plant cultivation. The study was based on data collected from 400 tribal women who participated in structured training programmes aimed at promoting entrepreneurship and livelihood enhancement. The impact was analyzed across three dimensions, namely social, economic, and behavioral aspects. The findings revealed that the training programmes had a significant positive influence on the respondents. A majority of the women reported increased exposure to markets and institutions, enhanced participation in self-help groups, and improved social recognition. Economic improvements were observed in terms of increased employment opportunities, higher savings, and better asset creation, although investment in high-value assets such as land remained relatively low. The behavioral impact was the most prominent, with a large proportion of respondents acquiring new skills, developing a positive attitude towards value addition and entrepreneurship, and gaining awareness about government schemes. The study concludes that value addition training programmes play a crucial role in empowering tribal women by enhancing their skills, confidence, and livelihood opportunities. However, for sustained economic development, there is a need to strengthen market linkages, access to credit, and institutional support. An integrated approach combining skill development, financial inclusion, and entrepreneurship promotion can further accelerate the socio-economic upliftment of tribal women.

Key words: Tribal Sub Plan (TSP), Tribal Development, Perceived Benefits, Socio-Economic Impact, Livelihood Enhancement, Skill Development, Women Empowerment, Rural Development, Livestock-Based Livelihoods, Uttarakhand

INTRODUCTION

India is home to a large and diverse tribal population, which constitutes a significant segment of the rural poor and often resides in geographically isolated and resource-constrained regions. Despite possessing rich traditional knowledge and a close relationship with natural resources, tribal communities continue to face challenges such as low income levels, limited access to markets, lack of

technical skills, and inadequate institutional support. Among them, tribal women remain one of the most vulnerable groups, as they are often engaged in low-paying, subsistence-based activities with minimal opportunities for economic advancement. (Kandpal and Kwatra, 2025)

In recent years, there has been growing recognition of the need to promote livelihood diversification and entrepreneurship among

tribal populations, particularly women, as a pathway to sustainable development and poverty reduction. Value addition in agriculture and allied sectors has emerged as a promising strategy in this regard. By transforming raw agricultural produce into processed and marketable products, value addition not only enhances income but also generates employment opportunities and reduces post-harvest losses. (Kandpal, 2025)

Training programmes focusing on value addition and entrepreneurship development play a crucial role in equipping tribal women with the necessary knowledge, skills, and confidence to engage in income-generating activities. Interventions related to millet and vegetable cultivation and processing, milk-based value-added products, and horticultural and medicinal plant cultivation offer significant potential for improving livelihoods. These activities are particularly suitable for tribal women, as they can be undertaken at the household or community level with relatively low investment and utilize locally available resources.

Millet, known for their nutritional richness and climate resilience, are gaining importance in the context of food and nutritional security. Similarly, the development of milk-based products such as paneer, ghee, and curd provides opportunities for enhancing income

through livestock-based enterprises. Horticulture and medicinal plant cultivation further diversify income sources while promoting sustainable use of natural resources. When combined with proper training in processing, packaging, and marketing, these activities can significantly enhance the economic status of tribal women. (Kandpal *et.al.*, 2025)

Moreover, participation in such training programmes also contributes to social and behavioral transformation by increasing awareness, improving institutional linkages, and fostering a positive attitude towards entrepreneurship. Women become more confident, socially active, and capable of making informed decisions regarding their livelihoods.

In this context, the present study aims to assess the perceived impact of value addition training programmes on tribal women, with specific focus on social, economic, and behavioral changes. The study provides insights into how training interventions can contribute to empowerment and livelihood enhancement among tribal women, and highlights the need for integrated approaches that combine skill development, financial support, and market linkage for sustainable development.

S.N.	Impact Category	Modified Variables (As per Training Themes)	No. of Respondents	Percentage (%)	Rank
A	Social Impact				
1		Increased exposure to markets, trainings and institutions	328	82%	1
2		Improved food and nutritional practices through millets & vegetables	260	65%	6
3		Increased participation in SHGs and entrepreneurship activities	312	78%	3
4		Improved linkage and credibility with extension officials	296	74%	5
5		Enhanced interaction with veterinarians for livestock-based enterprises	320	80%	2
6		Increased social recognition as entrepreneur/producer	276	69%	4

B	Economic Impact				
7		Improvement in housing through income from value-added products	220	55%	5
8		Investment in land/horticulture/ medicinal plant cultivation	112	28%	6
9		Increase in household assets through value addition enterprises	288	72%	3
10		Increase in savings from milk, millets & processed products	304	76%	2
11		Reduction in debts through income generation activities	240	60%	4
12		Increased employment through value addition and allied activities	336	84%	1
C	Behavioral Impact				
13		Increased awareness about government schemes for tribal entrepreneurship	360	90%	2
14		Skill development in milk processing, millet products & value addition	352	88%	3
15		Positive attitude towards entrepreneurship and value addition activities	368	92%	1

Methodology

The study was conducted in Sitarganj, Gadarpur, Khateema blocks located in Udham Singh Nagar district of Uttarakhand. A total sample of 400 tribal beneficiaries was selected through purposive sampling, focusing on individuals who had received benefits under Tribal Sub Plan (TSP) schemes. In addition to assessing the programme impact, a series of training programmes were also organized on key themes, namely promoting entrepreneurship through millets and vegetable cultivation and value addition; empowering tribal women through the development and marketing of milk-based value-added products; promotion of horticultural and medicinal plant cultivation for livelihood enhancement; and overall empowerment of tribal women through value addition activities. Primary data were collected using a structured and pre-tested interview schedule through personal interaction with the respondents. The perceived benefits were measured across dimensions such as income generation, skill development, access to resources, and social empowerment. The

collected data were analyzed using statistical tools including frequency, percentage, and mean scores, and ranking techniques were applied to prioritize the perceived benefits and constraints.

RESULTS AND DISCUSSION

The analysis of data collected from 400 tribal women respondents highlights the significant impact of training programmes on value addition, entrepreneurship development, and livelihood enhancement. The outcomes are discussed under social, economic, and behavioral dimensions.

Social Impact of Value Addition Training

The training programmes have brought notable improvements in the social empowerment and exposure of tribal women. A majority of respondents (82%) reported increased exposure to markets, training institutions, and extension systems, indicating that women are now more connected to external agencies and opportunities. This enhanced exposure is essential for promoting entrepreneurship and improving decision-making ability.

Further, 78% of respondents showed increased participation in Self-Help Groups (SHGs) and entrepreneurial activities, which reflects the strengthening of collective action and group-based enterprises. Participation in SHGs is particularly important in tribal areas as it facilitates knowledge sharing, financial inclusion, and marketing support.

About 80% of respondents reported enhanced interaction with veterinarians, especially among those engaged in milk-based value-added products, while 74% experienced improved linkage with extension officials. These findings indicate that training programmes have successfully bridged the gap between tribal women and institutional support systems. Additionally, 69% of respondents reported increased social recognition as entrepreneurs or producers, which reflects a positive shift in societal perception towards women's economic roles. However, only 65% reported improvement in food and nutritional practices through millets and vegetables, suggesting that while awareness has increased, behavioral adoption in dietary patterns is gradual.

These results indicate that training on value addition not only enhances technical skills but also strengthens social capital, institutional linkage, and community participation. The improved interaction with extension systems and increased recognition suggest that women are transitioning from traditional roles to active economic contributors and decision-makers.

Economic Impact of Value Addition Training

The economic impact of the training programmes is evident in terms of income generation, employment creation, and improved financial stability. A large proportion of respondents (84%) reported increased employment opportunities through value addition and allied activities, such as millet processing, milk product preparation, and horticulture-based enterprises. Similarly, 76% of respondents experienced increased savings

from income generated through milk products, millets, and other processed goods, indicating improved financial management and economic resilience. About 72% reported an increase in household assets, reflecting better living standards as a result of enhanced income. Moreover, 60% of respondents were able to reduce or clear their debts, which is a significant indicator of financial empowerment. Around 55% reported improvement in housing conditions, suggesting moderate progress in asset creation. However, only 28% of respondents reported investment in land, horticulture, or medicinal plant cultivation, indicating that adoption of high-investment enterprises is still limited. The findings clearly demonstrate that value addition training has a strong short-term economic impact, particularly in generating income and employment. Activities like milk processing, millet-based product preparation, and small-scale horticulture enterprises require relatively low investment and provide quick returns, making them highly suitable for tribal women. However, long-term economic sustainability, especially in terms of land investment and large-scale cultivation, remains limited due to constraints such as lack of capital, risk-bearing capacity, and access to credit. Strengthening financial linkages and providing subsidies or credit support could further enhance economic outcomes.

Behavioral Impact of Value Addition Training

The behavioral impact of the training programmes is the most significant among all dimensions. A very high percentage (92%) of respondents developed a positive attitude towards entrepreneurship and value addition activities, indicating strong acceptance and motivation to adopt income-generating practices. Further, 90% of respondents reported increased awareness about government schemes related to tribal development and entrepreneurship, which reflects the

effectiveness of training in information dissemination. Additionally, 88% of respondents acquired new skills in milk processing, millet-based products, and other value addition techniques, demonstrating the success of capacity-building efforts. The high level of behavioral change suggests that the training programmes have effectively enhanced the knowledge, skills, and attitudes of tribal women. Skill development in value addition plays a crucial role in enabling women to move from subsistence-level activities to market-oriented enterprises.

The development of a positive entrepreneurial mindset is particularly important for ensuring the sustainability and scalability of interventions. These findings confirm that hands-on training, practical demonstrations, and market-oriented approaches are highly effective in transforming the behavior of rural and tribal women.

A comparative analysis of all three dimensions reveals that behavioral impact is the highest, followed by social impact, and then economic impact. The training programmes were highly effective in building entrepreneurial skills, awareness, and positive attitudes. Social empowerment indicators such as participation, institutional linkage, and recognition have improved significantly. Economic gains are primarily reflected in income generation, savings, and employment, while investment in high-value assets such as land and horticulture expansion is still emerging.

CONCLUSION

The study clearly demonstrates that training on value addition and entrepreneurship

development has played a transformative role in improving the livelihoods and socio-economic status of tribal women. The interventions have successfully enhanced skills, awareness, and confidence, leading to increased participation in income-generating activities. While short-term economic benefits are clearly visible, sustained efforts are required to promote long-term asset creation, market linkage, and financial inclusion. An integrated approach combining training, credit support, and marketing facilities can further strengthen the impact and ensure sustainable empowerment of tribal women.

REFERENCES

- Kandpal, A.S. and Kwatra, J. (2025). Knowledge of tribal women on value added products under tribal sub plan scheme in Udham Singh Nagar district of Uttarakhand. Asian Journal of Extension Education. Vol.42, Year-2024. Pp: 205-211.
- Kandpal, A.S. (2025). Capacity Building in Value addition for tribal women through TSP. Agriculture Extension Journal. Vol.9 No.4 pp: 179-184.
- Kandpal, A. S., Kwatra, J., Bajpai, M., Goswami, P. and Joshi, A. (2025). Empowering tribal women through value addition: Impact of training on knowledge, economic motivation and livelihood enhancement in Uttarakhand. International Journal of Agriculture Extension and Social Development. Vol. 8, Issue:3, pp:277-282.

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REVIEW ARTICLE

Internet of Things (IoT) in Horticulture: Applications, Technologies and Future Prospects

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ABSTRACT

Traditional agricultural practices have increased food production mainly through the use of fertilizers and pesticides, but only up to a certain extent. Excessive use of these inputs causes soil degradation, loss of soil organic carbon, environmental pollution, and health problems. The Internet of Things (IoT) provides a smart solution for agriculture by enabling the precise and efficient use of inputs along with better farm management practices such as soil testing, irrigation management, weather forecasting, crop monitoring, and livestock management. IoT technologies use sensors, wireless communication, cloud computing, artificial intelligence, and data analysis to improve productivity and sustainability in horticulture. In the future, agriculture is expected to become more automated and connected through artificial intelligence, machine learning, and big data, helping farmers manage farming activities from sowing to yield prediction. This review paper discusses the applications, technologies, benefits, and future scope of IoT in horticulture.

Keywords: IoT, Sensors, Smart Farming, Horticulture, Precision Agriculture, Automation

INTRODUCTION

The horticulture sector plays an important role in nutritional security, employment generation, and economic development. India is the world's second-largest producer of fruits and vegetables, and the area and production of horticultural crops have continuously increased over the years. According to recent estimates, India's total horticultural production reached about 355.48 million tonnes during 2022–23, including around 110–113 million tonnes of fruits and more than 212 million tonnes of vegetables (Anonymous, 2025).

Despite this progress, Indian horticulture faces many challenges such as decreasing agricultural land per person, frequent droughts, low soil organic carbon, labour shortages, and climate change. Climate change has greatly affected vegetable cultivation and agricultural productivity due to irregular rainfall, temperature fluctuations, and extreme

weather conditions. Sudden climatic changes negatively affect pollination, flowering, fruit setting, fruit development, and ripening, especially in vegetable crops because they are highly sensitive to environmental changes (Solankey et al., 2021).

The use of advanced technologies such as the Internet of Things (IoT), drones, remote sensing, and artificial intelligence can help overcome these challenges. IoT is a modern technology that allows devices to connect and communicate remotely and supports smart decision-making in agriculture (Patil and Kale, 2016). It has improved efficiency and productivity in many sectors, including healthcare, communication, trade, energy, and agriculture (Elijah et al., 2018).

In horticulture, IoT technologies help in precision farming through real-time monitoring of soil moisture, temperature, humidity, nutrient status, pests, and crop growth. The use of drones in Indian agriculture, especially in states like

Maharashtra, provides better opportunities for precise input application, resource mapping, and crop monitoring, which helps improve productivity and sustainability (Patil et al., 2024).

World Scenario of IoT in Agriculture

Countries such as the United States, Japan, Germany, and China are leading in sensor technology, automation, and precision agriculture systems. These countries have developed advanced agricultural sensors such as soil sensors, weather sensors, water sensors, and plant sensors, which help in accurate data collection and better farm management (He et al., 2009).

According to the United Nations 2030 Agenda for Sustainable Development, the global community aims to end hunger and ensure food security by 2030. However, more than 800 million people around the world still face food shortages (Frona et al., 2019). Rapid population growth has increased the demand for quality food, creating the need for efficient and sustainable agricultural production systems.

The adoption of IoT-based smart farming technologies is considered an effective solution to improve crop productivity, reduce wastage of agricultural inputs, conserve natural resources, and promote environmental sustainability.

Smart Farming and Precision Agriculture

Smart farming is the use of advanced technologies such as IoT, artificial intelligence, robotics, cloud computing, and data analysis in agriculture. It supports precision farming by helping farmers monitor crops and farm activities remotely.

Automation of sensors and machinery has improved labour efficiency and crop management practices (O'Grady and O'Hare, 2017). Modern technologies have changed traditional farming into automated and data-based farming systems, creating a technological revolution in agriculture (Quy et al., 2022).

In smart agriculture, site-specific nutrient management helps provide the correct amount of nutrients required by crops and reduces the harmful effects of excessive fertilizer use on soil and the environment. Nutrient requirements depend on factors such as soil type, crop type, target yield, fertilizer type, nutrient-use efficiency, and weather conditions. IoT-based nutrient management systems help identify nutrient distribution in fields for efficient fertilizer application (Lavanya et al., 2020).

Technologies Used in Smart Horticulture

Global Positioning System (GPS)

GPS provides accurate location information that helps farmers identify variations in the field such as soil type, weed distribution, pest incidence, and soil moisture levels. This technology helps in the site-specific application of seeds, fertilizers, pesticides, and irrigation water, which improves input-use efficiency and reduces production costs (Batte and Van Buren, 1999).

Sensor Technologies

Plant health depends on several factors such as soil moisture, nutrient availability, temperature, humidity, light intensity, rainfall, and carbon dioxide concentration. Different sensors are used to continuously monitor these factors and send the information to microcontrollers for automatic decision-making.

Commonly used sensors in horticulture include soil moisture sensors, temperature sensors, humidity sensors, airflow sensors, CO₂ sensors, pressure sensors, light sensors, and pH and EC sensors. These sensors are reliable, portable, durable, and energy-efficient (Muhammad et al., 2020). Sensor-based monitoring systems help maintain suitable environmental conditions for crop growth and also help conserve water and energy resources (Srisruthi et al., 2016).

Geographic Information System (GIS)

GIS provides detailed information regarding soil type, nutrient status, topography, irrigation systems, drainage, and crop productivity. It establishes relationships among different factors affecting crop growth and supports precision farming decisions (Ojo and Ilunga, 2018).

Remote Sensing and Crop Monitoring

Satellite imagery and drone-based imaging systems are widely used for crop monitoring and yield estimation. Remote sensing helps identify variations in soil conditions, crop health, nutrient deficiencies, pest infestations, and water stress.

Vegetation indices derived from satellite imagery are used for early crop yield estimation and drought assessment (Felix et al., 2013). Automated systems facilitate data acquisition, processing, monitoring, and farm management operations such as weather forecasting, nutrient tracking, and field mapping (Chowdhury et al., 2020).

Soil and Plant Sensors

Soil and plant sensors are important components of precision agriculture. These sensors provide real-time information regarding soil fertility, moisture content, salinity, and plant health. Continuous monitoring enables timely corrective measures and efficient resource management (Adamchuk et al., 2004).

Rate Controllers

Rate controllers control the application of agricultural inputs such as fertilizers, pesticides, and irrigation water according to the needs of different parts of the field. These systems monitor the speed of vehicles and automatically adjust the flow rate of inputs in real time, ensuring accurate application and reducing wastage (Sushil et al., 2014).

Precision Irrigation Systems

Modern irrigation systems use GPS-based controllers, wireless communication,

sensors, and automated valves to improve irrigation efficiency. Soil moisture sensors and weather-based irrigation scheduling systems help save water while maintaining suitable conditions for crop growth (Hassan et al., 2020).

Drones also help in irrigation management, fertigation, and orchard monitoring by providing real-time information about the field (Magar et al., 2023).

Yield Monitoring Systems

IoT-based yield monitoring systems estimate crop productivity using software applications, sensors, and mathematical models. Mobile applications integrated with Bluetooth and cloud-based systems enable farmers to estimate crop yields accurately (Mishachandar and Vairamuthu, 2021).

Machine learning and satellite-derived crop models are increasingly being used for reliable yield prediction under varying environmental conditions (Olipa et al., 2021).

Agricultural Software and Cloud Computing

Agricultural software systems are used for mapping, data processing, visualization, analysis, and interpretation. These systems generate maps related to soil properties, nutrient status, crop yields, and variable-rate application zones.

Cloud computing facilitates real-time storage, sharing, and analysis of agricultural data, improving farm management decisions and operational efficiency (Ferrandez et al., 2018).

Intelligent Agricultural Machinery

Intelligent agricultural machinery helps perform farming operations efficiently and automatically, such as cultivation, sowing, transplanting, irrigation, spraying, fertilization, harvesting, and post-harvest management.

These machines can independently collect information about soil conditions, water quality, crop growth, and environmental factors, which supports precision agriculture and

sustainable horticultural production (Ma and Sun, 2020).

Applications of IoT in Horticulture

Crop Monitoring

IoT technology allows farmers to monitor crop growth and field conditions remotely using mobile phones and connected devices. Sensors provide information about temperature, humidity, rainfall, soil moisture, and nutrient status, helping farmers make better decisions.

IoT-based systems are also useful for early detection of nutrient deficiencies, pests, and diseases, which helps reduce crop losses and improve productivity (Mekala and Viswanathan, 2017).

Pest and Disease Management

IoT-enabled devices such as drones, wireless sensors, and robotic systems help identify and manage pests and diseases through real-time monitoring and disease forecasting models.

IoT-based strawberry disease prediction systems have demonstrated improved disease management efficiency and reduced pesticide usage (Kim et al., 2018).

Fruit Crop Monitoring

RGB and multispectral satellite images are used to monitor fruit size, colour, maturity, and quality. These technologies help farmers make timely harvesting and marketing decisions.

Optical sensors are also used to monitor fruit shrinkage and drying processes in crops such as papaya (Udomkun et al., 2016).

Water-Saving Irrigation

IoT-based smart irrigation systems improve irrigation efficiency, reduce water wastage, and decrease human labour. These systems supply water according to crop requirements and soil moisture levels.

Wireless sensor network (WSN)-based irrigation systems have shown significant improvements in greenhouse vegetable production and water-use efficiency (Srbínovska et al., 2015).

Application of IoT in Greenhouse Cultivation

Smart greenhouses automatically control environmental factors such as temperature, humidity, CO₂ concentration, light intensity, and irrigation scheduling.

IoT-enabled greenhouse systems protect plants from harmful weather conditions such as hailstorms, excessive ultraviolet radiation, and pest attacks. Studies have shown that smart greenhouse systems can reduce water use by 70–80% while increasing crop productivity (Kodali et al., 2016).

IoT-based greenhouse systems have also improved rose cultivation by monitoring and controlling humidity, CO₂ levels, nutrient solutions, UV light intensity, pH, and electrical conductivity (Tripathy et al., 2021).

Hydroponics and IoT

Hydroponics is a soilless cultivation system in which plants are grown using nutrient-rich water solutions. IoT technologies improve hydroponic farming through automated monitoring of nutrient concentration, pH, temperature, and dissolved oxygen.

Wireless sensor-based hydroponic systems enable real-time monitoring and precise nutrient management, thereby improving crop growth and greenhouse efficiency (Sambo et al., 2019).

Vertical Farming

Vertical farming is the practice of growing crops in vertically stacked layers under controlled environmental conditions. IoT-based vertical farming systems reduce the requirement of land and water while increasing crop productivity.

These systems provide precise control over light, temperature, humidity, and nutrient

supply, resulting in higher yields and better resource-use efficiency compared to traditional farming systems (Benke and Tomkins, 2017).

Advantages of IoT in Horticulture

IoT technology has many advantages in horticulture. It helps farmers use water, fertilizers, and pesticides efficiently and reduces wastage. IoT systems allow real-time monitoring of crops and environmental conditions such as temperature, humidity, and soil moisture. These technologies reduce labour and operational costs through automation. IoT also helps in the early detection of pests and diseases, which reduces crop losses and improves crop yield and quality. The information collected by sensors helps farmers make better decisions. Overall, IoT supports sustainable farming and increases farmers' income and profitability.

Challenges of IoT in Horticulture

Despite its many benefits, the adoption of IoT in horticulture faces several challenges. High installation and maintenance costs make it difficult for small farmers to use these technologies. Limited internet connectivity and power supply problems in rural areas also affect the proper functioning of IoT systems. Many farmers lack technical knowledge and training to operate advanced devices. In addition, issues related to data privacy, cybersecurity, and compatibility among different devices and platforms create difficulties in system management. Therefore, proper policy support, farmer training programmes, and better infrastructure development are necessary for the large-scale adoption of IoT technologies in horticulture.

Future Prospects

The future of horticulture is expected to become more technology-driven with the use of Artificial Intelligence (AI), Machine Learning (ML), robotics, automation, big data analytics, blockchain technology, smart drones, and climate-smart agriculture systems.

These advanced technologies will help develop automated farming systems that can monitor crop growth, predict diseases, manage the efficient use of inputs, and estimate crop yields accurately. Government initiatives such as the Digital Agriculture Mission and precision farming programmes are also expected to increase the adoption of IoT technologies in Indian agriculture.

Conclusion

IoT technologies have great potential to improve productivity, quality, and sustainability in horticulture. IoT-based systems help in the efficient use of resources through real-time monitoring of soil moisture, temperature, humidity, nutrient status, and crop health.

The use of sensors, artificial intelligence, cloud computing, drones, and automation technologies helps farmers make better decisions and improve farm management practices. IoT also supports precision irrigation, pest and disease management, greenhouse automation, hydroponics, and vertical farming.

Although challenges such as high initial costs, limited infrastructure, and lack of technical knowledge still exist, continuous technological developments and government support are expected to increase the adoption of IoT in horticulture. Therefore, IoT technology can play an important role in achieving sustainable and climate-resilient horticultural production in the future.

REFERENCES

- Adamchuk, V.I., Hummel, J.W., Morgan, M.T. and Upadhyaya, S.K. 2004. On-the-go soil sensors for precision agriculture. *Computers & Electronics in Agriculture*, 44: 71–91.
- Anonymous. 2025. APEDA Horticulture Statistics. Available at: <https://apeda.gov.in/Fresh Fruits And Vegetables>
- Batte, M.T. and Van Buren, F.N. 1999. Precision farming: Factors influencing productivity. *Proceedings of the*

- Northern Ohio Crops Day Meeting, Wood County, Ohio, USA.
- Benke, K. and Tomkins, B. 2017. Future food-production systems: Vertical farming and controlled-environment agriculture. *Sustainability: Science, Practice and Policy*, 13: 13–26.
- Chowdhury, M.E.H., Khandakar, A., Ahmed, S., Al-Khuzaei, F., Hamdalla, J., Haque, F., Reaz, M.B.I., Shafei, A.A. and Emadi, N.A. 2020. Design, construction and testing of IoT-based automated indoor vertical hydroponics farming test-bed in Qatar. *Sensors*, 20: 5637.
- Elijah, O., Rahman, T.A., Orikumhi, I., Leow, C.Y. and Hindia, M.N. 2018. An overview of Internet of Things (IoT) and data analytics in agriculture: Benefits and challenges. *IEEE Internet of Things Journal*, 5(5): 3758–3773.
- Felix, R., Clement, A., Igor, S. and Oscar, R. 2013. Using low-resolution satellite imagery for yield prediction and yield anomaly detection. *Remote Sensing*, 5: 1704–1733.
- Ferrandez-Pastor, F.J., García-Chamizo, J.M., Nieto-Hidalgo, M. and Mora-Martínez, J. 2018. Precision agriculture design method using a distributed computing architecture on Internet of Things context. *Sensors*, 18: 1731.
- Frona, D., Szenderák, J. and Rákos, M.H. 2019. The challenge of feeding the world. *Sustainability*, 11: 5816.
- Hassan, A., Aitazaz, A.F., Farhat, A., Bishnu, A. and Travis, E. 2020. Precision irrigation strategies for sustainable water budgeting of potato crop in Prince Edward Island. *Sustainability*, 12: 2419.
- He, Z.G., Ji, B. and He, J.G. 2009. Development of agricultural sensor technologies. *Modern Agricultural Technology*, 3: 94–95.
- Kim, S., Lee, M. and Shin, C. 2018. IoT-based strawberry disease prediction system for smart farming. *Sensors*, 18: 4051.
- Kodali, R.K., Jain, V. and Karagwal, S. 2016. IoT-based smart greenhouse. *Proceedings of the IEEE Region 10 Humanitarian Technology Conference*, Agra, India.
- Lavanya, G., Rani, C. and Ganeshkumar, P. 2020. An automated low-cost IoT-based fertilizer intimation system for smart agriculture. *Sustainable Computing: Informatics and Systems*, 28: 100300.
- Ma, Y.Q. and Sun, X. 2020. Intelligent agricultural machinery equipment and technology. *Agricultural Equipment Technology*, 46(1): 4–6.
- Magar, S.D., Patil, S.D., Pawar, V.R. and Shinde, S.R. 2023. Unlocking the potential of drones in orchard management: A review. *Asian Journal of Extension Education*, 41: 96–101.
- Mekala, M.S. and Viswanathan, P. 2017. Smart agriculture IoT with cloud computing: A survey. *Proceedings of the International Conference on Microelectronic Devices, Circuits and Systems*, Vellore, India.
- Mishachandar, B. and Vairamuthu, S. 2021. Crop yield estimation using the Internet of Things. *Journal of Information and Knowledge Management*, 20: 2140006.
- Muhammad, S.F., Shamyla, R., Adnan, A., Tariq, U. and Yousaf, B.Z. 2020. Role of IoT technology in agriculture: A systematic literature review. *Electronics*, 9: 319.
- O'Grady, M.J. and O'Hare, G.M.P. 2017. Modelling the smart farm. *Information Processing in Agriculture*, 4: 179–187.
- Ojo, O.I. and Ilunga, M.F. 2018. Geospatial analysis for irrigated land assessment modelling and mapping. In: *Multi-*

- Purposeful Application of Geospatial Data. Intech Open, London, UK.
- Olipa, N.L., Lydia, M.C., Chabala, S. and Chizumba, S. 2021. Satellite-based crop monitoring and yield estimation: A review. *Journal of Agricultural Science*, 13: 180–194.
- Patil, K.A. and Kale, N.R. 2016. A model for smart agriculture using IoT. *Proceedings of the International Conference on Global Trends in Signal Processing, Information Computing and Communication*, Jalgaon, India.
- Patil, S.D., Magar, S.D., Shinde, S.R. and Nalawade, S.M. 2024. Applications and challenges of drones in agriculture: A review. *Asian Journal of Extension Education*, 42: 173–181.
- Quy, V.K., Hau, N.V., Anh, D.V., Quy, N.M., Ban, N.T., Lanza, S., Randazzo, G. and Muzirafuti, A. 2022. IoT-enabled smart agriculture: Architecture, applications, and challenges. *Applied Sciences*, 12: 3396.
- Sambo, P., Nicoletto, C., Giro, A., Pii, Y., Valentinuzzi, F., Mimmo, T., Lugli, P., Orzes, G., Mazzetto, F. and Astolfi, S. 2019. Hydroponic solutions for soilless production systems: Issues and opportunities in a smart agriculture perspective. *Frontiers in Plant Science*, 10: 923.
- Solankey, S.S., Kumari, M., Akhtar, S., Singh, H.K. and Ray, P.K. 2021. Challenges and opportunities in vegetable production under changing climate: Mitigation and adaptation strategies. *Advances in Olericulture*. Springer, Cham.
- Srisruthi, S., Swarna, N., Ros, G.M.S. and Elizabeth, E. 2016. Sustainable agriculture using eco-friendly and energy-efficient sensor technology. *Proceedings of the IEEE International Conference on Recent Trends in Electronics, Information and Communication Technology*, Bangalore, India.
- Srbínovska, M., Gavrovski, C. and Dimcev, V. 2015. Environmental parameters monitoring in precision agriculture using wireless sensor networks. *Journal of Cleaner Production*, 88: 297–307.
- Sushil, S., Radha Mohan, S., Manhas, S.S. and Shiv Kumar, L. 2014. Potential of variable rate application technology in India. *AMA Agricultural Mechanization in Asia, Africa and Latin America*, 45: 74–89.
- Tripathy, P.K., Tripathy, A.K., Agarwal, A. and Mohanty, S.P. 2021. MyGreen: An IoT-enabled smart greenhouse for sustainable agriculture. *IEEE Consumer Electronics Magazine*, 10: 57–62.
- Udomkun, P., Nagle, M., Argyropoulos, D., Mahayothee, B. and Müller, J. 2016. Multi-sensor approach to improve optical monitoring of papaya shrinkage during drying. *Journal of Food Engineering*, 189: 82–89.
- Wang, Z., Walsh, K.B. and Verma, B. 2017. On-tree mango fruit size estimation using RGB-D images. *Sensors*, 17: 2738.
- Yang, W., Feng, H., Zhang, X., Zhang, J., Doonan, J.H., Batchelor, W.D., Xiong, L. and Yan, J. 2020. Crop phenomics and high-throughput phenotyping: Past decades, current challenges, and future perspectives. *Molecular Plant*, 13: 187–214.

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REVIEW ARTICLE

Documentation and Analysis of Indigenous Technical Knowledge in Livestock Disease Management in Ratnagiri District of Konkan Region

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ABSTRACT

Indigenous Technical Knowledge (ITK) plays a significant role in livestock health management, particularly in resource-constrained rural areas. The present study was conducted in Ratnagiri district of the Konkan region to document and analyse traditional livestock disease management practices followed by farmers. An exploratory research design was adopted, covering 120 respondents from 12 villages across three tehsils. Data were collected through personal interviews using a semi-structured schedule and validated through field observations and participatory discussions. The study identified a wide range of ITKs for managing diseases such as diarrhoea, respiratory disorders, wounds, ectoparasites, and bloat. Most practices involved locally available plant materials and household resources. Selected ITKs were analysed for their scientific relevance. The findings indicate that ITKs are cost-effective, culturally accepted, and environmentally sustainable. However, scientific validation is essential before their wider dissemination. The study highlights the need for systematic documentation, validation, and integration of ITKs into formal livestock healthcare systems.

Keywords: Indigenous Technical Knowledge, Ethnoveterinary practices, Livestock health, Konkan region, Ratnagiri

INTRODUCTION

Indigenous Technical Knowledge (ITK) refers to the location-specific, experience-based knowledge developed and practiced by rural communities over generations. In livestock management, ITKs play a crucial role in disease prevention and treatment, especially in areas where access to modern veterinary services is limited.

Despite advancements in veterinary science, farmers continue to rely on traditional practices due to their affordability, accessibility, and cultural compatibility. However, this knowledge is gradually declining due to modernization and lack of systematic documentation.

Recognizing the importance of preserving and validating such knowledge, the present study was undertaken to document and analyse indigenous livestock disease management practices followed by farmers in Ratnagiri district of the Konkan region.

MATERIAL AND METHODS

The study was conducted in Ratnagiri district of Maharashtra using an exploratory research design. Three tehsils - Khed, Chiplun and Sangameshwar - were purposively selected based on higher livestock population.

From each tehsil, four villages were selected, making a total of 12 villages. Ten livestock farmers with a minimum of 20 years of experience were selected from each village, resulting in a sample size of 120 respondents.

Data were collected through personal interviews using a pre-tested semi-structured interview schedule. Participatory discussions and field observations were also undertaken to verify the reported practices. The collected ITKs were categorized based on disease conditions and analysed using descriptive methods.

RESULTS AND DISCUSSION

Only the most commonly practiced and widely accepted ITKs are presented here for clarity and scientific relevance.

1. Indigenous Technical Knowledge for Digestive Disorders (Diarrhoea)

Use of Kokum (Garcinia indica) with Buttermilk

Farmers reported that dried kokum rinds are soaked overnight in buttermilk and administered orally to animals suffering from diarrhoea. This practice is widely followed due to the local availability of kokum.

Farmers perceive that this treatment controls loose motions and restores appetite.

Scientifically, kokum possesses **astringent properties**, which help reduce intestinal secretions, while buttermilk supports gut microbial balance, aiding recovery.

Use of Fenugreek Seeds (Trigonella foenum-graecum)

Fenugreek seeds are soaked overnight and fed to affected animals.

This practice is believed to reduce diarrhoea and improve digestion.

Fenugreek contains **mucilage**, which forms a protective layer on the intestinal lining, thereby reducing irritation and fluid loss.

2. Indigenous Practices for Respiratory Disorders

Use of Adulsa (Adhatoda vasica) Leaf Extract

Farmers administer fresh leaf extract of *Adulsa* for 2–3 days to animals suffering from cough and cold.

This is believed to relieve congestion and improve breathing.

Adulsa contains **vasicine**, a compound known for its bronchodilator and expectorant properties, supporting its effectiveness in respiratory ailments.

Smoke Inhalation (“Dhuri Dene”)

Animals are exposed to smoke generated by burning ajwain, coconut husk, and other plant materials.

Farmers believe that this helps in clearing nasal passages and reducing mucus.

Ajwain contains **thymol**, which has antimicrobial and decongestant properties, possibly aiding respiratory relief.

3. Indigenous Practices for Wound Healing

Application of Turmeric Paste

Farmers apply turmeric paste on wounds and cover them with leaves or cloth.

This practice is believed to promote faster healing and prevent infection.

Turmeric contains **curcumin**, which has strong antimicrobial, anti-inflammatory, and wound-healing properties.

Application of Karanj Oil (Pongamia pinnata)

Karanj oil is applied externally on wounds and skin infections.

Farmers report that it prevents maggot infestation and accelerates healing.

Karanj oil possesses **antibacterial and insecticidal properties**, making it effective in wound management.

4. Indigenous Practices for Ectoparasite Control

Use of Soapnut (Sapindus trifoliatus) Solution

A solution prepared from soapnut fruits is applied to the animal's body.

This helps in removing ticks and maintaining skin hygiene.

Soapnut contains **saponins**, which have natural cleansing and insecticidal properties.

Use of Lantana (Lantana camara) Leaf Extract

Leaf extract is applied to the animal's body for controlling ticks.

Farmers believe it reduces ectoparasite infestation.

Lantana has **insecticidal and repellent properties**, which may help control parasites.

5. Indigenous Practices for Bloat (Tympanitis)

Use of Herbal Mixture (Ajwain, Cumin, Plant Extracts)

Farmers prepare a mixture of ajwain, cumin, and plant extracts, which is administered orally.

This practice is believed to relieve gas accumulation and abdominal discomfort.

Ajwain and cumin have **carminative properties**, which help in reducing gas formation and improving digestion.

CONCLUSION

The study revealed that farmers in Ratnagiri district possess rich indigenous knowledge related to livestock disease management. These practices are economical, locally available, and environmentally sustainable.

Many of the documented ITKs have a scientific basis, indicating their potential usefulness in modern livestock healthcare. However, certain practices require careful validation before recommendation.

There is a need to:

- Systematically document indigenous knowledge
- Scientifically validate effective practices
- Integrate validated ITKs with modern veterinary systems

Such efforts can contribute to sustainable livestock development and improved rural livelihoods.

REFERENCES

- Khateeb, A. M., Khandi, S. A., Bhadwal, M. S., Dar, M. A., Wani, S. A., & Bafanda, R. A. (2017). Indigenous technical knowledge practices followed by pastoralists for the treatment of livestock diseases in hills of Jammu and Kashmir State in India. *Curr J Appl Sci Technol*, 27, 1-9.
- Nag, A., Galav, P., & Katewa, S. S. (2007). Indigenous animal healthcare practices from Udaipur district, Rajasthan. *Indian journal of traditional Knowledge*, 6(4), 583-588
- Panda, T., Mishra, N., Pradhan, B. K., Rout, S. D., Mishra, R. K., & Mohanty, R. B. (2017). Plants used in traditional healthcare of livestock: A case study from Kendrapara district, Odisha, India. *J Med Plants Stud*, 5(4), 175-182.
- Phondani, P. C., Maikhuri, R. K., & Kala, C. P. (2010). Ethnoveterinary uses of medicinal plants among traditional herbal healers in Alaknanda catchment of Uttarakhand, India. *African Journal of Traditional, Complementary and Alternative Medicines*, 7(3).

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RESEARCH ARTICLE

Economic Evaluation of Integrated Farming System Models for Tribal Farmers in Mandla District of Madhya Pradesh**Minakshi Meshram**

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ABSTRACT

The present study was conducted in the Mandla district of Madhya Pradesh to evaluate the efficiency of Integrated Farming System (IFS) models among 250 small and marginal tribal farmers. Data was collected from 25 villages (10 farmers per village) through face-to-face interactions using a structured and pre-tested interview schedule. The findings revealed that while 100% of respondents practiced traditional agriculture, there was significant adoption of allied enterprises: Dairy (93.6%), Vegetable cultivation (90%), and Horticulture (84.8%). Other components like poultry (66.4%), goat rearing (52.8%), and fisheries (47.2%) were also integrated. The study concludes that the comprehensive integration of Agriculture + Dairy + Goat rearing + Poultry + Vegetables + Fruit crops + Fisheries is the most economically viable model, yielding the highest Benefit- Cost (B:C) ratio through enterprise complementarity.

Key Words- Integrated Farming System (IFS), Tribal Farmers, Mandla District, B:C Ratio, Livelihood Security.

INTRODUCTION

Indian economy is predominantly rural and agriculture oriented where the declining trend in the average size of the farm holding poses a serious problem (Raut et al 2013). A significant portion of the Indian economy, approximately 17 per cent of GDP, comes from agriculture, which also employs more than 60 per cent of the country's people (Meshram , 2024). It seems that Indian economy is mainly rural and agricultural – based and dependent on Indian cultivable land consisting of mainly small holdings (65%) and overall 86.2 per cent farmers are small and marginal (Meshram *et al*, 2019).

Madhya Pradesh is well-known as tribal state of India. This state consists of different tribal farmers but majority of the farmers well-known as Bhil who resides in Mandla district (Meshram , 2024). A tribe is an Indian group who possesses certain qualities and characteristics that make him to adopt a unique culture, social and political identity. The tribal population is largely concentrated in and in the

region of the forest area of Madhya Pradesh. They have maintained their cultural peculiarity and individuality over the years. Agriculture has been and will continue to be the lifeline of our national economic at least in the foreseeable future (Meshram *et al*, 2020).

In the present scenario besides agriculture farmers grow fruits cultivation, dairy, goat rearing, poultry, bee-keeping etc., now this type of system including at least one component of farming is called the Integrated Farming System (Meshram et al, 2020). IFS reduces production risks [Behera and France (2023)], boosts yields and profits, improves the use of organic wastes [Meshram *et al*. 2020] and is socially acceptable, economically viable, and eco-friendly [Madhu Prasad and Chandrashekar (2018)]. Integrated Farming System as a part of farming system that considers ideas of account the concepts of minimizing risk, increasing production and profits which improving the utilization of organic wastes and crop residues (Gupta *et al* 2013; Kumari et al 2015; Kumaran

and Vasanthakumar 2010; Meshram *et al.* 2020). These integrated farming systems need to be socially acceptable, economically viable and eco-friendly (Madhu Prasad and Chandrashekar 2018). It also leads to improvement in nutritional quality of daily diet of farmers. Integration of farming system (integrating crop – livestock) as a resource management approach is essential to meet diverse desires of farm households and to protect their livelihood. Therefore, it was considered worthwhile to study for measuring analyzed to Integrated Farming System model for tribal farmers in Mandla District of Madhya Pradesh.

MATERIAL AND METHODS

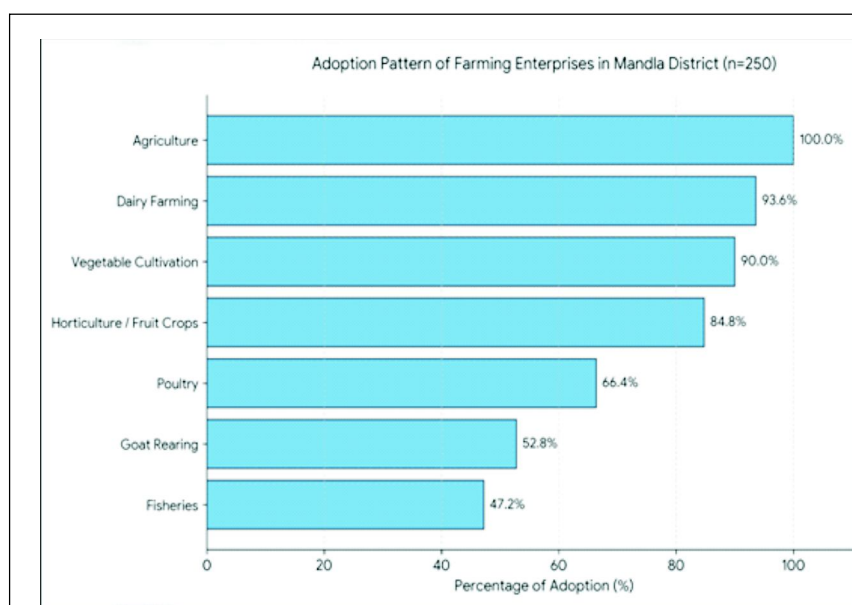
The study was carried out in Mandla district has been selected purposively from the Madhya Pradesh State as it possesses adequate population of tribal farmers. Sample of 250 small and marginal tribal farmers from 25 villages were purposively selected who had been adopted farming system other than agriculture or subsystem of agriculture. From Mandla district five development blocks namely Mandla, Gughari, Mawai, Niwas, and Nainpur have been selected purposively and a random selection of five villages from every block has been taken and after that 10 small and marginal tribal

farmers are selected from each village. The selected farmers have been interviewed personally with the help of a well structured and pre-tested interview schedule to obtain the appropriate information. In which Ex-post-facto research design was used in investigation. Findings regarding adoption of farming system in relation to selected independent variables viz. age, education, family size, occupation, land holding, income, cropping pattern, material possession, animal possession, credit seeking behaviour, social participation, information seeking behaviour, decision making ability, scientific orientation, risk orientation, economic motivation, innovativeness and management efficiency were included in investigation.

RESULTS AND DISCUSSION

Table 1. Adoption Pattern of farming Enterprises in Mandla District

S.N.	Farming system	Frequency	Percentage
1.	Agriculture	250	100.00
2.	Dairy	234	93.60
3.	Vegetable cultivation	225	90.00
4.	Horticulture/ fruit crops	212	84.80
5.	Poultry	166	66.40
6.	Goatry	132	52.80
7.	Fisheries	118	47.20



As illustrated in Table 1, agriculture was universally adopted by all respondents (100%). This was followed by a high prevalence of dairy farming (93.6%) and vegetable cultivation (90%). Additionally, a significant majority engaged in horticulture and fruit crops (84.8%), while poultry farming (66.4%), goat rearing (52.8%) & fisheries (47.2%) were also identified as key components of the local farming systems.

Table 2. Correlation coefficient of selected independent variables with integrated farming systems.

S. N.	Independent Variable	Integrated farming system (r value)
1.	Age	0.042
2.	Education	0.251**
3.	Family size	0.079
4.	Occupation	0.430**
5.	Land holding	0.319**
6.	Income	0.442**
7.	Cropping pattern	0.165*
8.	Material possession	0.457**
9.	Animal possession	0.228**
10.	Credit seeking behaviour	0.175*
11.	Social Participation	0.146*

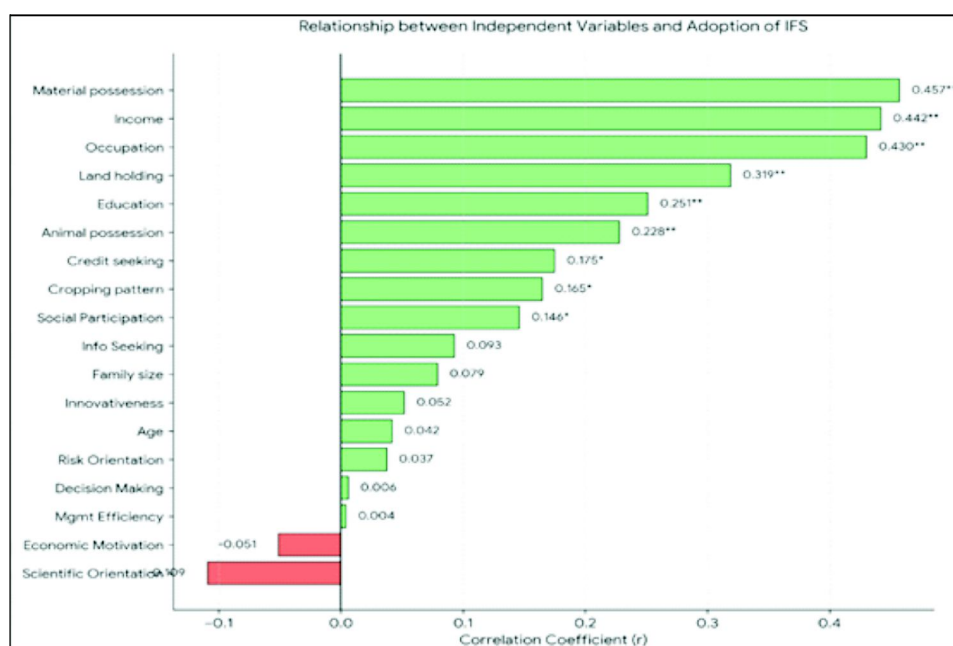
12.	Information Seeking Behaviour	0.093
13.	Decision Making Ability	0.006
14.	Scientific Orientation	-0.109
15.	Risk Orientation	0.0375
16.	Economic Motivation	-0.051
17.	Innovativeness	0.052
18.	Management Efficiency	0.004

** Significant at 0.01 level of probability

* Significant at 0.05 level of probability

The results presented in Table-2 indicated that correlation coefficient of independent variables with integrated farming system by tribal farmers. The study indicated that the scientific orientation ($r = -0.109$) and economic motivation ($r = -0.051$) were found to be negative and significant correlation with integrated farming system by tribal farmers. These findings are in accordance with the results of Mahesh et al. (2018).

The correlation coefficients of education ($r=0.251$) positively and highly significant with the occupation ($r= 0.430$), land holding ($r = 0.319$), income ($r= 0.442$) material possession ($r=0.457$) and animal possession ($r= 0.228$), were positively and highly significant (at



0.01 level of probability) correlation with integrated farming system by tribal farmers. This finding was in accordance with the results of Ekta et al. (2016) and Kumawat and Verma (2016).

Cropping pattern ($r = 0.165$) was positively and significantly correlated with credit seeking behaviour ($r = 0.175$) and social participation ($r = 0.146$) were positively and significantly correlated (at 0.05 level of probability) with integrated farming system by tribal farmers. These findings were consonance with the results of Mahesh et al. (2018).

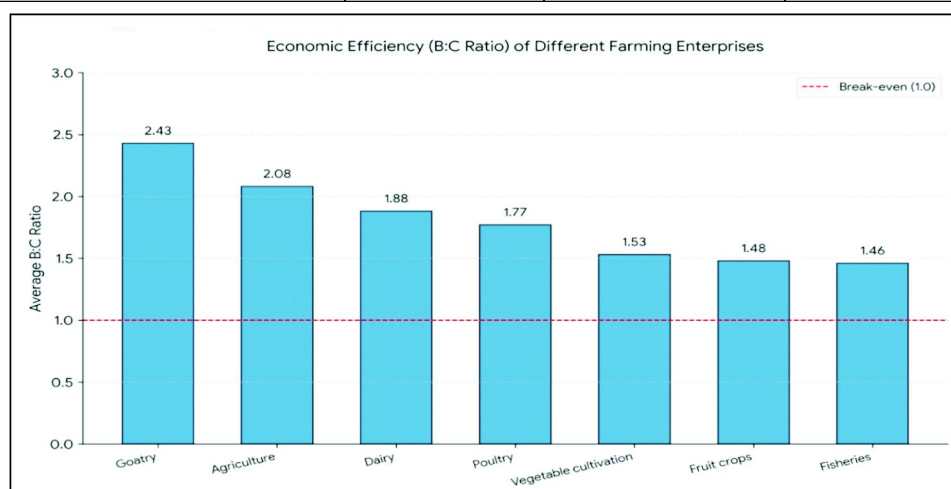
The Correlation coefficients of age ($r=0.042$), family size ($r = 0.079$), Information seeking behaviour ($r = 0.093$), decision making ability ($r = 0.006$), risk orientation ($r = 0.0375$), innovativeness ($r = 0.052$) and management efficiency ($r = 0.004$) were found to be non-significant. This finding was supported by Ekta

et al. (2016). And the above results indicate that some of the characteristics of the respondents had influenced their adoption of integrated farming systems. This result obtained was in conformity with the findings of Raut et al (2013).

The economic analysis of the various enterprises, as presented in Table 3, confirms that all integrated components are viable within the farmers' current socio-economic conditions. Among the seven systems evaluated, goat rearing emerged as the most profitable enterprise with the highest Benefit-Cost (B:C) ratio of 2.43, followed by agriculture (2.08), dairy (1.88), and poultry (1.77). Other integrated components, such as vegetable cultivation (1.53), fruit crops (1.48), and fisheries (1.46), also contributed positively to the total farm income. Notably, both goat rearing and agriculture demonstrated superior economic efficiency, yielding a return of more than two rupees for every single rupee invested.

Table 3. Economic analysis of different farming systems

SN.	Different Farming System	Average total income (Rs.)	Average total expenditure (Rs.)	Average Net Profit (Rs.)	Average B:C ratio
1.	Agriculture (250)	14848000	7358200	7489800	2.08
2.	Dairy (234)	6173080	3285964	2887116	1.88
3.	Vegetable cultivation (225)	4249800	2785640	1464160	1.53
4.	Horticulture/fruit crops (212)	2380500	1604505	775995	1.48
5.	Poultry (166)	1774000	998440	775560	1.77
6.	Goatry (132)	747600	307650	439950	2.43
7.	Fisheries (118)	520940	324570	166370	1.46



Integrated Farming System Model

The model of integrated farming system given in Fig. 1 is the combination of various farming systems such as goat rearing (B:C ratio=2.43) followed by agriculture (B:C ratio=2.08), dairy (B:C ratio=1.88), poultry (B:C ratio=1.77), vegetable cultivation (B:C ratio=1.53), fruit crop (B:C ratio=1.48) and fisheries (B:C ratio=1.46) are complementary to each other and helps to generate additional income that improves socio-economic characteristics of farmers.

Based on the Benefit-Cost (B:C) ratio and the complementary nature of the different enterprises, the proposed integrated model is highly beneficial for tribal farmers. Dairy and Goat rearing were identified as vital components within the system; although they require more labor and specific skills, they provide high-value products such as milk, ghee, butter, and khoya, ensuring both monetary gain and family nutritional security. Furthermore, these

livestock components provide Farm Yard Manure (FYM), which enhances soil fertility for crops, establishing them as essential complementary enterprises. Poultry farming (B:C ratio 1.77) was found to be a highly effective supplementary enterprise, particularly suitable for rural households as it can be managed by children or elderly family members. It provides a steady source of protein (eggs and meat) and significantly contributes to the economic empowerment of women, providing them with an independent source of income and strengthening the overall household economy.”

Integrated farming system model

Based on Benefit cost ratio compatibility of respondents and complementary amalgamation of different farming system was prepared for the farmers of Mandla district which is given Figure 1. Integration of different farming systems were also found beneficial by Raut et al. (2013), Sharma et al. (2008) and Channabasavanna et al. (2009) in their research of different States.

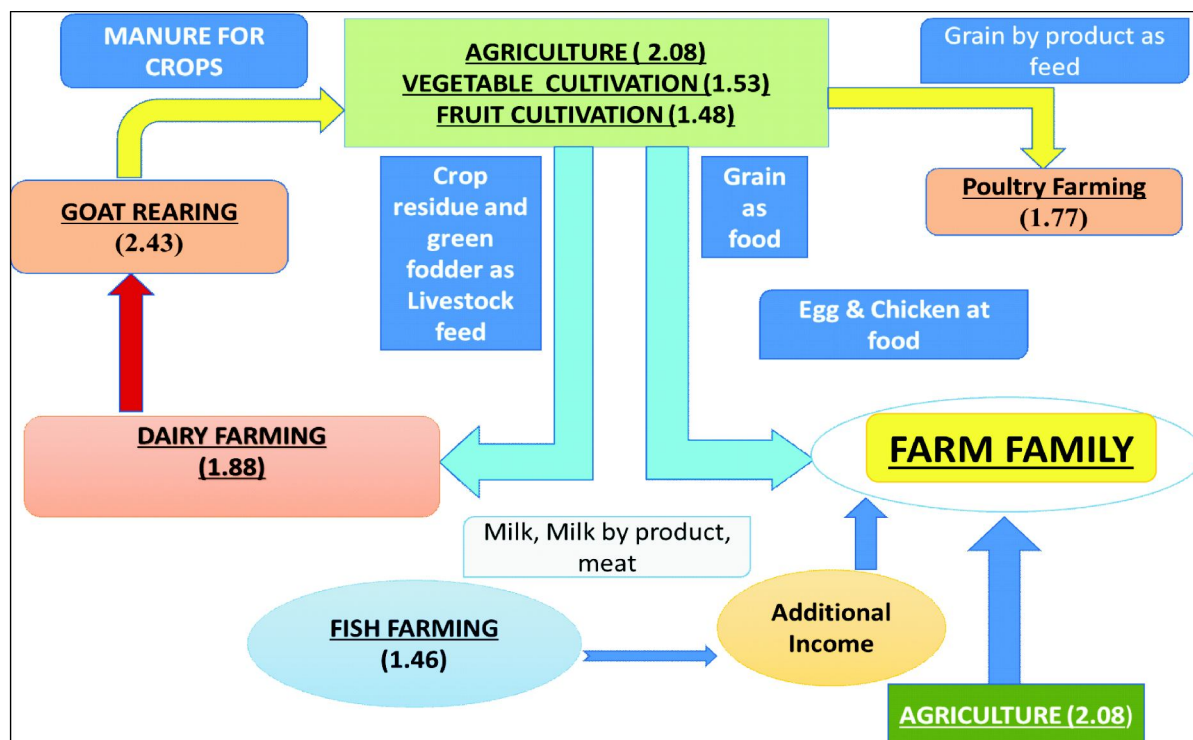


Fig 1. Integrated farming system model

CONCLUSIONS

The research findings indicate a significant shift towards diversified farming among tribal households in the Mandla district. Data analysis reveals that while 100 per cent of the respondents are primarily engaged in agriculture, there is a remarkably high adoption of allied sectors, specifically dairy farming (93.6%) and vegetable cultivation (90%). Furthermore, a substantial percentage of farmers have integrated horticulture (84.8%), poultry (66.4%), goat rearing (52.8%), and fisheries (47.2%) into their existing systems. The study concludes that the most economically viable and productive model is the comprehensive integration of Goat rearing + Agriculture + Dairy + Poultry + Vegetable cultivation + Fruit crops + Fisheries. This multi-enterprise approach was found to be the most beneficial in terms of the Benefit-Cost (B:C) ratio, largely due to the synergistic effects and complementarity between the enterprises, which effectively optimizes resource utilization and ensures sustainable income for small and marginal tribal farmers."

REFERENCES

- Behera UK, France J (2023) Farming systems research: Concepts, design and methodology. *Advan Agron* 177:1–49.
- Ekta, Godara A.K., Shehrawat PS and Bhatia R., (2016). Constraints and prospects in agro-forestry farming system for sustainable livelihood. *International Journal of Agriculture Sciences*, 8(25).
- Gupta, B., Kher, S.K. & Nain, M.S. (2013). Entrepreneurial Behaviour and Constraints Encountered by Dairy and Poultry Entrepreneurs in Jammu Division of J&K State. *Indian Journal of Extension Education*, 49(3 & 4): 126-129.
- Kumari, S., Sethi, N., Malik, J.S. & Yogi, V. (2015). Need Assessment of Women Dairy Farmers. *Indian Journal of Extension Education*, 51(3 & 4): 75-80.
- Kumaran, M. & Vasanthakumar, J. (2010). Farming System of Small and Marginal Farmers in rainfed Areas. *Indian Journal of Extension Education*, 46(3 & 4): 7-10.
- Kumawat, SR and Verma, MP. (2016). Adoption of Dairy Farming Technologies by the Farmers of Nagaur District of Rajasthan. *Indian Journal of Extension Education*, 52(3 & 4): 160-163.
- Kumar R and Tripathi H. 2009. Profitability of dairy husbandry through income and employment generation. *ISEE National Seminar*, pp-284.
- Kumar SNV, Desai BK, Channabasavanna AS, Rao S, Patil MG and Patil SS. 2017. Integrated farming system for livelihood security of small farmers of North- East Karnataka. *International Research Journal of Agricultural Economic & Statistics* 8(2): 216-221.
- Mahesh L., Sudharani V, Devi SKB and Reddy MJM (2018). Income Generation of Tribal Farmers of Adilabad and their Relationship with Profile Characteristics. *International Journal of Current Microbiology and Applied Sciences*, 7(11): 2035-2041.
- Madhu Prasad VL, Chandrashekar S (2018) Farmers perception about integrated farming system in eastern dry zone of Karnataka. *Inter J Agri Scien* 10(10):6184–6186
- Meshram M, Khare NK and Singh SRK. (2019). Assessing Integrated Farming System Models Apropos Employment Generation Potential in Madhya Pradesh. *Indian Journal of Extension Education*, 55(3): 65-68.
- Meshram, M., Khare NK, Singh SRK and Sharma HL. 2020. Analysis of Inherent Variability Among Livelihood Security

- Indices in Tribal Blocks in Madhya Pradesh. *Journal of Community Mobilization and Sustainable Development*, 15(2): 289-291.
- Meshram, M., Khare, N.K.& Singh, S.R.K.& Sharma, H. L.(2020).Constraints Faced by Tribal Farmers Apropos Integrated Farming System (IFS) in Madhya Pradesh: A Statistical Analysis. *Indian Journal of Extension Education*, 56 (1),181–185.
- Raut S, Rathod, M.K. and Deshmukh K. (2013). Integrated Farming System Model for the Farmers of Wardha District in Vidarbha. *Indian Journal of Applied Research*, 3 (8):1-3.
- Sharmin S, Harun- Ar-Rashid M, Begum R and Hoque SS. 2018. Relative profitability of farming systems research and development (FSRD) project farmers and non-project farmers of integrated systems in Tangail district of Bangladesh. *Journal Bangladesh Agricultural University* 16(1): 117 - 122.

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RESEARCH ARTICLE

A Comprehensive Review on Role of Agricultural Extension in Promoting Organic Farming Techniques among Rural Farmers

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ABSTRACT

This comprehensive review article explores the intricate relationship between agricultural extension services and the promotion of organic farming techniques among rural farmers in India. With the growing emphasis on sustainable agriculture, understanding how extension services can effectively support the transition and maintenance of organic farming is crucial. The review begins by elucidating the history of organic farming, emphasizing its principles and the global trends shaping its adoption. Despite the increasing global interest in organic farming, farmers, particularly in rural areas, face significant challenges in adopting these practices. These challenges include limited access to information, traditional farming mindsets, economic constraints, and the need for a systematic transition strategy. Agricultural extension services, traditionally aimed at enhancing farmers' knowledge and productivity, are pivotal in this context. The review delves into the evolution of these services, highlighting different models from the transfer of technology to more participatory and facilitative approaches. The effectiveness of these models in the context of organic farming is critically examined. The intersection of agricultural extension and organic farming is explored through various case studies and examples from India. These success stories illustrate how tailored extension strategies, such as farmer-to-farmer training and the use of information technology, have effectively promoted organic practices. The analysis reveals key factors contributing to successful implementation, including government support, community involvement, and market development. Despite these successes, there are notable barriers and limitations. The review addresses these, focusing on socio-economic and cultural challenges, limitations of current extension methods, and policy and institutional gaps. The economic implications, particularly for rural farmers, are scrutinized, highlighting the need for supportive policies and market linkages to enhance the viability of organic farming. Emerging trends in agricultural extension and organic farming are identified, with an emphasis on the increasing role of technology and innovation. The review concludes with recommendations for policymakers, extension agents, and farmers, underlining the importance of integrated approaches and continuous learning. Suggestions for further research are also provided, underscoring the need for long-term studies to assess the impact of organic farming practices on various aspects, including soil health, biodiversity, and farmer livelihoods.

Keywords: Organic Farming, Extension, Sustainability, Rural,

INTRODUCTION

Organic farming is a holistic agricultural system that prioritizes ecological balance, biodiversity, and soil health, distinct

from conventional farming in its strict avoidance of synthetic fertilizers and pesticides [1]. It is grounded in the principles of sustainable agriculture, aiming to produce food while

establishing an ecological balance to prevent soil fertility or pest problems [2]. The importance of organic farming lies in its multifaceted benefits, including environmental protection, conservation of natural resources, reduction of soil erosion, and maintenance of biodiversity. Furthermore, organic farming is associated with health benefits, as it limits consumers' exposure to synthetic chemicals and genetically modified organisms [3]. Agricultural extension services are educational and support activities designed to enhance farmers' skills and knowledge, primarily to improve their agricultural productivity and livelihoods [4]. Livelihood encompasses human capital (education, skills, health), physical capital (farm equipment, tools), social capital (networks, community participation), financial capital (savings, credit, livestock), and natural capital (soil, plants, water) [5]. These services act as a bridge between research and practice, translating complex agricultural research into accessible knowledge for farmers. Extension services encompass a range of activities, including the dissemination of best practices, individual and group trainings, demonstrations, and the provision of advisory services. Their role has evolved over time, adapting to changing agricultural landscapes and farmers' needs [6]. This review article aims to explore the role of agricultural extension in promoting organic farming techniques among rural farmers. It intends to assess how extension services have adapted to the unique challenges and opportunities presented by organic farming, and how they contribute to the knowledge, skill development, and overall adoption of organic practices among rural farmers. The review will also examine the impact of these services on farming communities, with a focus on sustainability and ecological benefits. The methodology of this review involves a comprehensive analysis of existing literature, including peer-reviewed articles, agricultural extension reports, case studies, and global agricultural databases. Sources such as the Food

and Agriculture Organization (FAO), the International Federation of Organic Agriculture Movements (IFOAM), and academic journals like "Agriculture and Human Values" have been extensively reviewed (IFOAM, 2020; FAO, 2019). The scope of the literature encompasses studies and reports from the past two decades, providing a contemporary perspective on the subject. This review also considers geographical diversity, including case studies from various regions to understand the global application and challenges of integrating agricultural extension services with organic farming.

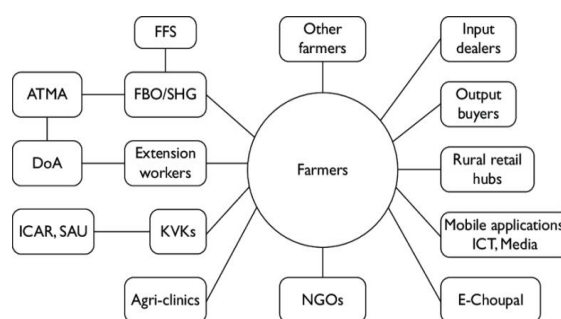


Figure1. Information Exchange between Extension and Farmers in India [7]

The Evolution of Organic Farming

The roots of organic farming can be traced back to the early 20th century, arising as a response to the rapidly industrializing agricultural sector. Pioneers like Sir Albert Howard in the United Kingdom and J.I. Rodale in the United States were instrumental in laying the foundational principles of organic farming. These early advocates were concerned with the negative impacts of synthetic fertilizers and pesticides on soil health and food quality [8]. The organic movement gained momentum in the 1960s and 1970s, fuelled by growing environmental awareness and concerns over the health implications of chemically-intensive agriculture [9]. Organic farming is based on several key principles, including the promotion of biodiversity, ecological balance, and soil biological activity. It emphasizes the use of natural processes and materials, avoiding the use of synthetic chemicals [10]. Practices such as

crop rotation, green manures, composting, and biological pest control are central to organic agriculture. These practices not only enhance soil fertility and health but also contribute to pest and disease management in a sustainable manner [11]. Globally, organic farming has seen substantial growth in recent decades. According to the FiBL and IFOAM – Organics International, the global market for organic food surpassed 100 billion USD, with significant growth in land area dedicated to organic agriculture [12]. This expansion reflects a growing consumer demand for organic products, driven by health and environmental concerns. Europe and North America are leading in terms of both consumption and production, but other regions, including Asia and Africa, are rapidly adopting organic farming practices [13]. Despite its growth, organic farming faces several challenges. One of the primary challenges is the higher cost of production compared to conventional farming, due to factors like higher labour inputs and lower economies of scale [14]. Organic farmers also face challenges in terms of managing pests and diseases without synthetic chemicals, which require a deep understanding of ecological processes and often more labour-intensive practices [15]. Market access and distribution challenges also persist, especially for small-scale farmers who may struggle to find markets for their organic products [16]. Additionally, the conversion process from conventional to organic farming can be a challenging period for farmers, both economically and in terms of adapting to new farming practices [17].

The Concept of Agricultural Extension

Agricultural extension is a service or system that provides education and information to farmers, aiming to improve their farming practices and livelihoods. The primary objective of agricultural extension is to transfer knowledge from technical experts to farmers, facilitating the application of scientific research to agricultural practices in an accessible and

practical manner [18]. Extension services are designed to enhance farmers' skills, improve agricultural productivity, promote innovation, and encourage sustainable agricultural practices [19]. The history of agricultural extension can be traced back to the early 19th century with efforts like "demonstration farms" in Ireland and the United Kingdom. However, a more formalized system began with the establishment of the land-grant university system in the United States in the 1860s, which included a mandate for extension services [20]. The Smith-Lever Act of 1914 formalized the cooperative extension service in the U.S., setting a model for other countries. In the mid-20th century, extension services expanded globally, often driven by governments and international agencies as part of agricultural development programs [21].

Table: Evolution of Agricultural Extension Services [22]

Period	Development
Ancient Times	Chinese officials were creating agricultural policies and disseminating advice to farmers at least 2,000 years ago, as early as 800 BC under the Zhou dynasty.
Late 18th to Early 19th Century	Philipp Emanuel von Fellenberg established agricultural schools and experimental farms in Switzerland in the late 18th century. Itinerant agricultural lecturers began to emerge in New England, New York, and France in the 1820s.
Mid-19th Century	The Irish Potato Famine (1845–1851) led to the creation of "practical instructors in husbandry" in Ireland. This initiative influenced the development of extension services in other European countries.

Late 19th to Early 20th Century	The concept of “university extension” emerged in the late 19th century. Agricultural extension services became formalized in various European countries, influenced by German models.
Early 20th Century in the U.S.	The Hatch Act of 1887 and the Smith-Lever Act of 1914 in the U.S. established a system of agricultural experiment stations and cooperative extension, respectively, in conjunction with land-grant universities.
Mid to Late 20th Century in Asia	Development of extension services in Asia went through several phases, including colonial agriculture, diverse top-down extension, unified top-down extension, and diverse bottom-up extension.
Modern Era	Extension services have adapted to changing landscapes, focusing on a variety of approaches, including technology transfer, advisory work, human resource development, and facilitation for empowerment.

Various models of agricultural extension have evolved over time, reflecting different philosophies and approaches. The “transfer of technology” model, dominant in the mid-20th century, focused on disseminating technology from researchers to farmers. In contrast, the “advisory” model emphasizes a two-way flow of information between extension agents and farmers, focusing more on farmer needs. The “facilitation” model, emerging in recent years, encourages farmers to become active learners and decision-makers, with extension agents acting as facilitators rather than just knowledge transmitters [23]. In modern agriculture, the role of agricultural extension is critical in addressing complex challenges such

as climate change, food security, and sustainable resource management. Extension services are essential in promoting innovative practices, such as precision agriculture, integrated pest management, and sustainable soil and water management [24]. Moreover, extension plays a crucial role in empowering smallholder farmers, including women and marginalized groups, ensuring that agricultural development is inclusive and equitable [25].

The Intersection of Agricultural Extension and Organic Farming

The integration of extension services in organic farming is crucial due to the specific challenges and knowledge requirements of organic practices. Organic farming relies heavily on an understanding of ecological processes and sustainable resource management, which can be complex and location-specific [26]. Extension services play a pivotal role in bridging the gap between organic farming research and practice, offering tailored advice and solutions that suit local environmental conditions and socio-economic contexts. Moreover, these services are vital in helping farmers transition from conventional to organic farming, a process that often requires significant changes in farm management and mindset [27]. There are numerous examples of successful integration of agricultural extension in organic farming. One notable example is in Denmark, where the government-supported extension services have played a key role in the country becoming a leader in organic production and consumption [28]. Another example is in India, where the state of Sikkim became fully organic, with extension services providing crucial support in terms of training, certification assistance, and market linkage [29]. Extension services employ various strategies to promote organic farming. These include farmer-to-farmer training programs, demonstration farms, and participatory research, where farmers are involved in the research process [30]. Extension programs also often focus on market

development for organic products, helping farmers to achieve certification and access organic markets. Additionally, the use of information and communication technologies (ICTs) in extension services, such as mobile phone applications and online platforms, has become increasingly important in disseminating organic farming knowledge [31].

The role of extension services in training and educating farmers about organic practices is multifaceted. They provide technical training on organic farming techniques such as composting, crop rotation, and natural pest control [32]. Extension agents also educate farmers on the regulatory aspects of organic farming, including certification processes and organic standards. Furthermore, these services play a critical role in raising awareness about the environmental and health benefits of organic farming, which is essential for long-term adoption [33].

Table 2 : Roles of Extension Services in Promoting Organic Farming Practices among Farmers

Aspect	Description
Awareness and Education	Educate farmers about the benefits and practices of organic farming, and raise awareness about environmental and health advantages.
Technical Training	Provide practical training in organic farming techniques such as composting, crop rotation, natural pest control, and the use of organic fertilizers and pesticides.
Certification Guidance	Assist farmers in understanding and navigating the process of obtaining organic certification for their products.

Market Access and Strategies	Train farmers on how to access markets for organic produce and advice on marketing strategies to promote their organic products effectively.
Policy Information	Inform farmers about relevant policies, subsidies, and regulations related to organic farming.
Networking Opportunities	Facilitate connections between organic farmers, enabling them to share resources, knowledge, and best practices.
Research and Development	Keep farmers updated on the latest research in organic farming and encourage the adoption of innovative and sustainable practices.
Problem Solving	Provide ongoing support and advice to farmers, helping them to address challenges and issues they encounter in organic farming.
Sustainability Practices	Educate on sustainable agriculture practices beyond organic farming, such as water conservation, soil health maintenance, and biodiversity.

CHALLENGES AND LIMITATIONS

A. Barriers in Adopting Organic Farming among Rural Farmers

In India, rural farmers face several barriers in adopting organic farming. One significant barrier is the initial decline in yield that often occurs during the transition from conventional to organic farming, which can deter farmers who rely on their crops for immediate livelihood needs [34]. There's also a lack of awareness and understanding about

organic farming practices and their long-term benefits, compounded by limited access to quality organic inputs like seeds and natural pesticides [35]. Additionally, small landholdings and fragmented farms make it challenging to practice organic farming, which often requires larger, more integrated systems to be effective [36].

B. Limitations of Current Agricultural Extension Methods in Promoting Organic Farming

The agricultural extension systems in India have limitations in effectively promoting organic farming. These systems often have a strong bias toward conventional farming methods, with insufficient training and resources dedicated to organic techniques [37]. Extension services are sometimes inadequately staffed or lack the necessary expertise in organic agriculture, leading to poor dissemination of organic farming knowledge [38]. Furthermore, there is often a disconnect between agricultural research institutions and extension services, hindering the flow of up-to-date organic farming research to farmers [39].

C. Socio-Economic and Cultural Challenges

Socio-economic and cultural factors also pose significant challenges. Many rural farmers in India are economically constrained and risk-averse, hesitant to adopt new practices that may initially reduce their already marginal incomes [40]. There is also a cultural aspect, as traditional farming practices are deeply ingrained in many rural communities, and shifting to organic methods can be perceived as challenging these traditions [41]. Moreover, the caste system and gender roles can influence farming practices and access to resources, affecting the adoption of organic farming in certain communities [42].

D. Policy and Institutional Challenges

Policy and institutional challenges significantly impact the adoption of organic farming in India. There is a lack of coherent and

supportive policies specifically tailored for organic agriculture [43]. Subsidies and support systems are often more aligned with conventional farming, offering little incentive for farmers to switch to organic methods [44]. Additionally, the process for certification of organic produce can be cumbersome and expensive for small-scale farmers, limiting their access to lucrative markets [45]. There's also a need for better infrastructure and marketing channels specifically for organic produce to ensure that farmers get a fair price for their products [46].

Success Stories and Best Practices

In India, there have been several successful case studies of organic farming implementation. One prominent example is the state of Sikkim, which was declared 100% organic in 2016. This transformation was achieved through a comprehensive approach involving government policy, farmer education, and extension services [47]. Another success story is the organic farming movement in Kerala, where the government's 'Zero Budget Natural Farming' initiative has been pivotal in promoting organic practices among farmers [48]. Several factors contributed to the success of these organic farming initiatives. In Sikkim, the government's strong policy support, including subsidies for organic inputs and a ban on chemical fertilizers and pesticides, played a crucial role [49]. The state also invested in extensive training and capacity building for farmers and extension agents. In Kerala, the success can be attributed to the grassroots-level movement and farmer-led groups that encouraged community participation and knowledge sharing [50].

The Impact of Agricultural Extension on Organic Farming

Agricultural extension services have significantly impacted the knowledge and skills of Indian farmers in organic farming. Extension programs, often conducted by government

bodies, NGOs, and sometimes in collaboration with international organizations, have provided training and education on organic farming techniques, such as composting, biological pest control, and soil health management. This education has enabled farmers to better understand the principles of organic agriculture, leading to more informed decisions and improved farm management practices [51]. Extension services have facilitated changes in farming practices towards more sustainable and eco-friendly methods. The promotion of organic farming has led to reduced reliance on chemical inputs, adoption of crop rotation, mixed cropping, and increased use of organic manures and bio pesticides. While there is often a perception that organic farming leads to reduced productivity, many Indian farmers have seen stable or even increased yields after an initial transition period, along with improved soil health and reduced input costs over time [52]. The shift towards organic farming practices, aided by agricultural extension services, has notable environmental and health benefits. Organic farming techniques contribute to reduced soil erosion, improved soil fertility, and increased biodiversity. Additionally, the reduction in chemical fertilizers and pesticides use has led to fewer environmental pollutants and a lower risk of chemical exposure for both farmers and consumers, contributing to overall better health outcomes (53). Economically, the impact of organic farming on rural farmers in India has been mixed but generally positive. Organic farming can potentially offer higher market prices and access to niche markets, both domestically and internationally. However, challenges such as certification costs, fluctuating market demands, and the need for effective marketing strategies can impact profitability. Extension services play a crucial role in addressing these challenges by providing market information, linking farmers to markets, and assisting in certification processes [54].

Future Directions and Recommendations

Emerging trends in agricultural extension and organic farming in India include an increased focus on sustainable and climate-resilient agricultural practices. This trend is driven by the growing recognition of the impacts of climate change on agriculture and the need for sustainable food production systems. There is also a growing emphasis on integrating traditional agricultural knowledge with modern organic farming practices, recognizing the value of indigenous wisdom in sustainable agriculture [55]. Additionally, digital technology is increasingly being used in agricultural extension services to provide timely and customized advice to farmers [56]. For policymakers, it's important to create an enabling environment for organic farming, which includes providing financial incentives, simplifying the certification process, and ensuring access to organic inputs and markets [57]. Extension agents should focus on building capacity and knowledge among farmers, emphasizing the long-term benefits of organic farming and providing practical, location-specific advice. Farmers are encouraged to engage actively in learning and adopting new organic practices, participate in cooperative structures, and share knowledge with peers. The role of technology and innovation in enhancing the effectiveness of extension services in India is becoming increasingly important. Mobile technology, for instance, allows for the widespread dissemination of agricultural information, even in remote areas. Digital platforms can facilitate farmer-to-expert communication, provide market-related information, and offer training through online modules [58]. Innovations like precision agriculture, remote sensing, and GIS technologies are also being integrated into extension services to provide more accurate and efficient advice to farmers [59].

Further research is needed to assess the long-term impacts of organic farming practices

on soil health, biodiversity, and farmer livelihoods in different agro-ecological zones of India. There is also a need for more studies on the economic viability of organic farming for small and marginal farmers. Research into the effectiveness of different extension approaches in promoting organic farming, and the role of women and marginalized groups in organic agriculture, is also crucial [60]. Additionally, exploring the potential of emerging technologies and innovations in agriculture can provide insights into future strategies for agricultural developments.

CONCLUSION

The interplay between agricultural extension services and organic farming in India presents a dynamic and evolving landscape. Extension services are crucial in disseminating knowledge and skills necessary for successful organic farming, addressing environmental, health, and economic challenges faced by rural farmers. The integration of traditional practices with modern technological innovations has shown promise in enhancing the effectiveness of these services. However, there remain areas for improvement and further research, particularly in policy support, market development, and the long-term sustainability of organic farming. The success stories and emerging trends provide valuable insights and lessons for policymakers, extension agents, and farmers alike. Embracing these lessons and continuing to innovate and adapt will be key in realizing the full potential of organic farming in India.

REFERENCES

- Kremen, C., & Miles, A. (2012). Ecosystem services in biologically diversified versus conventional farming systems: benefits, externalities, and trade-offs. *Ecology and society*, 17(4).
- Pretty, J. (2008). Agricultural sustainability: concepts, principles and evidence. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1491), 447-465.
- Brantsæter, A. L., Ydersbond, T. A., Hopping, J. A., Haugen, M., & Meltzer, H. M. (2017). Organic food in the diet: exposure and health implications. *Annual review of public health*, 38, 295-313.
- Antwi-Agyei, P., & Stringer, L. C. (2021). Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. *Climate Risk Management*, 32, 100304.
- Minakshi Meshram, SRK Singh, S.A. Dhege, V Meshram and Prashant Shrivastava. 2024. Sustainable livelihood for tribal farmers via Integrated farming system components. *Agricultural Research*, <https://doi.org/10.1007/s40003-024-00818-3>. NAAS Rating-7.2.
- Faure, G., Desjeux, Y., & Gasselin, P. (2012). New challenges in agricultural advisory services from a research perspective: A literature review, synthesis and research agenda. *The Journal of Agricultural Education and Extension*, 18(5), 461-492.
- Glendenning, C.J., Babu, S., & Asenso-Okyere, K. (2010). Review of agricultural extension in India—Are farmers' information needs being met? IFPRI Discussion Paper 01048.
- O'Sullivan, R. (2015). *American organic: A cultural history of farming, gardening, shopping, and eating*. University Press of Kansas.
- Youngberg, G., & DeMuth, S. P. (2013). Organic agriculture in the United States: A 30-year retrospective. *Renewable Agriculture and Food Systems*, 28(4), 294-328.
- Gamage, A., Gangahagedara, R., Gamage, J., Jayasinghe, N., Kodikara, N., Suraweera, P., & Merah, O. (2023). Role of organic

- farming for achieving sustainability in agriculture. *Farming System*, 1(1), 100005.
- Kumar, R., Mahajan, G., Srivastava, S., & Sinha, A. (2014). Green manuring: a boon for sustainable agriculture and pest management-a review. *Agricultural Reviews*, 35(3).
- Kumar, D., Willer, H., Ravisankar, N., & Kumar, A. (2023). Current Scenario of Organic Farming Worldwide. In *Transforming Organic Agri-Produce into Processed Food Products* (pp. 1-24). Apple Academic Press.
- Hocquette, J. F., Ellies-Oury, M. P., Lherm, M., Pineau, C., Deblitz, C., & Farmer, L. (2018). Current situation and future prospects for beef production in Europe—A review. *Asian-Australasian journal of animal sciences*, 31(7), 1017.
- Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. *Nature plants*, 2(2), 1-8.
- Siddique, S., Hamid, M., Tariq, A., & Kazi, A. G. (2014). Organic farming: the return to nature. *Improvement of Crops in the Era of Climatic Changes: Volume 2*, 249-281.
- Poulton, C., Dorward, A., & Kydd, J. (2010). The future of small farms: New directions for services, institutions, and intermediation. *World development*, 38(10), 1413-1428.
- Gomiero, T., Pimentel, D., & Paoletti, M. G. (2011). Environmental impact of different agricultural management practices: conventional vs. organic agriculture. *Critical reviews in plant sciences*, 30(1-2), 95-124.
- Anandajayasekeram, P. (2008). *Concepts and practices in agricultural extension in developing countries: A source book*. ILRI (aka ILCA and ILRAD).
- Muyanga, M., & Jayne, T. S. (2006). *Agricultural extension in Kenya: Practice and policy lessons* (No. 680-2016-46750).
- Marcus, A. I. (Ed.). (2015). *Service as mandate: How American land-grant universities shaped the modern world, 1920–2015* (Vol. 2). University of Alabama Press.
- Pretty, J. (2018). Intensification for redesigned and sustainable agricultural systems. *Science*, 362(6417), eaav0294.
- Kassa, H. (2008). Agricultural extension in Ethiopia: historical evolution, relevant policies and challenges. *Digest of Ethiopia's national policies, strategies and programs*, 469.
- Amungwa, F. A. (2018). Appraisal of innovations in agricultural extension and advisory services in Cameroon. *Journal of Advancements in Plant Science*, 1(2), 1-9.
- Muhie, S. H. (2022). Novel approaches and practices to sustainable agriculture. *Journal of Agriculture and Food Research*, 100446.
- Muhammad, L. W., Maina, I. N., & Pelletier, B. (2016). A participatory and integrated agricultural extension approach to enhancing farm resilience through innovation and gender equity. In *Food security, gender and resilience* (pp. 35-61). Routledge.
- Kmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., des Ios Rios, I., ... & Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *Journal of Rural Studies*, 59, 232-241.

- Gosnell, H., Gill, N., & Voyer, M. (2019). Transformational adaptation on the farm: Processes of change and persistence in transitions to 'climate-smart' regenerative agriculture. *Global Environmental Change*, 59, 101965.
- Dabbert, S., Haring, A. M., & Zanoli, R. (2004). *Organic farming: policies and prospects*. Zed Books.
- Meek, D., & Anderson, C. R. (2020). Scale and the politics of the organic transition in Sikkim, India. *Agroecology and Sustainable Food Systems*, 44(5), 653-672.
- Adamsone-Fiskovica, A., & Grivins, M. (2022). Knowledge production and communication in on-farm demonstrations: putting farmer participatory research and extension into practice. *The Journal of Agricultural Education and Extension*, 28(4), 479-502.
- Mapiye, O., Makombe, G., Molotsi, A., Dzama, K., & Mapiye, C. (2023). Information and communication technologies (ICTs): The potential for enhancing the dissemination of agricultural information and services to smallholder farmers in sub-Saharan Africa. *Information Development*, 39(3), 638-658.
- Kroma, M. M. (2006). Organic farmer networks: facilitating learning and innovation for sustainable agriculture. *Journal of Sustainable Agriculture*, 28(4), 5-28.
- Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. *Nature plants*, 2(2), 1-8.
- Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S., & Lebailly, P. (2017). Organic farming and small-scale farmers: Main opportunities and challenges. *Ecological economics*, 132, 144-154.
- Gomiero, T., Pimentel, D., & Paoletti, M. G. (2011). Environmental impact of different agricultural management practices: conventional vs. organic agriculture. *Critical reviews in plant sciences*, 30(1-2), 95-124.
- Rahman, S. A., Sunderland, T., Roshetko, J. M., & Healey, J. R. (2017). Facilitating smallholder tree farming in fragmented tropical landscapes: Challenges and potentials for sustainable land management. *Journal of environmental management*, 198, 110-121.
- Zikeli, S., RembiaBkowska, E., ZaB'cka, A., & Badowski, M. (2014). Organic farming and organic food quality: Prospects and limitations. *Sustainable food production includes human and environmental health*, 85-164.
- Emeana, E. M., Trenchard, L., Dehnen-Schmutz, K., & Shaikh, S. (2019). Evaluating the role of public agricultural extension and advisory services in promoting agro-ecology transition in Southeast Nigeria. *Agroecology and Sustainable Food Systems*, 43(2), 123-144.
- Bliss, K., Padel, S., Cullen, B., Ducottet, C., Mullender, S., Rasmussen, I. A., & Moeskops, B. (2019). Exchanging knowledge to improve organic arable farming: An evaluation of knowledge exchange tools with farmer groups across Europe. *Organic agriculture*, 9, 383-398.
- Singh, C., Dorward, P., & Osbahr, H. (2016). Developing a holistic approach to the analysis of farmer decision-making: Implications for adaptation policy and practice in developing countries. *Land use policy*, 59, 329-343.
- Sutherland, L. A. (2013). Can organic farmers be 'good farmers'? Adding the 'taste of necessity' to the conventionalization debate. *Agriculture and Human Values*, 30, 429-441.

- Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. *Nature plants*, 2(2), 1-8.
- Priyadarshini, P., & Abhilash, P. C. (2020). Policy recommendations for enabling transition towards sustainable agriculture in India. *Land Use Policy*, 96, 104718.
- Durham, T. C., & Mizik, T. (2021). Comparative economics of conventional, organic, and alternative agricultural production systems. *Economies*, 9(2), 64.
- Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S., & Lebailly, P. (2017). Organic farming and small-scale farmers: Main opportunities and challenges. *Ecological economics*, 132, 144-154.
- Bloom, J. D., & Hinrichs, C. C. (2011). Moving local food through conventional food system infrastructure: Value chain framework comparisons and insights. *Renewable Agriculture and Food Systems*, 26(1), 13-23.
- Bhatt, A., & John, J. (2023). Including farmers' welfare in a government-led sector transition: The case of Sikkim's shift to organic agriculture. *Journal of Cleaner Production*, 411, 137207.
- Munster, D. (2016). Agro-ecological double movements?: Zero Budget Natural Farming and alternative agricultures after the neoliberal crisis in Kerala. In *Critical perspectives on agrarian transition* (pp. 222-244). Routledge India.
- Bhatt, A., & John, J. (2023). Including farmers' welfare in a government-led sector transition: The case of Sikkim's shift to organic agriculture. *Journal of Cleaner Production*, 411, 137207.
- Mandi, K., Azad, A. K., Meena, D. C., & Chatterjee, D. Global Concepts of Extension as Applied to the Indian Context.
- Kmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., des Ios Rios, I., ... & Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *Journal of Rural Studies*, 59, 232-241.
- Verhulst, N., Govaerts, B., Verachtert, E., Castellanos-Navarrete, A., Mezzalama, M., Wall, P., ... & Sayre, K. D. (2010). Conservation agriculture, improving soil quality for sustainable production systems. *Advances in soil science: food security and soil quality*, 1799267585, 137-208.
- Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A. S., ... & Kaushal, J. (2021). An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of cleaner production*, 283, 124657.
- Ferris, S., Robbins, P., Best, R., Seville, D., Buxton, A., Shriver, J., & Wei, E. (2014). Linking smallholder farmers to markets and the implications for extension and advisory services. *MEAS Brief*, 4(10), 13-14.
- Jovovic, Z., & Kratovalieva, S. (2015). Global strategies for sustainable use of agricultural genetic and indigenous traditional knowledge. *Plant genetic resources and traditional knowledge for food security*, 39-72.
- Deichmann, U., Goyal, A., & Mishra, D. (2016). Will digital technologies transform agriculture in developing countries?. *Agricultural Economics*, 47(S1), 21-33.

- Brzezina, N., Biely, K., Helfgott, A., Kopainsky, B., Vervoort, J., & Mathijs, E. (2017). Development of organic farming in Europe at the crossroads: Looking for the way forward through system archetypes lenses. *Sustainability*, 9(5), 821.
- Singh, A. K., Singh, L., Burman, R. R., & Dubey, S. K. Information and Communication Technologies as the Enabler of Indian Farmers: Experiences of Agropedia.
- Sood, K., Singh, S., Rana, R. S., Rana, A., Kalia, V., & Kaushal, A. (2015, October). Application of GIS in precision agriculture. In *Paper presented as lead lecture in national seminar on "Precision farming technologies for high Himalayas* (pp. 04-05).
- Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S., & Lebailly, P. (2017). Organic farming and small-scale farmers: Main opportunities and challenges. *Ecological economics*, 132, 144-154.
- Sood, K., Singh, S., Rana, R. S., Rana, A., Kalia, V., & Kaushal, A. (2015, October).

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