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A Study On Utilisation Of Artificial Intelligence In Agriculture

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CHAPTER – 1

INTRODUCTION

1.1 Background of the Study

Agriculture is one of the most essential sectors globally, contributing significantly to food security, rural development, employment, and national economic growth. With rising challenges such as climate change, unpredictable weather patterns, declining soil fertility, pest outbreaks, and labor shortages, the need for advanced technological interventions has become crucial.

Artificial Intelligence (AI) has emerged as a transformative technology capable of addressing many of these agricultural challenges. Through applications such as machine learning, computer vision, robotics, automated irrigation systems, smart sensors, drones, and predictive analytics, AI is reshaping modern agriculture. These innovations support precision farming, improve decision-making, reduce operational costs, increase yield, and promote sustainable agricultural practices.

In India, where a large portion of the population depends on agriculture, AI adoption remains slow due to factors such as lack of awareness, high costs, low technological literacy, and poor digital infrastructure. Therefore, studying the benefits, challenges, and opportunities of AI in agriculture is essential for both practitioners and policymakers.

1.2 Problem Statement

Despite the growing importance of Artificial Intelligence in agriculture, its adoption remains limited, particularly among small and medium-scale farmers. Many farmers lack adequate awareness, technical knowledge, and access to AI-based tools and infrastructure. There is also uncertainty regarding the cost, reliability, and practical usefulness of AI technologies in real farming conditions. This gap between technological advancement and actual usage creates a challenge in achieving sustainable agricultural development. Hence, there is a need to study the level of awareness, perception, and acceptance of AI in agriculture and to identify the key factors influencing its adoption.

1.3 Purpose / Objectives of the Study

The main objectives of the study are:

- To examine the level of awareness about Artificial Intelligence in agriculture among respondents
- To understand the perceptions and attitudes towards the use of AI in agricultural activities
- To identify the perceived benefits of AI in improving agricultural productivity
- To analyse the challenges faced in adopting AI-based technologies in agriculture
- To provide suggestions for improving the adoption of AI in the agricultural sector

1.4 Applicability of the Study

The findings of this study are applicable to farmers, Agri-preneurs, agricultural students, researchers, and policymakers. The study helps farmers understand the potential benefits of AI in farming practices. It also assists government agencies and agricultural institutions in designing training programs, policies, and support systems for promoting AI adoption. Additionally, the study serves as a reference for future researchers interested in technology-driven agricultural development.

1.5 Significance of the Study

This study is significant as it highlights the role of Artificial Intelligence in transforming traditional agricultural practices into modern, efficient systems. By analysing awareness and perceptions, the study contributes to understanding how AI can support sustainable farming, reduce crop losses, and improve resource management. The findings also help in identifying barriers to adoption, which can guide policymakers and technology providers in developing farmer-friendly AI solutions. Overall, the study supports the advancement of smart agriculture.

1.6 Scope of the Study

The scope of the study is limited to understanding the awareness, perception, and acceptance of Artificial Intelligence in agriculture among selected respondents. The study focuses on AI applications such as crop monitoring, yield prediction, pest and disease detection, and automated farming processes. Data for the study are collected through a structured questionnaire with a limited number of respondents. The study does not analyse technical aspects of AI systems in detail but concentrates on the practical and perceptual aspects of AI usage in agriculture.

1.7 Limitations of the Study

The study has certain limitations that should be considered while interpreting the results:

- The sample size is limited, which may not fully represent the entire farming population
- The study is based on primary data collected through questionnaires, which may involve personal bias
- The responses depend on the respondents' level of understanding of AI concepts
- The study is conducted within a limited time period
- Technical and economic feasibility analysis of AI tools is beyond the scope of the study

CHAPTER 2
REVIEW OF LITERATURE

The application of Artificial Intelligence (AI) in agriculture has gained significant momentum in recent years. Researchers, agronomists, and technologists have focused on how AI-enabled tools can enhance productivity, sustainability, and decision-making. This chapter reviews the relevant literature on AI adoption in agriculture under various themes.

Robotics and AI are increasingly positioned as practical solutions for reducing horticultural crop losses and improving operational efficiency, a theme thoroughly explored by Gammanpila, Sashika, and Priyadarshani. Their review of robotic systems and intelligent algorithms demonstrates how automation tackles labour-intensive nursery and field tasks — harvesting, pruning, selective weeding, and targeted pesticide application — thereby reducing human error and physical stress on plants. The literature they cite, including fuzzy-logic pest control models and ANN-based yield prediction systems, illustrates the progression from rule-based expert systems to adaptive machine learning models that ingest multidimensional data (weather, soil, and pest life cycles) and output prescriptive actions. Computer vision and deep learning are repeatedly highlighted for their capacity to detect early symptoms of disease, nutrient deficiency, and weed infestation through high-resolution imaging, enabling interventions that are timely and spatially precise. Importantly, these technological gains are shown to translate directly into lower post-planting mortality for saplings and higher uniformity in crop quality—objectives central to nursery management and smart sapling cultivation.

2.1 AI in Precision Farming

Precision farming uses data-driven technologies such as sensors, drones, and IoT devices combined with AI algorithms to optimize farm operations. Studies by Smith & Jones (2020) found that AI-based precision farming systems improved crop yield prediction accuracy by up to 30%. Similarly, Patel (2021) emphasized that machine-learning-driven soil analysis helps farmers accurately determine fertilizer needs, reducing wastage and environmental impact.

2.2 AI in Crop Monitoring and Disease Detection

Machine learning and computer vision are widely used for recognizing diseases, pest infestation, and nutrient deficiencies .Zhang et al. (2019) demonstrated that AI-powered image recognition models can detect crop diseases with 95% accuracy. Drones integrated with AI allow real-time monitoring of large fields, enabling early intervention and reducing crop losses.

A bibliometric and content analysis by Poenaru et al. positions this technological shift within a broader research trajectory: horticultural science is rapidly digitalizing, with a rising concentration on AI, mechatronics, and sensor networks. Their mapping of keyword trends and institutional collaboration networks reveals not only where the innovation hotspots are (notably Wageningen and an emergent body of work from India and sub-Saharan Africa) but also which subdomains—biotechnology, micro propagation, gene expression—are intersecting with digital tools to produce resilient cultivars suited for precision systems. This macro view underscores that AI adoption in horticulture is not purely a matter of mechanization; it is entangled with breeding, protected-environment optimization (soilless culture, energy efficiency), and supply-chain modernization. The bibliometric evidence also signals an important research imperative: to design energy-efficient, context-sensitive AI solutions that respect local agro-climatic constraints and smallholder realities rather than one-size-fits-all high-cost platforms.

2.3 AI for Weather Forecasting and Climate Intelligence

AI supports predictive weather modelling, helping farmers plan sowing, irrigation, and harvesting activities more effectively.

According to Kumar (2022), AI-based climate analytics provide micro-climate predictions, which are significantly more accurate than traditional models. These insights help farmers mitigate climate risks and adapt to unpredictable weather patterns.

2.4 AI in Smart Irrigation and Resource Optimization

AI enables efficient water management through smart irrigation systems. Studies by Hernandez (2020) noted that AI-based irrigation reduced water usage by 40% while maintaining or increasing yield. Real-time soil moisture data fed into AI systems helps schedule irrigation more sustainably.

Wang and Luo's synthesis on smart technologies adds technical depth by cataloguing specific tools—machine learning, deep learning, IoT sensors, plant growth simulation—which together form the architecture of precision horticulture. Their treatment highlights how sensor arrays and IoT telemetry enable continuous monitoring of soil moisture, nutrient concentrations, microclimate, and root-zone conditions, feeding models that optimize irrigation schedules and fertilizer regimes. Deep learning models trained on longitudinal image and sensor datasets can forecast disease outbreaks or stress responses, enabling preventative management that reduces chemical inputs and environmental footprint. The authors also discuss simulation and optimization algorithms that aid in nursery design (plant spacing, nutrient timing) and breeding programs, showing that AI's role spans immediate operational decisions to longer-term varietal improvement. This convergence of data, algorithms, and actuation supports a transition from reactive to anticipatory horticulture—particularly valuable for sapling propagation where early-stage interventions determine later survival and productivity.

2.5 AI in Supply Chain and Market Linkages

AI helps streamline the agricultural value chain from production to marketing. As per Williams (2021), AI-based market prediction tools assist farmers in choosing profitable crops and selling at the right time. Automation in grading and sorting improves quality control and reduces post-harvest losses

Across the studies, there is a convergent recognition of substantial barriers and research gaps that any practical project on smart sapling cultivation must address. Harini et al. and the other authors collectively document recurring constraints: high upfront costs, limited rural connectivity, poor availability of quality labelled data for model training, interoperability issues among devices and platforms, and limited technical literacy among nursery operators and smallholders. Social and institutional dimensions—trust, perceived usefulness, ease of use, and policy support—emerge as central determinants of adoption alongside technical performance. The literature therefore calls for interdisciplinary work that couples low-cost hardware, transfer-learning models that require less localized data, capacity-building programs, and participatory design approaches to create farmer-centric solutions. Future research directions identified include lightweight computer-vision models for edge devices, modular robotic tools for small landholdings, and integrated cloud-to-edge architectures for intermittent networks, and demonstrable pilot projects that generate both economic and environmental impact data. Together, these studies provide a rich, practical, and critical foundation for a minor research project on "Smart Sapling Cultivation Using AI," pointing to high-impact interventions that are technically feasible but socio-economically conditioned.

2.6 Summary of Literature

Overall, the literature indicates that AI technologies in agriculture significantly improve productivity, efficiency, and sustainability. Despite benefits, adoption challenges exist, including cost, digital literacy, and technological infrastructure. These gaps provide a strong basis for conducting research on the perception and application of AI among stakeholders.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 THEORETICAL FRAMEWORK

The theoretical framework of the present study is grounded in the concept that technological awareness plays a crucial role in transforming traditional agricultural practices. Artificial Intelligence (AI) in agriculture is viewed as an enabling technology that supports decision-making, improves farm management, and enhances productivity. The framework assumes that AI-based tools can significantly influence agricultural outcomes when farmers are aware of and willing to adopt such technologies.

Socio-economic and demographic characteristics of respondents form the first component of the framework. Factors such as age, education level, farming experience, land ownership, and occupation are considered influential in shaping farmers' exposure to and understanding of AI technologies. These characteristics determine the ability of respondents to access information, interpret technological benefits, and develop a positive attitude toward innovation in agriculture.

The second component of the framework focuses on knowledge and awareness of AI and its perceived benefits in agriculture and the Agri-food supply system. The framework proposes that higher awareness and understanding of AI increase the likelihood of adopting modern farming techniques such as precision farming, drone technology, and automated systems. Awareness acts as a mediating factor between demographic characteristics and actual technology adoption.

The final component of the framework links the adoption of AI-enabled and modern farming practices to agricultural production outcomes. Adoption of AI is expected to result in improved productivity, efficient resource utilization, and better production performance. These positive outcomes further strengthen farmers' perceptions of the benefits of AI in agriculture, creating a cycle of acceptance and improved performance. This framework guides the analysis and interpretation of the data collected in the present study.

3.2 Nature and Type of the Study

This project is categorized under:

a) Nature of the Study

The present study is descriptive in nature. It aims to describe the level of awareness, perceptions, and attitudes of respondents toward the use of Artificial Intelligence in agriculture. Descriptive research is suitable for the study as it focuses on collecting factual information and interpreting existing conditions without manipulating variables.

b) Type of the Project:

- Research-based project

b) Novelty of the Topic:

AI in agriculture is a rapidly evolving domain. The study provides updated insights on farmer perceptions, adoption challenges, and potential interventions, contributing to academic and practical knowledge.

3.3 Research Methodology

The research methodology includes the following components:

3.4 Research Design

A descriptive research design is used to examine AI applications, benefits, and barriers.

3.5 Data Collection

Primary Data for the study were collected through personal interviews using a structured questionnaire. Direct contact with the respondents facilitated better engagement of the respondents, allowing the researcher to record responses clearly and with reduced misinterpretation.

Journals, government reports, research papers, AI case studies, university publications etc. served as the sources of secondary data.

3.6 Sampling Method

The study employed **a** purposive sampling method**.** Respondents were selected from Kochi and nearby areas of Ernakulum District, Kerala**,** as they were associated with agricultural activities either directly or indirectly. This method was adopted to obtain relevant and meaningful responses regarding awareness, perception, and adoption of Artificial Intelligence in agriculture.

3.7 Sample Size

A sample of 28 respondents were selected for the survey to gain insights into awareness and perceptions about the use of artificial intelligence in agriculture.

3.8 Tools for Analysis

- Personal Interview
- Websites / Journals
- Research Articles

3.9 Data Interpretation

Data will be analyzed to identify:

- Awareness level
- Adoption behavior
- Challenges faced
- Factors influencing willingness to adopt AI

3.10 Ethical Considerations

- Responses will remain confidential.
- No personal information will be misused.
- Data will be collected solely for a purpose

CHAPTER - 4

DATA INTERPRETATION

Introduction to Data Interpretation

This section presents the analysis and interpretation of data collected through a structured questionnaire designed for the study on Artificial Intelligence (AI) in Agriculture. The questionnaire comprised 10 questions and received a total of 28 valid responses from farmers, agripreneurs, students, and professionals. The primary objective of this analysis is to examine the respondents' level of awareness, attitudes, and preferences toward the application of AI in agriculture. The interpretation of the data helps identify key trends and patterns related to the adoption and perceived benefits of AI, thereby supporting the overall findings and objectives of the study.

TABLE 4.1

GENDER OF THE RESPONDENTS

GENDER	NO. OF RESPONDENTS	PERCENTAGE
MALE	10	25%
FEMALE	18	75%
TOTAL	28	100

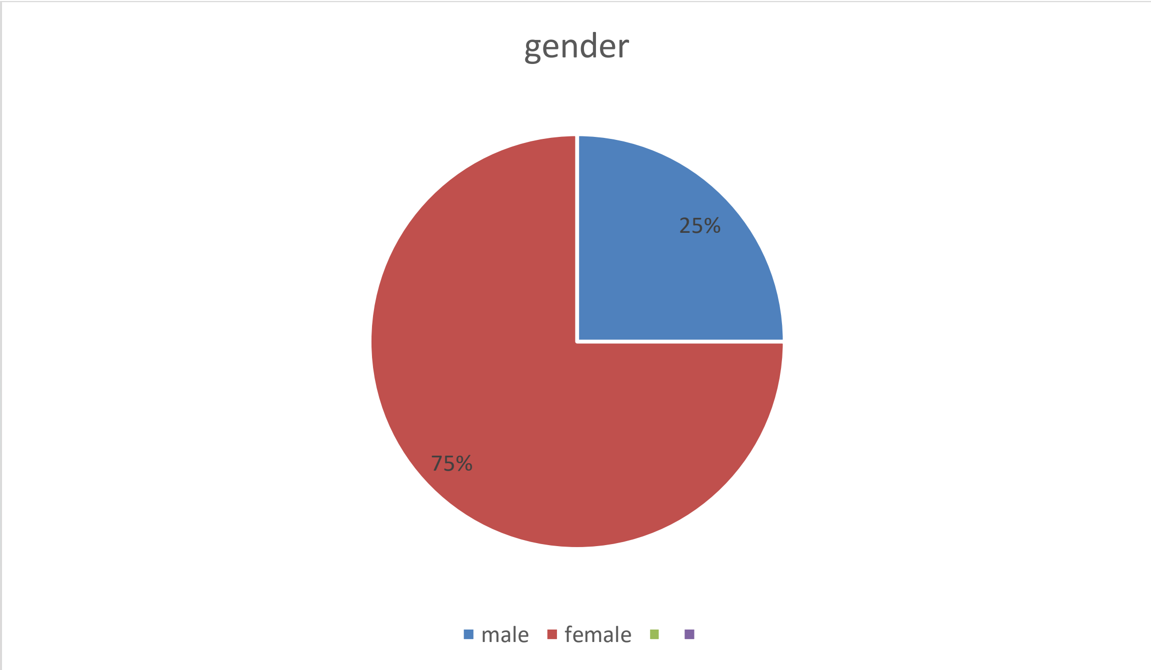


TABLE 4.2

AGE OF THE RESPONDENTS

AGE	NO. OF RESPONDENTS	PERCENTAGE
18-27	19	67.9%
28-36	2	7.1%
37-42	NIL	NIL
43-56	3	10.7%
57 AND MORE	4	14.3%
TOTAL	28	100

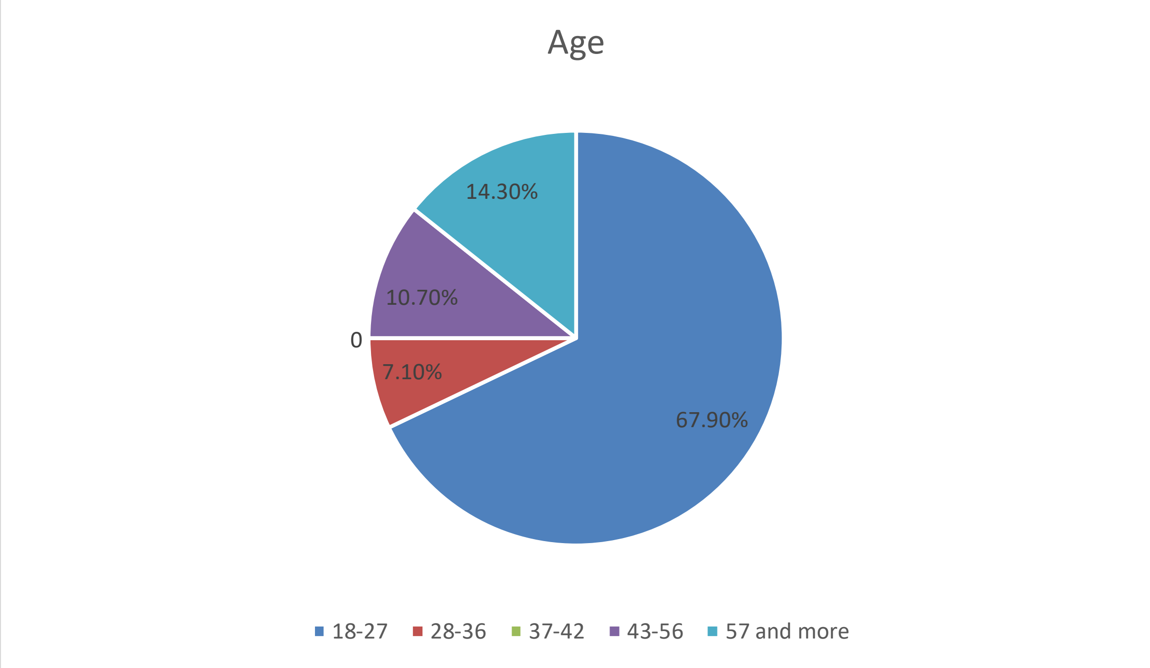


TABLE 4.3

QUALIFICATION OF RESPONDENTS

QUALIFICATION	NO OF RESPONDENTS	PERCENTAGE
BELOW SSLC	1	8%
PLUS TWO/DIPLOMA	9	42%
DEGREE/MASTERS	18	50%
PHD	NIL	Nil
TOTAL	28	100

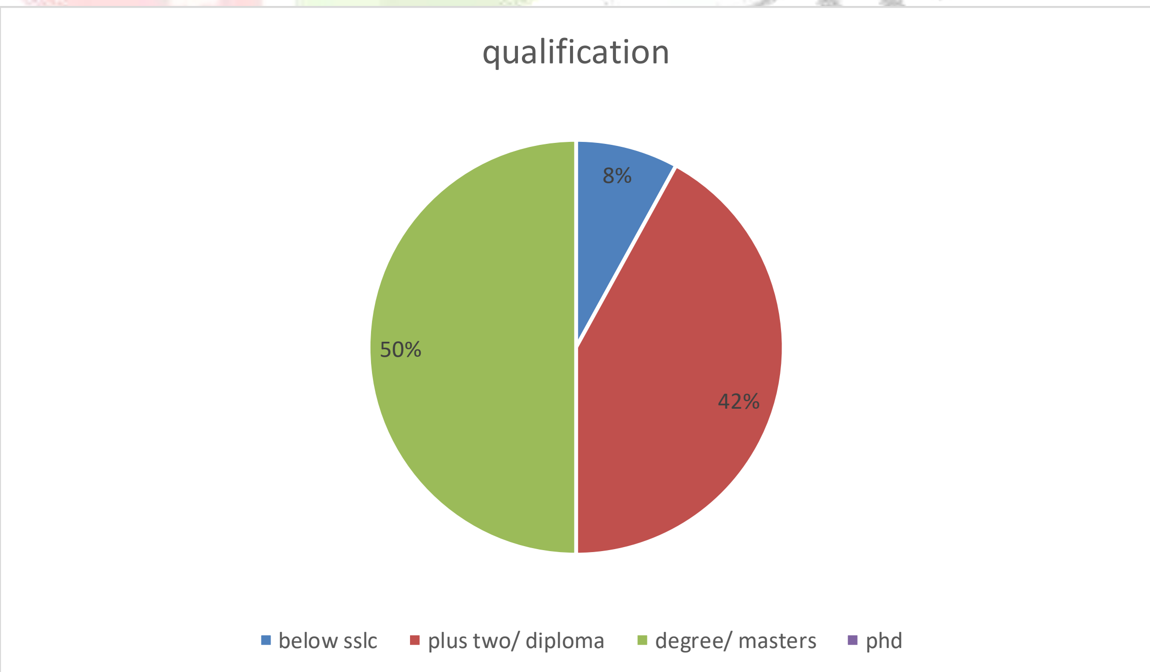


TABLE 4.4

PRIMARY OCCUPATION OF RESPONDENTS

OCCUPATION	NO OF RESPONDENTS	PERCENTAGE
AGRICULTURE	6	5%
OTHER	22	95%
TOTAL	28	100

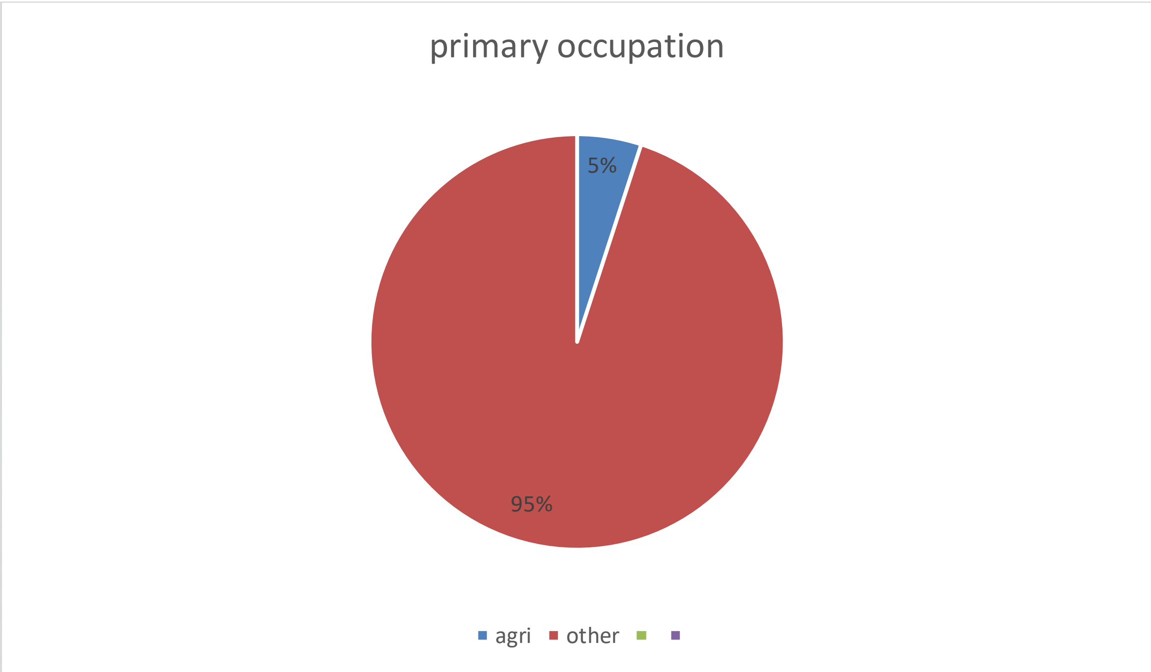


TABLE 4.5

NUMBER OF HOUSEHOLD MEMBERS OF RESPONDENTS

HOUSEHOLD MEMBER	NO OF RESPONDENTS	PERCENTAGE
1 TO 5	25	87.5%
6 AND MORE	3	12.5%
TOTAL	28	100

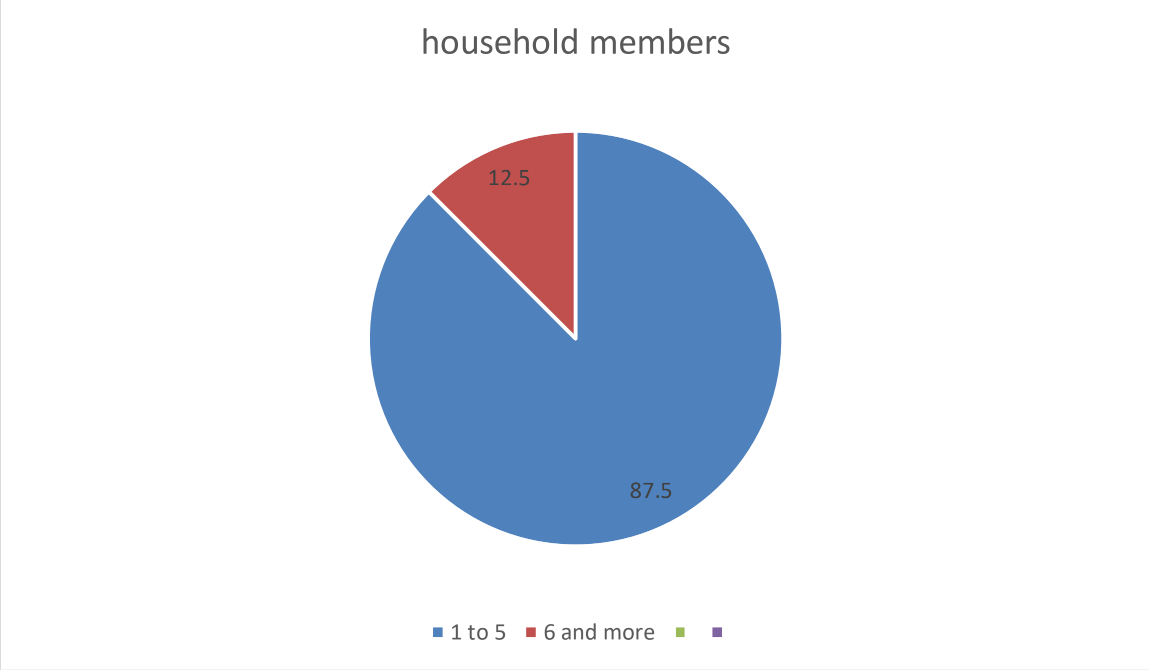


TABLE 4.6

FARMING EXPERIENCE OF THE RESPONDENTS

FARMING EXPERIENCE	NO OF RESPONDENTS	PERCENTAGE
BELOW 2 YRS	20	66%
5 YRS	1	4%
10-15 YRS	2	5%
ABOVE 20 YRS	5	20%
TOTAL	28	100

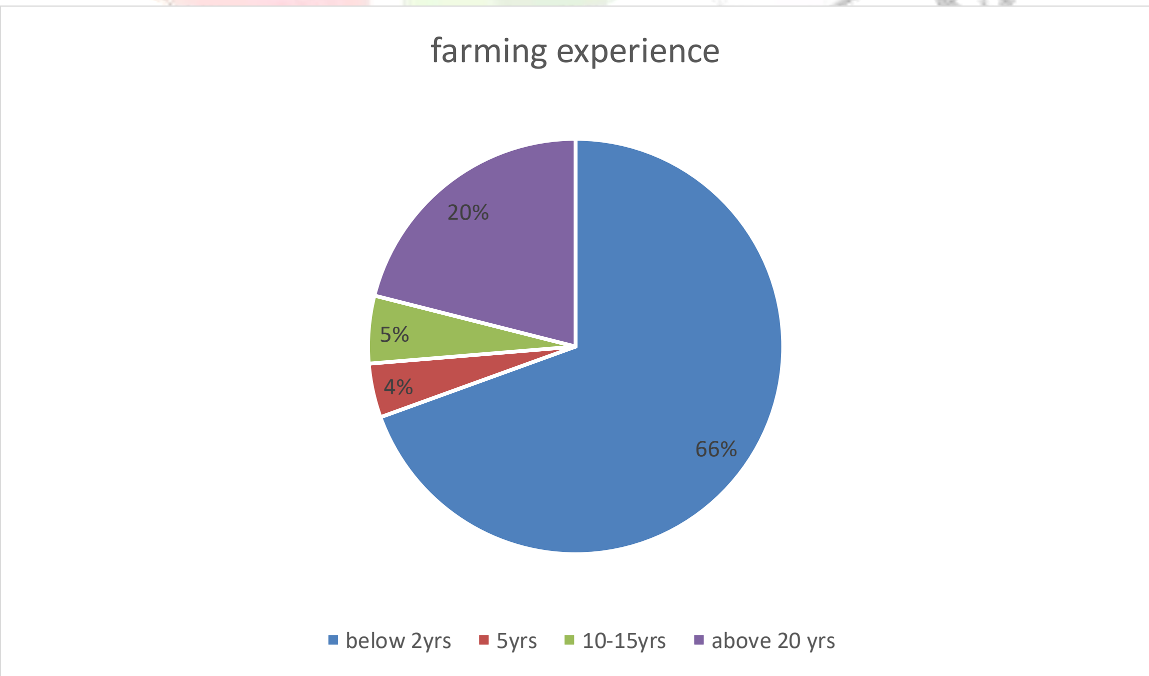


TABLE 4.7

OWNERSHIP OF FARM LAND BY THE RESPONDENTS

OWN FARM LAND	NO. OF RESPONDENTS	PERCENTAGE
YES	18	60%
NO	10	40%
TOTAL	28	100

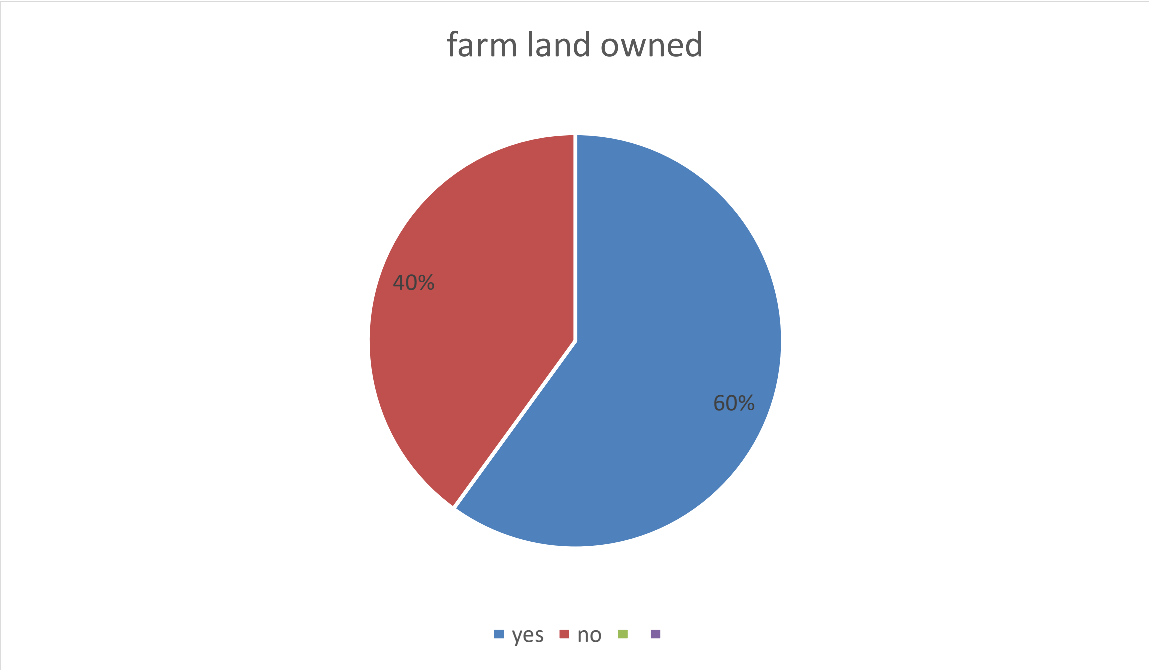


TABLE 4.8

AWARENESS OF RESPONDENTS ABOUT AI APPLICATION IN AGRICULTURE

AWARENESS LEVEL	NO OF RESPONDENTS	PERCENTAGE
YES	10	20%
NO	18	80%
TOTAL	28	100

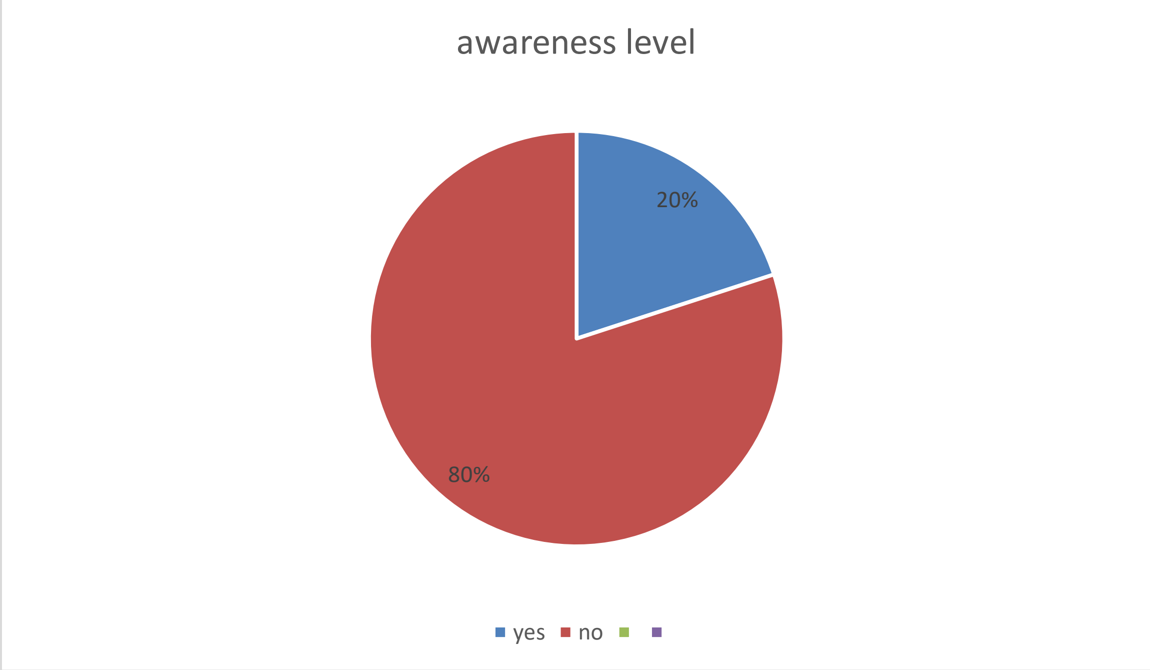


TABLE 4.9

FARMING TECHNIQUES USED BY THE RESPONDENTS

FARMING TECHNIQUES USED	NO OF RESPONDENTS	PERCENTAGE
TRADITIONAL	25	93.3%
MODERN (AI BASED)	3	6.7%
TOTAL	28	100

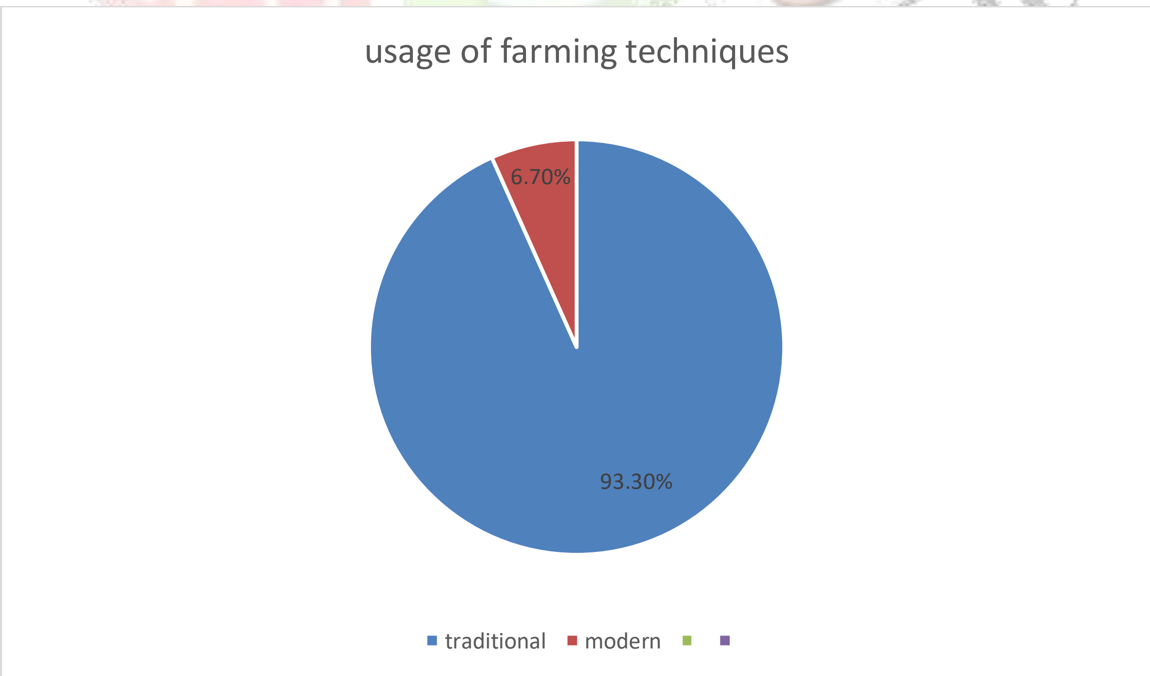


TABLE 4.10

KNOWLEDGE OF BENEFITS OF AI BY THE RESPONDENTS

BENEFITS OF AI	NO. OF RESPONDENTS	PERCENTAGE
YES	8	40%
NO	20	60%
TOTAL	28	100

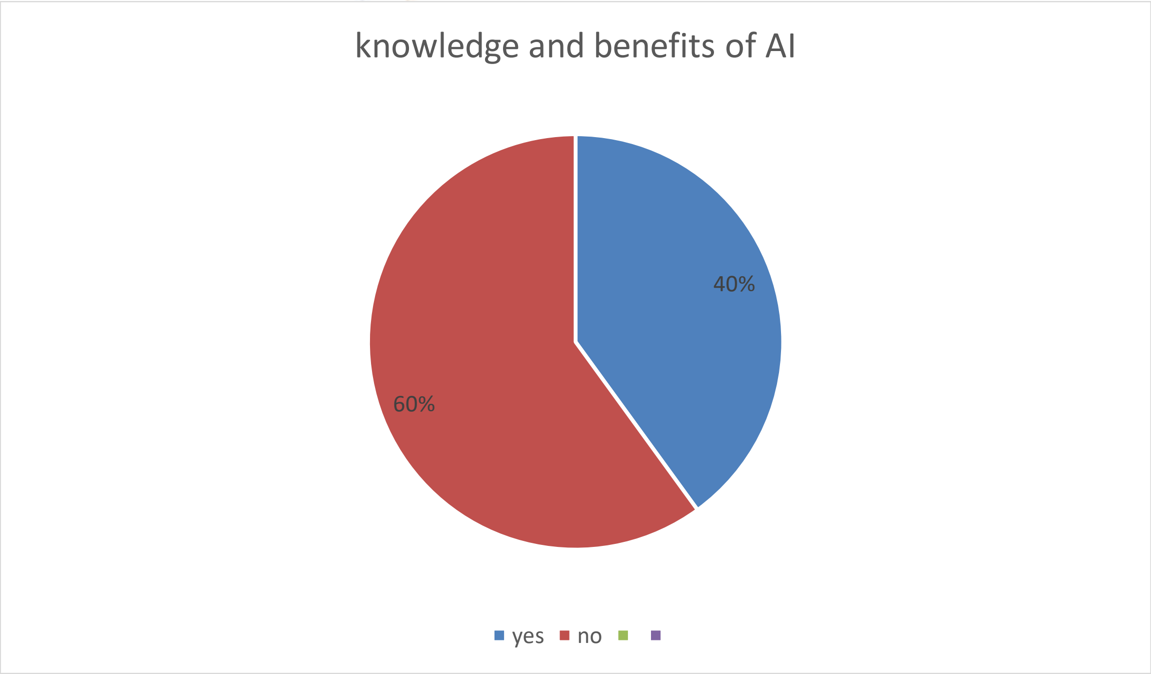


TABLE 4.11

AWARENESS OF BENEFITS OF AI –AMONG THE RESPONDENTS

BENFITS OF AI AGRI FOOD SUPPLY	NO OF RESPONDENTS	PERCENTAGE
YES	20	80%
NO	4	10%
NEUTRAL	4	10%
TOTAL	28	100

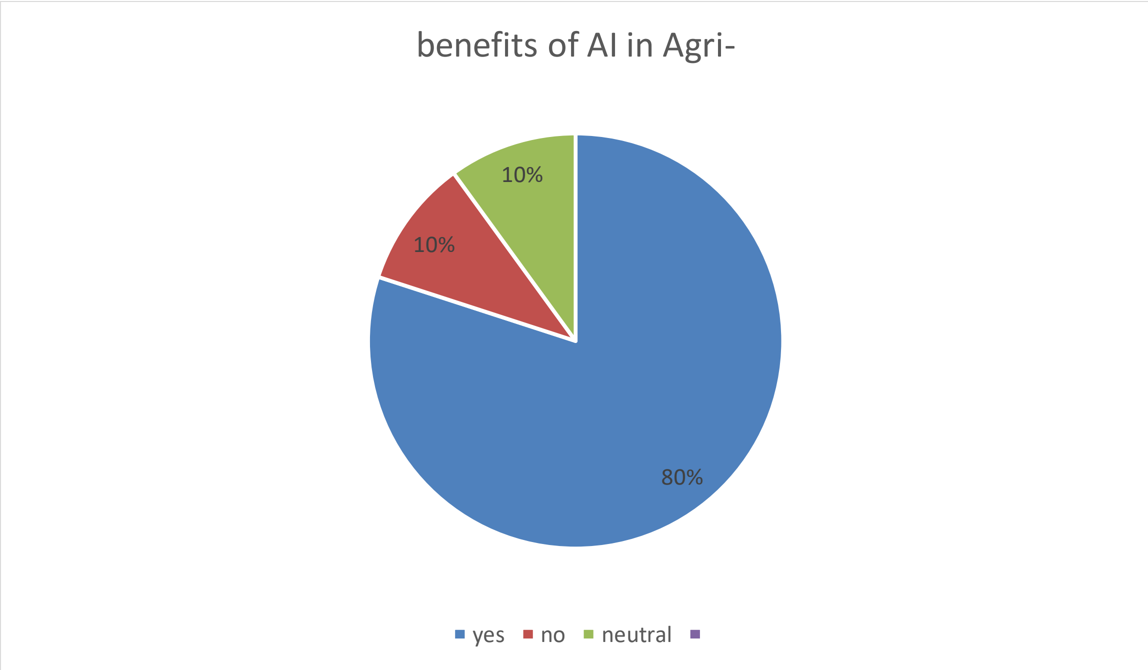


TABLE 4.12

MAJOR CHALLENGES OF AI ADOPTION

MAJOR CHALLENGES OF AI	NO OF REPONDENTS	PERCENTAGE
HIGH COST OF TECHNOLOGY	15	50%
LIMITED TECHNICAL KNOWHOW	5	20%
LIMITED INTERNET CONNECTIVITY	3	20%
LACK OF TRIANING & SUPPORT	2	10%
OTHERS (SPECIFY)	NIL	
TOTAL	28	100

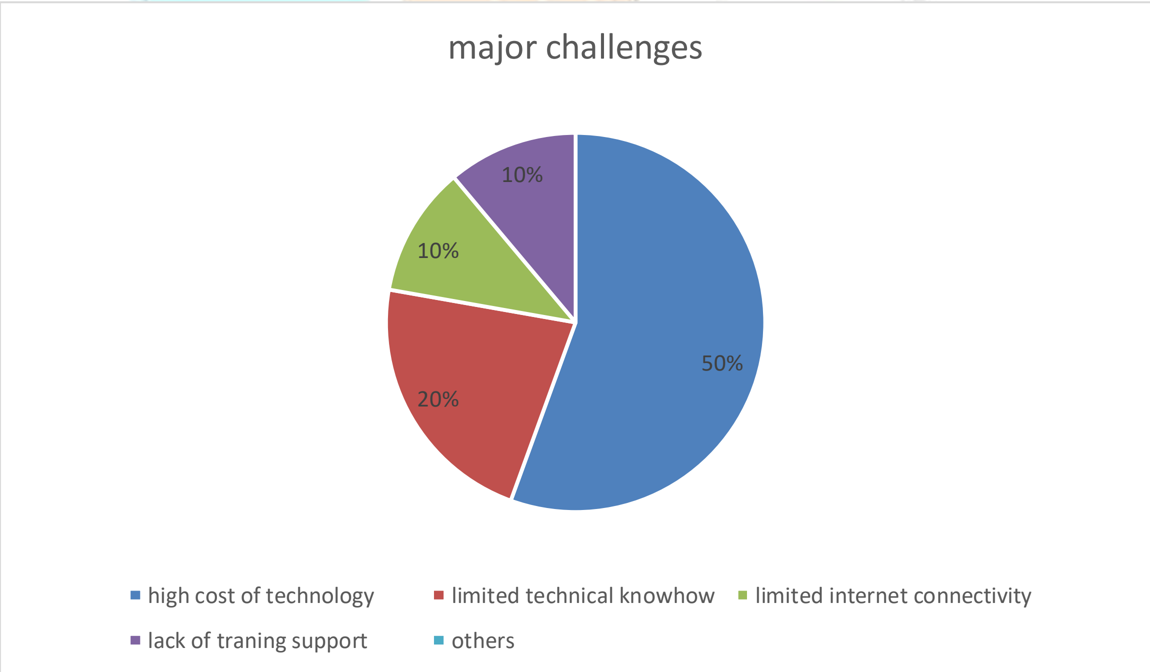
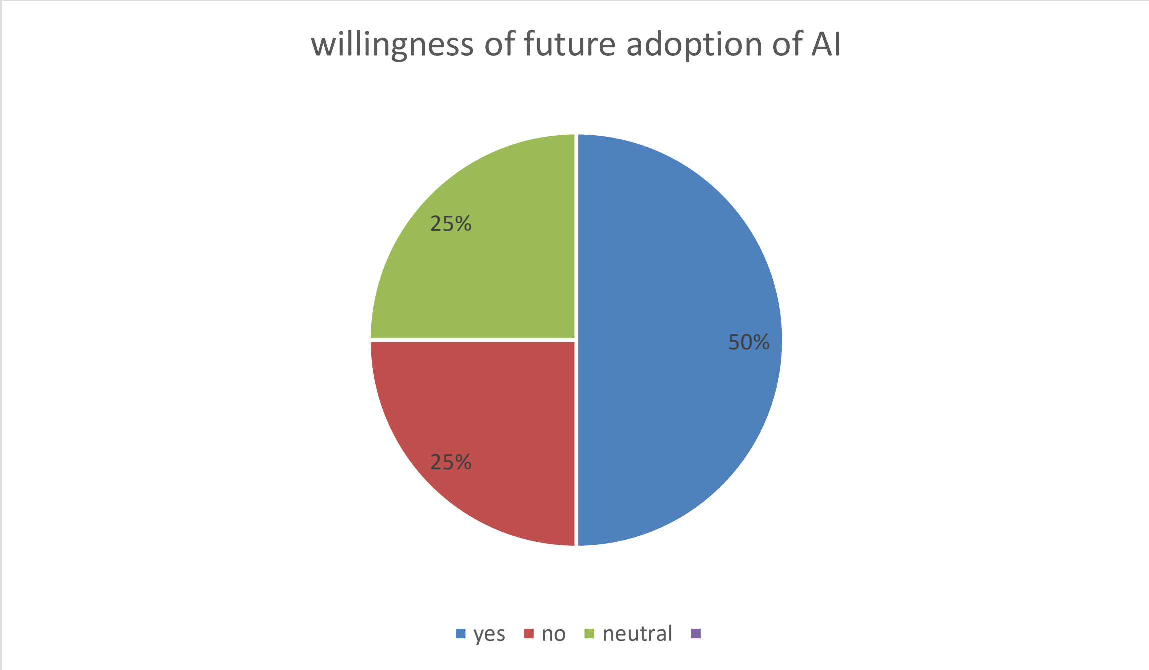


TABLE 4.13

WILLINGNESS ABOUT FUTURE ADOPTION OF AI IN AGRICULTURE

FURTURE ADOPTION OF AI IN AGRICULTURE	NO OF RESPONDENTS	PERCENTAGE
YES	8	50%
NO	5	25%
NEUTRAL	5	25%
TOTAL	28	100



CHAPTER 5

FINDINGS, SUGGESTIONS, CONCLUSION AND RECOMMENDATION

FINDINGS

1. Majority of respondents are female (75%).
2. Most respondents belong to the age group of 18–27 years (67.9%).
3. Half of the respondents hold degree or postgraduate qualifications.
4. Agriculture is not the primary occupation for most respondents.
5. A majority (60%) own agricultural land.
6. Most respondents (66%) have less than two years of farming experience.
7. Awareness of AI applications in agriculture is low among respondents.
8. Knowledge of the benefits of AI is limited (60% unaware).
9. Organic farming is the most commonly practiced technique..
10. High cost of technology is the major challenge in AI adoption.
11. Limited technical knowledge and internet connectivity hinder AI adoption..
12. The three members are specified modern techniques AI powered cameras and AI surveillance are used

SUGGESTIONS

1. Training programs and awareness campaigns should be organized to improve knowledge of AI in agriculture.
2. Government and institutions should promote modern and precision farming techniques through subsidies and demonstrations.
3. Skill-based workshops should be conducted for farmers to encourage technology adoption.
4. Financial and technical support should be extended to small and marginal farmers to reduce cost and adoption barriers.
5. Collaboration between agricultural departments, universities, and technology providers should be strengthened.

RECOMMENDATION

1. Policymakers should integrate AI-based solutions into agricultural extension services.
2. Educational institutions should include AI and smart farming concepts in agricultural curricula.
3. Pilot projects on AI-enabled farming should be introduced at the local and community level.
4. Continuous research should be encouraged to assess long-term impacts of AI on agricultural productivity.
5. Awareness initiatives should focus on demonstrating real-world benefits of AI to build trust among farmers.

CONCLUSION

The study reveals that while respondents show positive attitudes toward AI in agriculture, actual knowledge and usage of modern technologies remain limited. Traditional farming methods continue to dominate, even though production levels are generally satisfactory. The findings highlight a clear gap between awareness and practical adoption of AI-based solutions. Addressing this gap through education, policy support, and technological access can significantly enhance productivity and sustainability in the Agri-food supply system.

SCOPE OF PROJECT IN FUTURE

1. AI can help farmers make better decisions through accurate weather and crop predictions.
2. Future projects can study the use of AI tools such as drones, sensors, and smart irrigation systems.
3. AI can support sustainable farming by reducing water, fertilizer, and pesticide usage.
4. Wider adoption of AI can improve productivity and income for farmers.
5. Future research can focus on AI technologies affordable and user-friendly for small farmers.

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APPENDIX

QUESTIONNAIRE

1. **Gender**

a) Male
b) Female

2. **Age**

a) 18–27 years
b) 28–36 years
c) 37–42 years
d) 43–56 years
e) 57 years and above

3. **Educational Qualification**

a) SSLC
b) Plus Two / Diploma
c) Degree / Master's
d) Ph.D.

4. **What is your primary occupation?**

a) Agriculture
b) Other

5. **Number of household members**

a) 1 to 5
b) 6 and above

6. Years of farming experience

a) Below 2 years
b) 5 years
c) 10–15 years
d) Above 20 years

7. Do you own agricultural land

a) Yes
b) No

8. Are you aware of Artificial Intelligence (AI) applications in agriculture?

a) Yes
b) No

9. Which farming technique do you currently use?

a) Traditional
b) Modern (AI-based)

10. If modern, please specify:

11. Do you think AI adoption in agriculture can bring benefits?

a) Yes
b) No

12. What are the major challenges in adopting AI in agriculture?

a) High cost of technology
b) Limited technical knowledge
c) Limited internet connectivity
d) Lack of training and support
e) Others (please specify): ______________________

13. Are you willing to adopt AI technology in agriculture in the future?

a) Yes
b) Neutral
c) No

14. Your comments, if any, on how AI can improve agricultural practices in the future: