PROSPECTS AND PROBLEMS IN IMPLEMENTING 4AR INNOVATIONS IN RELATION TO 4IR PERSPECTIVES

A Thesis

By

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ABSTRACT

The Fourth Industrial Revolution (4IR) and the concept of the Fourth Agricultural Revolution (4AR) are interconnected, as they both refer to the application of advanced technologies. The Fourth Industrial Revolution has the power to revolutionize agriculture, enabling farmers to embrace innovation, increase productivity, and foster sustainable practices. The purpose of this study was to determine the extent of knowledge and attitude of respondents; to determine familiarity of the respondents with 4AR technologies, to measure the severity of problems perceived by the respondents in relation to 4AR, to find out the suitability of solutions for adopting 4AR innovations and to explore the relationship between each of the selected characteristics of the respondents with the focused issues. Primary data were collected from purposively selected 70 respondents during the period of 1st May, 2023 to 9th May, 2023 at Khulna district through face to face discussions and online interview by using a pre tested interview schedule. Descriptive statistics such as mean, standard deviation, percentage and Spearman Coefficient of Correlation (ρ) were measured for data interpretation by using SPSS. Almost 72.9 % of the respondents had low knowledge on 4AR technologies and a proportion of 95.7 % of the respondents had favorable attitude towards 4AR. Maximum respondents are highly familiar with the technology of "Using automated machine for seedling transplantation" and "Using agricultural drones in applying fertilizers and pesticides in crop field". The main problems based on problem severity index was "High initial investment to purchase 4AR technologies". The best possible solutions according to solution index were making the 4AR technologies available in low prices in the local market" followed by financial support from Government and other agencies. Knowledge and attitude towards 4AR technologies had significant positive relationship with the familiarity of 4AR technologies. Training experience had highly significant relationship with the determination of associated problems in 4AR implementation. Knowledge on 4AR and training experience had highly significant positive relationship with the measurement of suitability of probable solutions.

Keywords: Knowledge, Attitude, Familiarity, 4AR.

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ABBREVIATIONS AND ACRONYMS

%	=	Percentage
4AR	=	Fourth Agricultural Revolution
4IR	=	Fourth Industrial Revolution
AI	=	Artificial Intelligence
BSc.	=	Bachelor of Science
DAE	=	Department of Agricultural Extension
et al.	=	And others
FI	=	Familiarity Index
FS	=	Familiarity Score
GDP	=	Gross Domestic Products
GOs	=	Government Organizations
IoT	=	Internet of Things
Max	=	Maximum
Min	=	Minimum
MSc.	=	Master of Science
NGOs	=	Non-Government Organizations
No.	=	Number
PI	=	Problem Index
SD	=	Standard Deviation

CHAPTER I

INTRODUCTION

1.1 Background of the Study

Agriculture plays a key role in a country's economy as well as the everyday lives of the vast majority of rural people. Agricultural advancement has been acclaimed as one of the essential tools that could be used for putting an end to extreme poverty, therefore enhancing common prosperity, and feeding an estimated world-wide population of 9.7 billion people by 2050. Modern-day agriculture is solely responsible for a huge share of environmental destruction, which leads to the decline of continental and marine ecosystems, diminishing water resources, as well as driving climate change. To reduce these roadblocks, agriculture will need to be modernized via the contribution of technologies that fall under the Fourth Industrial Revolution (4IR).

The term Fourth Industrial Revolution (4IR) comprises a variety of innovative, developing, and breakthrough technologies such as Big Data, the Internet of Things, Artificial Inteligence, Blockchain, and Drones, to mention a few. It also makes provision for revolutionary techniques of organization, distribution, and production that is based upon digital transformation as well as automatization which can wipe boundaries between physical objects, transforming them into an all-encompassing, sophisticated system of interrelated and interdependent components. Consequently, such technologies have the possibility to have a positive effect on the efficiency and profitability of the agricultural sector as well as the creation of new-found locally based added value. The 4IR has been marked by emerging technology advances in a wide range of fields, involving robotics, nanotechnology, artificial intelligence, biotechnology, quantum computing, 3D printing, The Internet of Things, and autonomous vehicles.

The main focus of industrial agriculture is to increase technology adoption rates in farming, driving effective and efficient change that increases productivity in a sustainable, profitable and eco-friendly way (Liu et al., 2020). To make autonomously connection of computer based algorithm for open field agriculture, industry 4.0 builds intelligent networks among machines, work and systems in general through creating the entire value chain with the help of IoT which can control themselves and each other (Lasi et al., 2015; Hofmann and Rusch, 2017).

Bangladesh has a strong agriculture sector, which contributes significantly to the country's economy. The government and private sector are investing in technologies and innovations to improve yield, reduce waste, and enhance the quality of agricultural products. Some of the key initiatives in Bangladesh include the adoption of precision farming techniques, the use of drones for crop monitoring and fertilization, and the implementation of smart irrigation systems. These technologies are helping farmers to increase productivity and efficiency while minimizing the use of resources (Bhowmik and Hossain, 2020). One of the key areas where the 4AR is being implemented in Bangladesh is precision agriculture. This involves the use of sensors, drones, and satellite imagery to monitor and manage crops more efficiently. Precision agriculture enables farmers to make data-driven decisions regarding irrigation, fertilization, and pest control, leading to optimized resource utilization and improved yields.

In Bangladesh, the 4AR is closely linked to the 4IR, as the country strives to leverage technological advancements to modernize its agricultural sector and address the challenges faced by farmers. Bangladesh has a predominantly agrarian economy, with agriculture employing a significant portion of the population and contributing to the country's GDP (Ahmed et al., 2020).

Agriculture is one of the important sectors in Bangladesh's economy in terms of GDP and employment generation, which contributes about 13.32% and 43% respectively in FY 2018-19. Agriculture here, a means of food security and reducing poverty, is mostly in conventional form and more prone to Climate victim, limited diversity, degrading land, water resources, and harmful agro-chemical but in recent decades using the core technology in a narrow range of the industry 4.0, digital pieces of machinery, big data, IoT Devices i.e.(Soil Moisture, Solar radiation, Air temperature and moisture, Leaf Wetness), Data Model i.e. Irrigation data model, Crop Management and Soil properties), AI in farm machinery, seeding in the soil, farm management, production forecasting, data, and Software module such as Mobile App and irrigation are created a new era of prospect for food security of 170 millions of people in Bangladesh (Rezvi, 2018; Salim and Rahman, 2018).

The government of Bangladesh has recognized the potential of technology in transforming the agriculture sector and has taken initiatives to promote the adoption of digital solutions. The Digital

Bangladesh Vision 2021, a government program, emphasizes the use of ICT (Information and Communication Technology) to drive socio-economic development, including agriculture.

Furthermore, the 4IR is facilitating the development and deployment of AI-based systems for crop disease diagnosis, weather forecasting, and market prediction, among other applications. These technologies empower farmers with real-time information, enabling them to mitigate risks and make informed decisions.

The integration of technology in agriculture is also boosting farm mechanization in Bangladesh. Robotic systems and automation technologies are being employed to perform tasks such as seeding, spraying, and harvesting. This not only reduces labor requirements but also increases productivity and reduces post-harvest losses.

In addition, the 4AR is driving the establishment of digital platforms and mobile applications that connect farmers with markets, information, and financial services. These platforms enable farmers to access market prices, connect with buyers, and access credit facilities, thereby improving their income and livelihoods.

Hence we should use new advanced technology to grow more food grain. The world changes by the advanced applications of technology (Maddox, 2018). It described the applications of agriculture 4.0 which changes the business of farming. A digital farming is more productive and sustainable than the output of past. To grow more production the smart agricultural technology has no alternative. Thus this study would illustrate the 4IR effects in short on agriculture and analyzes it's contribution on agricultural development.

1.2 Statement of the Problem

As the practices of 4AR are not so popular in our country, we even don't know properly about the available technologies for automation and how intelligently they are performing to minimize the resource consumption. Some confusions also exists among the people about the economic potentiality, efficiency and effectiveness of that technologies. Besides the prevailing problems associated with the implementation of 4AR technologies are unknown to us. However the research in this line is highly scarce in Bangladesh. So regarding these issues under consideration the present study will be conducted to answer the following research questions:

i. What is the extent of knowledge and attitude of agriculturists on the topic of 4AR?
ii. To what extent the agriculturists are familiar with the 4AR innovations?
iii. What are the problems associated with the implementation of 4AR technologies?
iv. What are the possible solutions to overcome the associated problems?

1.3 Objectives of the study

In order to find proper direction of the present study, following objectives were formulated

a) To determine a the selected characteristics of the respondents and the extent of knowledge and attitude of agriculturists towards 4AR
b) To measure the extent of familiarity of the agriculturists towards 4AR technologies
c) To analyze the problems associated with the implementation of industrial agricultural technology.
d) To find out the possible solutions to overcome the associated problems.

1.4 Justification of the Study

The implementation of 4AR innovations in Bangladesh faces several challenges, including limited access to technology and digital infrastructure, financial constraints, lack of awareness and technical skills, a fragmented agriculture sector, policy and regulatory gaps, and inadequate infrastructure and power supply. Overcoming these challenges requires collaborative efforts among stakeholders, targeted investments, policy reforms, and capacity-building initiatives. Addressing these issues will be crucial to unlocking the full potential of 4AR innovations and driving sustainable agricultural development in Bangladesh. But the scientific research on this field is highly scarce in Bangladesh. So, evaluation of the prospects and problems in implementing 4AR innovations is necessary. Regarding this circumstances the researcher has undertaken the present study entitled "Problems and Prospects in Implementing 4AR Innovations in Relation to 4IR Perspectives.

1.5 Assumption of the Study

The researcher had the following assumptions in mind while undertaking this study:

1. The respondents included in the sample were capable of furnishing proper responses to the questions included in the interview schedule.

2. The data collected by the researcher were free from any bias and they were normally distributed.

3. The responses furnished by the respondents were valid and reliable.

4. Data were normally and independently distributed with their means and standard deviation.

5. The researcher was well adjusted to herself with the social contiguous of the study area. Hence, the collected data from the respondents were free from favoritism.

1.6 Limitation of the Study

The study was undertaken with a view to having an understanding of the prospects and problems in implementing Fourth Agricultural Revolution. However, from the research point of view, it was necessary to impose certain limitations as follows:

1. The study was confined to some selected agricultural institutions under Khulna district.

2. Graduates of Agriculture have many varied characteristics but only a few were selected to complete this study as stated in the objectives.

3. For information about the study, the researcher was depended on the data furnished by the selected respondents during data collection.

4. For some cases, the researcher faced unexpected interference from the over interested side-talkers while collecting data from the target populations. However, the researcher tried to overcome the problem as far as possible with sufficient tact and skill.

5. There were embarrassing situations at the time of data collection. So, the researcher had to manage proper rapport with the respondents to collect maximum proper information.

CHAPTER II

REVIEW OF LITERATURE

The 4IR has emerged as a transformative force, integrating cutting-edge technologies and reshaping various industries. With advancements in artificial intelligence, robotics, IoT, and quantum computing, 4IR is revolutionizing the way we live, work, and interact.

The prospects of implementing 4AR technologies in Bangladesh are promising. By leveraging advanced technologies such as precision agriculture, AI, and data analytics, Bangladesh can achieve increased productivity, resource efficiency, enhanced risk management, improved market access, and empowerment of smallholder farmers. It is essential for stakeholders, including the government, private sector, and development partners, to collaborate and invest in the necessary infrastructure, policies, and capacity building to unlock the full potential of 4AR technologies in the agricultural sector of Bangladesh.

2.1 Knowledge on Fourth Agricultural Revolution (4AR) Technology

According to LeCun et al., (2015), The 4IR has emerged as a transformative force, integrating cutting-edge technologies and reshaping various industries. With advancements in artificial intelligence, robotics, IoT, and quantum computing, 4IR is revolutionizing the way we live, work, and interact.

Russel and Norvig (2016) reported that AI lies at the core of the 4IR, enabling machines to perform tasks that typically require human intelligence. Machine learning algorithms and deep neural networks are driving breakthroughs in image recognition, natural language processing, and decision-making systems.

According to Siciliano and Khatib (2016) Robots are revolutionizing traditional industries by performing tasks autonomously and with high precision. Collaborative robots (cobots) are increasingly being deployed alongside human workers to enhance productivity and safety in manufacturing and logistics.

The fusion of AI and robotics is also driving the development of advanced autonomous systems, such as self-driving cars and unmanned aerial vehicles (UAVs), with promising applications in transportation, delivery services, and disaster response was reported by Čhoset et al., (2005)

Atzori et al. (2010) found that IoT applications span a wide range of domains, including healthcare monitoring, agriculture, energy management, and smart homes. The real-time data collected by IoT devices enhances decision-making and efficiency in various sectors.

2.2 Attitude Towards 4AR Technologies

According to Floridi et al., (2018), attitudes towards 4IR technologies are multifaceted, reflecting a range of perspectives and concerns. Public perception, workforce adaptation, and ethical considerations all play significant roles in shaping these attitudes. As society navigates the Fourth Industrial Revolution, it is essential to address these concerns through transparent communication, inclusive decision-making, and responsible development to foster a harmonious integration of 4IR technologies.

Bostrom and Sandberg (2009) and Eurobarometer (2019) reported that public perceptions and acceptance of 4IR technologies, revealing a diverse range of attitudes. While some individuals embrace the potential benefits of these technologies, others express concerns about job displacement, privacy, and ethical implications. Factors such as education, age, and prior exposure to technology have been found to influence attitudes towards 4IR technologies.

According to World Economic Forum (2020) attitudes towards 4IR technologies often depend on the perceived risk of automation and its consequences for employment. While some individuals express anxiety about job losses, others acknowledge the potential for new job opportunities and increased productivity.

2.3 Key Application of Robotics and Drones in Agriculture:

Cheein and Carelli (2013) reported that Smart tractors would work collaboratively to generate operational routes and intelligently avoid barriers in the field to ensure the safety for both farmland and humans.

According to Lottes et al., (2018) Robotic weeders can differentiate weeds from crops through computer vision, and then precisely spray the herbicide on weeds only or directly eradicate them without harming the crops.

Zhang et al., (2018) found that Picking and harvesting robots help farmers to collect tomatoes, citrus, apples, and strawberries more efficiently. They recognize fruits and vegetables in the field, determine their location, and harvest the ripe ones in boxes.

According to Zhang (2021) The use of robotics and automation in agriculture has transformed labor-intensive tasks and increased operational efficiency. Autonomous vehicles equipped with imaging sensors and AI algorithms can perform tasks such as planting, spraying, and harvesting with precision and speed. Robots can also be employed in indoor farming systems, enhancing crop production in controlled environments. Robotic systems reduce labor demands, minimize crop damage, and optimize resource utilization, thereby contributing to increased productivity and reduced costs

Potena et al., (2019) reported that since operating speed of drones is dozens of times faster than ground machines, aerial crop spraying and monitoring has attracted considerable attention recently. Finally, RAS also contribute to animal husbandry, such as automatic feeding, milking, and herding.

Within the framework of sensitive agriculture implementations, satellites and air vehicles are used to provide information about agricultural areas for a long time. As result of developments in drone technology, the use of these tools for agricultural purposes has become widespread and it has become possible for farmers to access the images they need instantly or by remote control of activities such as pesticide applications at low cost (Malveaux et al., 2014).

2.4 Key Applications of IoT in Agriculture:

The IoT, as a core technology in Industry 4.0, is transforming many aspects of our daily lives by creating a smart connected world. Some use cases are smart home, industrial internet, and connected vehicles. Accordingly, it is also expected to encourage the agricultural sector.

The agricultural applications of IoT include precision farming, livestock monitoring, smart green house, fishery management, and weather tracking.

According to Kaloxylos et al., (2012), using IoT in agriculture will improve the functionality of existing tools by making the physical world a part of the information system through advanced networked innovative systems. By bringing together information from different sensors and RFID tags, IoT has unlimited potential application areas from monitoring of greenhouses to animals and agricultural machinery

Sadeghi (2019) reported that, the integration of IoT devices and connectivity in agriculture has enabled the development of smart farming systems. IoT devices, such as sensors and actuators, can monitor and control various aspects of agricultural operations, including soil moisture, temperature, and pest infestations. These devices communicate through wireless networks, providing farmers with valuable insights and enabling remote monitoring and management of crops and livestock. IoT-based systems contribute to efficient resource utilization, reduced labor requirements, and improved decision-making.

Savale et al., (2015) and Balamurugan et al., (2016) reported that through sensor networks, agriculture can be established regardless of geographical differences between scientists, farmers, and crops by linking to the Internet of Things. IoT technology enables efficient use of resources by allowing producers to make timely and appropriate decisions with real-time and accurate data.

IoT supports agricultural enterprises with enough data to calculate how much wheat can be produced in a specific area in a given amount of seed, fertilizer, water and soil chemistry and weather. Agricultural enterprises can prepare sensitive production mixes to increase harvest yields through interconnected intelligent machines and cloud computing-based on big data analysis software was reported by O'Halloran and Kvochko (2015).

2.5 Key Applications of AI in Agriculture:

Intelligent animal health monitoring systems are a major focus of today's research and drive the growth of AI in agriculture markets. Animal wearables, computer vision systems, and other sensing devices can capture the status of animals in real time. Then, the intelligence engine helps analyze livestock health, animal welfare, production, etc. In recent years, many technological advances have been made in the area of intelligent animal health monitoring. The advancement in biosensors was summarized by Neethirajan (2017). Machine vision approaches for animal behavior detection were reviewed in Nasirahmadi et al., (2017).

Jo et al., (2018) reviewed that digital twin technology is helpful to prevent animal diseases in livestock.

Mobile expert system is another key application of AI in agriculture. Farmers can now easily use smartphones to identify plant pests and diseases. Prasad et al., (2014) found that they are also able to identify soil problems on their own with the help of mobile apps. In addition, the progress of farm land can be tracked by satellite imagery, which is then analyzed by an AI engine.

Mobile apps simultaneously visualize the result so that farmers could understand the status remotely. Finally, AI-enabled agricultural predictive analytics and big data technology are capable of forecasting weather conditions, predicting crop yields, modeling agricultural market volatility, and performing price estimation. Based on these observations, professional insights in production can be provided to farmers, as well as to guide companies to optimize business resources.

2.6 Key Applications of Big Data in Agriculture:

Big data plays a key role in agri-food supply chain management in addressing to solve food safety, imbalance supply, as well as food loss and waste. For example, the data-driven agricultural solution for sustainability management in the by-products supply chain was reviewed by Belaud et al., (2019).

Lezoche et al., (2020) reported a comprehensive discussion about the impacts of big data analytics on the agri-food supply chain, from multiple perspectives, including functional impact, economic impact, environmental impact, social impact, business impact, and technological impact.

Yang (2018) reported that by integrating big data from various sources, including weather patterns, soil quality, and historical yield data, AI algorithms can generate valuable insights for optimizing crop management strategies. AI-powered systems can detect disease outbreaks, predict optimal planting times, and recommend precise fertilizer and pesticide application rates. These technologies enhance crop yield, reduce input costs, and enable proactive pest and disease management

2.7 Fourth Agricultural Revolution in Bangladesh

Ahmed et al., (2020) found that Digital platforms have emerged as powerful tools for disseminating agricultural information to farmers in Bangladesh. Mobile phone applications and web-based platforms provide farmers with access to real-time weather updates, market prices, pest and disease management strategies, and best practices for crop cultivation. These platforms empower farmers with knowledge, enabling them to make informed decisions and improve their productivity and profitability.

According to Khan. (2020) mobile financial services, such as mobile banking and digital payment systems, have facilitated financial inclusion in rural areas of Bangladesh. Farmers can now access financial services, including loans, savings accounts, and insurance, using their mobile phones. This has enabled them to invest in modern agricultural technologies, purchase inputs, and manage financial risks more effectively, ultimately improving their agricultural productivity and resilience.

Remote sensing and satellite imagery have played a crucial role in enhancing agricultural practices in Bangladesh. By monitoring vegetation health, soil moisture levels, and crop growth patterns, remote sensing technologies provide valuable insights to farmers. This information helps them make informed decisions regarding irrigation scheduling, fertilizer application, and crop management. Remote sensing enables precision agriculture, leading to increased crop yield and reduced resource wastage was reported by Rahman (2019).

Iqbal (2020) reported that Bangladesh is highly vulnerable to climate change, and climate-smart agriculture technologies have proven instrumental in mitigating its adverse effects. Climate Smart Agricultural technologies, such as drought-tolerant crops, flood-resistant varieties, and climate-resilient farming practices, have helped farmers adapt to changing climatic conditions. These technologies enhance crop productivity, reduce vulnerability to extreme weather events, and improve farmers' livelihoods.

According to Rahman (2021) the advent of e-commerce platforms has transformed agricultural trade in Bangladesh. Farmers can now connect directly with buyers through online marketplaces, bypassing traditional intermediaries. This allows farmers to obtain better prices for their produce and increases their market access. E-commerce platforms have created new avenues for farmers to sell their products, improving their profitability and economic opportunities

2.8 Problems of Implementing 4AR Technologies in Bangladesh

Miah (2021) reported that one significant challenge in adopting 4AR technologies in Bangladesh is the limited access to technology and infrastructure, particularly in rural areas. Many farmers lack access to smartphones, computers, and high-speed internet, which are essential for utilizing digital platforms and accessing agricultural information. Poor infrastructure, including power supply and connectivity, hinders the effective implementation of technology-driven solutions.

According to Rahman (2021) the successful adoption of 4AR technologies requires a certain level of technical knowledge and skills among farmers. However, many farmers in Bangladesh have limited exposure to modern technologies and may lack the necessary training to effectively use them. The lack of awareness and technical know-how acts as a barrier to adopting and utilizing advanced technologies for improving agricultural practices

The cost of acquiring and implementing 4AR technologies can be prohibitive for small-scale farmers in Bangladesh. Investments in hardware, software, sensors, and other technological infrastructure may not be financially viable for many farmers. Additionally, the cost-effectiveness of adopting these technologies in terms of improved productivity and profitability may not always be evident, making it challenging to justify the initial investment. This report was given by Mahmud (2020).

Hossain (2021) reported that adopting 4AR technologies often requires farmers to make complex decisions regarding technology selection, customization, and integration into their existing farming practices. Lack of guidance and expertise in navigating these decision-making processes can deter farmers from embracing new technologies. Simplifying decision-making processes and providing support and guidance can facilitate technology adoption in Bangladesh

According to Bhuiyan (2019) cultural and social factors can also pose challenges to the adoption of 4AR technologies in Bangladesh. Traditional farming practices and deeply rooted beliefs may resist change and hinder the acceptance of new technologies. Social norms, language barriers, and gender disparities may also impact the accessibility and adoption of technology-driven solutions in agriculture.

2.9 Probable Solutions to Overcome Problems in the Implementation of 4AR Technologies

According to Khatun (2019) enhancing technology access and infrastructure is crucial for facilitating technology adoption. Efforts should focus on expanding network coverage, improving internet connectivity, and promoting the availability of affordable smartphones and computers in rural areas. Public-private partnerships can play a significant role in building and upgrading the necessary infrastructure to support the adoption of 4AR technologies.

Promoting technical education and training programs tailored to the needs of farmers can empower them with the knowledge and skills required to adopt and effectively utilize 4AR technologies. Collaborations between government agencies, educational institutions, and agricultural extension services can develop training programs that provide hands-on experience, practical demonstrations, and capacity-building initiatives. This report was given by Rahman et al. (2021).

Mahmud et al. (2020) reported that to address the affordability concerns associated with adopting 4AR technologies, providing financial support and incentives is crucial. Government policies can offer subsidies, grants, and low-interest loans to farmers to assist in acquiring the necessary technology infrastructure. Innovative financial mechanisms, such as pay-as-you-go models or shared equipment services, can also be explored to make technology adoption more accessible.

Hossain et al., (2021) stated that simplifying the decision-making processes related to 4AR technology adoption is essential. Providing farmers with clear guidelines, decision support tools, and user-friendly interfaces can help them understand the benefits and feasibility of adopting specific technologies. Extension services and technology providers can offer advisory services and support systems that simplify technology selection, customization, and integration.

To overcome cultural and social barriers, raising awareness about the benefits of 4AR technologies is crucial. Communication campaigns, farmer field schools, and demonstrations can showcase successful case studies and highlight the positive impacts of technology adoption. Addressing language barriers, gender disparities, and involving local community leaders can also help overcome cultural resistance and promote technology acceptance. This report was given by Bhuiyan et al. (2019).

2.10 The Conceptual Framework of the Study

In scientific research, selection and measurement of variables constitutes an important task. The hypothesis of a research while constructed properly contains at least two important elements i.e. "focus issues" and "selected characteristics". A focus issue is that factor which varies as the researcher introduces, removes or varies the selected characteristics. The present study prioritize two concepts: firstly, the selected socioeconomic characteristics of the respondents and secondly the focus issues. In view of prime findings, the researcher constructed a conceptual framework of the study which is presented in Figure 2.1.

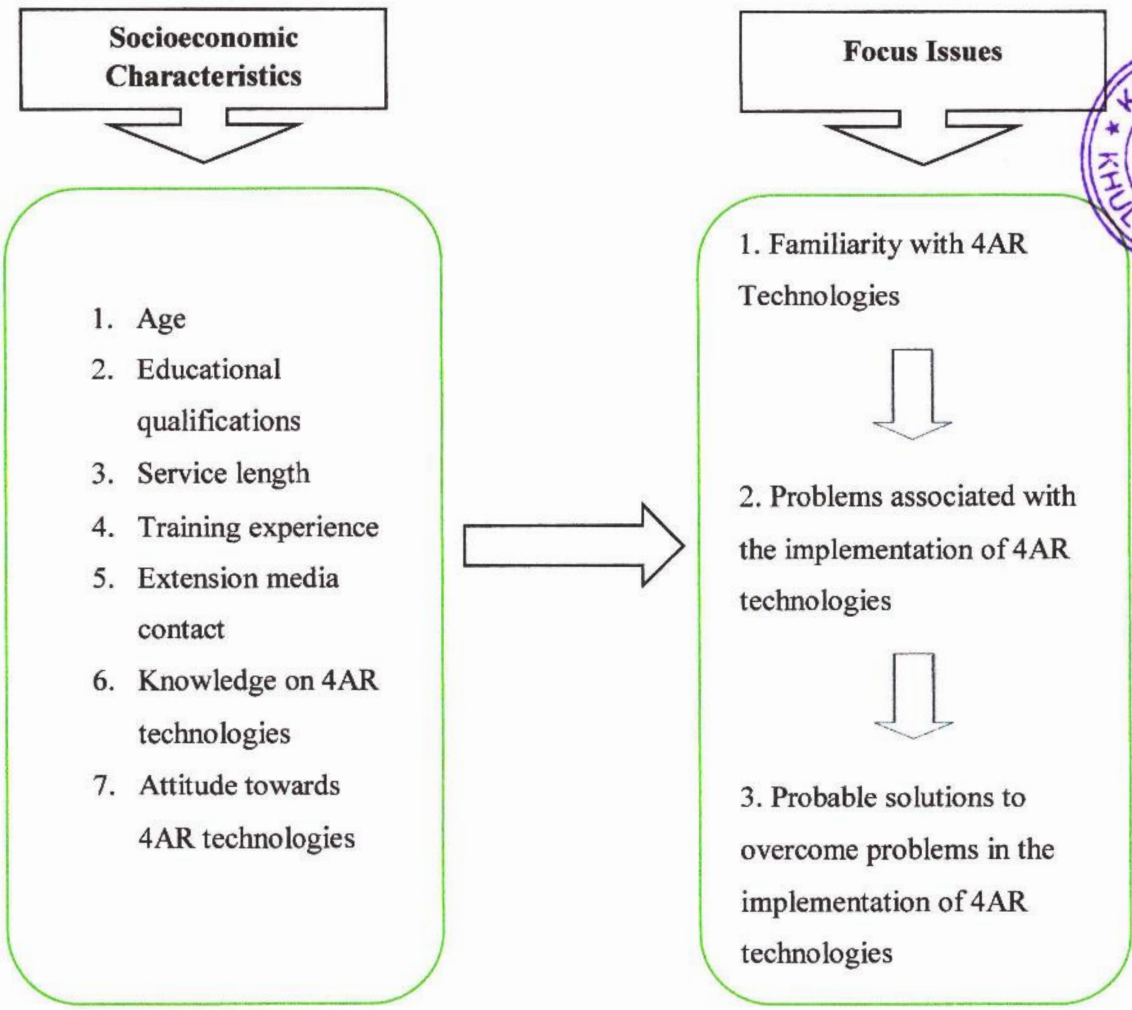

Figure 2.1: The conceptual framework of the study

CHAPTER III

MATERIALS AND METHODOLOGY

In conducting a research study, methodological issue is one of the prime considerations for yielding of valid and reliable findings. Appropriate methodology enables the researcher to collect valid and reliable information and to analyze the information properly in order to arrive at correct conclusions. According to Mingers (2001), research method is a structured set of guidelines or activities to generate valid and reliable research results. The methods and operational procedures followed in conducting the study e.g. selection of study area, sampling procedures, instrumentation, categorization of variables, collection of data, measurement of the variables and statistical measurements. A chronological description of the methodology followed in conducting this research work has been presented in this chapter.

3.1 Locale of the study

The research was conducted purposively at different agricultural research and extension organizations of Khulna district. Khulna University is located in Khulna and the agriculture of Khulna District has a wide range of diversity which was the main reason behind selecting Khulna as locale. Some responses were also collected remotely from graduate agriculturists of Bangladesh through online survey form. Map of Khulna City are presented in Figure 3.1.

3.2 Population and Sampling

All the graduate agriculturists of Khulna both employed and unemployed were primarily regarded as the population of this research. For fulfilling the requirement of desired sample size, some interviews were done remotely through online media from agriculture students staying in different portion of the country. The researcher purposively selected 30 agriculturists working in different agricultural research and extension organization of Khulna District and other 40 respondents were selected randomly those were graduated from different university of Bangladesh. While selecting the individual respondents the researcher remained herself unbiased. Due to some limitations such as time and budget constraints and individual limitations more respondents can not be interview but still 70 respondents were quite enough for this study.

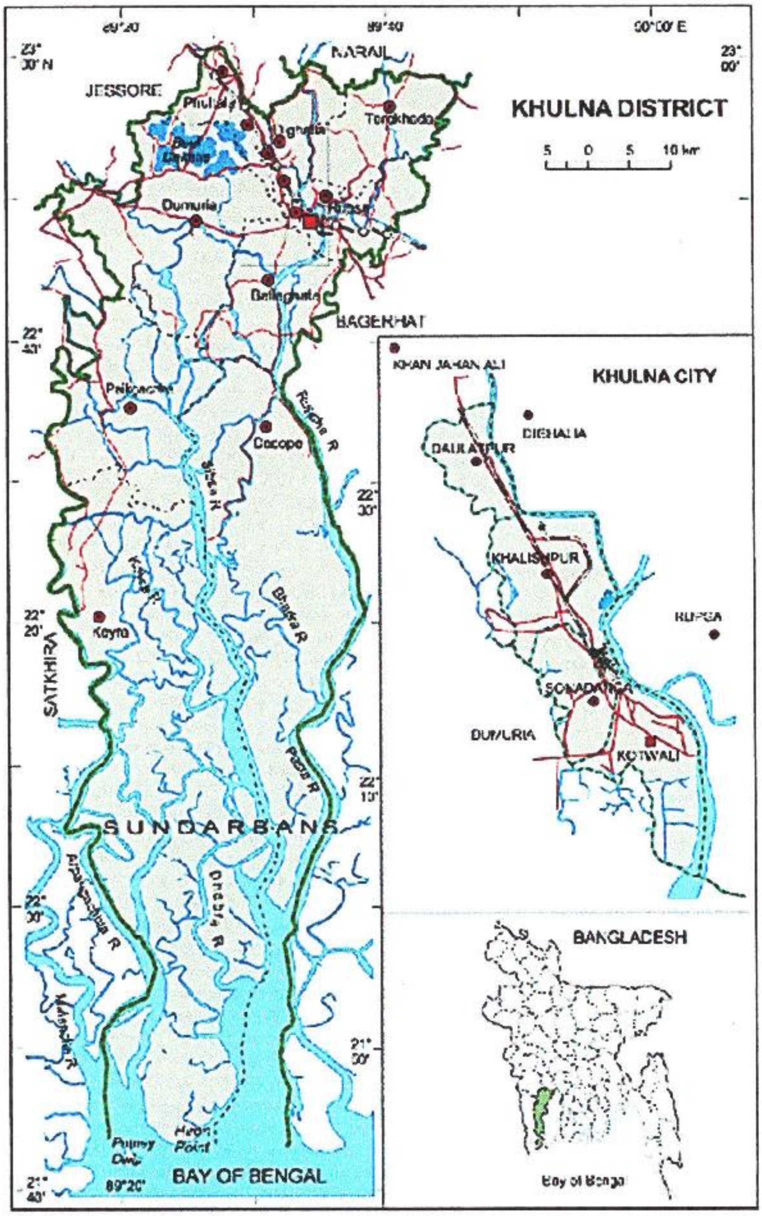

Figure 3.1: A map of Khulna District

3.3 Selection of Variables

For the research purpose "familiarity with 4AR technologies", "Problems associated with the implementation of 4AR technologies" and "Probable solutions for the problems" were selected as the focus issues. Nine socioeconomic characteristics of the graduate agriculturists were selected. The selected characteristics were:

a) Age
b) Educational qualifications
c) Service length
d) Training experience
e) Extension media contact
   i) Personal extension contact
   ii) Group extension contact
   iii) Mass media contact
f) Knowledge on 4AR technologies
g) Attitude towards 4AR technologies

3.4 Measurement of Variables

3.4.1 Measurement of Selected Socioeconomic Characteristics

Nine important characteristics of Graduate Agriculturists were regarded as selected characteristics of this study. Measurement of this variables are stated below:

3.4.1.1 Age

Age of the respondents was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the respondents. A score of one (1) was assigned for each year of one's age. This variable appears in item number 1 in the interview schedule as presented in Appendix-A. On the basis of age, the respondents were classified into three categories as shown in Table 3.1.

Table 3.1: Categories of respondents based on their age

Categories	Scores (Years)
Young	≤ 35
Middle-aged	36-55
Old	> 55

3.4.1.2 Educational Qualifications

Education of a respondent was measured on the basis his/her years of schooling. If a respondent completed BSc. Degree his/her education score was 16 (Appendix A, question no. 2 in the interview schedule). On the basis of level of education score, the respondents were grouped into two categories as presented in table 3.2

Table 3.2: Categories of respondents based on their educational qualifications

Categories	Scores (Year of Schooling)
Undergraduate (BSc)	16
Post Graduate (MSc)	17

3.4.1.3 Service Length

Service length of the respondents was measured in terms of actual years from their beginning of Service to the time of the interview, which was found on the basis of the verbal response of the respondents. A score of one (1) was assigned for each year of service. This variable appears in item number 3 in the interview schedule as presented in Appendix-A. On the basis of service length score the respondents are categorized into three groups as shown in Table 3.3.

Table 3.3: Categories of respondents based on their service length

Categories	Scores (Years)
Low	1-5
Medium	6-15
High	> 16

3.4.1.4 Training Experience

Training experience of the respondents was measured by if he/she had received any agricultural training or not. A score of one (1) was assigned for responding "Yes" and (0) was assigned for responding "No". This variable appears in item number 4 in the interview schedule as presented in Appendix-A.

3.4.1.5 Extension Media Exposure

3.4.1.5.1 Personal Extension Contact

Contact of the respondents with some officials working in DAE, Other extension source like (livestock, fisheries etc.) and NGOs is referred to as personal extension contact. The personal extension contact score was computed for each respondent on the basis of his/her extent of contact with the selected three categorized extension personnel (Question no. 5 (a) , Appendix A). A four point rating scale such as frequently, occasionally, rarely and not at all was employed against each of the category and score of 3, 2, 1, and 0 was assigned against the scales, respectively. Each of the respondents was asked to indicate the frequency of his/ her contact with the extension personnel. The personal extension contact of a respondent was determined by adding all scores against the categories. Thus the total score could range from 0 to 9, where 0 indicating no personal contact and 9 indicating high personal contact. On the basis of personal contact scores, the respondents were classified into 3 categories as shown in table 3.4.

Table 3.4: Categories of respondents based on their personal extension contact

Categories	Scores
Low	≤3
Medium	4-6
High	> 6

3.4.1.5.2 Group Extension Contact

The personal extension contact score was computed for each respondent on the basis of his/her extent of contact with a group of people through group discussion, demonstration and field trip/

farm visit (Question no. 5(b), Appendix A). A four point rating scale such as frequently, occasionally, rarely and not at all was employed against each of the category and score of 3, 2, 1, and 0 was assigned against the scales, respectively. Each of the respondents was asked to indicate the frequency of his/ her contact. The group extension contact of a respondent was determined by adding all scores against the categories. Thus the total score could range from 0 to 9, where 0 indicating no group contact and 9 indicating high group contact. On the basis of group contact scores, the respondents were classified into 3 categories as shown in table 3.5.

Table 3.5: Categories of respondents based on their group extension contact

Categories	Scores
Low	≤ 3
Medium	4-6
High	> 6

3.4.1.5.3 Mass Media Contact

The mass extension contact score was computed for each respondent on the basis of his/her extent of contact with the selected mass media (Question no. 5 (c) , Appendix A). A four point rating scale such as frequently, occasionally, rarely and not at all was employed against each of the category and score of 3, 2, 1, and 0 was assigned against the scales, respectively. Each of the respondents was asked to indicate the frequency of his/ her contact with the extension mass media. The mass media contact of a respondent was determined by adding all scores against the categories. Thus the total score could range from 0 to 21, where 0 indicating no mass media contact and 21 indicating high mass media contact. On the basis of mass media contact scores, the respondents were classified into 3 categories as shown in table 3.6.

Table 3.6: Categories of respondents based on their mass media contact

Categories	Scores
Low	≤ 7
Medium	8-15
High	> 15

3.4.1.6 Knowledge on 4AR Technologies

This refer to one's knowledge about 4AR technologies. It was measured by asking the respondents ten question on different technologies related to Fourth Agricultural Revolution (4AR). A score of 2 was assigned for each correct answer, 1 for partially correct answer and 0 for wrong answer. Thus the score could range from 0 to 20, where 0 indicating no knowledge and 20 indicating high knowledge (question no. 6 of the interview schedule, Appendix A). On the basis of knowledge score, the respondents were grouped into three categories as shown in Table 3.7.

Table 3.7: Categories of respondents based on their knowledge on 4AR technologies

Categories	Scores
Low	≤ 5
Moderate	6-15
High	> 15

3.4.1.7 Attitude towards 4AR Technologies

Attitude refers to one's favorable or unfavorable feelings, beliefs and actions towards and object or concept. It was measured by constituting 10 statements (Item no. 7 of interview schedule, Appendix A). There were five positive statements and five negative statements. A statement was considered positive if it possessed an idea favorable towards the 4AR technologies. On the other hand, a statement was considered negative if it was unfavorable towards 4AR. The respondents were asked to indicate their degree of agreement about each of the statements along with a five point rating scale such as strongly agree, agree, undecided, disagree and strongly disagree. Scores were assigned to these five alternative responses as 5, 4, 3, 2 and 1, respectively if the statement was positive. A reverse scoring method was followed in case of negative statements. The total attitude score could range from 1 to 50, where 1 indicates less favorable attitude towards 4AR and 50 indicates highly favorable attitude. On the basis of attitude score, the respondents were grouped into five categories as shown in table 3.8.

Table 3.8: Categories of respondents based on their attitude towards 4AR technologies

Categories	Scores
Highly unfavorable	0-10
Unfavorable	11-20
Neutral	21-30
Favorable	31-40
Highly favorable	41-50

3.4.2 Measurement of Focus Variables

3.4.2.1 Familiarity with 4AR Technologies

Familiarity of the respondents with the 4AR technologies was one of the main focus issues in this research. It was measured by using four point rating scale. The respondents were asked to indicate their extent of familiarity with selected 20 4AR technologies. A four point rating scale such as highly familiar, moderately familiar, slightly familiar and not familiar was employed against each of the 4AR technology and a score of 3, 2, 1 and 0 was assigned against each of the scale respectively. The extent of familiarity of a respondent was measured by adding the scores of all 20 items shown in question no. 8 of the interview schedule. Thus the familiarity score of a respondent could range from 0 to 60, where 0 indicating no familiarity and 60 indicating high familiarity. On the basis of the familiarity scores, the respondents were grouped into three categories as shown in Table 3.9.

Table 3.9: Categories of respondents based on their familiarity with 4AR technologies

Categories	Scores
Low	≤ 20
Moderate	$21 - 40$
High	> 41

Familiarity score of a respondent was determined by using the following formula:

$FS = N_{hf} \times 3 + N_{mf} \times 2 + N_{sf} \times 1 + N_{na} \times 0$

Where,

FS = Familiarity Score

N_{hf} = No. of the respondents having high familiarity

N_{mf} = No. of the respondents having moderate familiarity

N_{sf} = No. of the respondents having slight familiarity

N_{na} = No. of the respondents having no familiarity

After calculating the FS, the Familiarity Index was calculated by the following formula

$$\text{Familiarity Index (\%)} = \frac{\text{Observed Familiarity Score}}{\text{Possible Highest Familiarity Score}} \times 100$$

3.4.2.2 Problems Associated with the Implementation of 4AR Technologies

Problems associated with the implementation of 4AR technologies was another important focus issues in this research. It was measured by using a five point rating scale. The respondents were asked to give their opinions against the extent of severity of the selected 15 problems. A five point rating scale such as highly severe, severe, moderately severe, less severe and not at all was employed against each of the problems and a score of 4, 3, 2, 1 and 0 was assigned against each of the scale respectively. The extent of severity of the problems was measured by adding the scores of all 15 items shown in question no. 11 of the interview schedule. Thus the problem score of a respondent could range from 0 to 60, where 0 indicating no severity and 60 indicating high severity of the problems. On the basis of the problem scores, the respondents were grouped into three categories as shown in Table 3.10.

Table 3.10: Categories of respondents based on their assumed problem scores

Categories	Scores
Low	≤ 25
Medium	26-50
High	> 50

Solution score of a respondent was determined by using the following formula:

$$SS = N_{hs} \times 4 + N_s \times 3 + N_{ms} \times 2 + N_{ls} \times 1 + N_{na} \times 0$$

Where,

SS = Solution Score

N_{hs} = No. of the respondents who marked the solution as highly suitable

N_s = No. of the respondents who marked the solution as suitable

N_{ms} = No. of the respondents who marked the solution as moderately suitable

N_{ls} = No. of the respondents who marked the solution as less suitable

N_{na} = No. of the respondents who did not mark the solution at all

After calculating the SS, the Solution Index was calculated by the following formula

$$\text{Solution Index (\%)} = \frac{\text{Observed Solution Score}}{\text{Possible Highest Solution Score}} \times 100$$

3.5 Instrument of Data Collection

In order to collect data from the respondents, an interview schedule was prepared. The schedule was prepared keeping the objectives of the study in mind. The interview schedule contained both open and close ended questions. Simple and direct questions and statements were included in the interview schedule to obtain essential information. An English version of the interview schedule is enclosed in Appendix A.

3.6 Data Collection

The researcher herself collected data from the respondents through face to face interview and through online platform using a pre-tested interview schedule. The researcher took all possible care to establish rapport with the respondents and whenever the respondents faced any problem to understand questions the researcher explained them. Data collection was started in 1st May, 2023 and completed in 9th May, 2023.

3.7 Data Processing and Analysis

For data processing and analysis the following steps are followed:

3.7.1 Compilation of Data

At the end of the survey all the data of the interview schedule were compiled, tabulated and analyzed according to the objectives of the study. Tabulation was done on the basis of categories developed by the researcher.

3.7.2 Statistical Analysis

The statistical measures such as number, percentage, mean, standard deviation, minimum, maximum, rank order etc. were used for describing the variables. The coded data were put into the computer for statistical analysis. The analysis was performed using statistical software Statistical Package for the Social Sciences (SPSS). Spearman Coefficient of Correlation (ρ) was calculated in order to explore the relationship between the concerned variables. The Spearman rank coefficient of correlation was used as it evaluates the monotonic relationship; the variables (focus issues and other selected characteristics) tend to change together, but not necessarily at a constant rate. The analyzing social data is always not linear and constant. That is the motivation of using Spearman rank coefficient of correlation in determining the relationships.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this chapter is to describe the findings of the present study. Recorded observations were presented in line with the objective of the study and what was found was discussed with justifiable and relevant comments under this chapter.

4.1 Selected Characteristics of the Respondents

Nine characteristics of the graduate agriculturists were selected to find out their contribution with the focused issues of the study. The selected characteristics include their Age, Educational qualifications, Service Length, Training experience, Personal Contact, Group Contact, Mass Media Contact, Knowledge on 4AR and Attitude Towards 4AR. These characteristics of the respondents are described in this section.

Data contained in the Table 4.1 reveals the salient features of the characteristics of the graduate agriculturists in order to have an overall picture of these characteristics at a glance.

The age of the respondents have been varied from 24 to 50 years with a mean and standard deviation of 30.47 years and 7.01 years respectively. Considering the recorded age, respondents are classified into three age groups namely "young", "middle aged" and "old" that have been presented on Table 4.1.

The findings in the Table 4.1 indicates that the highest proportion (75.7 %) of the respondents were young compared to 24.3 % of them being middle aged and none of the respondents was from old aged. Data also indicates that the young and middle aged category constitute overall 100 % of total respondents.

Table 4.1: Salient features of the respondents with their characteristics (N= 70)

SL No.	Characteristics	Categories	Score	N = 70		(Mean ± SD)	Range	
				F.	%		Min.	Max.
1.	Age (years)	Young	≤ 35	53	75.7	30.47 ± 7.01	24	50
		Middle- aged	36-55	17	24.3			
		Old	> 55	0	0			
2.	Educational Qualifications (years of schooling)	Under-graduate (BSc)	16	20	28.6	16.71 ± 0.45	16	17
		Post Graduate (MSc)	17	50	71.4			
3.	Service length (years)	Low	1-5	51	72.9	3.74 ± 6.50	0	22
		Medium	6-15	13	18.6			
		High	> 16	6	8.5			
4.	Training experience	Yes		22	31.4			
		No		48	68.6			
5.	Extension Media Exposure							
5 (a)	Personal contact	Low	≤3	48	68.6	1.82 ± 2.73	0	8
		Medium	4-6	17	24.3			
		High	> 6	5	7.1			
5 (b)	Group contact	Low	≤ 3	48	68.6	2.57 ± 3.72	0	9
		Medium	4-6	4	5.7			
		High	> 6	18	25.7			
5 (c)	Mass media contact	Low	≤ 7	22	31.4	10.54 ± 4.49	5	20
		Medium	8-15	33	47.2			
		High	> 15	15	21.4			
6.	Knowledge on 4AR	Low	≤ 5	51	72.9	4.37 ± 2.16	1	10
		Moderate	6-15	19	27.1			
		High	> 15	0	0			
7.	Attitude towards 4AR	Highly unfavorable	0-10	0	0	35.78 ± 2.79	29	41
		Unfavorable	11-20	0	0			
		Neutral	21-30	2	2.9			
		Favorable	31-40	67	95.7			
		Highly favorable	41-50	1	1.4			

Table 4.1 shows that the mean and standard deviation of respondent's educational qualification scores was 16.71 and 0.45. Based on their educational scores, the farmers were classified into two categories namely Undergraduate and Post graduate.

According to Table 4.1, the educational qualification scores varies from 16 to17. Respondents in the .above post graduate category have the highest proportion (71.4 %) followed by undergraduate category (28.6 %).

The service length score of the respondents ranged from 0 to 22 with a mean of 3.74 years and standard deviation of 6.50 years . Based on the observed range of service length scores, the respondents were categorized into three categories namely low, medium and high. The distribution of the respondents according their service length score is presented in Table 4.1.

About 72.9 % of the respondents had low service length score while the 18.6 % of them have medium service length. Only 8.5 % of the respondents had high service length score.

According to Table 4.1 only 31.4 % of the respondents have received training on different agricultural topic. The maximum portion of the respondents, about 68.6 % do not have any training experience.

The observed personal extension contact scores of the respondents ranged from 0 to 8 along with the mean and standard deviation of 1.82 and 2.73 respectively. According to this score, the respondents were classified into three categories: "low personal contact" (up to 3), "medium personal contact" (4-6) and "high personal contact" (above 6). The distribution of the respondents according to their personal contact score is shown in Table 4.1.

A proportion of 68.6 % of the respondents had low personal extension contact compared to 24.3 percent of them having medium personal extension contact. About 7.1 % of the respondents only had high personal contact. Thus, overwhelming majority (92.9 %) of the respondents had low to medium personal extension contact.

The group contact score of the respondents ranged from 0 to 9 along with the mean and standard deviation of 2.57 and 3.72 respectively. According to this score, the respondents were classified into three categories: "low group contact" (up to 3), "medium group contact" (4-6) and "high group contact" (above 6). The distribution of the respondents according to their group contact score is shown in Table 4.1.

According to Table 4.1, a proportion of 68.6 % of the respondents had low group contact score compared to 5.7 % of them having medium group contact. About 25.7 % of the respondents had high group contact. Thus, majority (94.4 %) of the respondents had low to high group extension contact.

Table 4.1 shows that the mean and standard deviation of respondent's mass media contact scores were 10.54 and 4.49. Based on their educational scores, the respondents were classified into three categories namely low mass media contact, medium mass media contact and high mass media contact.

According to Table 4.1, the mass media contact score of the respondents ranged from 5 to 20. A proportion of 47.2 % of the respondents had medium mass media contact followed by 31.4 % of them having low mass media contact. Only 21.4 % of the respondents had high mass media contact. Thus, majority (78.6 %) of the respondents had medium to low mass extension contact.

Table 4.1 represents that the knowledge score of the respondents on 4AR have been ranged from 1 to 10 with a mean and standard deviation of 4.37 and 2.16 respectively. Considering the recorded value, respondents are classified into three categories namely "low knowledge", "moderate knowledge" and "high knowledge".

The findings in the Table 4.1 indicates that the highest proportion (72.9 %) of the respondents have low knowledge compared to 27.1 % of them having moderate knowledge. Data also indicates that the low and medium knowledge category constitute overall 100 % of total respondents and 0 percent of respondents have high knowledge on 4AR.

Table 4.1 shows that the mean and standard deviation of respondent's attitude scores were 35.78 and 2.79. The attitude score of the respondents towards 4AR ranged from 29 to 41. Based on their attitude scores, the respondent's attitude was classified into five categories namely highly unfavorable, unfavorable, neutral, favorable and highly favorable.

A proportion of 95.7 % of the respondents had favorable attitude towards 4AR whereas only 2.9 % respondents had neutral attitude followed by 1.4 % of them having highly favorable attitude. Thus, majority (95.7 %) of the respondents had favorable attitude towards 4AR.

Floridi et al., (2018) and Jobin et al., (2019) also reported that attitudes towards 4IR technologies are multifaceted, reflecting a range of perspectives and concerns.

4.2 Focus Issues of the Study

4.2.1 Extent of Familiarity of Respondents with 4AR Technologies

The familiarity score of the respondents ranged from 6 to 36 with a mean of 14.34 and standard deviation of 5.49. Based on the observed range of scores, the respondents were categorized into three categories namely less familiar, moderate familiar and highly familiar. The distribution of the respondents according their familiarity score is presented in Table 4.2.

Data presented in Table 4.2 indicates that, majority of the respondents (about 90%) have less familiarity with 4AR technologies. Only 10% respondents have moderate familiarity. None of the respondents have high familiarity with the 4AR technologies.

Table 4.2: Distribution of the respondents according to familiarity score

Characteristics	Categories	Score	N = 70		(Mean ± SD)	Range	
			Frequency	%		Min.	Max.
Familiarity with 4AR Technologies	Less	≤ 20	63	90	14.34 ± 5.49	6	36
	Moderate	21 – 40	7	10			
	High	> 41	0	0			

4.2.2 Comparative Familiarity of the Respondents Based on Familiarity Index

The purpose of this section was to have an understanding on comparative familiarity with the 4AR technologies assumed by the respondents. To compare among the technologies, a rank order was made based on Familiarity Index (FI). Familiarity index score ranged from 0 to 91.90 that was represented in Table 4.3.

On the basis of Familiarity Index, it was observed that "Using automated machines for seedling transplantation" ranked first followed by "Using agricultural drones in applying fertilizers and pesticides in crop field", "Using mobile apps to capture plant photos for disease diagnosis", "Using AI powered technology in monitoring and forecasting weather condition", "Using AI technology for providing fertilizer recommendation", "Using sensor in soil to measure different nutrient levels in soil for fertilizer management", "Using AI powered technology to automatically control temperature and light intensity in Greenhouse", "Using automated machine for collecting milk in dairy farm", "Using agricultural robots in different intercultural operations", "Using AI powered machine in determining soil and crop health", "Using AI for water management in hydroponics", "Using big data to get better insight into yield predication and minimize cost", "Using automated machine to determine seed rate for specific crop for a particular area.", "Using IoT for tracking, tracing and monitoring farms remotely", "Using IoT for smart aquaculture", "Using wireless sensor network module for real time data collection and farm monitoring", "Placement of chips and body sensors in cattle", "Using IoT and smart sensor technology in predictive analysis for smart farming", "Using big data analytics for supply chain management" and "Using robots for collecting eggs and waste management in poultry industry".

Table 4.3: Rank order of the 4AR technologies according to familiarity index

SL No.	4AR technologies	Familiarity score of 4AR technologies				Familiarity score	Familiarity index (%)	Rank
		Highly familiar (3)	Moderately familiar (2)	Slightly familiar (1)	Not familiar (0)			
1.	Using AI powered machine in determining soil and crop health	0	3	24	43	30	14.28	10th
2.	Using AI technology for providing fertilizer recommendation	1	19	33	17	74	35.23	5th
3.	Using AI powered technology in monitoring and forecasting weather condition	0	21	46	3	88	41.90	4th
4.	Using mobile apps to capture plant photos for disease diagnosis	25	17	15	13	124	59.04	3rd
5.	Using machines to determine seed rate for specific crop for a particular area.	1	1	5	63	10	4.76	13th
6.	Using machines for seedling transplantation	56	12	1	1	193	91.90	1st
7.	Using AI powered technology to automatically control temperature and light intensity in Greenhouse	1	5	50	14	63	30	7th
8.	Using AI for water management in hydroponics.	0	1	19	50	21	10	11th
9.	Using agricultural robots in different intercultural operations such as weeding, picking, harvesting etc.	0	2	30	38	34	16.19	9th
10.	Using agricultural drones in applying fertilizers and pesticides in crop field	23	32	14	1	147	70	2nd

SL No.	4AR technologies	Familiarity score of 4AR technologies				Familiarity score	Familiarity index (%)	Rank
		Highly familiar (3)	Moderately familiar (2)	Slightly familiar (1)	Not familiar (0)			
11.	Placement of chips and body sensors in cattle to get update about their physical condition through mobile apps	0	1	1	68	3	1.42	15th
12.	Using robots for collecting eggs and waste management in poultry industry	0	0	0	70	0	0	17th
13.	Using automated machine for collecting milk in dairy farm	1	6	33	30	48	22.85	8th
14.	Using big data to get better insight into yield predication and minimize cost	0	1	9	60	11	5.23	12th
15.	Using IoT for tracking, tracing and monitoring farms remotely	0	1	5	64	7	3.33	14th
16.	Using big data analytics for supply chain management	0	1	0	69	2	0.95	16th
17.	Using IoT and smart sensor technology in predictive analysis for smart farming	0	1	1	68	3	1.42	15th
18.	Using sensor in soil to measure different nutrient levels in soil for fertilizer management	0	12	44	14	68	32.38	6th
19.	Using IoT for smart aquaculture	1	0	4	65	7	3.33	14th
20.	Using wireless sensor network module for real time data collection and farm monitoring	1	1	2	66	7	3.33	14th

4.2.3 Extent of Severity of Problems as Perceived by the Respondents

The severity score of the problems as perceived by the respondents ranged from 40 to 59 with a mean of 47.64 and standard deviation of 3.87. Based on the observed range of scores, the severity of problems were categorized into three categories as presented in Table 4.4.

Data presented in Table 4.4 indicates that, majority of the respondents (about 77.1%) have regarded the problems as moderately severe. Only 22.9% respondents regarded the problems as highly severe. None of the respondents thought that the problems have less severity.

Table 4.4: Distribution of the respondents according to problem score

Characteristics	Categories	Score	N = 70		(Mean ± SD)	Range	
			Frequency	%		Min.	Max.
Extent of Problems	Less	≤ 25	0	0	47.64 ± 3.87	40	59
	Moderate	26-50	54	77.1			
	High	> 50	16	22.9			

4.2.4 Comparative Severity of the Problems Based on Problem Index

The purpose of this section was to have an understanding on comparative problems on implementing 4AR innovations assumed by the respondents. To compare among the problems, a rank order was made based on Problem Index (PI). Problem index (PI) of the respondents of the 15 problem items in 4AR technology implementation ranged from 69.64 to 95.35 as presented in Table 4.5.

On the basis of PI, it was observed that high initial investment to purchase 4AR technologies ranked first followed by "high maintenance and operating cost" (2^{nd}), lack of knowledge about 4AR technologies to operate and maintain (3^{rd}), lack of training programs and skilled manpower (4^{th}) etc. Preference of farmers in practicing traditional farming system (15^{th}) ranked as less severe problem followed by unwillingness of rural farmers to adopt new technologies in farming practices (14^{th}), small and fragmented land size (13^{th}), experienced farmers do not transfer their knowledge to any person except their family member (12^{th}) etc.

Bhowmik and Hossain (2020) and Ahmed et al., (2020) also found that limited access to technology and digital infrastructure, financial constraints, lack of awareness and technical skills, a fragmented agriculture sector are major problems in the implementation of 4AR technologies in Bangladesh. Miah (2021); Rahman (2021) and Mahmud (2020) also found similar results.

Table 4.5: Rank order of problems based on problem index

SL No.	Problems of 4AR implementation	Score of problems					Problem Score	Problem index (%)	Rank
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe(1)	Not at all (0)			
1.	Poverty of rural farmers	18	49	3	0	0	225	80.35	6th
2.	Unwillingness of rural farmers to adopt new technologies in farming practices	5	55	9	1	0	204	72.85	14th
3.	Preference of farmers in practicing traditional farming system	4	48	17	1	0	195	69.64	15th
4.	Lack of knowledge about 4AR technologies to operate and maintain	46	24	0	0	0	256	91.42	3rd
5.	High initial investment to purchase 4AR technologies	59	9	2	0	0	267	95.35	1st
6.	High maintenance and operating cost	52	16	2	0	0	260	92.85	2nd
7.	Lack of training programs and skilled manpower	43	26	1	0	0	252	90	4th
8.	Lack of incentives and support from Government Organizations and NGO's	29	28	13	0	0	226	80.71	5th
9.	Lack of expert guidance/ motivation/ extension support for implementation of 4AR technologies	24	31	15	0	0	219	78.21	9th

SL No.	Problems of 4AR implementation	Score of problems					Problem Score	Problem index (%)	Rank
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe(1)	Not at all (0)			
10.	Weak coordination between Research and Development Organizations	13	41	16	0	0	207	73.92	11th
11.	Small and fragmented land size	7	51	12	0	0	205	73.21	13th
12.	Insufficient network connectivity in rural areas along with a lack of basic computer knowledge and literacy	21	41	8	0	0	223	79.64	7th
13.	Unwillingness of farmers to become increasingly reliant on machines instead of their own knowledge	18	38	14	0	0	214	76.42	10th
14.	Migration of rural people to urban areas and shortage of young labor force in rural area	18	44	8	0	0	220	78.57	8th
15.	Experienced farmers do not transfer their knowledge to any person except their family member	10	46	14	0	0	206	73.57	12th

4.2.5 Extent of Suitability of the Solutions as Perceived by the Respondents

The suitability score of the solutions as perceived by the respondents ranged from 47 to 75 with a mean of 62.30 and standard deviation of 4.42. Based on the observed range of scores, the suitability of solutions were categorized into three categories as presented in Table 4.6.

Data presented in Table 4.6 indicate that, majority of the respondents (about 77.1%) have regarded the solutions as highly suitable. About 22.9% respondents regarded the solutions as moderately suitable. None of the respondents thought that the solutions were less suitable.

Table 4.6: Distribution of the respondents according to suitability of solutions score

Characteristics	Categories	Score	N = 70		(Mean ± SD)	Range	
			Frequency	%		Min.	Max.
Suitability of probable solutions	Less	≤ 30	0	0	62.30 ± 4.42	47	75
	Moderate	31-60	16	22.9			
	High	> 60	54	77.1			

4.2.6 Comparative Suitability of the Solutions Based on Solution Index

To measure the suitability of the solutions, the solution index (SI) were calculated. 15 probable solutions were ranked on the basis of Solution Index that was represented in Table 4.7.

On the basis of SI, it was observed that "making the 4AR technologies available in low prices in the local market" ranked as first according to suitability followed by financial support from Government and other agencies (2^{nd}), providing short term loan facilities or incentives to the small farmers (3^{rd}), organizing training programs for rural farmers on a regular interval (4^{th}), focus on future research on the adoption of 4AR technologies in every aspects of farming (5^{th}), experts should provide solutions to new problems regarding the use of 4AR technologies (6^{th}), proper identification and documentation of 4AR technologies (7^{th}), govt. officials and educated people should give more importance to 4AR technology using (8^{th}), building upon local people's knowledge and awareness on 4AR (9^{th}), using 4AR technologies in proper scientific way to get desired results within a short time (10^{th}), using 4AR technologies in proper scientific way to get desired results within a short time (11^{th}), ensuring Proper coordination between Research and Extension Organizations (12^{th}), discovering the ways to increase the use of 4AR technologies by

Table 4.7: Rank order of probable solutions according to solution index

SL. No.	Probable solutions	Suitability score of the solution					Solution Score	Solution index (%)	Rank
		Highly suitable (5)	Suitable (4)	Moderately suitable (3)	Less suitable (2)	Not at all (1)			
1.	Proper identification and documentation of 4AR technologies	16	54	0	0	0	295	84.57	7th
2.	Building upon local people's knowledge and awareness on 4AR through different extension teaching methods	12	55	3	0	0	289	82.57	9th
3.	Using 4AR technologies in proper scientific way to get desired results within a short time	18	35	17	0	0	281	80.28	10th
4.	Making the 4AR technologies available in low prices in the local market	43	27	0	0	0	323	92.28	1st
5.	Discovering the ways to increase the use of 4AR technologies by the researchers	18	31	20	1	0	276	78.85	13th
6.	Focus on future research on the adoption of 4AR technologies in every aspects of farming	28	38	4	0	0	304	86.85	5th
7.	Financial support from Government and other agencies to adopt 4AR technologies	44	23	3	0	0	321	91.71	2nd
8.	Experts should provide solutions to new problems regarding the use of 4AR technologies	19	48	3	0	0	296	84.57	6th

SL. No.	Probable solutions	Suitability score of the solution					Solution Score	Solution index (%)	Rank
		Highly suitable (5)	Suitable (4)	Moderately suitable (3)	Less suitable (2)	Not at all (1)			
9.	Govt. officials and educated people should give more importance to 4AR technology using	17	49	4	0	0	293	83.71	8th
10.	Experienced farmers should transfer their knowledge to others during different social gatherings	10	42	15	3	0	269	76.85	14th
11.	Ensuring Proper coordination between Research and Extension Organizations	7	53	10	0	0	277	79.14	12th
12.	Providing short term loan facilities or incentives to the small farmers	36	31	3	0	0	313	89.42	3rd
13.	Organizing training programs for rural farmers on a regular interval	30	38	2	0	0	308	88	4th
14.	Ensuring Sufficient network connectivity and computer learning facilities in rural area.	5	58	7	0	0	278	79.42	11th
15.	Building awareness among the rural people through different extension programs.	4	58	8	0	0	276	78.85	13th

4.3 Relationship between Each of the Selected Characteristics of the Respondents with Focus Issues

Table 4.8 showed that knowledge and attitude towards 4AR technologies had significant positive relationship with the familiarity of 4AR technologies. Knowledge on 4AR had highly significant relationship with the familiarity . That means with the increase of knowledge and favorable attitude the familiarity with 4AR technologies also become increased. Other socioeconomic characteristics like age, educational qualifications, service length, personal contact, group contact and mass media contact do not have any significant relationship with the familiarity of 4AR technologies.

According to Table 4.8, it was also observed that age, service length, personal contact and group contact had highly significant negative relationship with the problem associated in 4AR technology implementation. That means people with higher age, high service length, high personal and group contact assumes fewer problem in 4AR implementation. Training experience had highly significant relationship with associated problems in 4AR implementation. That means people having more training experience can easily analyze and find out the problems associated with 4AR implementation.

Table 4.8 also indicates that knowledge on 4AR and training experience had highly significant positive relationship with solution. That means those who have high knowledge and more training experience can easily find out the solution for solving the problems. On the other hand Age, Service length etc. had negative correlation with solutions. That may indicate that the people of higher age had high service length but their problem solving capacity is lower than younger people.

Table 4.8: Co-efficient of correlation showing relationship between each of the selected characteristics of the respondents with focus issues (N=70)

Socioeconomic Characteristics	Familiarity with 4AR Technologies	Associated problems in 4AR implementation	Probable Solutions
1. Age	0.023	-.260*	-.149
2. Educational Qualifications	0.110	-.086	.164
3. Service Length	0.035	-.343**	-.319**
4. Training Experience	-0.078	.377**	.311**
5. Personal Contact	0.131	-.385**	-.272*
6. Group Contact	0.125	-.345**	-.231
7. Mass Media Contact	0.194	-.179	-.182
8. Knowledge on 4AR	0.728**	.084	.356**
9. Attitude towards 4AR	0.235*	.038	.042

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

* Correlation is significant at the 0.05 level (2-tailed)

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Findings

5.1.1 Selected Characteristics of the Respondents

Age

The highest proportion (75.7 %) of the respondents were young compared to 24.3 % of them being middle aged.

Educational Qualifications

The educational qualification scores varies from 16 to17. Respondents in the post graduate category have the highest proportion (71.4 %) followed by undergraduate category (28.6 %).

Service Length

About 72.9 % of the respondents had low service length score while the 18.6 % of them have medium service length. Only 8.5 % of the respondents had high service length score.

Training Experience

Only 31.4 % of the respondents have received training on different agricultural topic. The maximum portion of the respondents, about 68.6 % do not have any training experience.

Personal Extension Contact

A proportion of 68.6 % of the respondents had low personal contact compared to 24.3 % of them having medium personal contact. About 7.1 % of the respondents only had high personal contact.

Group Extension Contact

A proportion of 68.6 % of the respondents had low group contact score compared to 5.7 % of them having medium group contact. About 25.7 % of the respondents had high group contact.

Mass Media Contact

A proportion of 47.2 % of the respondents had medium mass media contact followed by 31.4 % of them having low mass media contact. Only 21.4 % of the respondents had high mass media contact.

Knowledge on 4AR Technology

The highest proportion (72.9 %) of the respondents have low knowledge compared to 27.1 % of them having moderate knowledge. And no respondent have high knowledge on 4AR.

Attitude towards 4AR Technology

A proportion of 95.7 % of the respondents had favorable attitude towards 4AR whereas only 2.9 % respondents had neutral attitude followed by 1.4 % of them having highly favorable attitude.

5.1.2 Focus Issues

Extent of Familiarity of Respondents with 4AR Technologies

On the basis of Familiarity Index, it was observed that maximum respondents have high familiarity with "Using machines for seedling transplantation" followed by "Using agricultural drones in applying fertilizers and pesticides in crop field", "Using mobile apps to capture plant photos for disease diagnosis" etc.

Comparative Severity of the Problems According to the Respondents

On the basis of PI, High initial investment to purchase 4AR technologies ranked as most severe problems followed by "High maintenance and operating cost" (2nd), Lack of knowledge about 4AR technologies to operate and maintain (3rd), Lack of training programs and skilled manpower (4th).

Comparative Suitability of the Solution According to the Respondents

On the basis of SI, it was observed that "Making the 4AR technologies available in low prices in the local market" ranked as first according to suitability followed by Financial support from Government and other agencies (2nd), Providing short term loan facilities or incentives to the small farmers (3rd), Organizing training programs for rural farmers on a regular interval (4th) and others.

Relationship between Each of the Selected Characteristics of the Respondents with Focus Issues

Knowledge and attitude towards 4AR technologies had significant positive relationship with the familiarity of 4AR technologies. Other socioeconomic characteristics like Age, Educational Qualifications, Service length, Personal Contact, Group Contact and Mass media contact do not have any significant relationship with the familiarity of 4AR technologies.

Age, service length, personal contact and group contact had highly significant negative relationship with the problem associated in 4AR technology implementation. Training experience had highly significant relationship with associated problems in 4AR implementation.

Knowledge on 4AR and training experience had highly significant positive relationship with solutions. On the other hand Age, Service length etc. had negative correlation with solutions.

5.2 Conclusions

Based on the findings and their interpretations in the light of relevant facts the researcher had drawn the following conclusions:

i. Almost 72.9 % of the respondents had low knowledge on 4AR technologies and a proportion of 95.7 % of the respondents had favorable attitude towards 4AR. As most of the respondents have favorable attitudes, so it will be more easier to motivate them for adopting 4AR technologies.
ii. Maximum respondents are highly familiar with the technology of "Using automated machine for seedling transplantation"; "Using agricultural drones in applying fertilizers and pesticides in crop field", "Using mobile apps to capture plant photos for disease diagnosis" etc. Through this output, it can be possible to utilize the familiarity of these technologies fully on different farming practices
iii. The main problems according to the extent of severity was "High initial investment to purchase 4AR technologies". The best solutions according to the extent of suitability were making the 4AR technologies available in low prices in the local market" followed by financial support from Government and other agencies and Providing short term loan facilities or incentives to the small farmers. The severe problems should be solved immediately by the GOs and NGOs by taking proper steps.

iv. The findings revealed that Knowledge and attitude towards 4AR technologies had significant positive relationship with the familiarity of 4AR technologies. Age, service length, personal contact and group contact had highly significant negative relationship with the problem associated in 4AR technology implementation. Training experience had highly significant relationship with associated problems in 4AR implementation at 1% level of significance. Knowledge on 4AR and training experience had highly significant positive relationship with the suitability of probable solutions at 1% level of significance. That means the respondents who have high knowledge and training experience can easily find out the best possible solutions for solving the problems.

5.3 Recommendations

i. Similar research should be conducted by the researchers in the other parts of Bangladesh
ii. GOs and NGOs should take necessary steps to make 4AR technologies available in market at low price and motivate the farmers in implementing 4AR innovations.
iii. DAE and other agriculture related organizations should organize necessary training and skill development programs to increase the knowledge and familiarity about 4AR technologies
iv. This study investigated a few selected characteristics of the respondents. It is therefore recommended that further study should be conducted involving the other related characteristics.

CHAPTER VI

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APPENDIX A

An English version of interview schedule

Agrotechnology Discipline

Life Science School

Khulna University, Khulna-9208

Interview schedule for a research study on

PROSPECTS AND PROBLEMS IN IMPLEMENTING 4AR INNOVATIONS IN RELATION TO 4IR PERSPECTIVES

(Confidentiality will be maintained and all information will be used only for study purposes)

Respondent No.:

Date:

Personal information of the respondent:

Name:
Working Address:
Contract No:

1. Age (years):

2. Educational Qualifications:

3. Service Length (years):

4. Training Experience: Have you received any agricultural training? ☐ Yes ☐ No

If yes, Please mention the name of the training with the duration you have received from different organization

SL.	Name of the training	Duration (Days)	Organized by
1.			
2.			
3.			
4.			

5. Extension Media Exposure

5 (a). Personal Extension Contact

Please indicate the extent of your contact by putting tick (√) in any one of the four responses:

SL. No.	Medium	Extent of contact			
		Frequently (3)	Occasionally (2)	Rarely (l)	Not at all (0)
1.	Department of Agricultural Extension (DAE)	5 or more times/month	3-4 times/month	1-2 times/month	0 time/year
2.	Other Extension Sources (Livestock, Fisheries etc.)	3-4 times/month	1-2 times/month	1 time/year	0 time/year
3.	NGO's	4-5 times/month	3-4 times/year	1-2 time/year	0 time/year

5 (b). Group Extension Contact

Please indicate the extent of your contact by putting tick (√) in any one of the four responses:

SL. No.	Medium	Extent of contact			
		Frequently (3)	Occasionally (2)	Rarely (l)	Not at all (0)
1.	Group Discussion	4 or more times/month	2-3 times/month	1-2 times/year	0 time/year
2.	Demonstration	4 or more times/month	2-3 times/month	1-2 times/year	0 time/year
3.	Field Trip/ Farm Visit	3 or more times/month	2 or more times/month	1 or more times/year	0 time/year

5 (c). Mass Media Contact

Please indicate the extent of your communication by putting tick (√) in any one of the four responses:

SL. No.	Place of visit	Extent of contact			
		Frequently (3)	Occasionally (2)	Rarely (I)	Not at all (0)
1.	Radio	3 or more times/week	1-2 times/month	1-2 times/year	0 time/year
2.	Television	4 or more times/week	2 or more times/month	1 or more times/month	0 time/year
3.	Newspaper	4 or more times/week	2 or more times/month	1 or more times/month	0 time/year
4.	Agriculture fair	3 or more times/month	1-2 times/month	1-2 times/year	0 time/year
5.	Exhibition	3 or more times/month	1-2 times/month	1-2 times/year	0 time/year
6.	Seminar/ Symposium	3 or more times/month	1-2 times/month	1-2 times/year	0 time/year
7.	Conferences	3 or more times/month	1-2 times/month	1-2 times/year	0 time/year

6. Knowledge on 4AR technologies:

SL No.	Question	Correct (2)	Partially Correct (1)	Wrong (0)
1.	What is your concept about Artificial Inteligence?			
2.	Mention two application of AI in farming practices			
3.	What dose IoT mean?			
4.	Mention two uses of IoT in agriculture			
5.	What is blockchain technology?			
6.	How can you use robotics in agriculture?			
7.	Tell something about big data			
8.	Mention two benefits of using drones in agriculture			
9.	Name two types of agricultural drones			
10	Name two types of Robots in farming operations			

7. Attitude of Agriculturists towards 4AR:

Please share your opinion by putting tick (√) in any one of the five responses:

Serial	Attitude parameters	Attitude about the statement				
		Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1.	4AR technologies are widely used in farming practices.					
2.	The use of 4AR technologies requires more time to get desired results					
3.	4AR technologies are largely available in market and easy to operate					
4.	4AR technologies require high initial investment for installment.					
5.	4AR technologies do not have any adverse effect on environment					
6.	4AR technologies require skilled manpower for operation and maintenance.					
7.	4AR technologies can ensure high productivity and sustainability					
8.	The risk of adopting 4AR technologies is large.					
9.	4AR technologies ensures food safety and food security.					
10.	4AR technologies are only profitable in large scale farming.					

8. Do you have any familiarity with the following 4AR technologies?

Please indicate the extent of your familiarity with the following 4AR technologies by putting tick (√) in any one of the responses:

SL No.	Items	Do you familiar with this technology?		Extent of familiarity			
		Yes	No	Highly familiar (3)	Moderately familiar (2)	Slightly familiar (1)	Not familiar (0)
1	Using AI powered machine in determining soil and crop health						
2	Using AI technology for providing fertilizer recommendation						
3	Using AI powered technology in monitoring and forecasting weather condition						
4	Using mobile apps to capture plant photos for disease diagnosis						
5	Using automated machine to determine seed rate for specific crop for a particular area.						
6	Using automated machine for seedling transplantation						
7	Using AI powered technology to automatically control temperature and light intensity in Greenhouse						

SL No.	Items	Do you familiar with this technology?		Extent of familiarity			
		Yes	No	Highly familiar (3)	Moderately familiar (2)	Slightly familiar (1)	Not familiar (0)
8	Using AI for water management in hydroponics						
9	Using agricultural robots in different intercultural operations such as weeding, picking, harvesting etc.						
10	Using agricultural drones in applying fertilizers and pesticides in crop field						
11	Placement of chips and body sensors in cattle to get update about their physical condition through mobile apps						
12	Using robots for collecting eggs and waste management in poultry industry						
13	Using automated machine for collecting milk in dairy farm						
14	Using big data to get better insight into yield predication and minimize cost						
15	Using IoT for tracking, tracing and						

SL No.	Items	Do you familiar with this technology?		Extent of familiarity			
		Yes	**No**	**Highly familiar (3)**	**Moderately familiar (2)**	**Slightly familiar (1)**	**Not familiar (0)**
	monitoring farms remotely						
16	Using big data analytics for supply chain management						
17	Using IoT and smart sensor technology in predictive analysis for smart farming						
18	Using sensor in soil to measure different nutrient levels in soil for fertilizer management						
19	Using IoT for smart aquaculture						
20	Using wireless sensor network module for real time data collection and farm monitoring						

9. Problems associated with the implementation of 4AR technologies:

Please share your opinion by putting tick (√) in any one of the five responses:

SL. No.	Problems of 4AR implementation	Extent of problems				
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe (1)	Not at all (0)
1.	Poverty of rural farmers					
2.	Unwillingness of rural farmers to adopt new technologies in farming practices					
3.	Preference of farmers in practicing traditional farming system					
4.	Lack of knowledge about 4AR technologies to operate and maintain					
5.	High initial investment to purchase 4AR technologies					
6.	High maintenance and operating cost					
7.	Lack of training programs and skilled manpower					
8.	Lack of incentives and support from Government Organizations and NGO's					
9.	Lack of expert guidance/ motivation/ extension support for implementation of 4AR technologies					

SL. No.	Problems of 4AR implementation	Extent of problems				
		Highly severe (4)	**Severe (3)**	**Moderately severe (2)**	**Less severe (1)**	**Not at all (0)**
10.	Weak coordination between Research and Development Organizations					
11.	Small and fragmented land size					
12.	Insufficient network connectivity in rural areas along with a lack of basic computer knowledge and literacy					
13.	Unwillingness of farmers to become increasingly reliant on machines instead of their own knowledge					
14.	Migration of rural people to urban areas and shortage of young labor force in rural area					
15.	Experienced farmers do not transfer their knowledge to any person except their family member					

10. Solutions for the adoption of 4AR technologies:

Please share your opinion by putting tick (√) in any one of the five responses:

SL. No.	Probable solutions	Suitability of the solution				
		Highly suitable (5)	Suitable (4)	Moderately suitable (3)	Less suitable (2)	Not at all (1)
1.	Proper identification and documentation of 4AR technologies					
2.	Building upon local people's knowledge and awareness on 4AR through different extension teaching methods					
3.	Using 4AR technologies in proper scientific way to get desired results within a short time					
4.	Making the 4AR technologies available in low prices in the local market					
5.	Discovering the ways to increase the use of 4AR technologies by the researchers					
6.	Focus on future research on the adoption of 4AR technologies in every aspects of farming					

SL. No.	Probable solutions	Suitability of the solution				
		Highly suitable (5)	**Suitable (4)**	**Moderately suitable (3)**	**Less suitable (2)**	**Not at all (1)**
7.	Financial support from Government and other agencies to adopt 4AR technologies					
8.	Experts should provide solutions to new problems regarding the use of 4AR technologies					
9.	Govt. officials and educated people should give more importance to 4AR technology using					
10.	Experienced farmers should transfer their knowledge to others during different social gatherings					
11.	Ensuring Proper coordination between Research and Extension Organizations					
12.	Providing short term loan facilities or incentives to the small farmers					
13.	Organizing training programs for rural farmers on a regular interval					

SL. No.	Probable solutions	Suitability of the solution				
		Highly suitable (5)	Suitable (4)	Moderately suitable (3)	Less suitable (2)	Not at all (1)
14.	Ensuring Sufficient network connectivity and computer learning facilities in rural area.					
15.	Building awareness among the rural people through different extension programs.					

Thank you for your kind co-operation in data collection.

Signature of Interviewer

Date: