



**STATUS OF APPLICATION OF INFORMATION
COMMUNICATION TECHNOLOGIES IN AGRICULTURE IN
NAGALAND**

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY

By

SENTINUNGSHI

Admn. No. Ph – 349/22 Regn. No. Ph.D/RDP/00715

Department of Rural Development and Planning
School of Agricultural Sciences,
Nagaland University, Medziphema campus – 797 106
Nagaland
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**STATUS OF APPLICATION OF INFORMATION
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NAGALAND**

BY

Name of Candidate – SENTINUNGSHI

Name of Supervisor - Dr. MARY N ODYUO

Submitted

In partial fulfillment of the requirements for the Degree of Doctor of
Philosophy in

Rural Development and Planning of Nagaland University

Dedicated
To
Our Almighty God,
My loving Mother & Sister
and
My Respected Supervisor

Nagaland University
November, 2025

I, Sentinungshi, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form the basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis had not been submitted by me for any research degree in any other university/institute.

This is being submitted to Nagaland University for the degree of Doctor of Philosophy in Rural Development and Planning.

(SENTINUNGSHI)

(Head)

.....
Dr. Mary N Odyuo
Supervisor

NAGALAND UNIVERSITY
Medziphema Campus
School of Agricultural Sciences
Medziphema – 797 106, Nagaland

Dr. Mary N. Odyuo
Associate Professor
Department of Agricultural Extension Education

CERTIFICATE – I

This is to certify that the thesis entitled “**Status of Application of Information Communication Technologies in Agriculture in Nagaland**” submitted to Nagaland University in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy (Agriculture) in Rural Development and Planning is the record of research work carried out by SENTINUNGSHI Registration No. Ph.D/RDP/00715 under my personal supervision and guidance.

The results of the investigation reported in the thesis have not been submitted for any other degree or diploma. The assistance of all kinds received by the student has been duly acknowledged.

Date :
Place :

.....
Dr. MARY N. ODYUO
Supervisor

NAGALAND UNIVERSITY
Medziphema Campus
School of Agricultural Sciences
Medziphema – 797 106, Nagaland

CERTIFICATE – II

**VIVA VOCE ON THESIS OF DOCTOR OF PHILOSOPHY IN RURAL
DEVELOPMENT AND PLANNING**

This is to certify that the thesis entitled “Status of Application of Information Communication Technologies in Agriculture in Nagaland” submitted by SENTINUNGSHI, Admission No. Ph-349/22 Registration No. Ph.D/RDP/00715 to the NAGALAND UNIVERSITY in partial fulfilment of the requirements for the award of degree of Doctor of Philosophy in Rural Development and Planning has been examined by the Advisory Board and External examiner on

The performance of the student has been found **Satisfactory/Unsatisfactory**.

Member	Signature
1. Dr. Mary N. Odyuo (Supervisor)
2. Dr. Utpal Barman (External examiner)
3. Pro –Vice Chancellor’s nominee (Dean, SAS: NU)
4. Dr. Deepa Thangjam
5. Dr. N.K. Patra
6. Prof. T. Longkumer

Head
Department of
Rural Development and Planning

Dean
School of Agricultural
Sciences

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Date :

Place: Medziphema

(Sentinungshi)

CONTENTS

CHAPTE R	TITLE	PAGE NO.
1.	INTRODUCTION	1 – 10
2.	REVIEW OF LITERATURE	11 – 33
	2.1 To study the socio-economic status of the respondents.	
	2.2 To assess the Knowledge Level and extent of use ICT by the respondents.	
	2.3 To examine the Attitude of farmers on application of ICT in agriculture.	
	2.4 To study the factors influencing adoption of ICT tools.	
	2.5 To identify the constraints faced by the farmers in using ICT and to suggest measures for improvement.	
3.	RESEARCH METHODOLOGY	34-55
	3.1 Area of investigation and sampling design	
	3.1.1 Selection of the district	
	3.1.2 Selection of agricultural blocks	
	3.1.3 Selection of villages	
	3.2 Selection of the respondents	
	3.3 Selection of variables	
	3.4 Relevant variables and their empirical measurements	
	3.5 Methods of data collection	
	3.6 Statistical tools used for data analysis	
4.	RESULTS AND DISCUSSION	56-109
	4.1 Socio-economic status of the respondents	
	4.1.1 Age	
	4.1.2 Sex	
	4.1.3 Family Type	
	4.1.4 Family size	
	4.1.5 Annual Income	
	4.1.6 Educational Qualification	
	4.1.7 Primary Occupation	
	4.1.8 Secondary Occupation	
	4.1.9 Farming experience	
	4.1.10 Social Participation	
	4.1.11 Total Landholding	

4.1.12	Source of Information	
4.2	Knowledge Level and extent of use ICT by the respondents	
4.2.1	Knowledge Level of the respondents towards the use of ICT tools.	
4.2.2	Extent of use ICT by the respondents	
4.3	Attitude of farmers on application of ICT in agriculture	
4.3.1	Overall distribution of respondents based on their attitude towards ICT tools.	
4.4	Factors influencing adoption of ICT tools	
4.4.1	Adoption of ICT tools by the respondents	
4.4.2	Extend of adoption of ICT tools by the respondents.	
4.5	Constraints faced by the farmers in using ICT tools	
5.	CONCLUSION AND RECOMMENDATIONS	110-114
	REFERENCES	i-ix

LIST OF TABLES

TABLE NO.	TITLE	PAGES
4.1.1	Distribution of respondents based on age	57
4.1.2	Distribution of respondents based on sex	58
4.1.3	Distribution of respondents based on family type	59
4.1.4	Distribution of respondents based on family size	60
4.1.5	Distribution of respondents based on annual income	61
4.1.6	Distribution of respondents based on educational Qualification	62
4.1.7	Distribution of respondents based on Primary Occupation	64
4.1.8	Distribution of respondents based on Secondary Occupation	65
4.1.9	Distribution of respondents based on Farming experience	66
4.1.10	Distribution of respondents based on Social Participation	67
4.1.11	Distribution of respondents based on total landholding	69
4.1.12(a)	Distribution of respondents based on source of information	70
4.1.12(b)	Distribution of respondents based on extension contact	71
4.1.12(c)	Distribution of respondents based on mass media	72
4.1.12(d)	Distribution of respondents based on personal localite	73
4.2.1 (a)	Overall knowledge level of the respondents towards the use tools.	74
4.2.1 (b)	Distribution based on knowledge level of the respondents towards the use of ICT tools.	74-75
4.2.2(a)	Distribution of respondents based their accessibility of ICT tools	78-79
4.2.2(b)	Distribution of respondents based the availability of ICT tools	81-82
4.2.2(c)	Distribution of respondents based their extend of usage of ICT tools	84-85

4.2.2(d)	Structural Equation Modeling Results for Accessibility, Availability, and Usage	88
4.2.2(e)	Pearson Correlation Matrix for Accessibility, Availability, and Usage of ICT Tools	90
4.2.2(f)(i)	ANOVA Results for Multiple Regression of Accessibility and Availability on ICT Usage	91
4.2.2(f)(ii)	Regression Coefficients for Accessibility and Availability Predicting ICT Usage	92
4.3.1	Overall distribution of respondents based on their attitude towards ICT tools.	93
4.3.2	Distribution of respondents based on their specific attitude towards ICT tools.	93-94
4.4.1	Distribution of adoption of ICT tools by the respondents.	100
4.4.2(b)	Logistic Regression Results for Factors Influencing Adoption	101
4.4.2(e)	Area Under the Curve.	103
4.5.1	Per cent positions and Garret values	104
4.5.2	Distribution of constraints based on ranking given by respondents	104-105
4.5.3	Distribution of constraints based on Garret values	104-105

LIST OF FIGURES

FIGURE NO.	CAPTION	IN BETWEEN PAGES
3.1	Map of Nagaland	34 – 35
3.2	Sampling Design	34– 35
4.1.1	Distribution of respondents based on age	57-58
4.1.2	Distribution of respondents based on sex	59-60
4.1.3	Distribution of respondents based on family type	60 – 61
4.1.4	Distribution of respondents based on family size	60 – 61
4.1.5	Distribution of respondents based on Annual Income	61-62
4.1.6	Distribution of respondents based on Educational Qualification	63 – 64
4.1.7	Distribution of respondents based on primary occupation	65-66
4.1.8	Distribution of respondents based on secondary occupation	65-66
4.1.9	Distribution of respondents based on farming experience	68-69
4.1.10	Distribution of respondents based on social participation	68-69
4.1.11	Distribution of respondents based on total landholding	69-70
4.2.2(d)	Path model for utilisation pattern of ICT tools by respondents	89-90
4.2.2(f)(i)	Normal P-P plot of regression standardized Residuals	92-93
4.2.2(f)(ii)	Scatter plot of dependent variable Extend of usage	92-93
4.4.2(b)	Forest Plot (log scale) for Significant Predictors	103-104

4.4.2(e) ROC curve

103-104

LIST OF APPENDICES

APPENDIX NO.	TITLE	PAGES
A	Survey Schedule	i-x

LIST OF ABBREVIATIONS

ICT / ICTs	Information and Communication Technology / Technologies
eNAM	National Agriculture Market
SMS	Short Message Service
KVK	Krishi Vigyan Kendra
ATMA	Agricultural Technology Management Agency
VLW	Village Level Worker
AFA	Agriculture Field Assistant
NGO / NGOs	Non-Governmental Organization(s)
CD/DVD	Compact Disc / Digital Versatile Disc
ATM	Automated Teller Machine
FAO	Food and Agriculture Organization
UNESCO	United Nations Educational, Scientific and Cultural Organization
DACNET	Directorate of Agriculture & Cooperation Network
SEEDNET	Seeds Network
RKVY	Rashtriya Krishi Vikas Yojana
NHM	National Horticulture Mission
INTRADAC	Integrated DAC Portal
NFSM	National Food Security Mission
APY	Acreage, Productivity, and Yields
SEM	Structural Equation Modeling
SPSS	Statistical Package for the Social Sciences
AMOS	Analysis of Moment Structures
ROC	Receiver Operating Characteristic
AUC	Area Under the Curve
OR	Odds Ratio
CI	Confidence Interval
TV	Television
GPS	Global Positioning System

ABSTRACT

Information communication technology (ICT) refers to electronic devices, networks, mobiles, services and applications which help to disseminate information with the help of technology. ICTs essentially make it easier to create, manage, store, retrieve, and disseminate any relevant data, knowledge, and information that has already been processed and altered. It includes a wide range of technologies and applications, such as sensors, drones, satellite imaging, mobile applications, and data analytics, that allow farmers to make educated decisions, optimise resource utilisation, and increase output. Application of ICT in agriculture is not limited to farm information and creating marketing but is multidimensional in nature, ultimately empowering the users at social, political and economic arena. A study was conducted in the state of Nagaland during the period of 2023 to 2024 with the objective to study the application of ICT by farmers in agriculture in Nagaland following a descriptive and multistage purposive cum random sampling design. Six districts from Nagaland were purposively selected to ensure comprehensive data representation, encompassing all four blocks in the study. A total of 24 villages, with 12 randomly selected from each block, with a sample size of 360 respondents.

The findings from the study revealed that the majority of farmers were middle-aged (65.28%), male (61.94%) and all the respondents engaged in agriculture as their primary occupation. 60.56 per cent of the respondents reported medium levels of annual income, 66.11 per cent of the respondents had moderate landholding (4-6 acres) and 71.94 per cent of the respondents had 11 to 21 years of farming experience. 72.50 per cent of the respondents belonged to medium family size (4-7 members) and 87.22 per cent were from nuclear family. 29.72 per cent of the respondents had an education level till secondary level. 72.22 per cent of the respondents possessed a medium level of information source.

Knowledge level assessment indicated that farmers had low knowledge on ICT tools. Among the six cognitive criteria, practical application skills (applying) was found out to be the lowest. Usage analysis showed that their frequency of use was higher in mobile phones and basic applications, with higher-order digital tools rarely applied for agricultural purposes. Correlation and regression analyses indicated that both accessibility and availability significantly influenced usage, with availability ($\beta=0.442$, $p<0.001$) emerging as the stronger determinant. This highlights the role of infrastructure such as internet connectivity, electricity, and service centers in shaping ICT utilization beyond personal ownership. The overall attitude towards ICT was medium (64.44%), with “ICT based extension services assist the farmer in planning and decision making aspects in agriculture” ranking the highest among the other attitude items.

Adoption analysis showed that 54.2% of farmers were adopters of ICT tools, with annual income, farming experience, source of information, knowledge, attitude, availability and education emerging as significant predictors through the logistic regression conducted. Correlation and regression analyses confirmed that accessibility and availability were positively associated with ICT usage, with availability exerting a stronger influence. Despite these trends, constraints such as lack of training, poor infrastructure, language barriers, and weak institutional support hindered wider adoption.

The study concludes that ICTs hold strong potential to enhance agricultural decision-making and productivity in Nagaland, but their impact remains constrained by infrastructural and socio-economic barriers. Strengthening digital infrastructure, capacity-building, and inclusive ICT service design is recommended to enable effective integration of ICTs into farming systems.

Keywords: Adoption, Agriculture, Attitude, Farmers, Knowledge, Nagaland, ICT, Usage.

CHAPTER I
INTRODUCTION

INTRODUCTION

Agriculture plays a vital role in India's economy. 54.6% of the total workforce is engaged in agricultural and allied sector activities (Census 2011) and will contribute for 17.8% of the country's Gross Value Added (GVA) in 2019-20 (at current prices). The country has a total geographical area of 328.7 million hectares, of which 139.4 million hectares is reported net sown area and 200.2 million hectares is gross cropped area with a cropping intensity of 143.6%. The net sown area is 42.4% of the entire geographical area. The net irrigated area is 68.6 million hectares (Land Use Statistics 2016-17). Contributing over 13 percent to India's GDP, the ICT sector and the Digital Economy are major economic drivers for the country. India aims to grow the ICT sector to \$1 trillion by 2025, or 20 percent of GDP (International Trade Administration). Bengaluru (also known as the Silicon Valley of India), Hyderabad, Chennai, New Delhi, Gurugram, Mumbai, and Pune are the major ICT centres in India. According to the National Association of Software and Services Companies (NASSCOM), India's technology industry recorded its highest-ever rate of growth by reaching \$227 billion revenue in 2021, from \$200 billion in 2020.

Nagaland, located in the north-eastern region of India, is a state known for its rich cultural heritage, and diverse tribal communities. As per the official list of naga tribes given by the Department of Personnel and Administrative Reforms in the year 2016 there are 15 Naga tribes in Nagaland namely; Angami, Ao, Chakhesang, Chang, Khamniungan, Konyak, Lotha, Phom, Pochury, Rengma, Sangtam, Sumi, Tikhir, Yimchunger, Zeliang. This landlocked nation is bordered by Myanmar, Assam, Arunachal Pradesh, and Manipur. The distinct physical features of Nagaland, along with its advantageous meteorological circumstances, have greatly influenced the state of its agriculture. Geographically speaking, Nagaland is distinguished by its steep terrain and untamed surroundings. The state's elevation ranges from 200 to 3,840 meters

above sea level and it is a part of the Eastern Himalayan range. Nagaland's hills and valleys are covered in luxuriant woods, rivers, and streams, making for a lovely landscape. These geographic characteristics present opportunities and challenges for the region's agriculture. The traditional farming methods used by the local tribal groups in Nagaland are the mainstay of the country's agricultural economy. With a large majority of the people working in farming, agriculture is the economy's backbone. With 70% of the workers engaged in agriculture (Census, 2011). Nagaland is rich in natural resources, and harnessing them for the benefit of its people would entail the development of human resources as well as the building of market links. Agriculture, forestry, livestock, and rural non-farm activity will be critical to the development of the region's rural economy. The territory's diverse topography and geo-climatic conditions allow for the production of a wide range of agricultural goods, as well as horticulture and floriculture, giving the region significant potential for increasing primary sector output. 70 % of Indian rural households still depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal (Food and agricultural Organization, India). In Nagaland round 70% of all workers are engaged in agriculture (Anonymous, 2017).

In common parlance, Information and Communication Technology (ICT) refers to electronic devices, networks, mobiles, services and applications which help to disseminate information with the help of technology. ICTs essentially make it easier to create, manage, store, retrieve, and disseminate any relevant data, knowledge, and information that has already been processed and altered. It includes a wide range of technologies and applications, such as sensors, drones, satellite imaging, mobile applications, and data analytics, that allow farmers to make educated decisions, optimise resource utilisation, and increase output. “Among other ICTs, mobile telephony has emerged as the technology of choice of the majority of the urban and even the rural masses” (Ansari and Pandey, 2013). “As such, mobile phones have been regarded as the widely accessed tool

among the farmers for communication and also accessing agriculture-related information particularly for the marketing of produce” (Chhachar et al., 2014). It has changed the way information is communicated, and being able to use this knowledge to enhance the agriculture industry has a huge positive impact that benefits everyone. The ICT adoption process in agriculture can be understood through established frameworks such as the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT) and Diffusion of Innovations (DOI) theory. These models highlight the importance and influence of factors such as the usefulness and ease of use of the technology, social influence and the surrounding infrastructure support which are crucial determinants for adoption of technologies. Similar challenges have been documented in rural Africa, Southeast Asia, and Latin America, where socio-economic conditions, education, infrastructure, and cultural factors influence ICT adoption (Donner, 2008; Qiang et al., 2011).

Information and communication technology (ICT) has been viewed as a tool that can be used to help poor countries achieve their development goals. These technologies have the potential to aid in the fight against illiteracy, sickness, unemployment, poverty, agriculture, and other development issues. ICT in agriculture provides various advantages, allowing farmers to monitor and manage their crops, livestock, and overall farm operations more effectively. Farmers can collect real-time data on aspects such as soil moisture, weather conditions, and crop health by using sensors and monitoring systems. This data is then processed and analysed with complex algorithms and data analytics techniques, yielding useful insights for decision-making. “For example, ICT-enabled precision agriculture can help optimize irrigation scheduling, fertilizer application, and pest management practices, resulting in improved resource efficiency and yield outcomes” (Shinde and Pingle, 2020).

The importance of ICT in the field of agriculture research and extension is becoming indispensable. “Research, education & extension and farmers are the leading stakeholders of agricultural system” (Lemma and Tesfaye, 2016; Deneke and Gulti, 2016). “The performance and capability of each stakeholder to ensure rural food security depends on the continuous flow of agricultural knowledge and information among all stakeholders. Generally, the importance of information is well established in the life of every human being as it serves as a source of knowledge and skills for individuals” (Odiaka, 2015). “Particularly in the field of agricultural development access to information is one of the basic ingredients to increase farm productivity” (Pandey, 2017). “To foster adoption of technologies, there is need of better exchange of information among farmers” (Aguilar et al. 2015). This augments the vital importance of agricultural information among farmers to decide uptake of innovations.

Socio-economic impacts of mobile phones and other ICT tools on Indian agriculture, have revealed that access to real-time information empowers farmers to make informed choices, improve yields, and adapt to changing market conditions (Mittal et al., 2010). Studies have highlighted the role of ICTs in agriculture extension in North-East India, suggesting that digital initiatives can bridge knowledge gaps and support inclusive rural development (Sharma et al., 2025). On a broader scale, ICT adoption in developing countries is influenced by a variety of factors—ranging from socio-economic status and education to infrastructure, farming experience, and attitudes toward technology (Aker, 2011). The effectiveness of ICT-driven interventions hinges on context-specific approaches tailored to local needs and farmer characteristics (Kath et al., 2022). Role of social networks and traditional decision-making structures in influencing technology adoption among Maasai farmers, underscoring the importance of cultural context (Arvila et al., 2018).

Rural farmers get agricultural information through their mobile phones using Short Message Service (SMS) and Voice over Call. The Central Government, in collaboration with the State Government, has established numerous ICT Centres equipped with PCs, phones, internet, and broadband connections, as well as development officers, for example, e-choupal, e-arik, cyber dhaba, IFFCO-ISRO GIS project, Gyandoot project, AMARKET, VISTANET, and so on. Knowledge-based information is made available through several web and mobile-based web portals, including the farmer's web portal (www.farmer.gov.in), the mkisan portal (www.mkisan.gov.in), and Kisan Call Centres. These portals provide knowledge-based information and advice from subject matter specialists. With the help of the National Informatics Centre, the Department of Agriculture and Cooperation has created more than 80 portals, websites, and mobile-based applications. SEEDNET, DACNET, RKVY, ATMA, NHM (National Horticulture Mission), INTRADAC, NFSM (National Food Security Mission), and APY (Acreage, Productivity, and Yields) are major portals.

1.1 Statement of the problem

The development of rural economy is central to the development of Nagaland for the main reason that 70% of the population are cultivators (Department of Agriculture, Government of Nagaland), which shows that they are largely dependent on agriculture for their livelihood and employment. However, Nagaland is not able to exploit its full agricultural production potential. The scenario of food grain production of Nagaland in 2019-20, 2020-21 and 2021-22 are 125.15 MT, 139.89 MT and 155.51 MT respectively; which is lower than the required production i.e., 487.37 MT, 499.54 and 512.01 MT respectively (Department of Agriculture, Government of Nagaland). Agricultural information unavailability and poor market linkage can be two major factors contributing to the low production status of Nagaland. This calls for an intervention through ICT, based on the success stories of ICT models such as e-choupal and e-arik etc., where production, productivity of the crops were increased and marketing platform were created through the application of ICT in agriculture.

In this age of information explosion. Telecommunication and information technology have become vital systems in the socio-economic development and particularly for agriculture development. Therefore, application of ICT can provide right information at the right time in remote areas where by timely interventions on field related issues can be applied/undertaken by the farming community. This will lead to increase in productions of crops helping them to realize maximum potential from their field activity. One of the best results in application of ICT in agriculture is to provide marketing intelligence and create marketing platforms for the farmers, through which they can gain maximum profit by excluding the exploitation activity of middle men.

Application of ICT in agriculture is not limited to farm information and creating marketing but is multidimensional in nature, ultimately empowering the

users at social, political and economic arena. Through this research, the researcher wants to explore the possibility of developing a workable ICT model for the farmers of Nagaland to help in increasing the production, productivity and income of the farmers/field activities. Also, This research will try to explore the current status of various ICT tools available in this region; factors influencing its adoption; their awareness of ICT; and perception of the people on its usage. Therefore, a study will be undertaken under the topic “**Status of Application of Information Communication Technologies in Agriculture in Nagaland,**” with the following Objectives:

1.2 Objectives of the study

1. To study the socio-economic status of the respondents.
2. To assess the Knowledge Level and extent of use ICT by the respondents.
3. To examine the Attitude of farmers on application of ICT in agriculture.
4. To study the factors influencing adoption of ICT tools.
5. To identify the constraints faced by the farmers in using ICT and to suggest measures for improvement.

1.3 Significance of the study

The study on the status of application of Information and Communication Technologies (ICTs) in agriculture in Nagaland is significant as it highlights the transformative role of digital tools in improving agricultural productivity, efficiency, and sustainability. By examining how ICTs are currently utilized, the research can provide valuable insights into the opportunities and challenges faced by farmers in adopting modern technologies.

ICTs play a crucial role in providing timely access to agricultural information, such as weather forecasts, market prices, pest and disease management, and modern farming techniques. Understanding the extent of their application helps identify gaps in awareness, accessibility, and utilization, ensuring that interventions are designed to make these tools more farmer-friendly and impactful.

The study also contributes to the promotion of sustainable agricultural practices by analyzing how ICTs assist in precision farming, resource management, and decision-making processes. By integrating ICT applications with traditional farming systems, farmers in Nagaland can optimize inputs, reduce losses, and improve productivity while minimizing environmental impacts.

The research is significant in addressing issues of digital inclusion and rural development. ICT adoption is often influenced by factors such as infrastructure, education, training, and affordability. By assessing these factors, the study provides policymakers, agricultural extension agencies, and development organizations with evidence-based recommendations to bridge the digital divide and enhance ICT accessibility in rural farming communities.

The study also recognizes the importance of ICT tools in empowering farmers socially and economically. Access to real-time information can

strengthen decision-making, increase bargaining power in markets, and open opportunities for entrepreneurship and innovation in agriculture. For Nagaland, where agriculture forms the backbone of livelihoods, such empowerment is crucial for rural prosperity and food security.

1.4 Limitations of the study

1. The study was confined to selected districts and specific farming communities within Nagaland. Therefore, while the findings provide useful insights, they may not fully represent the status of ICT application across the entire state. However, they can be considered relevant in areas with similar socio-economic and agricultural contexts.
2. Although efforts were made to collect accurate and unbiased data, it is acknowledged that complete elimination of bias may not have been possible. Farmers' responses could have been influenced by factors such as personal perceptions, recall limitations, or expectations from the survey. Nonetheless, careful measures were taken to ensure objectivity and reliability throughout the research process.
3. The study relied on a sample size that was limited by time, resources, and accessibility. As such, the representativeness of the sample may be constrained, and the findings should be interpreted with caution when generalizing to the broader population of farmers in Nagaland.
4. As with most research endeavours, this study faced certain logistical and resource constraints. Factors such as limited time, financial resources, and the challenges of reaching remote farming areas may have influenced the scope of data collection. These constraints should be taken into account when assessing the comprehensiveness of the results.
5. The study focused primarily on the current status and extent of ICT application, and less on long-term impacts or future adoption trends. Therefore, while the research provides a snapshot of the present situation,

further longitudinal studies would be necessary to capture changing patterns of ICT use among farmers over time.

CHAPTER II
REVIEW OF LITERATURE

REVIEW OF LITERATURE

This chapter deals with the review of literature based on the studies of, Information Communication Technologies keeping in view the objectives of the present studies. The literatures reviewed are present under the following sub-heads:

- 2.1 To study the socio-economic status of the respondents.
- 2.2 To assess the Knowledge Level and extent of use ICT by the respondents.
- 2.3 To examine the Attitude of farmers on application of ICT in agriculture.
- 2.4 To study the factors influencing adoption of ICT tools.
- 2.5 To identify the constraints faced by the farmers in using ICT and to suggest measures for improvement.

2.1 Socio-economic status of the respondents.

Ajijola *et al.*, (2015) Educational qualification represents a predetermined factor in information assimilation, dissemination and adoption of technologies among rural farmers in diverse socio-economy. The educational status of a farmer does not only raise his productivity and income, but also increases his ability to understand and evaluate the information on new techniques and processes. About 58% of the respondents have no formal education, while those with primary, secondary and tertiary education constitutes 19%, 16.4% and 7% respectively. The result shows that there exists high level of illiteracy among farmers which might be a menace to the use of ICTs in the study area. Majority (71%) of the respondents were married, while the widow, single and divorcee constituted about 19%, 7% and 3% respectively. The mean household size of the farmers was 6. Conversely, farming (91.4 %) was the major occupation of the farmers in the study area followed by teaching (5.2%). Few farmers engaged in private business such as clergy, motorcycling, bicycle repairing, hairdressing and student. Therefore, it could be deduced that farming is the major occupation in the study area

Kabir (2015) stated that majority (60.0%) of the respondent's belonged to young age group followed by middle age (27.8%) and old age (12.2%) group. The frequency distribution was highly skewed towards the younger respondents. This means that more young people are getting involved in making use of ICT services for getting useful information. While looking at the educational status of respondent, result revealed that majority (54.4%) of respondents had secondary education followed by higher education (42.2%) and primary education (3.3%) respectively. The study findings lead to conclude that future development program on ICTs will be helpful in the present study areas due to better educational qualification of the respondents. The respondent farmers of the study areas had good farming experience with a mean score 11.29 and standard deviation 10.43. Out of total 90 farmers under study, 68.9 percent had small farm land followed by 21.1 percent marginal, 8.9 percent medium and only 1.1 percent had large farm land. Moreover, it was observe that 82.2 percent of the respondents had low income followed by 14.4 percent medium and only 3.3 percent had high income from both agricultural and non-agricultural source. The results also show that 88.9 percent of the respondents participate in training program on ICTs and they had a medium contact (58.9%) with different information sources followed by 40.0 percent had low contact and only 1.1 percent had high contact with different extension source. their household. That's why they need to depend on the ICT hub for their necessary information. From training program arranging by the project authority of ICT hub they (68.9%) had the skills on how to use internet and collect necessary information.

Osondu *et al.*, (2015) found that 40.00% of the farmers were within the age bracket of 51-60 years and 11.67% of them were of the age range of 61 years and above. The mean age of the farmers was 51 years. The prevalence of older farmers in the study area may be the result of rural-urban drift of younger people in search of white-collar jobs and greener pastures. This may have serious implications on the interest and ability of these farmers to adopt and use ICTs.

According to the ability of a farmer to bear risk, adopt new innovations and be able to do normal work decreases with age. The farmer respondents were more of males than females. This does not however, justify the generally held view and common practice in developing countries that extension should be directed to the males. According to while women contribute between 60 and 70 percent of agricultural production in developing countries, women farmers are less likely to benefit from agricultural extension services and technologies that can improve their production. None of the farmer respondents in the area was an illiterate. More than 50 percent of them however, did not exceed the secondary level of education. The involvement of people who had tertiary education in farming in this area can be explained by the growing interest in farming of teachers, civil servants and self-employed graduates to augment family incomes and ensure family self-sufficiency. This situation is likely to foster favourable attitudes that will not only increase their farm activities but will also enhance their ability to understand, evaluate and utilize new production technologies such as ICTs to more productive advantage.

Kafura *et al.*, (2016) in their study indicate that most of the respondents were young aged (54%), having secondary education (48%), small family (65%) and farm size (53%) followed by short-term service experience (62.2%). It is also found that majority of had low farming experience (57%), medium annual income (69%) and low training experience (59%). It was also indicating that most of them had medium organizational participation (57%), medium cosmopolitanism (65%), and medium innovativeness (68%).

Prasad *et al.*, (2017) in their study found that Nagaland-focused work shows farmers typically fall in the medium socio-economic status (SES) bracket, have nuclear families, and small–medium farms; education is commonly up to high school and extension training exposure is low. For example, among mithun-rearing households (a major livestock sub-sector in Nagaland), 69% had medium

SES; most were ≤ 50 years, with secondary education, nuclear families, and medium annual incomes—and SES correlated positively with production scale and income, underscoring how SES maps onto farm performance and capacity to engage with new tools and services.

Singh *et al.*, (2019) reported that most respondents were middle-aged (48.57%), followed by young (37.50%) and older farmers (13.93%). The majority were educated up to high school or higher secondary level, with no illiterate respondents. Over half belonged to medium-sized families, and most fell into lower or lower-middle income categories. Small landholdings were most common, followed by semi-medium and marginal holdings, with very few large farmers. In terms of information-seeking behaviour, most respondents exhibited a medium level, while smaller proportions showed high or low levels.

Lotha *et al.*, (2022) in their study found that within Nagaland's crop sector, district studies (e.g., Wokha) similarly find most respondents are 35–55 years, primary to secondary educated, small landholders, with medium information-source use and extension contact, medium scientific/risk orientations, and very low prior training exposure—a pattern that matters because training, education, and contact points (KVKs/ATMA/SMS advisories) are gateways for ICT uptake.

Ratna *et al.*, (2024) found in their study that broader Northeast/India evidence aligns: profiles often show middle age, small/marginal holdings, medium incomes, and medium levels of innovativeness, economic motivation, scientific orientation, and information-seeking behavior—traits repeatedly linked to ICT awareness and use. Recent surveys in Andhra Pradesh (outside NE but on ICT in agriculture) reinforce these exact distributions (middle age; income around ₹1–1.5 lakh; medium scientific orientation, ICT possession, innovativeness, extension contact, information-seeking), indicating these variables are widely observed and relevant benchmarks for characterizing respondents in ICT studies

2.2 Knowledge Level and Extent of use ICT by the respondents in agriculture

Raj (2008) Earlier work on e-Arik (North-East India) documents how village knowledge centers and ICT-enabled extension raise farmers' knowledge and decision quality among tribal smallholders, underscoring that localized content, two-way support, and demonstrations are key to knowledge gains—insights directly relevant to Nagaland.

Raghuprasad *et al.*, (2013) Predominant number (85 per cent) of the respondents knew that TV provides information regarding agriculture. The television has become an integral part of rural India. Most of the farmers have knowledge that the TV is one of the sources of agriculture information because TV medium has grown to such an extent that most of the farm families have TV in their house. It can be said that, a house without a television in rural areas is hardly seen. Communication of farm information through television will be the most prioritised source of communication. As indicated in this particular study, it is possible to reach more number of farmers in the shortest possible time with television as an extension tool. More than three-fourths (80 per cent) of respondents knew that mobile provides agricultural information. A source says that mobile has become a basic requirement in all the spheres of life. Data like market information, weather forecasting and emergency situations like flood, drought and weather extremities can be quickly communicated to farmers through mobile. Since most of the farmers are aware of farm communication through mobiles it will be a supreme choice for the extension functionaries. The study reveals that 41.67 percent of the respondents knew that agricultural information can be obtained through telephone. The Kissan Call Centre (KCC) is making some difference in the farming community by one of the sources that a farmer can easily access. However, there is a need to equip this sector further.

Raj (2013) Findings indicated that four-fifths of the rural population possessed a radio, and nearly one-third of farmers had a TV and fixed phone line. However, very few possessed cellular phones (9%), and in three villages no one had a computer or internet facility. More than half of the households (56%) were not connected with electricity. Very few students and degree holders used the internet (3%) at all, or even occasionally. Among ICTs, radio was widely possessed (80%) and used for getting agricultural information (Saravanan, 2010). Farmers were asked to express their preference of ICT for getting farm information; the majority of the farmers preferred a computer with internet access (88%), radio (84%) and television (76%). In contrast to this, only four farmers (16%) preferred receiving information by telephone (Saravanan, 2010). During the survey it was found that none of the village households had a computer. However, 88% stated a computer with internet access as their preference for receiving agricultural information. This was mainly due to a high awareness of using computers among the rural tribal population.

Musa *et al.*, (2014) found that the ICT used by farmers in Gezira state are: Radio, TV, Mobile Phone, Internet and others. The highest number (21.9%) of farmers is using Radio to access the agricultural information while 14.6% percent of farmers are using TV. The national radio and TV broadcast at least one weekly programme of about one hour long on agriculture. The respondents mentioned additional advantages of the radio, namely, wide coverage, portable, battery operation, relatively inexpensive to produce and to broadcast and effective in case of illiterate audience. The respondents also mentioned the advantages of the TV, The likely advantage of TV include the fact that most of the farmers owned TV sets and the visual nature of TV content. Mobile Phones were used by 10.2% of farmers. According to the results farmers noted that mobile phone is portable, having high speed in transmitting agricultural information and inexpensive. Only 3.3% of farmers are using Internet.

Kabir (2015) revealed from his study, that half of the respondents (50.0%) belongs to medium category i.e. they had medium level of knowledge on ICTs while 26.7% and 23.3% had low and high level of knowledge respectively. Thus, the findings indicate that proper training program should be arranged to enrich the level of knowledge of the farmers regarding the use of different ICTs. was that all farmers had heard and seen about mobile phone respectively, 98.9% farmers had used mobile phone while 95.6% had the mobile phone and same percent farmers had skills on how to operate mobile phone finding will help further research on mobile phone and technology dissemination aspects on that respective study area. Furthermore, all of the farmers had heard about and seen computer respectively while 72.2% had used computer. Also 68.9% farmers had skills on how to operate computer but there were no farmer who had a computer in the study area. Finally, all of the farmers had heard about Internet, while 78.9% farmers had the opportunity to see and 72.2% farmers had the opportunity to use the internet. But unfortunately, none of the farmers had the access of internet.

Rahman *et al.*, (2015) presented in their study that extent of use of ICT by the farmers in receiving farming information is considerably low in the study area. Relatively good proportions (37.3%) of the farmers were found using mobile phone for information. This was mainly due to the fact that mobile phone now-a-days is easily available and its „user friendly“ nature. Many farmers inform that they found it convenient to use mobile phone for getting information from SAAOs, input dealers and UAOs. As the data were collected from AICC members and many of them received training on ICT use, it was not unusual to observe that 21.3% of them were using AICC (Agricultural Information and Communication Centre) facilities to get farm related information. On the other hand, only few farmers were found using smart phones for receiving farming information. However, many of them informed that they use the user-friendly device (smart phone) for recreational purposes (seeing movie, drama, song and other videos). No farmers were found using other remaining sources of ICT and

it is a testimony that the farmers of Bangladesh still need to take long time to use ICTs for receiving farming related information unless the facilities are provided and challenges are met.

Syiem *et al.*, (2015) On an overall, mobile phone was regarded as the most frequently used ICT tool among the farmers using it very frequently. This indicated that the increase in the usage of mobile phones is increasing at an alarming rate even in the state. This is due to the reason that mobile phones are easily affordable and could be used by even illiterate farmers. The usage trend in mobile phones also indicated that it can offer huge scope in the future if appropriately use for the purpose of agriculture and other rural development purposes. Next to mobile phones, television was also used very frequently by the farmers. It was also reported that the use of radio is lower as compared to mobile phones and television since the level of availability and accessibility of ICTs is also lower as compared to other ICTs. Internet and its applications are still being used rarely by few of the respondents who are young and educated. Further, few farmers also visited the CSCs occasionally as and only when required to avail services on rural governance, rural education and commercial services such as recharging mobile phones, photocopying and printing. ATMs were also being used rarely by the few of the farmers when most needed.

Kafura *et al.*, (2016) found that TV ranked in 1st position to watch Hridoye Mati-o-Manush and 2nd position to watch Mati-o-Manush. Radio occupied 3rd position to listen Sonali Phashal and 5th to listen Desh Amar Mati Amar. Mobile phone ranked in 4th position to get agricultural information. Sixth and 7th positions were occupied by internet and Banglalink Jigyasha 7676, respectively. Mobile application and e-Krishok service jointly ranked in 8th position while computer ranked in 9th position. Tenth position was occupied by both Grameenphone Community Information Center service and CD/DVD. The rank order of extent of use of different ICT tools indicates that television and radio

which are considered as traditional ICT tools are mostly used tool to get agricultural information. Among the modern ICT tools mobile phone ranked in 4th position and others are least used.

Luqman *et al.*, (2019) found that respondents had knowledge and skill of medium level to use ICTs as perceived by the greater than half respondents (53.3%). Similar findings were reported by Kabir (2015) as 50% of respondents had a medium level of knowledge on the use of ICTs. Of the total respondents, less than one fifth (16.7%) respondents had a high level of knowledge and skill to access required information from ICTs. Furthermore, 30% of respondents reported their low level of knowledge and skill to use ICTs to meet their information needs. This implies that respondents are not enjoying the full potential of ICTs as their knowledge and skill are hindering the level of use. Osondu & Ibezim (2015) arbitrated that inadequate knowledge and awareness of ICTs use among farmers allow them to get benefits partially. With the unit increase in their knowledge and skill can ensure the increased use of ICTs among farmers.

Kath *et al.*, (2022) found evidence from Nagaland that where farmers regularly receive mobile-based agro-advisories, their awareness and knowledge of key farm decisions (e.g., time of sowing, weather forecasts, crop/livestock practices) is high. In a Tseminyu (Nagaland) survey of 200 farmers, 93–99% reported complete or partial knowledge on items like sowing time, weather, suitable crops, and animal health after engaging with mobile advisories—attributed to widespread smartphone access and frequent use of apps/WhatsApp groups.

Sipai *et al.*, (2022) reported that studies from other states (e.g., Gujarat) also found that many farmers possess practical knowledge on using ICTs to access varietal/market/soil information, again with stronger knowledge on everyday mobile/internet uses than on specialized digital tools. Together, these findings

suggest that for Nagaland respondents you should expect high knowledge on mobile/SMS/app-based info access, moderate knowledge on portals/call centres, and lower knowledge on advanced or capital-intensive digital agriculture tools—unless there has been targeted training.

Shehrawat *et al.*, (2024) Broader Indian studies provide a comparative baseline: in Haryana, a 2024 study (n = 80) found 57.61% of farmers were aware of ICT tools overall; awareness clustered around mobiles and WhatsApp, while knowledge of advanced ICTs (GPS, drones, precision tools) lagged—pointing to a common “basic-ICT high / advanced-ICT low” knowledge pattern and highlighting training gaps.

2.3 Attitude of farmers on application of ICT in agriculture.

Kabir *et al.*, (2015) Information on input service and availability like sources of quality seed, fertilizer or different farm machineries etc. were considered most appropriate information by majority (37.8%) of the respondents while about the same percentage of respondents (37.8%) rated it as appropriate. Looking forward to the importance of different inputs on improved agricultural production and management practices farmers felt that information regarding input service and their availability was most appropriate and appropriate information perceived through ICTs. The information relating to post-harvest technology was perceived as less appropriate by majority (66.7%) of the farmers. Giving due consideration to importance on market information, including daily updates on the prices of agricultural commodities in the local markets a sizeable portion (27.8%) of sample of farmers perceived “market information” as most appropriate information for their farming. This was seen as most appropriate by 23.3 percent of farmers to get information by watching different agricultural program on TV. Majority of the respondent farmers were unaware about the importance of information regarding different post-harvest technologies. Moreover, question and answering, information regarding different agricultural news and program

services through ICTs should be need based and updated covering different risk factors of the farmers.

Islam *et al.*, (2016) On the basis of attitude towards e-Agriculture, the respondents were categorized into three classes' namely poorly favourable attitude, moderately favourable attitude and highly favourable attitude. The observed data showed that the most of the rural farmers (73.7 percent) had a medium attitude towards e-Agriculture while 20.3 and 6.0 percent of them had strong and poor attitude respectively. The attitude of the respondents expressed their perception about e-Agriculture. In addition to that, the study also revealed the factors that effective farm size, annual household income, farming experience, participation in training, knowledge one-Agriculture, organizational participation and cosmopolitaness had significant contribution on farmers' attitude towards e-Agriculture. These variables contributed total 61.9 percent in farmers' attitude towards e-Agriculture. Based on these findings, the researcher would like to suggest that it is high time prepare the farmers to use these e-Agriculture tools for their wellbeing through proper educational activities and to popularize this service, government should implement integrated marketing communication using the popular print and electronic media so that more and more people get aware of this service.

Palaiah *et al.*, (2016) It was observed that more than two-fifth (40.83%) of the farmers had favourable attitude towards ICT tools followed by 31.67 per cent of the farmers had least favourable attitude and 27.50 per cent of the farmers had most favourable attitude towards ICT tools. The possible reason might be the fact that younger generation who are also literate are knowledgeable about ICT tools and its usages. They are few in number. Generally old age people with less exposure will have less favourable attitude towards ICT tools. The medium and high attitude may indicates that they are convinced about the utility of these tools and many of them opined that these tools provides wide range of information

except cost of few ICT tools like internet and accessibility to the rural women. As per the results obtained, statements agreed by respondents are nearly 78 per cent of the respondents agreed that I like to use ICT tools, ICT tools provide global information (76.66%), ICT provides wider information regarding agriculture (73.33%), ICT usage is socially, economically and culturally feasible (69.17%), usage of ICT tools lead to modernization (79.16%), ICT tools will build social capital among farmers (68.33%), ICT tools are only suitable to literate people (78.33%), ICT tools are costly (90.00%), youth will have more access to ICT tools (70.83%), information can be obtained from ICT tools without any assistance (50.83%). ICT tools provide timely information (69.16%), it is very easy to get information from ICT tools (76.66%) and frequency of broadcasting/telecasting/conferencing of ICT tools is not convenient (60.83%).

Verma *et al.*, (2016) found that 82.50 percent of the respondents had moderately favourable attitude towards e- Choupal, followed by 10.83 percent having highly favourable and only 6.66 percent of the respondents had least favourable attitude towards e-Choupal. It is further mentioned that large majority of the farmers (93.33%) had favourable attitude towards e-Choupal. The possible reasons for this could be that those who have benefitted from e-Choupal will definitely report positive attitude towards e-Choupal. It is also an indicator of overall satisfaction of farmers with the e-Choupal. Regarding attitude of respondents towards services of e-Choupal, it was observed that more than two-third respondents (77.50%) had moderately favourable attitude, whereas only 15.00 percent had highly favourable attitude towards services. Further, only 7.50 percent respondents had least favourable attitude towards services of e-Choupal. Overall 80.00 percent of the respondents has moderately favourable attitude towards e-Choupal, followed by 13.33 percent of respondents having highly favourable attitude and only 5.66 percent respondent with least favourable attitude. The education level and convenience of these tools for obtaining agriculture information might have contributed towards respondents' favourable

attitude. The other possible reason might be existing knowledge level of the respondents on e-Choupal, which resulted in favourable attitude also, since majority of the respondents were literate and belonged to middle age group. might have also influenced the respondents to have favourable attitude towards e-Choupal. The medium and highly favourable attitude may indicate that farmers are convinced about the utility of e-Choupal and many of them opined that e-Choupal provides a wide range of information.

Ali *et al.*, (2017) found that in northern Pakistan, farmers viewed ICTs such as electronic media, mobile phones, and radio as useful for agricultural information and expressed generally favourable attitudes. Yet their enthusiasm was dampened by infrastructure constraints, affordability issues, and limited digital literacy, particularly among smallholders.

Naik *et al.*, (2020) reported that most respondents had a moderately favourable attitude toward ICT tools. The majority agreed that ICTs provide reliable, practical, and shareable information, support interaction, create employment opportunities, and improve social status and standard of living. However, many respondents felt that ICTs are not easily accessible everywhere or anytime, may not simplify complex ideas, and often provide information unsuitable for local problems or not in local languages. While most disagreed that ICT tools are difficult for rural or illiterate users and that initial costs are very high, concerns remained about time wastage, costs for accessing information, cultural barriers for rural women, and limited local relevance of ICT-based information.

Nyairo (2020) found that in Kenya, smallholder farmers expressed favourable perceptions of agricultural technologies, with their attitudes shaped by perceived benefits, risks, and ease of use, while social and cultural values also influenced their readiness to adopt ICT-enabled practices. However, financial

constraints and access limitations were cited as key barriers to sustaining positive attitudes.

Hasan *et al.*, (2020) found that farmers from northern Bangladesh generally held medium to high attitudes toward ICT-enabled e-governance services in agriculture. Positive relationships were observed with education, income, training, and prior ICT exposure, while cost of access and limited exposure reduced favourability levels.

Khan *et al.*, (2022) found that in Charsadda district of Pakistan, all surveyed farmers were aware of ICT tools, and many agreed that applying ICT-based information enhanced farm productivity. Their attitudes toward ICT adoption were positive, but challenges like poor internet availability, low literacy, and high costs limited consistent use and integration into everyday farm practices

2.4 Factors influencing the respondents in adoption of ICT tools.

Mittal *et al.*, (2015) investigated the factors that may influence farmer's adoption of different information sources. Taking into account the potential correlation among alternative information sources, multivariate probit model is used and the results showed that socio-economic characteristics of farmers like age, level of education and farm size are significantly related to farmer's use of different sources of agricultural information. These results can be used further to design programmes specific to farmer's profile. More simply, using these results, information providers can better anticipate which types of farmers would use their information in combination with other information sources. These results show the complementarity in the use of different sources of information and role of education in getting farmers connected to new sources of information. Also the inferences drawn in this paper need further exploration with farmers through experimental research. Overall, the farmers rely on multiple sources of information, but they still continue to extensively use other farmers and face-to-face interactions. We also do not deny the fact that successful use of information

as a resource for agriculture development depends largely on the accessibility and adequacy of the information source, farmers preference for a particular information source and farmer's ability to use information.

Arvila *et al.*, (2018) investigated the socio-cultural factors that appear to impact the adoption of technology among Maasai farmers in rural Tanzania. Firstly, we found that the social networks that an individual is surrounded by shapes the way technology is perceived. Many Maasai farmers are unfamiliar with modern technology, which was revealed in the use of technology for farming activities. Following traditional methods for decision making is perceived less risky than trusting into new information sources. Secondly, the hierarchical social structures impact the adoption of technology among Maasai. Local leaders and well-respected community members have the potential to influence the uptake of new technologies through their position within a social setting. Lastly, the factors of tribal affiliation and language demonstrate the strongly rooted value system that influences decision-making processes as well as the willingness or resistance to adopt to new technologies.

Okoroji *et al.*, (2020) examined the factors that affect the uptake of mobile apps technology by farmers in Nigeria using SEM. SEM helped to analyze and present the causal relationships among the constructs in the proposed research model. An extended TAM framework was estimated to identify the factors that affected the adoption of mobile apps. The study, in general, explained the fundamental relationships between the proposed external variables and the original TAM variables. The results are in line with previous studies, and show that SI, PR, PC, IA, PU and ITU are all crucially significant variables in deciding the factors that affect the adoption of mobile applications by farmers in Abia State. However, internet connective which seems to have a significant influence on the adoption of ICT in developing countries did not stand out as a significant factor from the study's exploratory factor analysis. Instead, the influence of

internet connectivity was overlapped in perceived cost as farmers reported that they paid a high cost for data subscription. This potentially had a negative influence on farmers' intention to use and the actual adoption of mobile applications. The study demonstrates that extended TAM is a suitable model to explain the factors that influence mobile apps adoption for agricultural purposes. The study showed the level of importance of information awareness as a predictor of behavioural intention and actual usage in the context of mobile apps adoption. Most empirical studies on technology adoption using TAM have ignored this important variable, especially in an agricultural setting. The result of this study confirmed that information awareness is a key factor in the adoption of agricultural mobile applications. This study, therefore, lays a good theoretical foundation for other research using extended TAM (TAM2) to examine the impact of IA on the adoption of the ICT being studied. It also demonstrated the empirical applicability of extended TAM (TAM2) in studying technology acceptance in a developing country context such as Nigeria. The study helped to bridge the information gap between agricultural app developers and farmers by revealing the factors that affected the adoption and continuing use of mobile apps.

Hoang *et al.*, (2020) examined the determinants of mobile phone adoption among fruit farmers for marketing purposes. The study revealed that perceived benefits, smartphone ownership, market connectivity, and access to training were the strongest drivers of ICT adoption. Younger and more educated farmers were more likely to use mobile phones, while older farmers and those with limited literacy were less inclined. Importantly, the study emphasized that while farmers acknowledged the usefulness of ICT tools, transaction costs, unreliable network infrastructure, and lack of advanced digital skills remained barriers to widespread adoption. These findings highlight how a combination of technological perception (usefulness, ease), socio-economic background (age,

education, income), and structural access (networks, costs) collectively shape the adoption process in developing agricultural markets.

Diaz *et al.*, (2021) assessed the willingness to adopt a new mobile App by bamboo farmers in Maasin, Iloilo, Philippines using the Technology Acceptance Model. They found that farmers were willing to adopt the bamboo mobile app. Their adoption is positively affected by the perceived ease of use of the technology, perceived innovativeness, and social influence of friends, co-farmers, and relatives. On the other hand, farmers' willingness to use Bamboost is negatively affected by the cost attached to the use of technology in terms of mobile data, transaction, and downloading costs. Smallholder farmers are cost wary and most of them tend to be sensitive to the slight fluctuations on services fees of certain commodity or technology. Therefore, access to internet and improvement of existing mobile ecosystem in the area need to be the focus of the government's programs and policies in order to successfully implement farmers' adoption of mobile app as well as to reduce the rural poverty through the increased access of the local products to the market. Through a Public-Private Partnership (PPP) program, the concerned stakeholders could work hand-in-hand with the private sector to provide efficient and affordable internet infrastructure for the farmers. It is also important that the policy makers formulate relevant plans that would empower the smallholder farmers in the rural areas by maximizing the benefits of advanced technology like mobile apps in marketing their produce to increase their market access. Modern and digital technology, if properly adopted, promises a transformative impact in agriculture from farm production to marketing.

Nikam *et al.*, (2021) Age showed a positive but non-significant relationship with the adoption of mobile app. Negative relation was expected as younger farmers were more ready to adopt new technology as found by Ali (2011) and Das (2014). Mittal and Mehar (2015) also found positive but non-significant

relation with the age in adoption of ICT. Family size of the farmers negatively though non-significantly affected the adoption of mobile app. Education was positively related to the adoption of mobile app. Many empirical studies have shown positive influence of education on adoption of technology by the farmers (Das 2014, Mittal and Mehar 2015). With one percent increase in education level, probability of adoption of mobile app increased only by 0.3%. Ali (2011) while studying adoption of ICT in vegetable farmers also found a non-significant positive relation of education with the adoption of mass media information by the farmers. Among social network characteristics, village adoption rate significantly and positively affected the adoption of mobile app. With one percent change in the village adoption rate, probability of adoption of mobile app increases by 3.65%. Village adoption rate as a variable shows the impact of social network and social learning on the adoption of the mobile app. Education of the social network members was a highly significant determinant of adoption of mobile app. One unit change in education will likely to enhance the probability of adoption of mobile app by 0.8 unit. Landholding of the social network was a significant factor affecting the adoption of the mobile app. With one unit change in the landholding of social network members, probability of adoption of mobile app increases by 0.9 units. Probability of adoption of mobile app increases by 1.13% with one percent increase in the frequency of interaction with the network members. There was a positive influence of social network member distance from farmers and adoption of mobile app. Other studies have shown that less the distance of social members, more would be influenced on adoption of the technology.

Mdoda *et al.*, (2022) focused on livestock farmers in South Africa to assess the factors affecting ICT adoption. Their findings showed that education, income, and access to extension services had significant positive effects on the uptake of ICT tools. Farmers who were members of cooperatives or who received formal training were also more likely to adopt ICT for herd

management and market access. Conversely, infrastructure-related challenges, such as poor internet connectivity and high mobile data costs, discouraged regular ICT use. Age was also negatively associated with adoption, suggesting younger farmers had a greater propensity to integrate ICT into their farming practices. The study concludes that beyond socio-economic status, institutional support (extension and cooperatives) and infrastructural improvements are critical enablers in fostering ICT use among rural livestock farmers.

Shrestha *et al.*, (2023) conducted research in Nepal among smallholder farmers in Chitwan and Lamjung districts to identify the factors influencing ICT use for agricultural information. The study found that education level, training exposure, farm size, and income were positively related to ICT adoption. Farmers with access to smartphones and prior experience with digital platforms were more inclined to use ICT tools, particularly for market and weather information. On the other hand, barriers such as poor infrastructure, high costs of devices, and limited digital literacy prevented consistent use. Extension contact played a pivotal role in bridging knowledge gaps, with those frequently engaging with extension agents demonstrating higher ICT uptake. The study emphasizes that capacity-building and infrastructure development are necessary conditions for greater ICT penetration in smallholder farming contexts.

Pandey *et al.*, (2023) explored the socio-economic factors influencing ICT adoption among farmers in Uttar Pradesh, India. Their study found that education, landholding size, income level, media exposure, and information-seeking behavior were strongly correlated with ICT use. Farmers who had regular extension contact and who participated in training programs were significantly more likely to adopt ICT tools for accessing agricultural information and market trends. However, adoption was hindered by infrastructural limitations (poor connectivity), affordability of smartphones and data, and lack of localized content in regional languages. The findings suggest

that socio-economic variables set the baseline for ICT use, but institutional touchpoints like KVKs and extension programs play a decisive role in motivating farmers toward adoption.

Ntsoane *et al.*, (2025) employed a multivariate probit model to analyze the use of ICTs for agricultural information among smallholder farmers in Mpumalanga, South Africa. Their results showed that education, farming experience, household size, and access to credit significantly influenced ICT adoption. Farmers with higher education levels were more open to using a variety of ICT platforms (voice calls, SMS, WhatsApp, and agricultural apps), while those with larger households had better labor support to integrate ICTs into farm operations. Credit availability emerged as a critical enabler since it allowed farmers to purchase smartphones and data services. The study concluded that economic empowerment through credit, targeted ICT training, and household support structures are key drivers of ICT adoption, while lack of funds and digital skills are deterrents.

2.5 To identify the constraints faced by the farmers in using ICT

Musa *et al.*, (2014) found that educational level (47%) was the main socio-economic challenge to ICT adoption, followed by income (37%), gender (13%), and farm size (5%). Chi-square analyses showed significant relationships between ICT adoption and socio-economic factors ($p = 0.013$), cultural factors such as beliefs, legal frameworks and politics ($p = 0.028$), and technical challenges ($p = 0.003$). The major technical barrier was the scarcity of skilled staff (53%), followed by weak dissemination methods (21%) and poor information packaging and lack of ICT centres (13%). Infrastructural challenges were also prominent, with about half of farmers lacking access to electricity (50.8%) and roads (54.2%), while telecommunications infrastructure was relatively better, with only 30.8% reporting little or no access.

Ajijola *et al.*, (2015) found that the major aim of information technologies is to know the problem(s) encountered by respondents while using any information technology newly introduced to them thereby providing a lasting solution to it. A majority (91%) of the respondents was faced with lack/fluctuation/inadequate of constant power supply, 86.2% inadequate infrastructure and 66.4% lack of barrier. More than half of the respondents (66.4%) were faced with lack of awareness, 68.9% were faced with inadequate knowledge about ICT while other constraints like lack of time to assess the qualities information, lack of knowledge about the internet, Government policy, Time wastage, High cost of equipment, Distance to town, Accessibility of the village, lack of mast network and rural poverty.

Syiem *et al.*, (2015) reported that farmers faced multiple constraints in using ICTs, including low confidence and skills due to limited exposure, awareness, and ICT literacy. Poor and unreliable power supply hindered phone charging, while weak network connectivity reduced trust in mobile-based services. Many farmers were unaware of the socio-economic benefits of ICTs beyond personal communication, largely due to lack of training, demonstrations, and practical exposure. Additional barriers included illiteracy, difficulty using basic phone functions, lack and high cost of repair facilities in villages, financial constraints, and negative attitudes among some older farmers.

Shanthya *et al.*, (2017) found that majority (93.33 %) of the respondents encountered the problem of lack of feedback followed by problems of foreign language (90.00%) and 86.66 per cent said lack of skills to use ICT gadgets. This is in line with Jayanthi (2016). Apart from that respondents (80.00 %) expressed that clarification is difficult, if any doubt arises followed by 76.66 per cent faced cyber phobia while using ICT services. 70.00 per cent of the respondents revealed that public sector infrastructure such as power supply, internet facilities are unavailable to access ICT.

Sumi *et al.*, (2018) identified lack of awareness of information sources as the most critical constraint to ICT use among farmers (GMS = 77.03), largely because ICTs were mainly used for personal communication and due to limited localized sensitization programs. Other major constraints included poor educational facilities (GMS = 75.54), lack of region-specific information and use of non-local languages (GMS = 70.49), inadequate ICT knowledge and skills (GMS = 65.04), and complexity of ICT tools (GMS = 63.91). Additional barriers were poor socio-economic status, weak network and internet access, negative attitudes toward ICTs, and erratic power supply.

Anand *et al.*, (2020) surveyed 100 farmers during 2018-19 about difficulties accessing and utilising ICT tools. The most severe constraint was insufficient power supply, followed closely by poor/slow internet connection. Other important constraints included a lack of knowledge about ICT tools, low confidence in using them, and lack of training. Also cited were high cost, low literacy, language barriers, and scarcity of awareness of benefits. Farmers suggested that improving power supply, internet connectivity, and organizing ICT-training programmes would substantially reduce these constraints.

Sandhiya *et al.*, (2022) found that in Dindigul district, Tamil Nadu, among 300 farmers, constraints in the usage of ICT-based advisory services were well detailed: high cost of data packs (94.66%) was the most frequently cited constraint; followed by lack of locally relevant information (88.33%), poor internet availability (86.66%), lack of training on ICT (81.33%), language/linguistic drawbacks (71%), and lack of e-skill (50.66%). Other lesser constraints included delay in responses, non-trustworthiness of online information, difficulty reading, lack of technical support, and more. The study recommended localized content, training, and improving internet/data affordability.

Naik *et al.*, (2022) studied constraints faced by farmers in usage of ICT tools. Key constraints included high cost of ICT gadgets (smartphones, computers) ($\approx 92.5\%$), high servicing charges ($\approx 90.8\%$), low skills in usage ($\approx 85\%$), irregular or insufficient power supply ($\approx 84\%$), lack of servicing centres locally ($\sim 76.7\%$), and difficulties understanding device language/localization issues ($\sim 75\%$) among others. Farmers' suggestions included reducing costs, improving power supply, subsidizing gadgets, and establishing local service centres.

Chinni *et al.*, (2025) found in Chittoor district of Andhra Pradesh that the primary constraint was lack of sufficient skills in operating ICT tools. Other major constraints reported were poor network connectivity, high cost and maintenance of ICT devices, and complexity of use. Farmers also noted that many tools are not user-friendly, requiring better design and local language support. Suggested interventions included skill training, simplification of tools, and better maintenance services.

CHAPTER III

RESEARCH METHODOLOGY

RESEARCH METHODOLOGY

This chapter deals with the details of the research methodology adopted for the present study. The present chapter deals with the concise description of the data collection and analytical methods used in the light of stated objectives. The research methods and procedures taken up in the present study for conducting the investigation are given under the following heads.

- 3.1 Area of investigation and sampling design
- 3.2 Selection of the respondents
- 3.3 Selection of variables
- 3.4 Relevant variables and their empirical measurements
- 3.5 Methods of data collection
- 3.6 Statistical tools used for data analysis

3.1 Area of investigation and sampling design

The study was conducted in the state of Nagaland during the period of 2023 to 2024.

According to Kerlinger (1987), research design is a plan, structure, and strategy of investigation conceived so as to obtain answers to research questions and to control variance.

The study followed an analytical research design. Multistage with purposive cum random sampling design was followed for the study. A diagrammatic representation of the study area as well as sampling design followed in this study has been depicted in the figure 3. and figure 3. respectively.

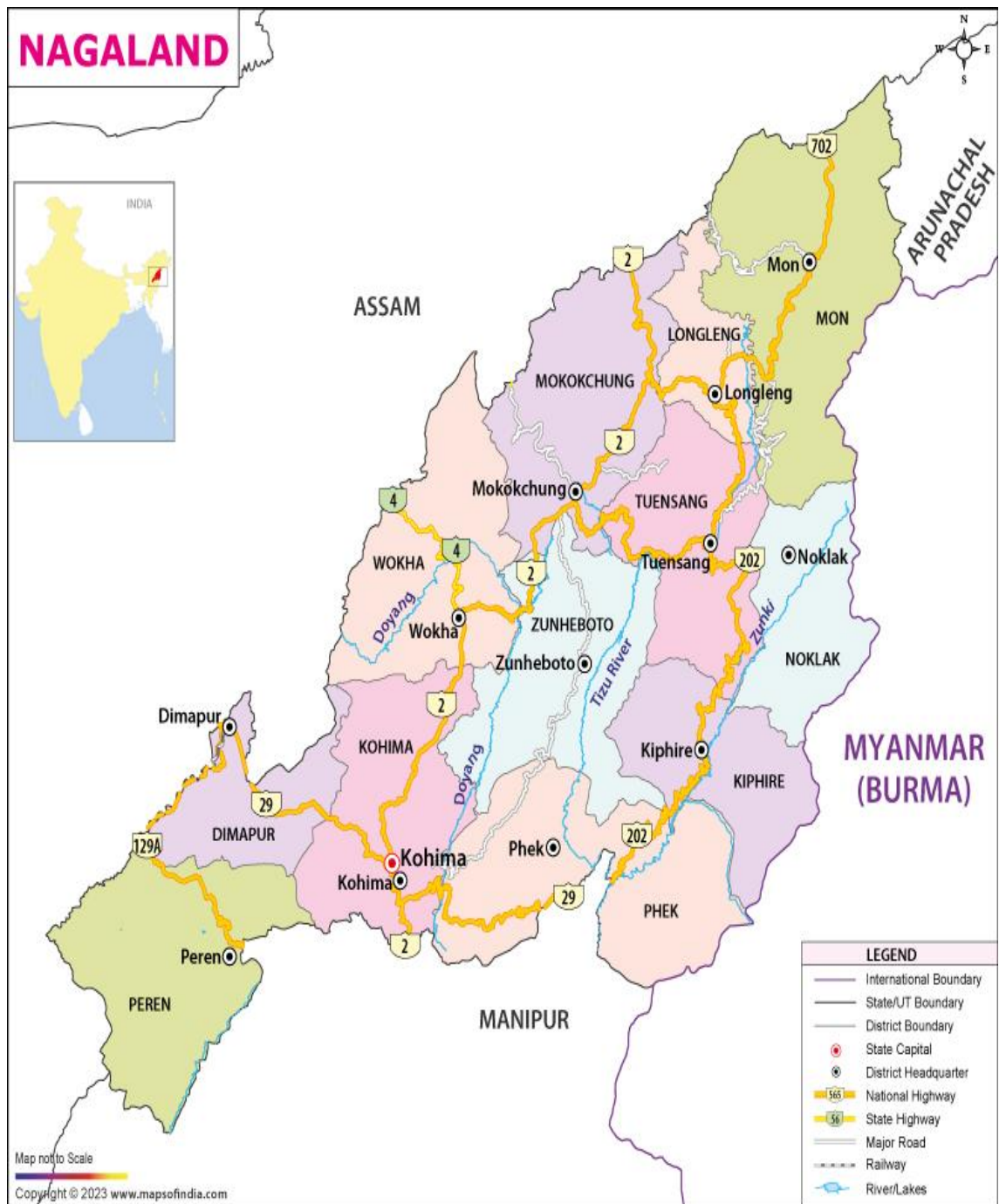


Fig 3.1: Map of Nagaland

**GOVERNMENT OF NAGALAND
LAND RECORDS AND SURVEY
Map of Kohima District**

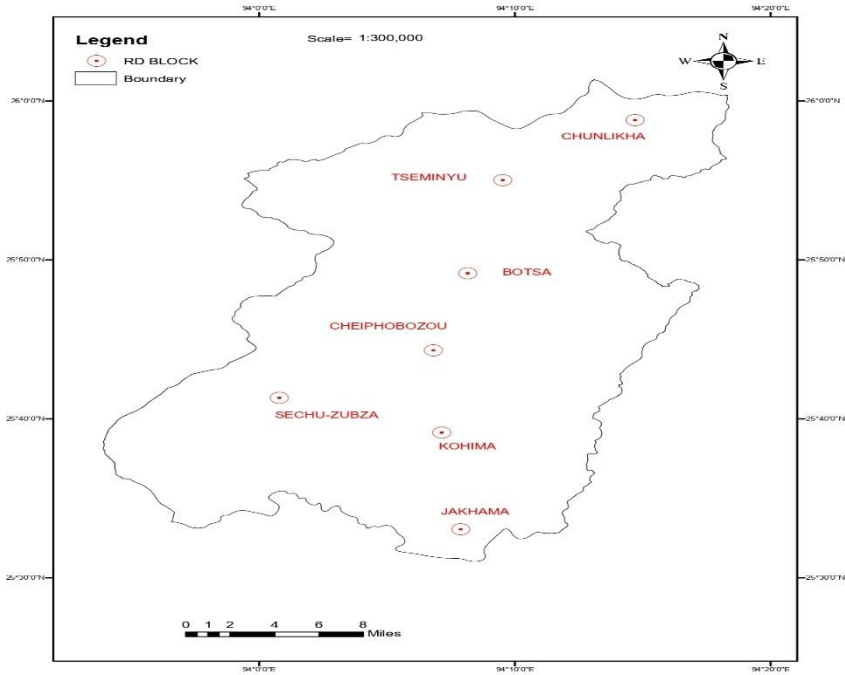


Fig 3.2: Map of Kohima

**SURVEY OF NAGALAND
MAP OF MOKOKCHUNG DISTRICT**

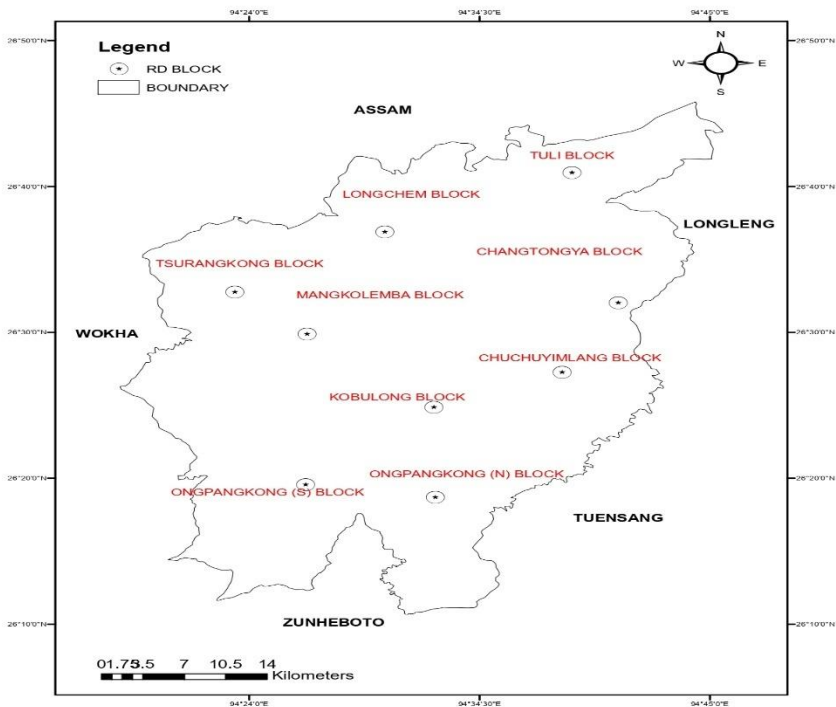


Fig 3.3: Map of Mokokchung

**SURVEY OF NAGALAND
MAP OF MON DISTRICT**

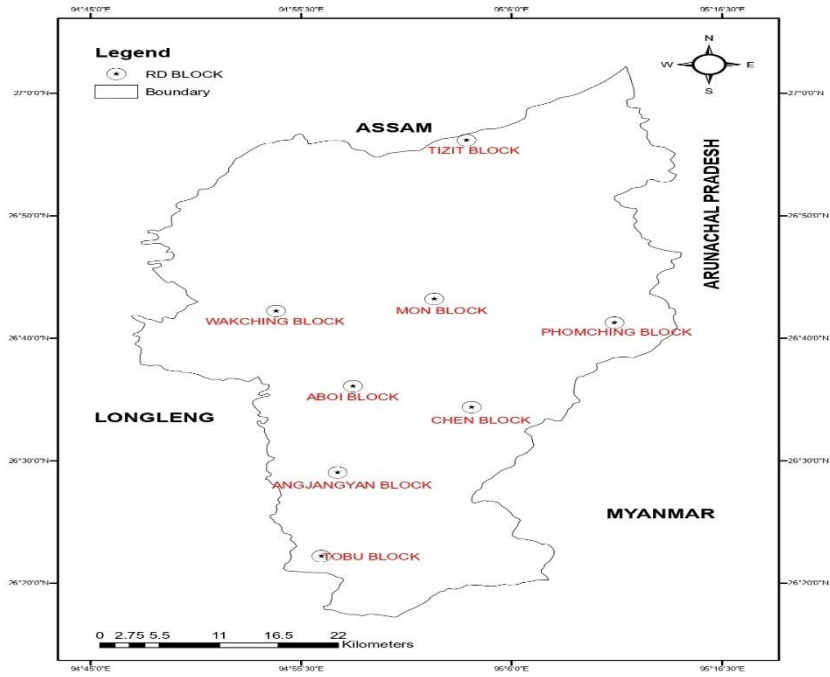


Fig 3.4: Map of Mon

**SURVEY OF NAGALAND
MAP OF PHEK DISTRICT**

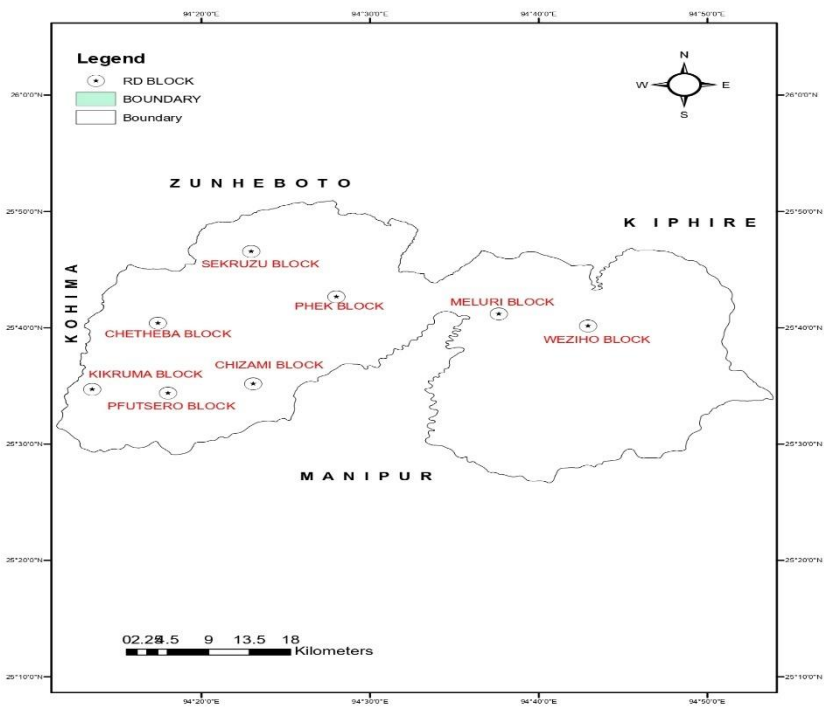


Fig 3.5: Map of Phek

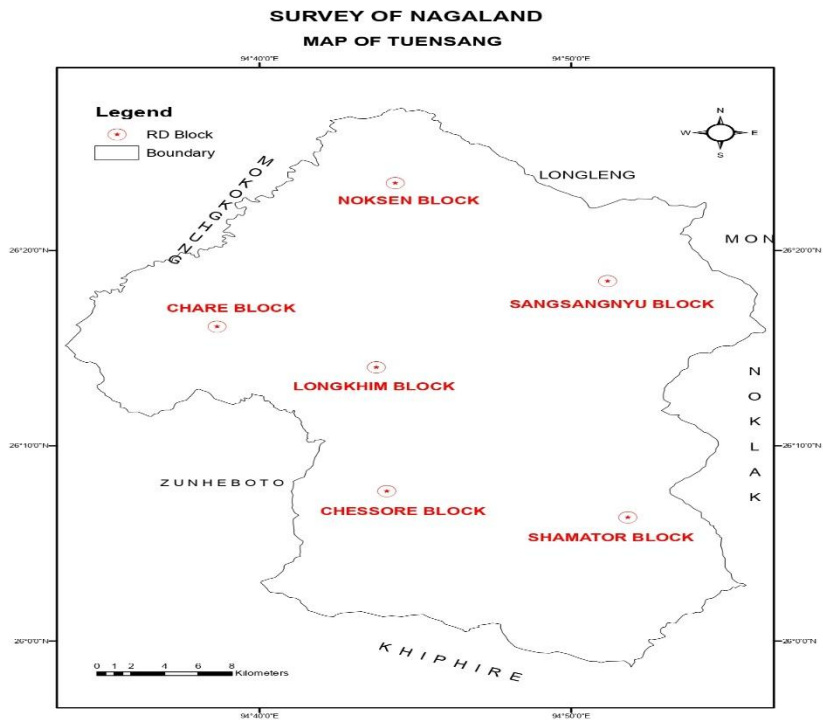


Fig 3.6: Map of Tuensang

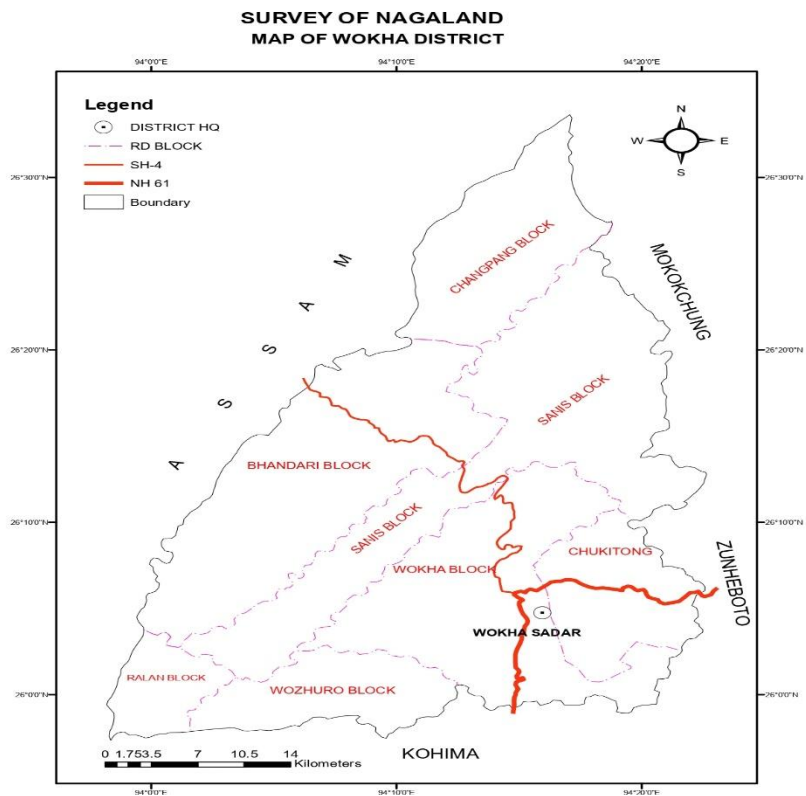


Fig 3.7: Map of Wokha

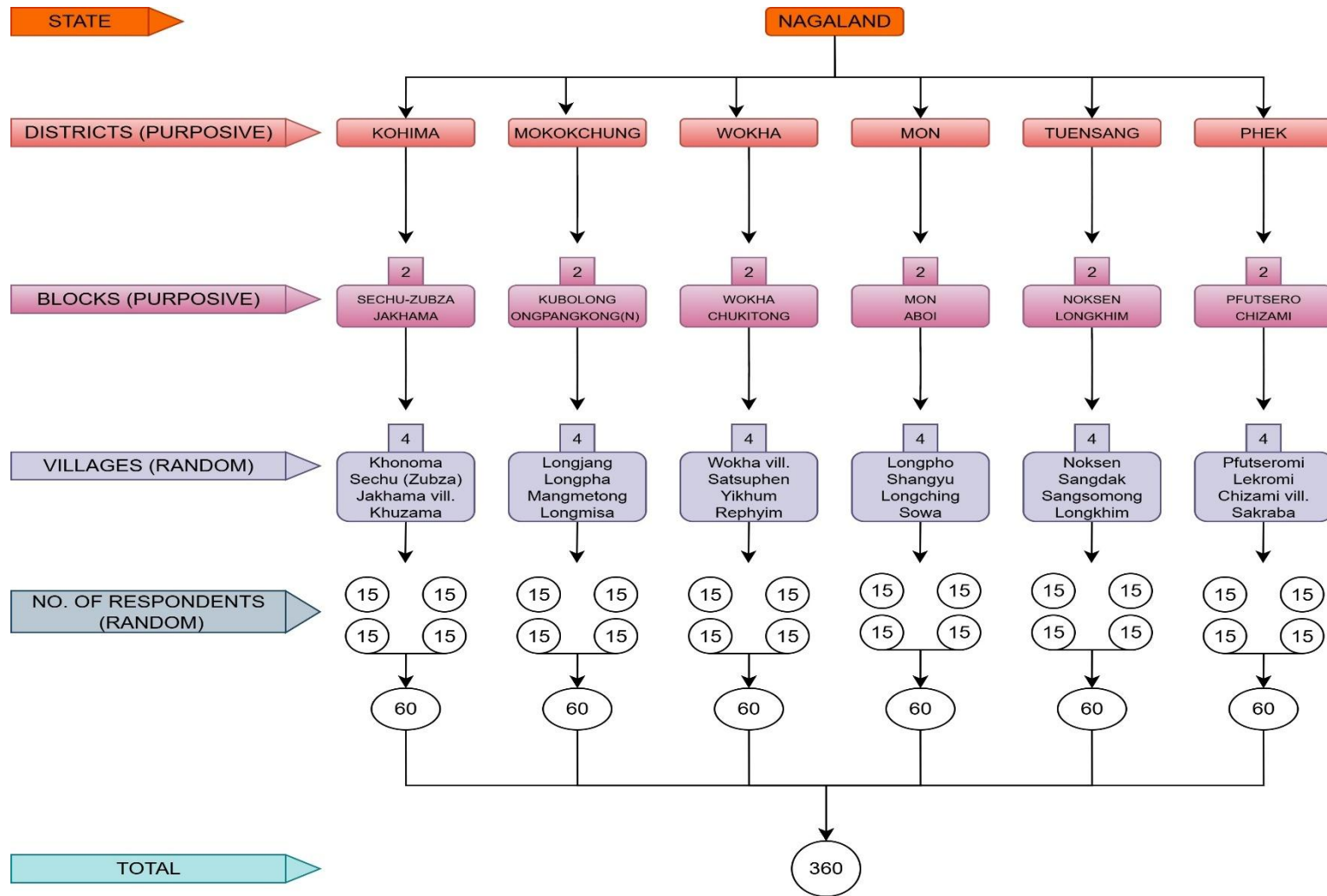


Fig 3.8: Sampling Design

3.1.1 Selection of the district

The study was conducted in the state of the Nagaland. Nagaland is located in the hills and mountains of the country's northeastern region. Nagaland is bordered to the northeast by Arunachal Pradesh, to the south by Manipur, to the west and northwest by Assam, and to the east by Myanmar (Burma). The state capital is Kohima, which is located in southern Nagaland.

At present, there are 17 districts in the state of Nagaland namely; Chümoukedima, Dimapur, Kiphire, Kohima, Longleng, Meluri, Mokokchung, Mon, Niuland, Noklak, Peren, Phek, Shamator, Tuensang, Tseminyü, Wokha and Zünheboto. Out of which 6 districts in total will be purposively selected: Backward area consisting of people from the District of Mon, Tuensang and Phek; Forward area from the districts of Wokha, Mokokchung and Kohima (Anonymous, 2017).

3.1.2 Selection of agricultural blocks

From each district, 2 blocks were randomly selected for the study. Therefore, a total of 12 blocks were selected for the present study. From Kohima district Sechu-Zubza and Jakhama blocks were selected; from Mokokchung district Kubolong and Ongpangkong(N) blocks were selected; from Wokha district Wokha and Chukitong blocks were selected; from Mon district Mon and Aboi blocks were selected; from Tuensang district Noksen and Longkhim blocks were selected and from Phek district Pfutsero and Chizami blocks were selected for the study.

3.1.3 Selection of villages

For the study 2 villages from each block (12 blocks) were selected, making a total of 24 villages.

Sl no.	CD-Block	VILLAGE
1	Sechu-Zubza	Khonoma and Sechu (Zubza)
2	Jakhama	Jakhama village And Khuzama
3	Kubolong	Longjang and Longpha
4	Ongpangkong(N)	Mangmetong and Longmisa
5	Wokha	Wokha village and Satsuphen
6	Chukitong	Yikhum and Rephyim
7	Mon	Longpho and Shangyu
8	Aboi	Longching and Sowa
9	Noksen	Noksen and Sangdak
10	Longkhim	Sangsomong and Longkhim
11	Pfutsero	Pfutseromi and Lekromi
12	Chizami	Chizami village and Sakraba

3.2 Selection of the respondents

For the present study, from each selected village. A list constituting of progressive farmers from each selected blocks was collected from reliable sources with the assistance of Nagaland State Agriculture and allied Departments. Then, 15 farmers from each village were randomly selected for the purpose of collection of information and data. Thus, 360 respondents constituted the final sample for this study.

3.3 Selection of variables

After reviewing available literature relevant for the study and receiving constructive opinion from the experts, 12 profile characteristics and 4 descriptive variable was selected for this study.

3.3.1 Profile characteristics

- i. Age
- ii. Sex
- iii. Family Type
- iv. Family size
- v. Annual Income
- vi. Educational qualification
- vii. Primary occupation
- viii. Secondary occupation
- ix. Farming experience
- x. Social participation
- xi. Total Landholding
- xii. Sources of Information

3.3.2 Descriptive variable

- i. Knowledge Level
- ii. Attitude
- iii. Adoption
- iv. Extend of Usage

3.4 Relevant variables and their empirical measurements

3.4.1 Profile characteristics

3.4.1.a Age

Age refers to the chronological age of the respondents in terms of completed years at the time of interview. The respondents were categorized as young, middle age and old age under the following ranges. The empirical measures used for this variable were mean and standard deviation.

Sl no.	Category	Categorization method
1.	Young	Up to ($\bar{X} - SD$)
2.	Middle age	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
3.	Old	($\bar{X} + SD$) and above

3.4.1.b Sex

Sex refers to the biological and physiological characteristics that define male and female. The respondents were classified as male and female and scores of 1 and 2 were given as shown in table.

Sl no.	Category	Score
1.	Male	1
2.	Female	2

3.4.1.c Family Type

Family type refers to the specific structure and composition of a family unit, defined by the relationships among its members. Respondents were classified as joint and nuclear and scores of 1 and 2 were given as shown in table.

Sl no.	Category	Score
--------	----------	-------

1.	Joint	1
2.	Nuclear	2

3.4.1.d Family Size

Family size refers to the total number of individuals living together as members of a single-family unit. The respondents were categorized as small, medium and large family under the following ranges. The empirical measures used for this variable were mean and standard deviation.

Sl no.	Category	Categorization method
1.	Small	Up to ($\bar{X} - SD$)
2.	Medium	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
3.	Large	($\bar{X} + SD$) and above

3.4.1.e Annual Income

Annual income refers to the total earnings obtained from farming, animal husbandry, off-farming activities *etc.* from the respondents in one calendar year. The empirical measures used for this variable was mean and standard deviation.

The respondents were classified as follows:

Category	Score
Low	Up to ($\bar{X} - SD$)
Medium	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
High	($\bar{X} + SD$) and above

3.4.1.f Educational Qualification

Educational status refers to the level of formal education an individual has attained, usually classified according to the highest grade, stage, or degree successfully completed. The respondents were categorized based on the classification suggested by Kothari Commission (1966) with slight modification. They were classified into eight categories, *viz.* illiterate, lower primary, upper primary, secondary, higher secondary and graduate. The empirical measures used for this variable was frequency and percentage.

Sl no.	Category	Score
1	Illiterate	0
2	Lower Primary	1
3	Upper Primary	2
4	Secondary	3
5	Higher Secondary	4
6	Graduate	5

3.4.1.g Primary Occupation

Primary occupation refers to the main type of work or livelihood activity that an individual depends on for earning income and sustaining their living. The respondents were classified into four categories based on the occupational status as shown in the table. The empirical measures used for this variable was frequency and standard percentage.

Sl no.	Category	Score
--------	----------	-------

1	Farming	1
2	Government Employee	2
3	Business	3
4	Others	4

3.4.1.h Secondary Occupation

Secondary occupation refers to the supplementary type of work or activity undertaken by an individual, in addition to their primary occupation, to provide extra income or support their livelihood. The respondents were classified into four categories based on the occupational status as shown in the table. The empirical measures used for this variable was frequency and standard percentage.

Sl no.	Category	Score
1	None	0
2	Government Employee	1
3	Business	2
4	Handloom Weaving	3
5	Collection of Non-Timber Forest Products	4

3.4.1.i Farming experience

Farming experience refers to the number of years of experience in farming by the respondents. The respondents were categorized as low experience, medium experience and high experience. The empirical measures used for this variable was mean and standard deviation.

Sl no.	Category	Categorization method
1	Low experience	Up to ($\bar{X} - SD$)
2	Medium experience	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
3	High experience	($\bar{X} + SD$) and above

3.4.1.j Social Participation

Social participation refers to the degree of involvement of the respondents in formal organizations as a member, as an office bearer and both. The degree of involvement taken into consideration includes both present and past involvement for quantifying the variables. The empirical measures used for this variable was frequency and standard percentage.

Sl no.	Category	Score
1	None	0
2	Church officials	1
3	Village Council	2
4	SHG group	3

3.4.1.k Total Landholding

Total landholding refers to the entire amount of land owned, leased, or possessed by a household or individual, irrespective of its type, location, or use. On the basis of total land holding, the respondents were categorized as small, medium and big farmers as shown in the table. The empirical measures used for this variable was mean and standard deviation.

Category	Range

Small	Up to ($\bar{X} - SD$)
Medium	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
Large	($\bar{X} + SD$) and above

3.4.1.1 Source of information

Source of information refers to the origin or medium through which an individual receives knowledge, facts, or messages, such as people, organizations, media, or digital platforms. The scoring procedure followed was:

Extension Contact

Sl no.	Category	Weightage
1	Agricultural Officer	1
2	KVK professionals	2
3	Horticultural Officer	3
4	ATMA professionals	4
5	VLW/ AFA	5
6	NGOs	6
7	Veterinary Officer	7

Mass media

Sl no.	Category	Weightage
1	Exhibition	1

2	Mobile phones (mobile internet)	2
3	Newspaper	3
4	Magazines	4
5	Radio	5
6	TV	6
7	Print media: poster/folder/leaflet	7

Personal Localite

Sl no.	Category	Weightage
1	Relatives	1
2	Friends	2
3	Progressive Farmers	3
4	Neighbours	4

The final scores was calculated by taking the sum of all the scores obtained from all the three categories. The respondents were further categorized as low, medium and high using mean and standard deviation.

Category	Score
Low	Upto ($\bar{X} - SD$)
Medium	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
High	($\bar{X} + SD$) and above

3.4.2 Descriptive variable

3.4.2.a Knowledge

Knowledge refers to the degree or level of information that the respondents have on Information communication technologies. Knowledge allows a person to know about the existence of an innovation and the way it works.

In this study, the knowledge level on Information Communication Technologies was assessed using a structured schedule developed by Sayem *et al.*, (2022) with four levels of measurement, *viz.*, strongly disagree, disagree, agree and strongly agree. Each respondent was asked to put his/her opinion against each question in any one of the above mention alternatives.

$$\text{Knowledge Index (KI)} = \frac{\text{Total score obtained by the respondents}}{\text{Maximum possible score}} \times 100$$

Based on the results obtained, the respondents were classified into three categories as low, medium and high knowledge level as follows:

Sl. No.	Knowledge Level	Score Range
1	Low	Upto ($\bar{X} - SD$)
2	Medium	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
3	High	($\bar{X} + SD$) and above

To further assess the relationship of knowledge level with the socio-economic profile of the respondents pearson correlation, regression and chi-square test was conducted.

3.4.2.b Attitude

Attitude refers to a learned predisposition of an individual to think, feel, or behave in a consistent manner toward a particular object, person, idea, or situation, typically shaped by experiences, beliefs, and values.

In this study, the Attitude of the respondents towards Information Communication Technologies was assessed using a slightly modified structured schedule developed by Kumar *et al.*, (2011) with five levels of measurement, *viz.*, strongly disagree, disagree, undecided, agree and strongly agree. Each respondent was asked to put his/her opinion against each question in any one of the above mention alternatives.

Based on the results obtained, the respondents were classified into three categories as low, medium and high attitude towards ICT, as follows:

Sl. No.	Attitude	Score Range
1	Low	Upto ($\bar{X} - SD$)
2	Medium	Between ($\bar{X} - SD$) and ($\bar{X} + SD$)
3	High	($\bar{X} + SD$) and above

3.4.2.c Adoption

Adoption implies to the acceptance and sustained use of improved technologies or practices introduced to enhance livelihood or productivity.

In order to analyze the adoption pattern of ICT tools among the respondents, a binary classification was carried out. Each respondent was evaluated based on their responses to usage or access to various ICT tools. Based on the overall usage, ownership pattern and availability, the respondents were categorized into two categories as mentioned below:

- **Adopters** (coded as **1**): Respondents who reported active use or ownership of a significant number of ICT tools.
- **Non-adopters** (coded as **0**): Respondents who either did not use, had limited or no access to ICT tools or showed minimal engagement with such technologies.

This binary variable was constructed by averaging the responses from individual ICT usage, accessibility of ICT tools and availability of ICT tools. Binary Logistic Regression was employed to identify the predictors influencing ICT adoption.

3.4.2.d Extend of usage

Extent of usage refers to the degree or frequency with which an individual makes use of a particular resource, tool or practice, usually measured in terms of how often and how intensively it is applied within a given context. In the current study it implies to how regularly and to what level farmers employ different communication technologies (e.g., radio, WhatsApp, YouTube, ATM, etc.) for agricultural purposes.

To assess the utilisation pattern of ICT tools the following were categories were considered; accessibility of ICT tools, availability of ICT tools and extent of usage The scoring procedure followed was:

Accessibility (Ownership)

S. No.	Category		Not Owned	Shared	Owned
1	Traditional Media	Radio			
		Television			
2	Mobile based tools	SMS			
		Whatsapp			

		Weather app			
3	Internet	You tube			
		Facebook			
		e-Mail			
		e-Books			
4	Digital Infrastucture	Computer			
		CD/DVD			

Availability

S. No.	Category		Not Available	Hard to access	Easily Available
1	Traditional Media	Radio			
		Television			
2	Mobile based tools	SMS			
		Whatsapp			
		Weather app			
3	Internet	You tube			
		Facebook			
		e-Mail			
		e-Books			
4	Digital Infrastucture	Computer			
		ATM			
		CD/DVD			

Extend of usage

S. No	Category		Never	Rarely	Occasionally	Frequently	Very Frequently
1	Traditional Media	Radio					
		Television					
2	Mobile based tools	SMS					
		Whatsapp					
		Weather app					
3	Internet	You tube					
		Facebook					
		e-Mail					
		e-Books					
4	Digital Infrastructure	Computer					
		ATM					
		CD/DVD					

Pearson correlation was used to examine the relationship among accessibility, availability, and usage. A multiple linear regression model was used with "Extent of Usage" as the dependent variable and "Accessibility" and "Availability" as independent variables. A path model was constructed using mean scores of the three variables to study the directional influence among accessibility, availability, and usage.

3.4.2.e To identify the constraints faced by respondents with regard to Information communication Technologies

In this study, constraint is referred to the problems, hindrance or barriers which come in the way of acceptance and adoption of indigenous technical knowledge. A list of constraints was prepared after the pilot study conducted in the study with reference from past study and researches conducted. The constraints were further reviewed and reconsidered to finalize as recognized constraints for the study. Altogether, 12 constraints were included in the study and respondents were allowed to rank the statement. Based on the response provided, garrett ranking technique was used for the study.

3.5 Methods of data collection

Primary and secondary data's were collected for the purpose of the study. An interview schedule was prepared based on the objectives set for the study. Primary data was collected from the respondents through personal interview and group discussion. Secondary data was collected from relevant journals, internet sources, State agriculture department *etc.*, the collected data were coded, tabulated and analyzed to get the result.

3.6 Statistical tools used for data analysis

For drawing valid conclusion, the data was processed, classified, tabulated and systematically analyzed with appropriate statistical tools. Following are statistical tools used for analysis of available data.

3.6.1 Percentage

Percentage is a way of expressing a number as a fraction of 100.

$$\text{Percentage (\%)} = \frac{\text{Number of observations}}{\text{Total number of observation}} \times 100$$

3.6.2 Arithmetic mean

Arithmetic mean of a set of values is the quantity commonly called the mean or the average. It is defined as the sum total of all observations divided by the number of cases.

$$\text{Mean} = \frac{\text{Sum total of all observations}}{\text{Number of observation}}$$

3.6.3 Standard deviation

Standard deviation is defined as the square root of the sum of squared deviation about the mean divided by the number of cases.

$$\text{SD} = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$$

Where,

SD = Standard Deviation

x = Individual Score

N = Number of Observations

3.6.4 Garrett ranking

To assess the constraints faced by farmers towards Information communication Technologies, Garrett's Ranking Technique was used. The prime advantage of this technique over simple frequency distribution is that the constraints are arranged based on their severity from the point of view of respondents. It is used to find the most significant factor which had influenced the respondent in their practices. As suggested by Garrett for converting rank into scores, when the preference of a particular problem different from respondent to respondent. The conversion method was as follows

$$\text{Per cent Position} = \frac{100(R_{ij}-0.5)}{N_j}$$

Where,

R_{ij} = Rank given for the i^{th} variable by the j^{th} respondents.

N_j = Number of variable ranked by the j^{th} respondents.

With the help of Garrett's table, the per cent position estimated is converted into scores by referring to the table given by Garrett and Woodworth (1969).

3.6.5 Pearson's correlation coefficient

Pearson's correlation coefficient was used to measure the extent of the relationship prevailing between the variables which can be expressed as

$$\rho_{XY} = \frac{\text{cov}(XY)}{\sigma_X \sigma_Y}$$

where,

cov is the covariance

σ_X is the standard deviation of X

σ_Y is the standard deviation of Y

3.6.5 Regression

Regression is a statistical method used to model and analyze the relationship between a dependent variable and one or more independent variables.

3.6.5.a Simple Linear regression

For a single predictor variable, the regression equation is:

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

Where:

Y = Dependent variable

X = Independent variable

β_0 = Intercept

β_1 = Slope coefficient

ε = Error term

3.6.5.b Multiple Linear regression

For a multiple predictor variable, the regression equation is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon$$

Y = Dependent variable

X = Independent variable

β_0 = Intercept

β_1 = Slope coefficient

ε = Error term

3.6.5.c Binary Logistic regression

Binary logistic regression is a classification technique used when the dependent variable is binary. In this study Adoption was considered as the dependent variable. Logistic regression predicts the probability that a respondent may fall under or belong to a certain category; in this study adopter or non-adopter category. The current statistical analysis was carried out in SPSS v26. The logit model and the formula is given below.

Logit model:

$$z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n$$

Where,

Y = Dependent variable

X = Independent variable

β_0 = Intercept

β_1 = Slope coefficient

Log-odds (logit) form:

$$\ln \left(\frac{p}{(1-p)} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where,

$\ln \left(\frac{p}{(1-p)} \right)$ = log-odds of adoption

β_0 = intercept

β_i = regression coefficient for the i^{th} predictor variable

X_i = value of the i^{th} predictor variable

p = probability of adoption

3.6.6 Chi-square test

The Chi-Square test is a non-parametric statistical test used to determine whether there is a significant association between two categorical variables or whether an observed frequency distribution differs from an expected distribution.

It works by comparing the observed frequencies with the expected frequencies. The differences are squared, weighted by the expected values, and summed to produce the chi-square statistic. The formula of chi square test is given below.

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where,

O_{ij} =observed frequency in the i^{th} row and j^{th} column

E_{ij} =expected frequency

r = number of rows

c = number of columns

3.6.7 Path analysis

Path analysis helps to identify the indirect and total causal relationships among a set of observed variables. It is a type of Structural Equation Modeling (SEM) where all variables are observed and no latent variables are involved.

The path analysis for the study was carried out using SPSS AMOS v26 to examine the causal relationships between variables, estimating both direct and indirect effects. The formula for path analysis is as under:

$$Y = \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon$$

Where,

Y = endogenous variable

X_1, X_2, \dots, X_k = exogenous or predictor variables

$\beta_1, \beta_2, \dots, \beta_k$ = path coefficients

ε = error

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The collected data for the study have been organized and analysed according to the objectives of the study. The results and discussions of the current study are given under the following headings:

- 5.1 To study the socio-economic status of the respondents.
- 5.2 To assess the Knowledge Level and extent of use ICT by the respondents
- 5.3 To examine the Attitude of farmers on application of ICT in agriculture.
- 5.4 To study the factors influencing adoption of ICT tools.
- 5.5 To identify the constraints faced by the farmers in using ICT and to suggest measures for improvement.

4.1 Socio-economic status of the respondents

Under this the socio-economic characteristics of the respondents was studied. All the possible considerations related to profile characteristics were included and discussed accordingly under this objective.

4.1.1 Age

Age is recognized as a crucial socio-economic factor influencing decision-making across various domains. It reflects an individual's level of experience, mental maturity, and psycho-physical capacity, all of which can significantly affect the adoption of innovations such as ICT tools. Hence, age has been included as a key variable in this study, as shown in Table 4.1.1.

Table 4.1.1 Distribution of respondents based on age

N=360

Sl no.	Age	Frequency	Percentage	Mean	SD
1	Young (< 41 years)	60	18.06	51.19	10.29
2	Middle-age (41-61 years)	235	65.28		
3	Old (> 61 years)	65	16.67		
Total		360	100		

The distribution of the respondents as seen from the Table 4.1.1 and Fig 4.1.1 revealed that majority of the respondents belonged to the category of middle-age group with 65.28 per cent followed by young age group with 18.06 per cent and old age group with 16.67 per cent. Similar type of finding was reported by Singh and Kameswari (2019).

It can be understood from the study that individuals under the middle-aged category were in their prime working years as this age group were more established and financially stable.

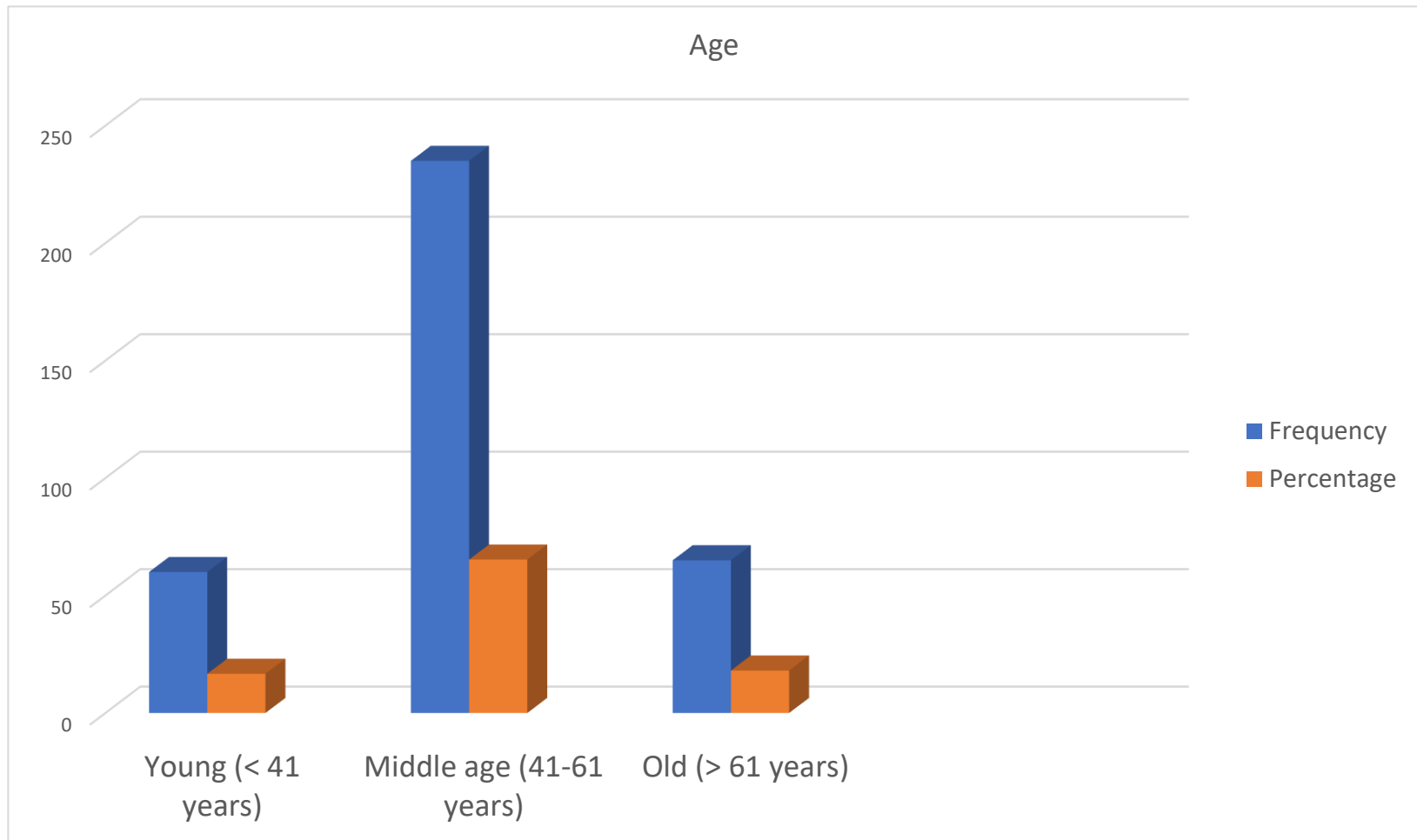


Fig 4.1.1 Distribution of respondents based on age

4.1.2 Sex

Sex is a fundamental social category that distinguishes individuals within a society. It is a cultural construct associated with gender-specific roles, behaviours, and expectations, which influence individuals' actions and participation within a social group. Accordingly, the distribution of respondents based on sex has been examined in this study and is presented in Table 4.1.2.

Table 4.1.2 Distribution of respondents based on sex

N=360			
Sl no.	Category	Frequency	Percentage
1	Male	223	61.94
2	Female	137	38.06
Total		360	100

Table 4.1.2 and fig 4.1.2 clearly depicts that majority (61.94 %) of the respondents were male and 38.06% of the respondents were female. Similar findings were reported by Arockiaraj and Kumar (2021).

This disparity may be attributed to the fact that, in many rural and agricultural settings, men are more often recognized as the primary decision-makers and landholders, resulting in their greater representation in agricultural activities.

4.1.3 Family Type

Family type is one of the most important socio-economic factors influencing decision-making and resource sharing within households. It plays a vital role in shaping social interactions, support systems, and work participation.

Thus, family type has been considered as one of the variables in this study and is presented in Table 4.1.3.

Table 4.1.3 Distribution of respondents based on family type

N=360

Sl no.	Category	Frequency	Percentage
1	Joint	46	12.78
2	Nuclear	314	87.22
Total		360	100

Table 4.1.3 and fig 4.1.3 shows that majority 87.22 per cent of the respondents belonged to nuclear family while 12.78 per cent of the respondents belonged to joint family. Among the Nagas, the tradition of living in nuclear families has been prevalent since olden days, reflecting their cultural preference for independent family units and self-sufficiency in household management.

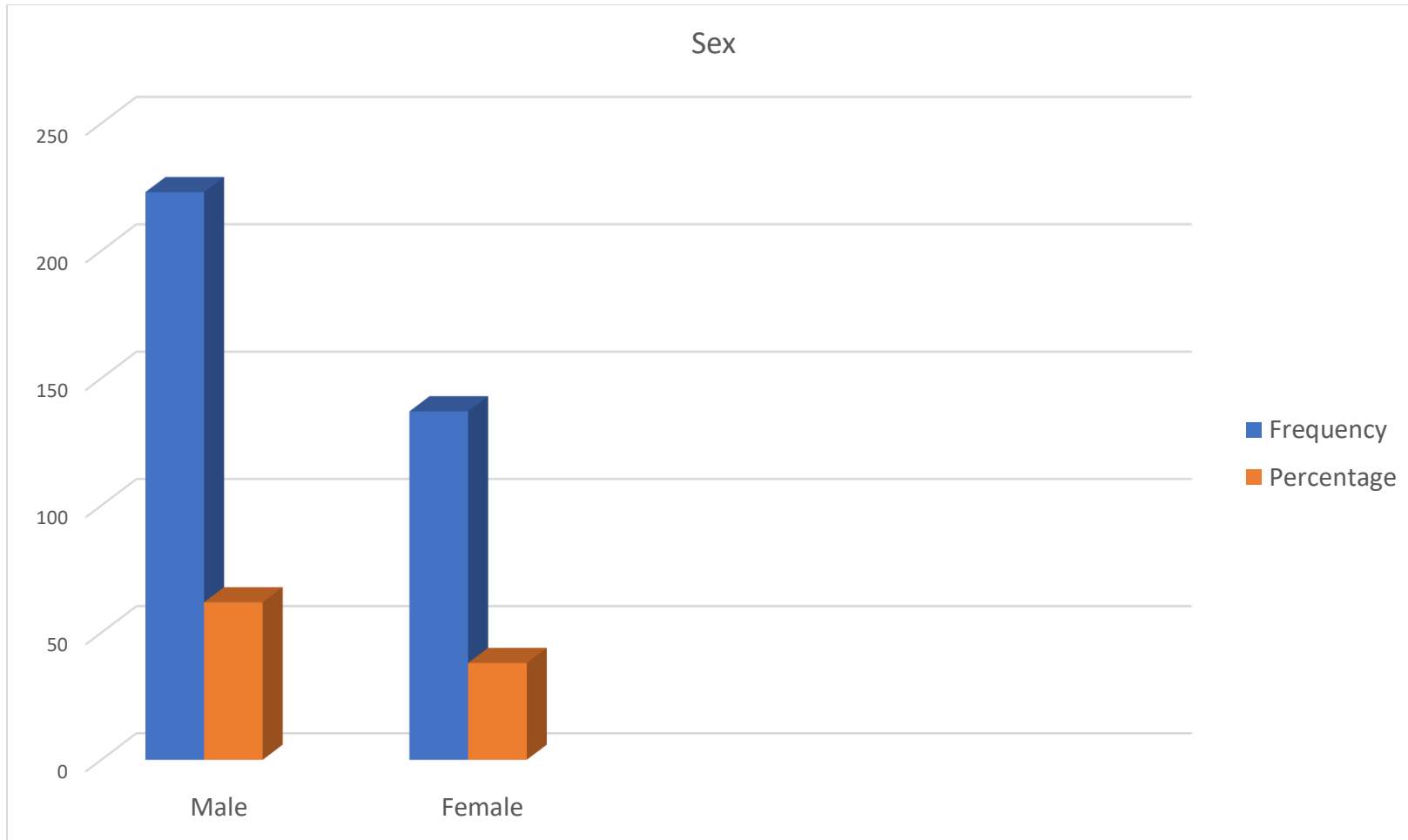


Fig 4.1.2 Distribution of respondents based on sex

4.1.4 Family size

Family size is a key demographic variable that influences household structure, labor availability, and socio-economic decision-making. It affects the distribution of responsibilities, access to resources, and participation in agricultural and livelihood activities. Considering its relevance to household dynamics, family size has been incorporated as one of the variables in this study, as presented in Table 4.1.4

Table 4.1.4 Distribution of respondents based on family size

N=360

Sl no.	Family size	Frequency	Percentage	Mean	SD
1	Small (<4)	46	12.78	5.56	1.80
2	Medium (4-7)	261	72.50		
3	Large (>7)	53	14.72		
Total		360	100		

Table 4.1.4 and fig 4.1.4 revealed that majority (72.50%) of the respondents had medium family size (4-7 members). 14.72 per cent of the respondents belonged to large family and only 12.78 per cent of the family belonged to small family size.

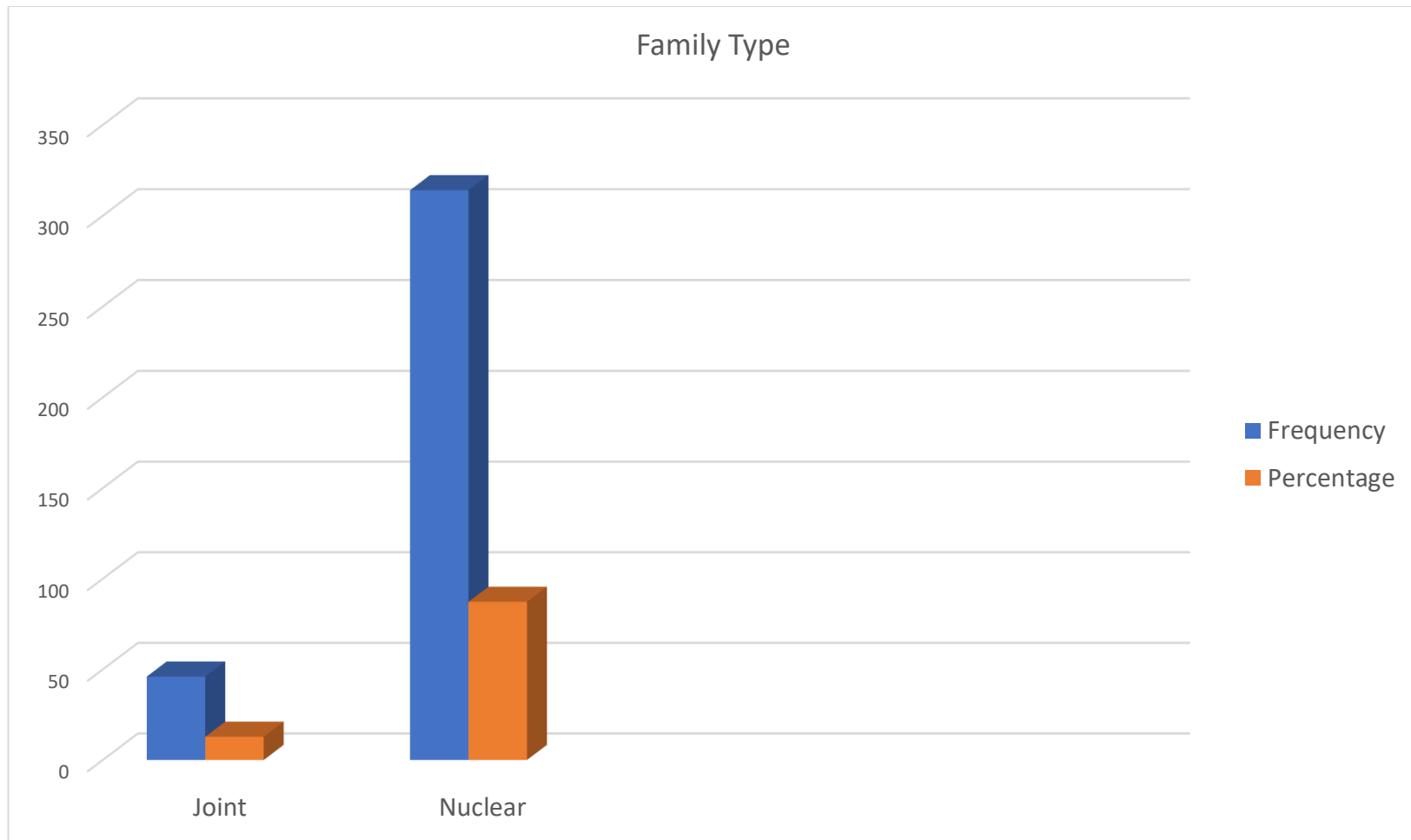


Fig 4.1.3 Distribution of respondents based on family type

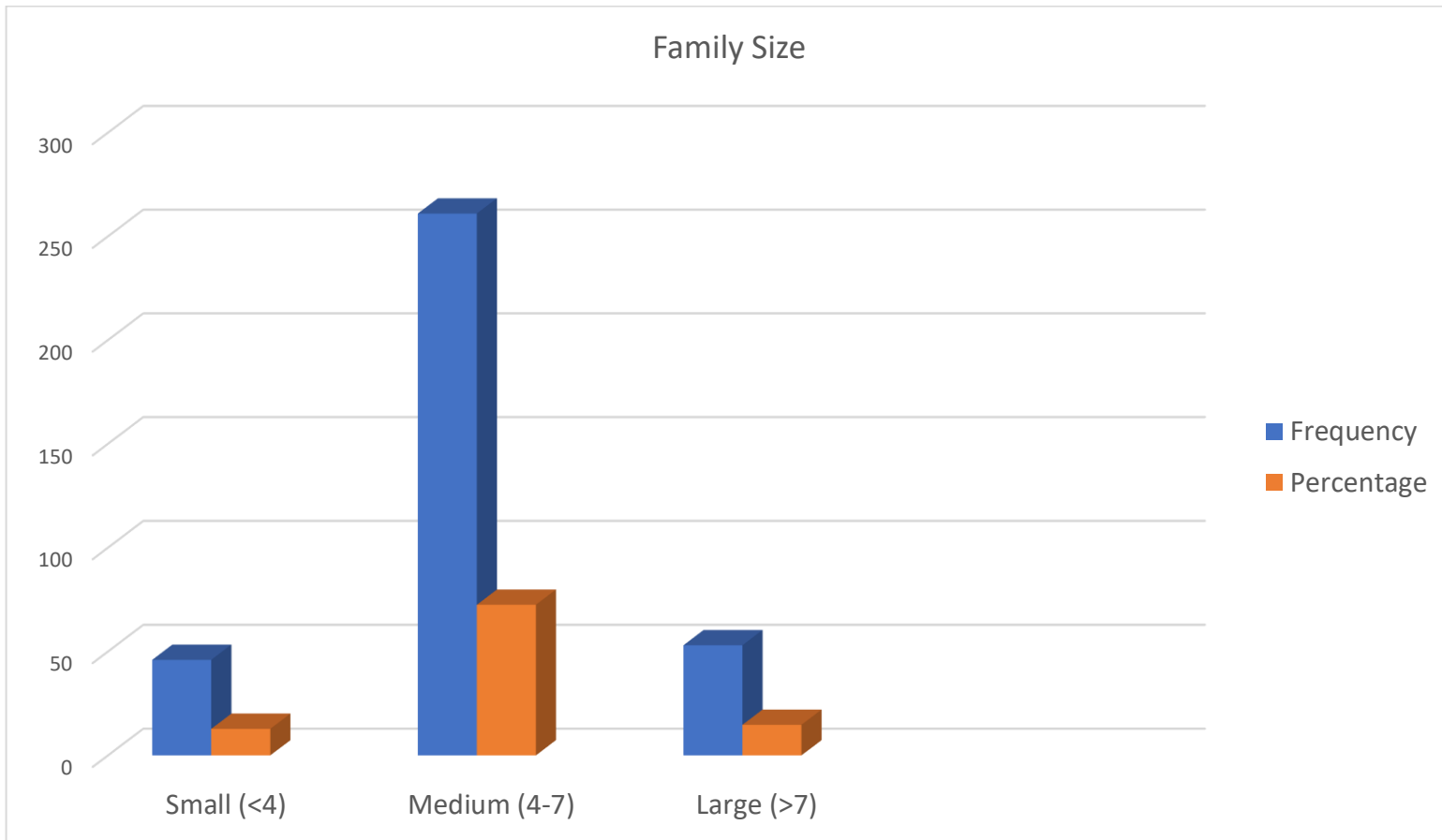


Fig 4.1.4 Distribution of respondents based on family size

The predominance of medium-sized families may be attributed to the balance they offer between labor availability for agricultural activities and manageable household expenditure, which is suitable for rural agrarian settings. This family size suggests a balance between having children and maintaining a manageable household.

4.1.5 Annual Income

Annual income is recognized as a crucial socio-economic variable, significantly influencing household decision-making, investment capabilities, and overall socio-economic status. Income levels directly affect the ability of individuals to access resources, adopt innovations, and improve livelihoods. Considering its importance in shaping agricultural practices and technology adoption, annual income was selected as a key variable for this study and is presented in Table 4.1.5.

Table 4.1.5 Distribution of respondents based on annual income

N=360

Sl no.	Annual Income	Frequency	Percentage	Mean	SD
1	Low (<₹215031)	70	19.44	3863 41.67	17131 0.73
2	Medium (₹215031-₹557652)	218	60.56		
3	High (>₹557652)	72	20.00		
Total		360	100		

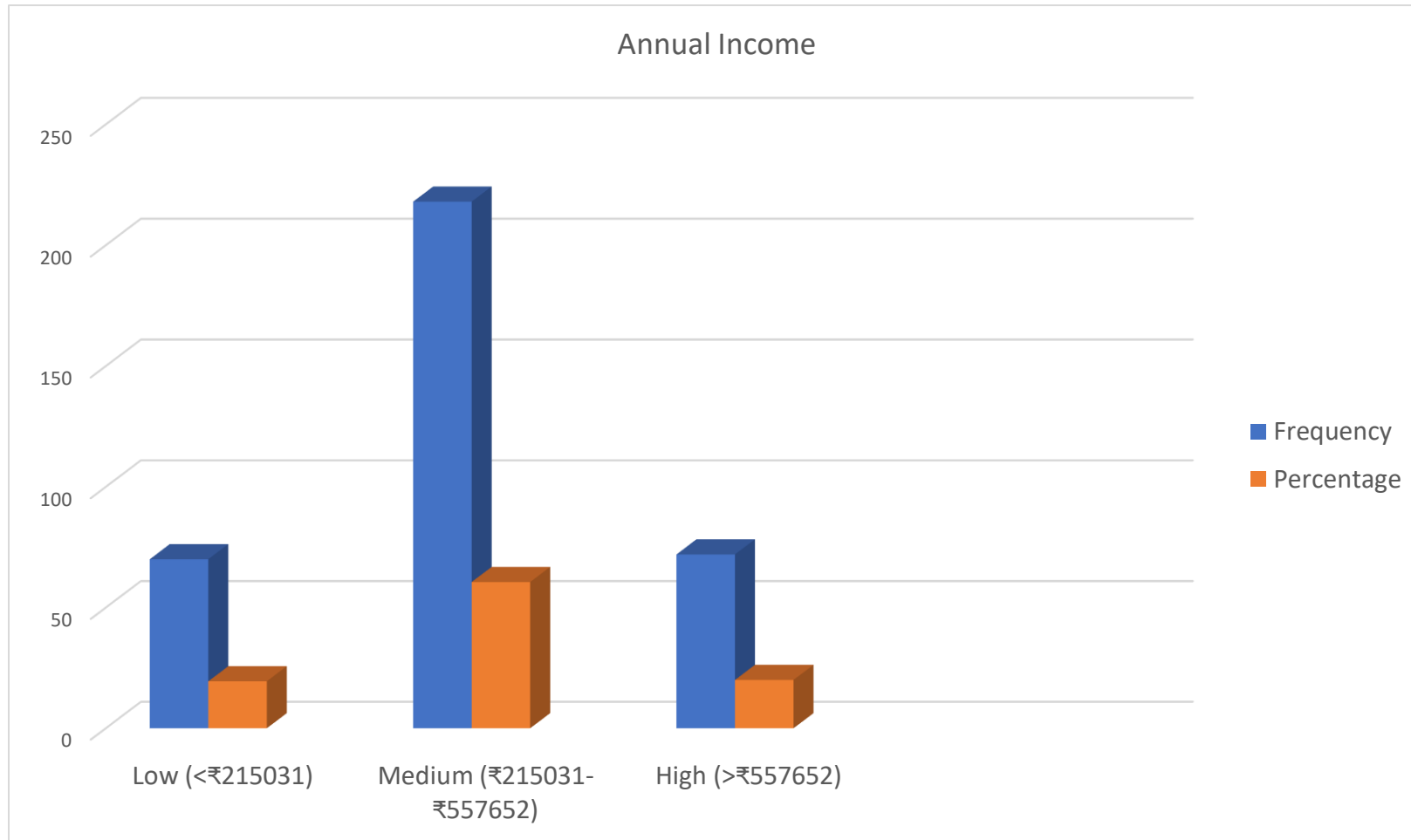


Fig 4.1.5 Distribution of respondents based on Annual Income

Table 4.1.5 and Fig 4.1.5 shows that respondents with medium income category having income between ₹215031-₹557652 formed the major segment with 60.56 per cent, followed by high income category of >₹557652 with 20.00 per cent and lastly low income category with <₹215031 with 19.44 per cent respectively. Similar findings were reported by Kafura *et al.* (2016).

The predominance of medium income respondents may be attributed to the semi-commercial nature of agricultural activities, where farming provides a stable but moderate income, supplemented by other small-scale livelihood activities like livestock rearing and small businesses.

4.1.6 Educational Qualification

Educational qualification is recognized as a critical socio-economic variable that significantly influences an individual's decision-making capacity, access to information, and ability to adopt innovations. Higher levels of education enhance awareness, analytical skills, and openness to new practices, particularly in the context of agricultural development. Therefore, educational qualification has been included as an important variable in this study and is presented in Table 4.1.6.

Table 4.1.6 Distribution of respondents based on educational Qualification

N=360

Sl no.	Category	Frequency	Percentage
1	Illiterate	39	10.83
2	Lower Primary	36	10.00
3	Upper Primary	58	16.11

4	Secondary	107	29.72
5	Higher Secondary	80	22.22
6	Graduate	40	11.11
Total		360	100

Table 4.1.6 and Fig 4.1.6 depicts that 29.71 per cent of the respondents had secondary level of education followed by 22.22 per cent of the respondents with higher secondary level of education, 16.11 per cent of the respondents had education till upper primary, 11.11 per cent of the were educated till graduate level, 10.83 per cent of the respondents were illiterate and 10 per cent of the respondents had education level till lower primary.

Majority of the respondents had secondary level of education which can be attributed to the emphasis on basic education in rural areas of Nagaland, where access to primary and secondary schools has improved over the years. However, factors such as economic hardships, limited availability of higher educational institutions in remote areas, and the early involvement of youth in agricultural activities have restricted the pursuit of higher education.

4.1.7 Primary Occupation

The nature of an individual's primary occupation is a critical determinant of their socio-economic status, livelihood security, and engagement with developmental initiatives. It significantly affects income levels, resource management, and the ability to adopt innovations, particularly in rural settings. Accordingly, primary occupation has been included as an important variable in this study and is presented in Table 4.1.7.

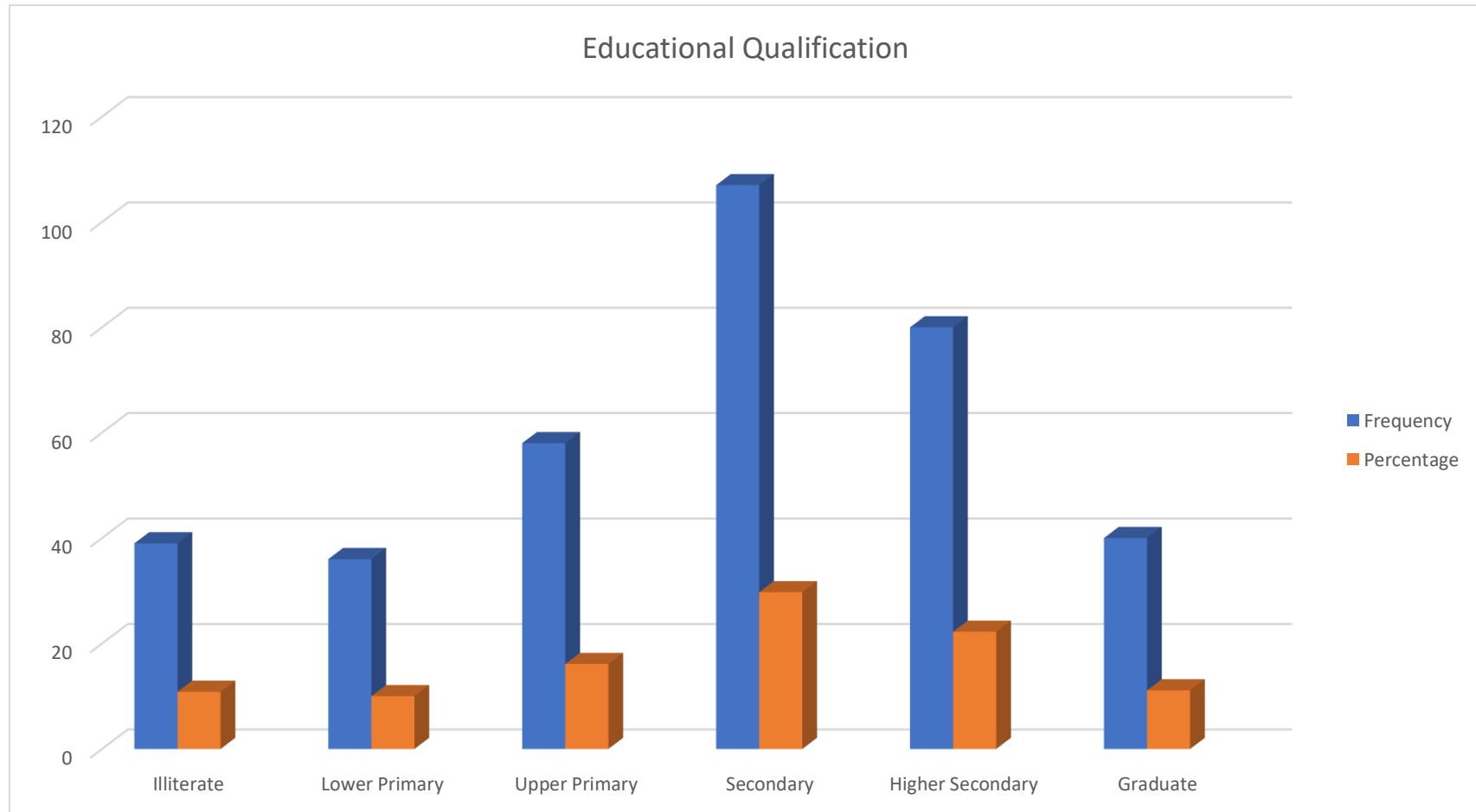


Fig 4.1.6 Distribution of respondents based on Educational Qualification

Table 4.1.7 Distribution of respondents based on Primary Occupation

N=360

Sl no.	Category	Frequency	Percentage
1	Farming	360	100
2	Government Employee	0	0
3	Business	0	0
4	Others	0	0
Total		360	100

Table 4.1.7 and Figure 4.1.7 indicate that all respondents (100%) were engaged in farming as their primary occupation. This is attributed to the agrarian nature of the economy in rural Nagaland, where agriculture remains the principal source of livelihood due to traditional practices, favourable climatic conditions, and limited opportunities for alternative employment.

4.1.8 Secondary Occupation

Secondary occupation serves as an important socio-economic indicator reflecting livelihood diversification, income enhancement, and economic resilience. It contributes to financial security, reduces dependency on a single source of income, and influences household decision-making and investment patterns. In recognition of its significance, secondary occupation has been included as one of the variables in this study and is presented in Table 4.1.8.

Table 4.1.8 Distribution of respondents based on Secondary Occupation

N=360

Sl no.	Category	Frequency	Percentage
1	None	207	57.50
2	Government Employee	37	10.28
3	Business	40	11.11
4	Handloom Weaving	7	1.94
5	Collection of Non-Timber Forest Products	69	19.17
Total		360	100

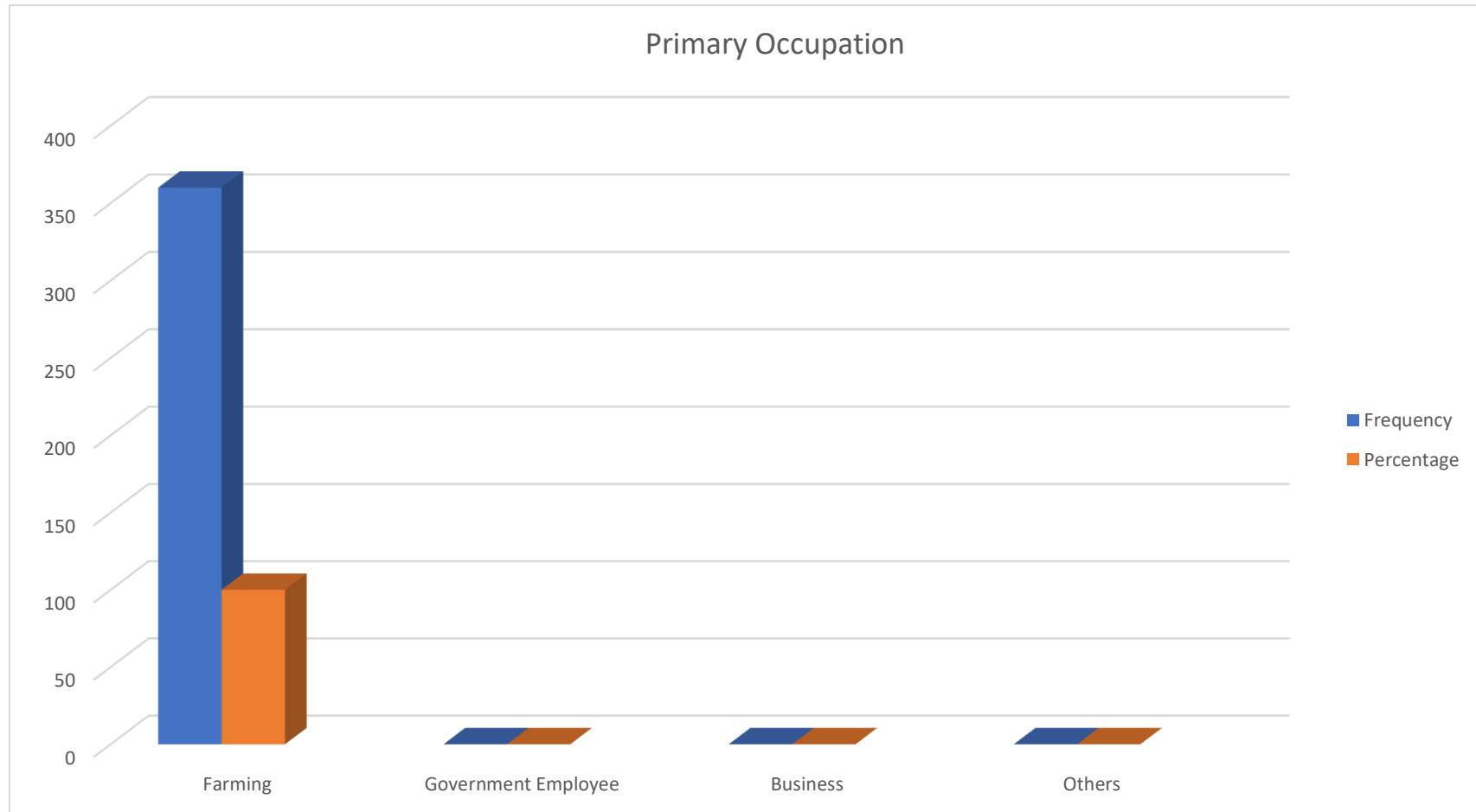


Fig 4.1.7 Distribution of respondents based on primary occupation

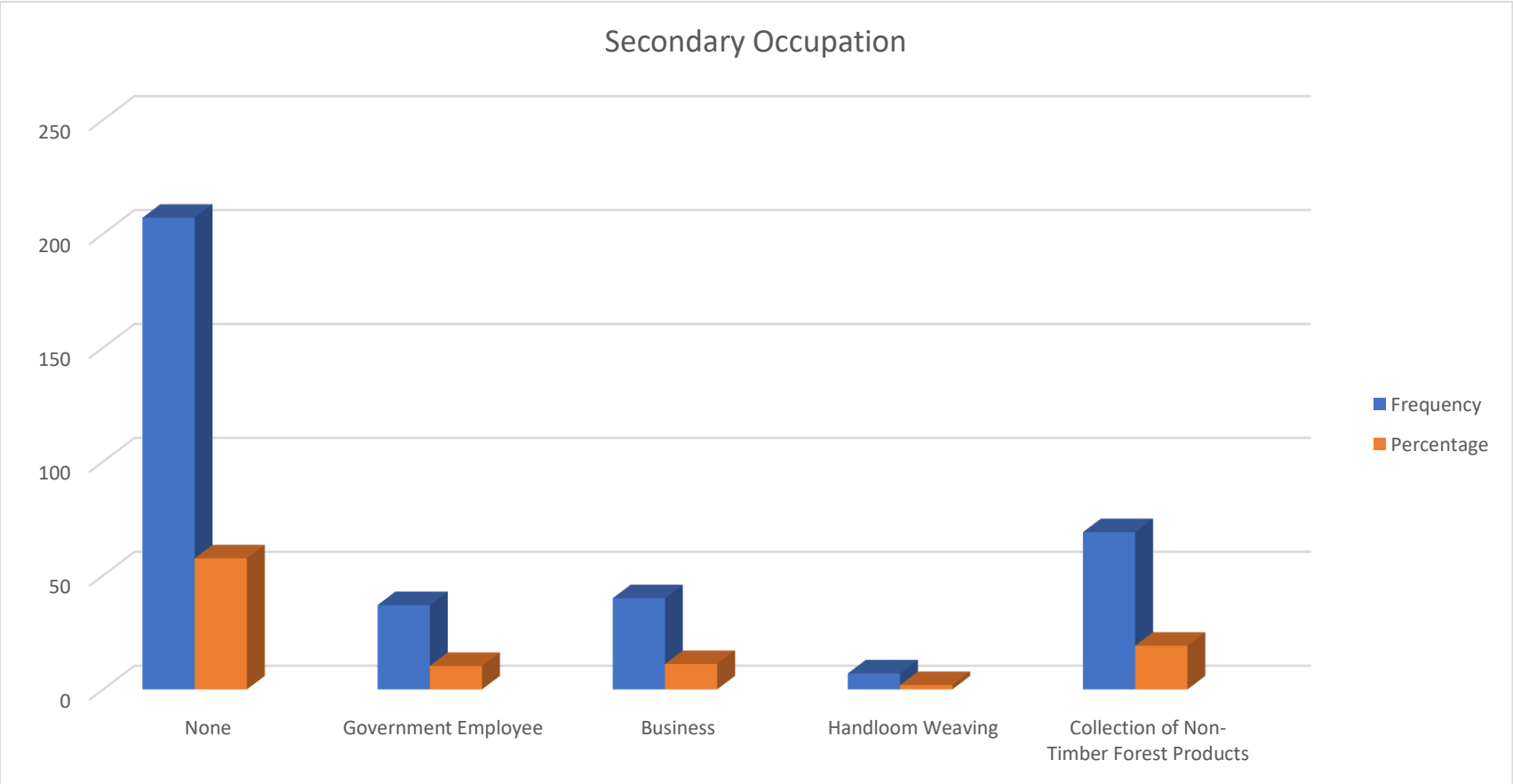


Fig 4.1.8 Distribution of respondents based on secondary occupation

Table 4.1.8 and Figure 4.1.8 shows that 57.50 per cent of the respondents did not engage in any secondary occupation and were solely farmers. 19.17 per cent of the respondents were engaged in collection of Non-Timber Forest Products as their secondary occupation followed by 11.11 per cent of the respondents were engaged in business activities, 10.28 per cent of the respondents were government employees and 1.94 per cent of the respondents were engaged in handloom weaving.

The labour-intensive nature of agricultural practices in rural Nagaland, where traditional farming systems, such as shifting cultivation and terrace farming, demand significant time, effort, and household labour, leaving limited scope for pursuing secondary occupations.

4.1.9 Farming experience

Farming experience refers to the number of years an individual has been actively engaged in agricultural activities, encompassing the knowledge, skills, and practical understanding gained over time through direct involvement in farming practices. It significantly influences decision-making, adoption of innovations, and the efficiency of farm management. Thus, farming experience has been considered as one of the variables in this study and is presented in Table 4.1.9.

Table 4.1.9 Distribution of respondents based on Farming experience

N=360

Sl no.	Farming experience	Frequency	Percentage	Mean	SD
1	Less than 11 years	45	12.50	15.76	4.97

2	11 to 21 years	259	71.94		
3	More than 21 years	56	15.56		
Total		360	100		

Table 4.1.9 and Figure 4.1.9 indicate that majority (71.94 %) of the respondents had farming experience between 11-21 years followed by 15.56 per cent of respondents had farming experience of more than 21 years and 12.50 per cent of the respondents had farming experience less than 11 years.

Majority of the respondents had 11–21 years of farming experience. This can be attributed to the demographic structure of the farming community, where a significant proportion are middle-aged individuals actively engaged in agriculture. This range also reflects a period during which farmers possess sufficient practical experience while remaining physically capable of managing labour-intensive farming activities.

4.1.10 Social Participation

Social participation refers to an individual’s active involvement in community organizations, groups, or collective activities, which facilitates information exchange, social networking, and collective action. It plays a crucial role in enhancing social capital, improving access to resources, and influencing decision-making processes within a community.

Table 4.1.10 Distribution of respondents based on Social Participation

N=360

Sl no.	Category	Frequency	Percentage
1	None	218	60.56

2	Church officials	67	18.61
3	Village Council	44	12.22
4	SHG group	31	8.61
Total		360	100

Table 4.1.10 and figure 4.1.10 shows that majority (60.56%) of the respondents did not involve in any social organization. 18.61 per cent of the respondents were church officials, 12.22 per cent of the respondents were involved in village council and 8.61 per cent of the respondents were members in SHG groups.

Table 4.1.10 infer that majority of the respondents did not involve in any social organization, this can be due to the demanding nature of agricultural activities and the preference for focusing on household and farm responsibilities over external community engagements.

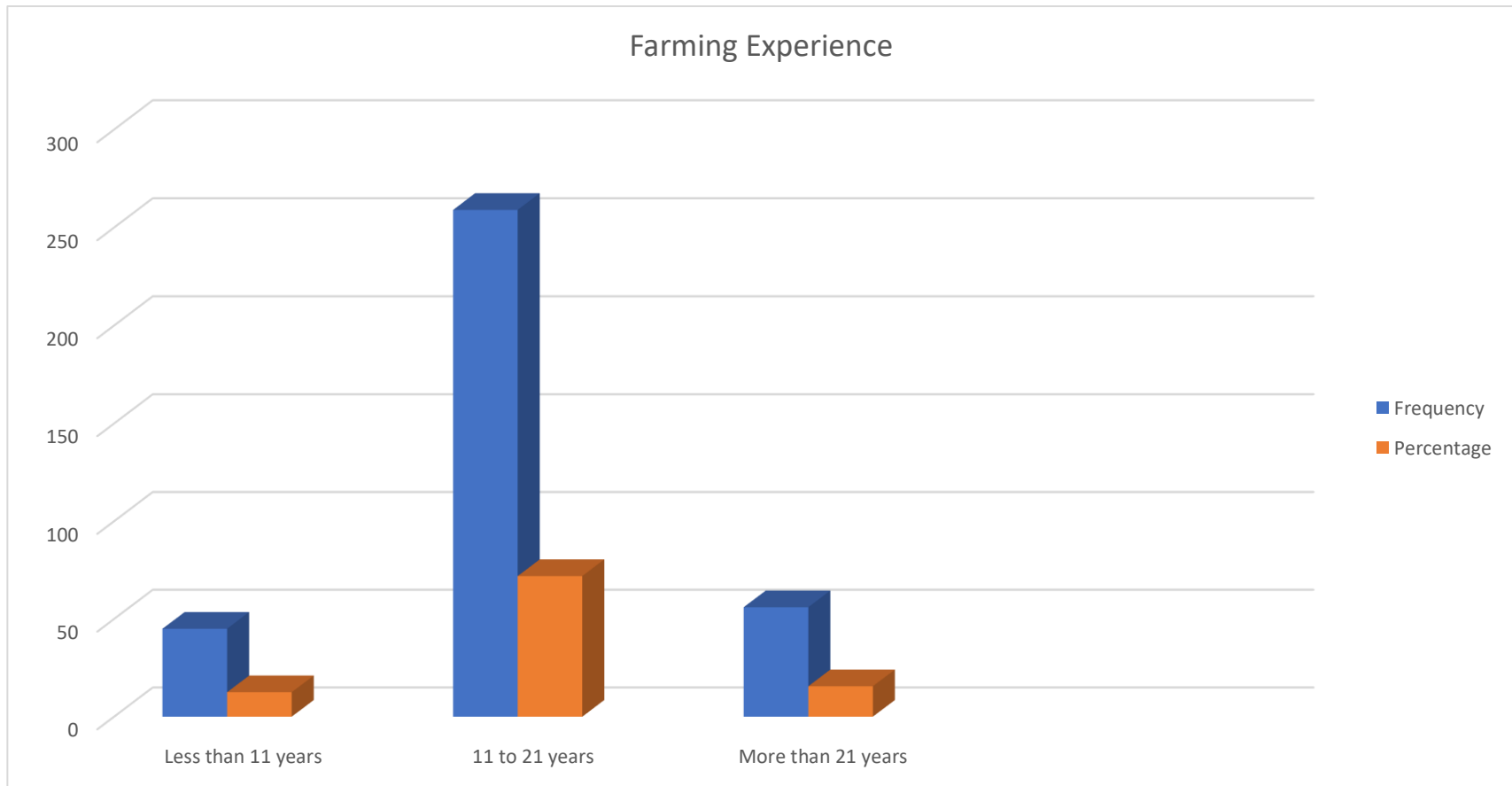


Fig 4.1.9 Distribution of respondents based on farming experience

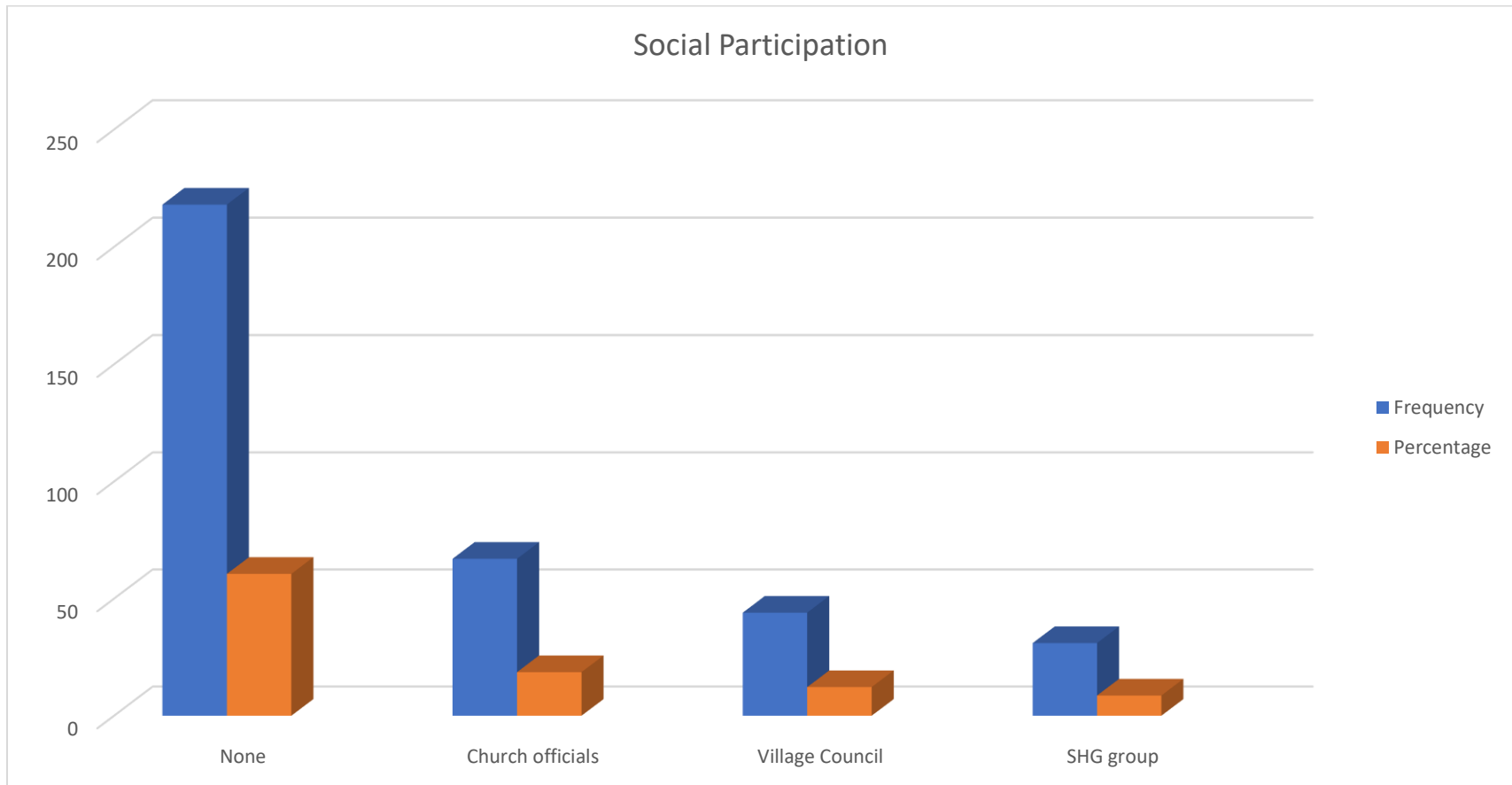


Fig 4.1.10 Distribution of respondents based on social participation

4.1.11 Total Landholding

Total land holding refers to the total area of land owned and/or cultivated by an individual or household, including both owned and leased land. It serves as a crucial indicator of agricultural potential, economic stability, and resource availability. The distribution of the farmers based on total land holding is presented in the Table 4.1.11.

Table 4.1.11 Distribution of respondents based on total landholding

N=360

Sl no.	Total landholding	Frequency	Percentage	Mean	SD
1	Low (Less than 4 acres)	58	16.11	5	1.47
2	Medium (4-6 acres)	238	66.11		
3	High (More than 6 acres)	64	17.78		
Total		360	100		

Table 4.1.11 and figure 4.1.11 show that majority (66.11%) of the respondents had a total landholding between 4-6 acres followed by 17.78 per cent of the respondents with more than 6 acres of total landholding and 16.11 per cent of the respondents had land holding of less than 4 acres.

From table 4.1.11 it is clearly depicted that majority of the respondents had medium-sized landholdings, which is attributed to the traditional patterns of land inheritance and distribution within families, where land is divided among heirs, resulting in moderate-sized holdings. Additionally, medium landholdings are often manageable in terms of labour and resource availability, making them more common and sustainable.

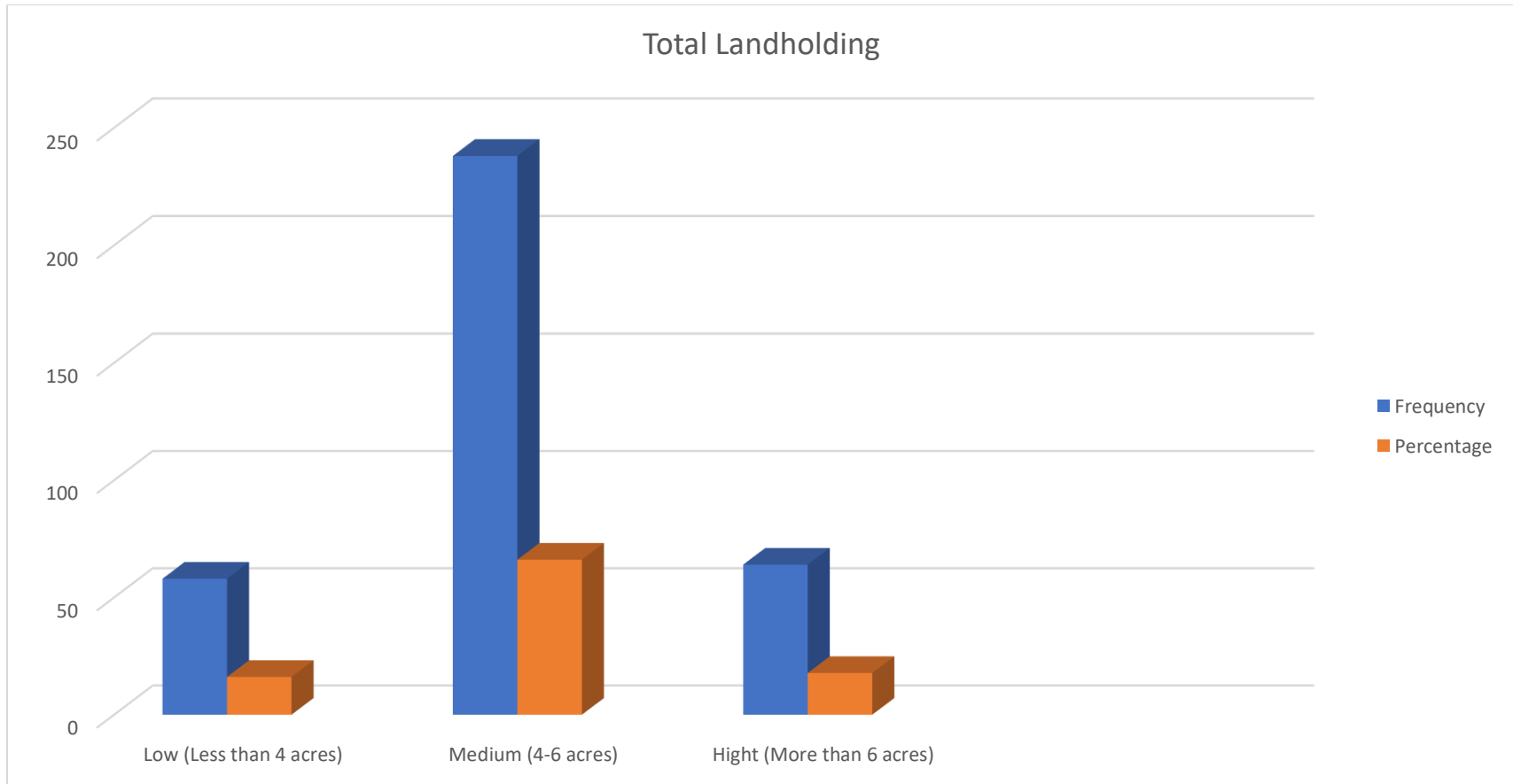


Fig 4.1.11 Distribution of respondents based on total landholding

4.1.12 Source of Information

Source of information refers to the various channels through which the farmers access knowledge, updates, and guidance related to agricultural practices, market trends, and technological innovations. These sources may include interpersonal contacts, mass media, digital platforms, and institutional agents. The reliability and accessibility of information sources play a critical role in shaping awareness, decision-making, and adoption of improved agricultural practices in rural communities.

Total source of information

Table 4.1.12(a) Distribution of respondents based on source of information

N=360

Sl no.	Category	Frequency	Percentage	Mean	SD
1	Low (Less than 4)	43	11.94	9.87	5.54
2	Medium (4-15)	260	72.22		
3	High (more than 15)	57	15.83		
Total		360	100		

Table 4.1.12(a) indicate that majority (72.22%) of the respondents had medium level of access to source of information. 15.83 per cent of the respondents had high access to source of information and 11.94 per cent of the respondents had low access to source of information.

Table 4.1.12(b) Distribution of respondents based on extension contact**N=360**

Sl no.	Category	Frequency			Percentage
		Sometimes	Often	Never	
1	Agricultural Officer	72	62	218	37.22
2	KVK professionals	62	100	195	45
3	Horticultural Officer	12	86	261	27.22
4	ATMA professionals	82	85	185	46.39
5	VLW/ AFA	25	49	286	20.56
6	NGOs	21	9	330	8.33
7	Veterinary Officer	2	40	317	11.67

Table 4.1.12(b) shows the access to information by farmers based on extension contact. The data in Table 4.1.12(b) reveal that 46.39 per cent of the respondents received agricultural information from ATMA officials, followed by 45.00 per cent from KVK professionals and 37.22 per cent from agricultural officers. Additionally, 27.22 per cent accessed information through horticulture officers, 20.56 per cent from VLWs/AFAs, 11.76 per cent from veterinary officers, and 8.33 per cent from non-governmental organizations (NGOs).

Table 4.1.12(c) Distribution of respondents based on mass media

N=360

Sl no.	Category	Frequency			Percentage
		Sometimes	Often	Never	
1	Exhibition	65	77	218	39.44
2	Mobile phones (mobile internet)	208	141	11	96.94
3	Newspaper	36	58	266	26.11
4	Magazines	26	24	310	13.89
5	Radio	12	58	290	19.44
6	TV	26	38	296	17.78
7	Print media: poster/folder/leaflet	9	62	289	19.72

Table 4.1.12(c) shows the access to information by farmers based on mass media. The table indicates that 65 per cent received information through mobile phones (mobile internet), followed by 39.44 per cent who accessed information from exhibitions and 26.11 per cent from newspapers. 19.72 per cent obtained information through print media such as posters, folders, and leaflets, 19.44% from radio, 17.78 per cent from television, and 13.89 per cent from magazines.

Table 4.1.12(d) Distribution of respondents based on personal localite

N=360

Sl no.	Category	Frequency			Percentage
		Sometimes	Often	Never	
1	Relatives	96	120	144	60
2	Friends	121	161	78	78.33
3	Progressive Farmers	118	101	141	60.83
4	Neighbours	120	114	126	65

Table 4.1.12(d) shows the access to information by farmers based on personal localite. The table indicates that 78.33 per cent of the respondents received information from friends, followed by 65.00 per cent from neighbours, 60.83 per cent from progressive farmers, and 60.00 per cent from relatives.

4.2 Knowledge Level and extent of use ICT by the respondents

4.2.1 Knowledge Level of the respondents towards the use of ICT tools.

The knowledge level of the respondents based on their knowledge towards the use of ICT tools is discussed below:

4.2.1 (a) Overall knowledge level of the respondents towards the use tools.

Table 4.2.1 (a) Distribution based overall knowledge level of the respondents towards the use of ICT tools **N=360**

Sl no.	Category	Frequency	Percentage
1	Low (< 50%)	354	98.33
2	Moderate (50-74.99%)	6	1.67
3	High (>75%)	0	0
Total		360	100

Table 2.1.1 (a) revealed that majority (98.33%) of the respondents were under low knowledge category. 1.67 per cent of the respondents had moderate knowledge on use ICT tools while none were found to have high knowledge of ICT usage.

It can be observed from table 2.1.1(a) that 98.33 per cent of the respondents had low knowledge towards the usage of ICT tools. Digital literacy among the farmers is significantly low which can be clearly seen from the table above. Although some farmers may own mobile phones, these are often used solely for basic communication purposes, and not for accessing agricultural information or advisory services.

Table 4.2.1 (b) Distribution based on knowledge level of the respondents towards the use of ICT tools

N=360

Sl No.			SDA		DA		A		SA		Total per cent Score	Mean Per cent Score	Rank
			f	%	f	%	f	%	f	%			
1	REMEMBERING	I know the dial or hotline number of the Krishi Call Center.	276	76.67	25	6.94	52	14.44	7	1.94	16.39	16.76	I
		I can identify social media platforms relevant to agriculture (e.g., Facebook, YouTube).	276	76.67	21	5.83	57	15.83	6	1.67	17.50		
		I can recognize the basic parts of a computer.	283	78.61	18	5.00	46	12.78	13	3.61	16.39		
2	UNDERSTANDING	I understand what ICT (Information and Communication Technology) stands for.	280	77.78	32	8.89	19	5.28	29	8.06	13.33	11.67	II
		I understand how social media helps in sharing or	276	76.67	48	13.33	15	4.17	21	5.83	10		

		getting agricultural information.											
		I understand the general functions of mobile phones in communication.	280	77.78	38	10.56	19	5.28	23	6.39	11.67		
3	EVALUATION	I believe ICTs in agricultural extension can save time and reduce costs.	131	36.39	201	55.83	26	7.22	2	0.56	7.78	9.44	III
		I think ICT-based advisory services are better than traditional extension methods.	113	31.39	218	60.56	26	7.22	3	0.83	8.06		
		I think agriculture-related TV programs are helpful and easily accessible.	290	80.56	25	6.94	22	6.11	23	6.39	12.50		
4	ANALYZING	I understand why mobile phones are suitable for agricultural extension activities.	287	79.72	40	11.11	16	4.44	17	4.72	9.17	9.35	IV

		I understand why call centres are becoming popular among farmers.	121	33.61	217	60.28	20	5.56	2	0.56	6.11		
		I know why passwords are used in ICT tools to ensure security.	282	78.33	32	8.89	24	6.67	22	6.11	12.78		
5	CREATING	I know how to download and install a new mobile app (Android).	129	35.83	210	58.33	16	4.44	5	1.39	5.83	8.52	V
		I know how to increase the storage capacity of my mobile phone.	290	80.56	37	10.28	17	4.72	16	4.44	9.17		
		I know how to transfer data from a computer using pen drive, data cable, or Bluetooth.	285	79.17	37	10.28	19	5.28	19	5.28	10.56		
6	APPLYING	I know how to protect my computer or smartphone from virus attacks.	296	82.22	24	6.67	15	4.17	5	1.39	5.56	7.78	VI

		I can take photographs using mobile or digital cameras.	108	30.00	228	63.33	17	4.72	23	6.39	11.11		
		I know how to get internet connectivity through mobile data.	112	31.11	228	63.33	21	5.83	3	0.83	6.67		

Table 4.1.1(a) shows the knowledge level of farmers towards the use of ICT tools. The data was categorized under six cognitive domains: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. Each domain consisted of three specific knowledge statements evaluated on a four-point Likert scale, ranging from Strongly Disagree (SDA) to Strongly Agree (SA).

1. The table showed that “Remembering” ranked the highest among the six cognitive domains with a mean per cent score of 16.76 per cent. This theme, assessed the farmers’ ability to recall or recognize basic ICT elements. It was found that 16.39 per cent of the respondents agreed that they knew the Krishi Call Centre number followed by 17.50 per cent of the respondents agreed that they could identify social media platforms relevant to agriculture (e.g., Facebook, YouTube). 16.39 per cent of the respondents could recognize the basic parts of a computer. The higher performance in this domain is due to increased exposure to basic digital tools and services in recent years. With the growing spread of smartphones usage, even in rural areas and government-led digital awareness campaigns (such as Digital India), farmers are coming to know more about basic ICT elements through advertisements, mobile phone usage and local community interactions. Some farmers cited that their children who are more familiar with social media or digital communication have contributed towards the awareness of such tools.
2. The “Understanding” domain ranked second with a mean per cent score of 11.67 per cent. It is revealed from the table that 13.33 per cent of the respondents understood the term “ICT” and what it stands for, 10 per cent understood that social media can aid in agricultural information dissemination and 11.67 per cent understood the general function of mobile phones in communication. The relatively higher ranking of the “Understanding” domain among the other four domains suggest that a small portion of farmers have progressed beyond mere recognition of ICT

tools to grasping their conceptual significance. The widespread usage of mobile phones and growing popularity of platforms like Facebook, WhatsApp, and YouTube may have indirectly fostered awareness though the connection to agriculture is not yet fully recognised by the farmers in the study area.

3. “Evaluation” ranked third with a mean per cent score of 9.44 per cent. This theme assessed the farmers’ judgment of ICT effectiveness. It was found that 12.50 per cent of the respondents think agriculture-related TV programs are helpful and easily accessible followed by 8.06 per cent think ICT-based advisory services are better than traditional extension methods and 7.78 per cent believe ICTs in agricultural extension can save time and reduce costs. Among the items, the highest response was observed for television-based agricultural programs. This is because television remains a relatively accessible and familiar medium for information dissemination in rural areas. Farmers who watch agricultural segments on regional channels like DD Kisan find them understandable and convenient. Limited exposure to successful ICT-based agricultural advisory models prevent farmers from recognizing their advantages and further develop skepticism. Without practical demonstrations or localized examples, farmers may struggle to envision how these tools can benefit them.
4. “Analysing” was ranked fourth among the six cognitive domains with a mean per cent score of 9.35 per cent. It evaluated the farmers’ ability to interpret the purpose and importance of ICT tools. Here, 12.78 per cent of the respondents understood why passwords are used in ICT tools to ensure security followed by 9.17 per cent who understood why mobile phones are suitable for agricultural extension activities and 6.11 per cent understood why call centres are becoming popular among farmers. 12 per cent of the respondents understood the purpose of passwords in ICT systems due to their exposure and experience in digital banking or mobile

phone security. Just over 9 per cent of the farmers recognized the usefulness of mobile phones in extension suggests that most have not been exposed to structured digital advisory models. Also, the minimal awareness regarding the popularity of call centres in agriculture (6.11%) reveals that such services have not been introduced in their area nor were they made aware of such services.

5. The “Creating” domain ranked fifth among the cognitive domains with a mean per cent score of 8.52 per cent. Under this it was found that 10.56 per cent of the respondents knew how to transfer data from a computer using pen drive, data cable, or Bluetooth, 9.17 per cent of the respondents knew how to increase the storage capacity of their mobile phone and 5.83 per cent of the respondents knew how to download and install a new mobile app. The low performance observed under the "Creating" domain can be traced to a variety of determinants. Firstly, low exposure to high-end smartphones and digital technologies denies farmers access to and development of high-end ICT competencies. Most rural users continue to utilize basic feature phones, which lack the capability to support applications downloads as well as major data storage enhancements. Secondly, lack of practical training and demonstration opportunities obstructs them to carry out such activity. Lastly, language barrier discourages farmers who are more comfortable in their native language from experimenting with such tools.
6. The “Applying” domain ranked last among the cognitive domains to assess the knowledge level of farmers towards the use of ICT tools. Here farmers were assessed on their ability to perform ICT tasks. 11.11 per cent of the farmers were able take photographs using mobile or digital cameras. 6.67 per cent of the respondents knew how to get internet connectivity through mobile data and 5.56 per cent of the respondents knew how to protect their computer or smartphone from virus attacks.

Majority of farmers worry about breaking their phones by mistake or paying extra costs that lead to the avoidance of tasks perceived as risky or complicated, e.g., the installation of antivirus software or the setup of a mobile network. Cultural reliance on face-to-face knowledge sharing compared to digital sources persists. Farmers still prefer direct consultation with their counterparts or expert farmers, with minimal need to navigate digital sources independently.

4.2.2 Extent of use ICT by the respondents

Differences in socio-economic conditions, levels of education, infrastructural development, and cultural practices among farmers across rural areas give rise to wide variations in the way Information and Communication Technology (ICT) tools are used in agriculture. Farmers in some regions are able to adopt modern tools such as mobile-based applications, internet platforms, and digital infrastructures, while others remain dependent on traditional media like radio and television, which have long served as reliable sources of information in farming communities. These variations reflect not only economic disparities but also differences in digital awareness, accessibility of services, and local patterns of technology acceptance.

To evaluate the utilisation pattern of ICT by the respondents for the current study the variable was divided into three categories namely; “accessibility” that is the ownership of ICT tools by the respondents followed by “availability” which seek to see the condition and the environment for the existence of ICT tools like infrastructure, network coverage, internet connectivity and servicing centres and lastly “extent of usage” which is to see how frequently the respondents use ICT tools. In the discussion below the following categories are elaborated in-depth.

4.2.2(a) Accessibility (Ownership)

Table 4.2.2(a) Distribution of respondents based their accessibility of ICT tools

N=360

Sl. No.	Category		Not Owned		Shared		Owned	
			f	%	f	%	f	%
1	Traditional Media	Radio	41	11.39	26	7.22	293	81.39
		Television	17	4.72	45	12.50	298	82.78
2	Mobile based apps	SMS	5	1.39	11	3.06	344	95.56
		WhatsApp	158	43.89	113	31.39	89	24.72
		Weather app	135	37.50	114	31.67	111	30.83
3	Internet platforms	You tube	100	27.78	123	34.17	137	38.06
		Facebook	236	65.56	0	0	124	34.44
		e-Mail	235	65.28	4	1.11	121	33.61
		e-Books	293	81.39	30	8.33	37	10.28
4	Digital Infrastructures	Computer	337	93.61	13	3.61	10	2.78
		CD/DVD	333	92.50	13	3.61	14	3.89

1. Under traditional media radio and television were considered as these are the most common and longstanding tools that were owned by rural households for decades. According to table 4.2.2(a) it can be seen that 81.39 per cent of the respondents owned a radio and 82.78 per cent of the respondents owned a television. This indicates that radio and television still remains a foundational part in the rural “ICT tools” ecosystem. The government of India has been delivering various agricultural programs on Doordarshan such as Krishi Darshan aired by All India Radio which have formed the backbone of farm communication strategies. These programs have been delivered in local dialect which have been relevant to farm communities. Additionally, these ICT tools like radio and television are affordable and durable, especially in the case of radio it is a highly portable device which the farmers can easily carry around, even to their fields or while working. From this perspective it is evident that traditional media plays a vital role in agricultural communication.
2. Mobile based tools include SMS, whatsapp and weather apps. Table 4.2.2(a) shows that 95.56 per cent of respondents own SMS-enabled mobile phones, reflecting the widespread penetration of basic mobile handsets in rural Nagaland. In contrast, only 24.72 per cent of respondents personally own WhatsApp, while a notable 43.89 per cent do not own access to WhatsApp at all, and 31.39 per cent access it through shared devices. Similarly, ownership of weather apps stands at only 30.83 per cent, with 37.50 per cent not owning and 31.67 per cent sharing access. SMS has a near-total adoption because it is compatible with basic feature phones, which are affordable, user-friendly, and do not require internet access. This high ownership reflects successful penetration of government policies such as the Digital India initiative and PM-Garib Kalyan Yojana, which have encouraged mobile ownership through subsidized schemes. The lower ownership of whatsapp and weather apps

indicates that access to smartphones is still limited especially for the old age population, less educated and economically weaker section of the rural people. This is one of the reason why majority of the farmers either share smart phones within their household or access it through devices owned by others in the community. Extension services and KVKs (Krishi Vigyan Kendras) must consider promoting curated WhatsApp-based agri-groups and interactive weather alert systems that blend with the simplicity of SMS, using local languages and voice prompts where needed.

3. Internet based ICT tools consist of YouTube, Facebook, email, and e-books. Table 4.2.2(a) indicates that only 38.06 per cent of respondents personally own YouTube access, while 34.17 per cent have shared access and 27.78 per cent do not have access at all. In contrast, Facebook and email show lower personal ownership only 34.44 per cent and 33.61 per cent respectively, with more than 65 per cent of farmers not owning access to these tools. The least adopted among all is the use of e-books, with only 10.28 per cent ownership and 81.39 per cent of respondents reporting no access. Internet reliant tools like facebook, email, youtube and ebooks have certain drawback as compared to basic mobile tools like SMS, as for these tools smartphones, good internet connectivity and digital literacy is required which is not accessible to many farmers especially the small and marginal ones. Comparatively, youtube among the other tools has higher engagement but even this tool is mostly accessed and shared among family member. This shows a gap in the digital literacy among the rural communities which requires better and more capacity building in digital literacy along with trust building towards these platforms and a design centred around their needs.
4. The category digital infrastructure consists of computer and CD/DVD player. From table 4.2.2(a) it can be seen that 2.78 per cent of respondents personally own a computer, while 93.61 per cent do not own one and 3.61

per cent have shared access. In ownership of CD/DVD tools 3.89 per cent of the respondents own CD/DVD, 3.61 per cent sharing, and 92.50 per cent do not have access to CD/DVD. The low ownership of these ICT tools such as computers and CD/DVD players as compared to phones or radio is due to higher investment and along with that these devices especially requires other external attachment such as antivirus, speakers, power backups, printer etc. For farmers especially the small and marginal ones are mostly concerned with their day-to-day daily household needs and they consider investing in such tools not very necessary and less feasible. Aside from economic and skill barrier another reason for the low ownership of CD/DVD tools is its obsolescence because in the era of smart phones and streaming platforms like youtube, CD/DVD players are considered outdated.

4.2.2(b) Availability

Table 4.2.2(b) Distribution of respondents based the availability of ICT tools

N=360

Sl. No.	Category		Not Available		Shared		Available	
			f	%	f	%	f	%
1	Traditional Media	Radio	53	14.72	116	32.22	191	53.06
		Television	59	16.39	108	30	193	53.61
2	Mobile based apps	SMS	48	13.33	125	34.72	187	51.94
		WhatsApp	137	38.06	132	36.67	91	25.28
		Weather app	132	36.67	132	36.67	96	26.67
3	Internet platforms	You tube	105	29.17	142	39.44	113	31.39
		Facebook	159	44.17	114	31.67	87	24.17
		e-Mail	167	46.39	97	26.94	96	26.67
		e-Books	179	49.72	113	31.39	68	18.89
4	Digital Infrastructures	Computer	188	52.22	132	36.67	40	11.11
		ATM	103	28.61	142	39.44	115	31.94
		CD/DVD	195	54.17	118	32.78	47	13.06

1. From table 4.2.2(b) under traditional media, it is depicted that 53.06 per cent of farmers reported that radios are easily available, while 32.22 per cent find them available but not easily accessible, and only 14.72 per cent indicated that radios are not available. For televisions, 53.61 per cent of the respondents has easy availability while 30 per cent reported limited access, and 16.39 per cent indicated that they are not available. The high availability of radio and television among the farmers at household or community level is due to its nature of content delivery and these tools does not require high literacy or advanced technical skills. These tools are less susceptible to local constraints like power supply and connectivity. In both the case for radio and television around 30 per cent of the respondents share these tools within their families or friends. Farmers often gather around a television during evening hours or listen to regional agri programs on radio. From these insights it shows that traditional media still has a prominent place in the life of the rural farmers and if used strategically it can help farmers by giving region specific agricultural advisories, weather reports and market prices.
2. Table 4.2.2(b) shows the availability pattern of mobile-based tools such as SMS, WhatsApp, and weather apps. Among the three tools under this category, SMS showed the highest level of availability, with 51.94 per cent of farmers reporting it as easily available, followed by 34.72 per cent for whom it was hard to avail and only 13.33 per cent who say it is not available. The availability of more advanced tools like WhatsApp and weather apps is significantly lower. Only 25.28 per cent of respondents find WhatsApp easily available while 38.06 per cent reported it as not available, and 36.67 per cent said it is hard to avail. A similar trend is observed with weather apps, where only 26.67 per cent find them easily available, 36.67 per cent of the respondents found it hard to avail and 36.67 per cent could not avail it. The high availability of SMS is due to

the dominance of basic mobile mobile phones among the farmers which are comparatively cheaper to afford and does not require internet connectivity. However, the lower availability of whatsapp and weather app among the farmers is due to requirement of smart phones. For these tools to function it requires smart phones which is expensive for most of the farmers to afford and also requires additional mobile data recharge and good internet connectivity.

3. Among the availability of internet-based ICT tools, from table 4.2.2(b) it can be seen that YouTube had the highest availability, with 31.39 per cent of respondents stating that it was easily available, while 39.44 per cent find it hard to avail and 29.17 per cent of the respondents reported that it was not available. For Facebook, only 24.17 per cent of farmers reported that it was available for access, 31.67 per cent indicated that it was hard to avail and 44.17 per cent said that it was not available. e-Mail was easily available to 26.67 per cent of the respondents, 26.94 per cent of the respondents found it hard to avail and 46.39 per cent of the respondents stated that it was not available. For e-Books only 18.89 per cent of the respondents reported that it was available and 49.72 per cent stated that it was not available. The relatively higher availability of YouTube is due to its video-based content as these can be utilized both by literate or non-literate farmers. Unlike YouTube and Facebook which are visual and social in nature, e-Mail and e-Books demand a more structured form of engagement. The consistent reporting of internet tools as “hard to access” (27%–40%) indicates that these tools are often present in the environment but not reachable. This is due to limited smartphone availability within households, poor or unstable mobile network coverage, lack of public internet hubs and social hierarchies in technology usage; where younger or male members dominate access to internet-enabled devices. Even when

physical access is possible, language barriers and low awareness on agriculture-specific content hinder actual usage.

4. According to table 4.2.2(b), 11.11 per cent of the respondents reported that computers were available, 36.67 per cent found them hard to avail and 52.22 per cent stated that they were not available. For CD/DVD players, 13.06 per cent reported that it was available, 32.78 per cent said that it was hard to avail and 54.17 per cent reported that it was not available. ATMs showed considerable availability with 24.17 per cent of the respondents said that it was available, 43.06 per cent reported them as hard to access and 32.78 per cent indicated that they were not available. From the pattern of availability, it can be seen that there is an existence of both infrastructural and economical limitations. Since farmers are mostly marginal and small owning a computer is not practical for all but the absence of internet cafés or educational institutions has also contributed to the lower availability of such tools in the study area as most of these facilities are available in their district head quarters and town which are usually far away. As for ATMs the case is quite similar as most of the respondents reported that it was hard to access as ATMs were mostly located far from their villages and had to travel far to access it, except for some whose villages were located near the district head quarters or lucky enough to have one in their own village.

4.2.2(c) Extend of usage

Table 4.2.2(c) Distribution of respondents based their extend of usage of ICT tools

N=360

Sl. No.	Category		Never		Rarely		Occasionally		Frequently		Very Frequently	
			f	%	f	%	f	%	f	%	f	%
1	Traditional Media	Radio	29	8.06	64	17.78	82	22.78	107	29.72	78	21.67
		Television	22	6.11	61	16.94	94	26.11	108	30.00	75	20.83
2	Mobile based apps	SMS	24	6.67	56	15.56	93	25.83	111	30.83	76	21.11
		WhatsApp	91	25.28	81	22.50	101	28.06	63	17.50	24	6.67
		Weather app	70	19.44	81	22.50	88	24.44	83	23.06	38	10.56
3	Internet platforms	You tube	59	16.39	75	20.83	94	26.11	99	27.50	33	9.17
		Facebook	119	33.06	87	24.17	57	15.83	67	18.61	30	8.33
		e-Mail	133	36.94	74	20.56	56	15.56	58	16.11	39	10.83
		e-Books	128	35.56	114	31.67	56	15.56	49	13.61	13	3.61
4	Digital Infrastructures	Computer	146	40.56	108	30.00	59	16.39	44	12.22	3	0.83
		ATM	131	36.39	98	27.22	92	25.56	39	10.83	0	0.00
		CD/DVD	161	44.72	93	25.83	52	14.44	49	13.61	5	1.39

1. From table 4.2.2(c) under traditional media, it showed that, for Radio 21.67 per cent of respondents reported using radio very frequently followed by 29.72 per cent who use frequently, 22.78 per cent of the respondents use occasionally, 17.78 per cent rarely use and 8.06 per cent of the respondents do not use. For television 30 per cent of farmers from the study area watch TV frequently, 20.83 per cent watch very frequently, 26.11 per cent of the respondents watch occasionally, 16.94 per cent watch rarely and only 6.11 per cent never use TV. The higher usage of TV under the study area is credited to the widespread rural electrification, government broadcasting initiatives like Doordarshan Kisan and localized language content that enhances comprehension. One more advantage of TV is its visual appeal for the viewers, as both literate and non-literate farmers can benefit from viewing the programs. The decline in usage of radio as compared to television can be due to the shift of radio users to mobile phones. While some farmers still use these tools occasionally as in some areas there is improper or limited mobile network coverage.
2. For mobile-based tools it can be seen from table 4.2.2(c) that 30.83 per cent of farmers reported frequent use, 21.11 per cent of the respondents used SMS very frequently, 25.83 per cent of the respondents use SMS occasionally, 15.56 per cent of the respondents rarely use SMS and 6.67 per cent of the respondents do not use SMS. As reported by the respondents, the higher use of SMS service by the respondents is due to the flexible nature of this service as it can be operated both in a basic mobile phone or in a smart phone, it does not require internet connectivity and can be operated even while the mobile connectivity is not at its best. For WhatsApp it can be seen from the table that 6.67 per cent of respondents use it very frequently, 17.50 per cent use it frequently, while 28.06 per cent of the respondents occasionally use it, 22.50 per cent use it rarely and

25.28 per cent of the respondents never use it. WhatsApp being an app-based tool require more digital familiarity which becomes a hinderance for most of the respondents even though they own smart phones to operate it. Most of the farmers rely on their younger family member like their sons and daughter to operate this app. For weather apps the table shows that 23.06 per cent of the respondents use them frequently, 10.56 per cent use very frequently, 24.44 per cent use them occasionally, 22.50 per cent use them rarely and 19.44 per cent of the respondents never use them. Weather apps are crucial for climate resilient farming the fact that 19.44 per cent never use this apps is due to their knowledge gap in knowing the functionality and utility of this app. Also, some farmers do not have the economic strength to own devices to operate such apps.

3. Table 4.2.2(c) depicts that under internet-based tools, YouTube is the most widely used platform. It is found from the table that 27.50 per cent of the respondents use YouTube frequently and 9.17 per cent use very frequently, 26.11 per cent of the respondents use it occasionally, 20.83 per cent use it rarely and 16.39 per cent never use it. YouTube provides both audio based and visual contents which is helpful to many farmers even though they have limited formal education. Demonstration videos on farming practices, pest control, crop management, and animal husbandry are readily available in the platform which make the content easily understandable for the farmers, moreover these contents are mostly free to access which makes the platform more farmer-friendly. From the table it was found that for Facebook 18.61 per cent of the respondents use it frequently, 8.33 per cent use it very frequently, 15.83 per cent use it occasionally, 33.06 per cent never use it, 24.17% rarely use it. The lower usage reflect the platform's less direct utility in agricultural knowledge sharing, as contents for agriculture under this tool is not easily discoverable and relatable. The usage of e-Mail is even more limited.

36.94 per cent of the respondents reported never using email, and only 16.11 per cent use it frequently, only 10.83 per cent use it very frequent. e-Books recorded the lowest level of active engagement among all internet-based tools. 35.56 per cent of respondents never used e-books, 31.67 per cent rarely used them and only 3.61 per cent use them very frequently. This limited usage highlights a clear preference among farmers in the study area for more interactive or demonstrative digital content, as opposed to text formats.

4. From table 4.2.2(c) it was found that 40.56 per cent of the respondents never use computers, 30.00 per cent use them rarely, while only 12.22 per cent use them frequently, and a mere 0.83 per cent use them very frequently. This lower frequency of usage is due to its difficulty in operation and high cost for many farmers. For many farmers mobile and television offer simpler and more direct information they need related to agriculture. The table revealed that 44.72 per of respondents never use CD/DVD, and 25.83 per cent rarely use it, while only 13.61 per cent use them frequently, and only 1.39 per cent use them very frequently. This shows that CD/DVD players are now largely obsolete and out dated as an ICT tool in rural areas, due to technological shifts toward mobile-based and streaming services. The usage of ATM data presents a relatively stronger picture as compared to computer and CD/DVD. 25.56 per cent of respondents use ATMs occasionally, 10.83 per cent use them frequently, 36.39 per cent never use them, and 27.22 per cent use them rarely. ATMs is an important financial infrastructure that enables farmers to access government subsidies, loan disbursement and cash withdrawal. While having relatively higher utilisation compared to the other two tools, still usage of ATMs is not much common for the respondents as for most of them ATMs are located far from their villages.

4.2.2(d) Structural Relationships among Accessibility, Availability, and Usage of ICT

The path analysis model was constructed using the mean score of the variables under utilisation pattern i.e., Accessibility, availability and extend of usage. The model studied the directional influence of accessibility over availability and availability over extend of usage and it also studied the mediating influence of availability on extend of usage of ICT tools.

Table 4.2.2(d) Structural Equation Modelling Results for Accessibility, Availability, and Usage

Path	Estimate (β)	S.E.	Critical Ratio (C.R.)	Significance
Accessibility → Availability	0.477	0.047	10.086	0.25
Accessibility → Usage	0.588	0.070	8.457	0.31
Availability → Usage	0.701	0.068	10.245	0.44

Note: $p < .001$

From table 4.2.2.1(a) it is depicted that the Estimate value (β) for the path “Accessibility → Availability” is 0.477 and the Critical Ratio (C.R.) is 10.086 which shows that the path is statistically significant. For the path “Accessibility → Usage” the Estimate value (β) is 0.588 and the Critical Ratio (C.R.) is 8.457 which shows that the path is statistically significant. Lastly, for the path “Availability → Usage” the Estimate value (β) is 0.701 and the Critical Ratio (C.R.) is 10.245 which is statistically significant.

The path models show an interdependent nature of ICT usage. In the case of “Accessibility → Availability → Usage,” farmers who personally own or have access (shared) to ICT tools are more likely to perceive that the services to access these tools like network coverage or services are available in their local environment. This perception of availability enhances the frequency of usage among the farmers.

For “Accessibility → Usage” contextual availability plays a critical role in driving actual usage behaviour. This depicts that even though the farmers personally own the tools they cannot use them if there is no mobile signal, power supply and services within their area of operation. The study proves that improving physical access (ownership) must go hand in hand with enhancing infrastructural support and service availability to ensure optimal utilisation.

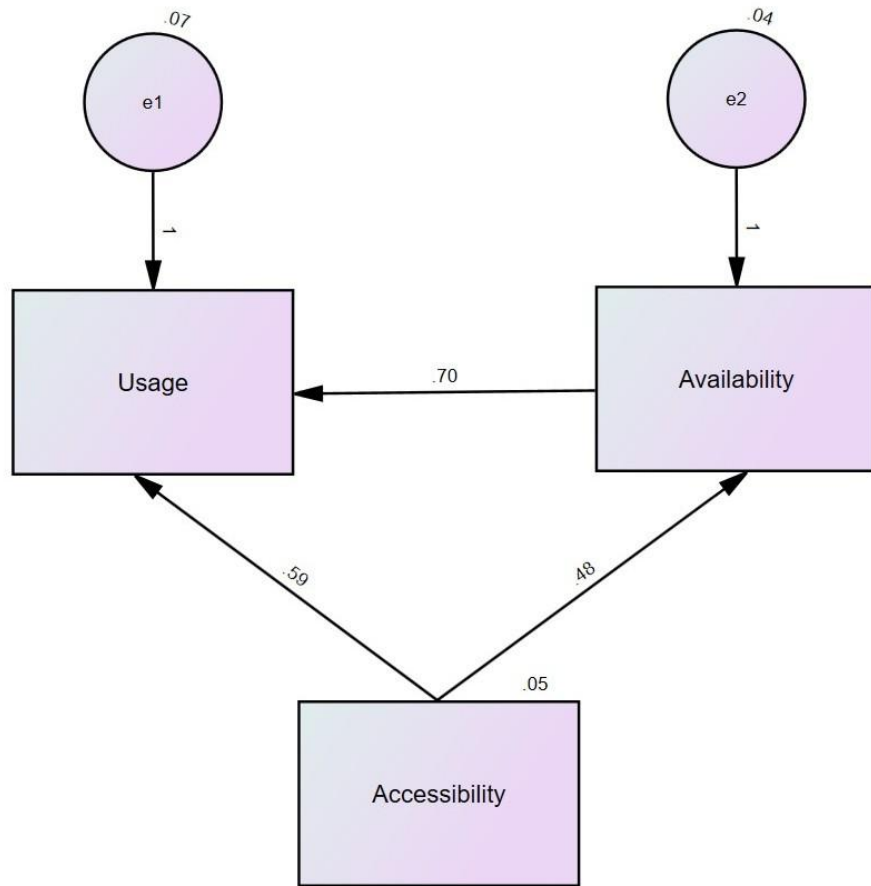


Fig 4.2.2(d): Path model for utilisation pattern of ICT tools by respondents

4.2.2(e) Pearson Correlation Analysis of Accessibility, Availability, and Usage

To examine the strength and direction of association among the three variables of ICT utilisation accessibility, availability, and usage; a Pearson correlation analysis was carried out. The results are presented in Table 4.2.2(e).

Table 4.2.2(e) Pearson Correlation Matrix for Accessibility, Availability, and Usage of ICT Tools

	Accessibility	Availability	Usage
Accessibility	1	.470**	.572**
Availability	.470**	1	.613**
Usage	.572**	.613**	1

*Note: ** significance at 0.01 level*

From table 4.2.2(e) showed that accessibility and availability are significant and are positively correlated ($r = 0.470$). This indicates that farmers who have greater accessibility, either through personal ownership or shared access to ICT tools, are more likely to report higher levels of availability of supportive services such as network coverage, electricity, and infrastructural facilities.

Table 4.2.2(e) also showed that there is a positive and significant correlation between accessibility and usage ($r = 0.572$). This finding suggests that when ICT tools are more easily accessible to farmers, their actual usage increases significantly. Accessibility therefore plays an important role in driving ICT utilization, as farmers who can readily access these tools tend to integrate them more actively into their agricultural practices.

Table 4.2.2(e) revealed that availability and usage also have a positive and significant relationship ($r = 0.613$). This shows that when farmers possess or have access to ICT tools, their frequency of use is highly dependent on the availability of supporting services such as reliable internet connectivity, power

supply, and local infrastructure. Availability, therefore, emerges as a slightly stronger determinant of ICT usage than accessibility, underscoring the critical role of infrastructural and service-related factors in influencing ICT utilization among farmers.

4.2.2(f) Multiple Regression Analysis of Accessibility and Availability on ICT Usage

To further examine the predictive influence of Accessibility and Availability on the Usage of ICT tools, a multiple linear regression analysis was conducted. This analysis allowed for the simultaneous assessment of how much variance in ICT usage could be explained by these two independent variables and to what extent each contributed to the model.

Table 4.2.2(f)(i) ANOVA Results for Multiple Regression of Accessibility and Availability on ICT Usage

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	22.107	2	11.054	164.579	.076
Residual	23.977	357	.067		
Total	46.085	359			

a. Dependent Variable: Usage

b. Predictors: (Constant), Availability, Accessibility

Table 4.2.2(f)(i) revealed that the regression model was statistically significant, $F(2,357)=164.579$, $p<.001$, indicating that the combination of Accessibility and Availability reliably predicted the usage of ICT tools. The model explained approximately 48% of the variance in ICT usage ($R^2=0.480$), with an adjusted $R^2=0.477$ suggesting a moderately strong explanatory power. The Durbin-Watson statistic of 1.978 further indicated that there was no major concern of autocorrelation in the residuals.

Table 4.2.2(f)(ii) Regression Coefficients for Accessibility and Availability Predicting ICT Usage

Predictor	Unstandardized B	Std. Error	Beta (β)	t-value	Sig.
Accessibility	0.588	0.070	0.365	8.434	.049
Availability	0.701	0.069	0.442	10.217	.067

Table 4.2.2(f)(ii) shows the relative contributions of each predictor. Both Accessibility ($\beta=0.36$, $p<.001$) and Availability ($\beta=0.442$, $p<.001$) were found to have significant positive effects on ICT usage. This means that increase in accessibility and availability were both associated with higher levels of ICT utilization among farmers. Among the two predictors, Availability emerged as the stronger determinant, indicating that infrastructural and service-related factors (such as internet connectivity, electricity, and local support systems) play a slightly greater role in encouraging actual usage of ICT tools compared to accessibility alone.

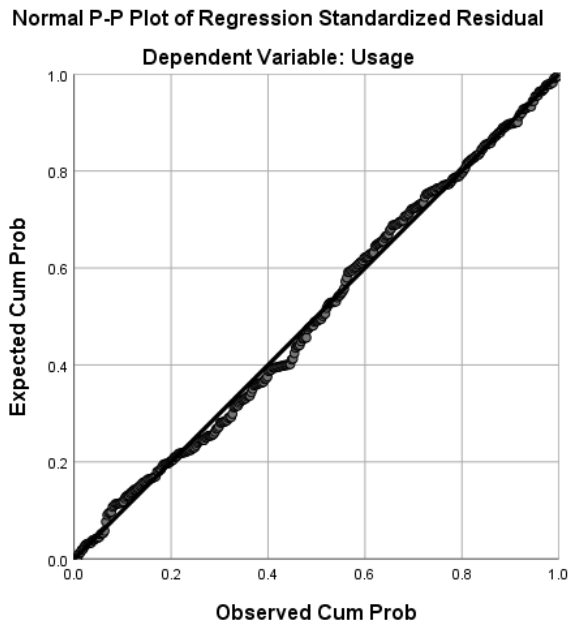


Fig 4.2.2(f)(i): Normal P-P plot of regression standardized Residuals

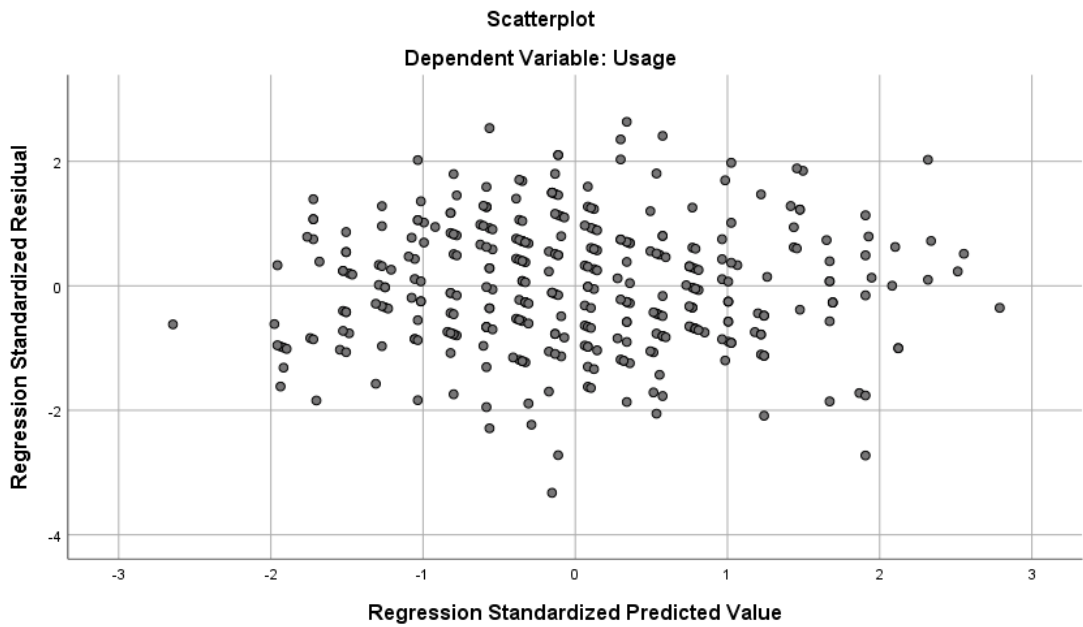


Fig 4.2.2(f)(ii): Scatter plot of dependent variable Extend of usage

4.3 Attitude of farmers on application of ICT in agriculture

Table 4.3.1 Overall distribution of respondents based on their attitude towards ICT tools **N=360**

Sl No.	Attitude Level	Frequency	Percentage	Mean	SD
1	Low (< 25.28)	53	14.72	30.24	4.66
2	Medium (25.58-34.90)	232	64.44		
3	High (> 34.90)	75	20.83		
		360	100		

Table 4.3.1 revealed that majority of respondents (64.44%) showed a medium level of attitude. This indicates that most farmers recognize the potential of ICT in agricultural development but are not fully confident in its application. 20.83 per cent demonstrated high attitude, reflecting a strong positive perception and likely openness to adopting ICT tools in their farming practices. 14.72 per cent of the respondents showed a low level of attitude towards ICT tools.

Table 4.3.2 Distribution of respondents based on their specific attitude towards ICT tools

N=360

Sl. No.	Items	SDA		DA		UD		A		SA		Mean Score	Rank
		f	%	f	%	f	%	f	%	f	%		
1	ICT based extension services assist the farmer in planning and decision making aspects in agriculture.	60	16.67	65	18.06	82	22.78	80	22.22	71	19.72	3.09	I
2	ICTs alone would solve the problems of farmers. *	62	17.22	70	19.44	75	20.83	79	21.94	73	20.28	3.08	II
3	ICT based Pest/disease outbreak warning system facilitate farmers to take preventive measures.	63	17.50	69	19.17	78	21.67	70	19.44	77	21.39	3.06	III
4	Only resourceful farmers can get the benefit of the ICTs. *	66	18.33	64	17.78	78	21.67	64	17.78	81	22.50	3.04	IV
5	Access to information centre at village level is boon to the farming community.	68	18.89	81	22.50	77	21.39	67	18.61	75	20.83	3.04	IV

6	ICTs based extension services provide new opportunity to build a skilled and knowledge community.	73	20.28	61	16.94	66	18.33	66	18.33	84	23.33	3.02	V
7	ICTs can not meet location specific needs of the farmers.*	74	20.56	82	22.78	67	18.61	68	18.89	75	20.83	3.0	VI
8	Farmers feed back is fast through ICTs than traditional methods.	77	21.39	60	16.67	82	22.78	88	24.44	56	15.56	2.98	VII
9	Expert advice makes the farmers enterprise/activities productive.	83	23.06	77	21.39	63	17.50	69	19.17	74	20.56	2.97	VIII
10	ICTs are potential tools to reach the needy farmers.	77	21.39	71	19.72	68	18.89	78	21.67	66	18.33	2.96	IX

Table 4.3.2 shows the attitude of farmers towards ICT tools. The table consist of 10 statements (positive and negative* items) focused to measure the attitude of farmers towards ICT tools. Each item was evaluated using a five-point Likert scale, ranging from Strongly Disagree (SDA) to Strongly Agree (SA).

1. “ICT based extension services assist the farmer in planning and decision-making aspects in agriculture” ranked first among the 10 statements with a mean score of 3.09. This indicates that the farmers in the study area believes that ICT tools can assist in their decision-making aspects in agriculture such as pest management, weather forecasting and accessing market prices. This perception can be backed by the fact that ICT based extension services such as Kisan Call Centres provides the farmers with real-time and location-specific advice which bridges the gap between farmers and experts, reducing the gap in knowledge access. In a state like Nagaland where the rough terrain hinders the coverage of physical extension services, ICT service is a critical alternative to deliver crucial agriculture related information which can assist the farmers in their daily decision-making process.
2. “ICTs alone would solve the problems of farmers” was ranked second with a mean score of 3.08 among the 10 items to measure the attitude of farmers towards ICT. This item falls under the negative item category to measure the attitude of the farmers. This analysis gives an important insight into the perspective of the farmers which shows an idealistic expectation on how ICT alone can achieve to solve their farm related problems. This perception arises due to the farmers’ association to technology as a quick fix medium to their problems not realising the need for complementary factors such as institutional support, capacity building and infrastructural readiness. This reflects a lack in their awareness of ICT technologies where they may lack a deeper understanding of how these tools function within a broader agricultural support system. Extension

services must focus on building critical awareness, promoting realistic expectations, and ensuring that ICT interventions are backed by human advisory systems and practical demonstrations.

3. “ICT based Pest/disease outbreak warning system facilitate farmers to take preventive measures” was ranked third with a mean score of 3.06. In Nagaland ICT based pest/disease warning system is still not widely used by the farmers but this positive attitude arises from their general understanding of mobile phone capabilities; awareness from farmer friends, progressive farmers and peer discussion. Outbreak of pest/disease is a common problem faced by farmers all over the world similarly, the farmers in study area also faces this problem. With limited access to extension services and support system, it was found that the idea of receiving support through ICT was logically appealing to the farmers in the study area. Farmers want tools that can provide early warnings and help them take preventive measures, even if such tools are not yet available or familiar to them.
4. “Only resourceful farmers can get the benefit of the ICTs” was ranked fourth among the items with a mean score of 3.04. This item falls under the negative item category to measure the attitude of the farmers. In the rural context of Nagaland many farmers especially small land holders do not have full access to smartphone and internet connection creating a digital divide among the socio-economic groups. This has created a perception among the farmers that only the economically stronger ones can have access to the digital tools. Farmers who are well off have higher income, better education and have more contact with the urban setting leading to their exposure to digital platforms, while the economically weaker ones mostly have low digital literacy, lower income and lesser exposure. As a result, respondents may feel that the benefits of ICT tools are not equally distributed and only those with stronger economic

background can actually utilize them. This moderate agreement to the item suggest that the farmers are not fully dismissive to ICT tools but on the other hand remain skeptical about its accessibility for all section of the farming community.

5. “Access to information centre at village level is boon to the farming community” was also ranked fourth among the ten items to measure the attitude of farmers towards ICT technologies with a mean score of 3.04. Most villages in Nagaland including the villages undertaken for the study are in remote, hilly and infrastructure challenged region. These challenges supplement the idea of having a dedicated ICT centre where they can get timely agriculture related information on weather, pest management, improved farming practices and government schemes. However, the moderate mean score also indicates that even if such centre existed, they would either be underutilised or not well maintained. Information centres, if properly resourced and staffed, have the potential to bridge the last-mile gap between farmers and digital extension services. But if these centres just merely exist without active facilitation, relevance and community trust the full effectiveness cannot be guaranteed.
6. “ICTs based extension services provide new opportunity to build a skilled and knowledge community” with a mean score 3.02 was ranked fifth among the ten items. This score reflects a moderate agreement towards ICT tools and platforms, indicating that farmers in the study area recognize the long-term developmental potential of ICT, particularly in enhancing knowledge and skills within the farming community. Through the presence of mobile phones, farmers in the study area have also developed a conceptual understanding that digital tools and platforms can help them build a more informed and connected farming community even though they have not directly participated in any structured ICT based training. ICT serves as a medium to decentralize knowledge reducing

dependence on traditional extension models, enabling wider community access. ICT tools when deployed appropriately can help in collective knowledge building for the farming community and uplift agriculture literacy.

7. “ICTs cannot meet location specific needs of the farmers” falls under the negative statement category, with a mean score of 3.0 and was ranked sixth among the ten items to measure the attitude of farmers towards ICT tools. The farmers in the study area though not completely aware of ICT tools and its applications but they still possess some general idea of its benefits which may be because most farmers these days have mobile phones and internet connection. But on the other hand, they are not certain whether these tools can effectively and accurately deliver location and culturally specific agricultural needs of their area. This is because Nagaland has high agro-ecological variability (altitude, rainfall, soil), most farmers are still practicing Jhum cultivation which is still not considered in national ICT content and lastly there is language and literacy barrier which hinders and reduces the accessibility of ICT platforms. Therefore, the farmers in the study area, though they agree with the benefits and utility of the ICT tools, hesitates to accept that ICT tools can fully meet their location specific agricultural needs.
8. “Farmers feedback is fast through ICTs than traditional methods” with a mean score of 2.98 was ranked seventh among the ten items. From the items’ ranking and the mean score it can be depicted that feedback through ICT is still not a common procedure that is actively followed by farmers in the study area as feedbacks are not unidirectional like SMS services or social media platforms. It requires interactivity, trust and technical functionality which is not operational and accessible to all the farmers in study area. In rural areas of Nagaland farmers still suffers from lack of proper internet connectivity, mobile signal strength and power

outages. These problems create delay in response and reception of timely information which results in frustration among farmers. Trust remains highly valued in agricultural decision-making; farmers in the study area still prefer face-to-face interaction with extension officers or progressive farmers. Farmers still prefer personal interaction even though ICT tools are available especially for seeking clarification and for time sensitive farming situations. Lack of user support and digital literacy is also a cause in reducing the use of ICT tools for feedback.

9. “Expert advice makes the farmers enterprise/activities productive” was ranked eighth with a mean score of 2.97. The lower ranking of the statement is because the farming communities in Nagaland consist mostly of small and marginal farmers who mostly operate their farming activities in difficult agro-ecological terrain. In such situations if farmers are exposed to standardized one size fit advices which are not suitable with their terrain of operation or indigenous practices, the information becomes irrelevant and difficult to adopt or implement. Another factor influencing the low ranking of this item is the lack in timely follow up by experts like extension personnels on the information received through messages and app based contents. So that the information received can be contextualized and validated for the farmers according to their existing problems. This is true especially for villages located in far flung areas under Tuensang and Mon districts, as these villages are still not properly accessible and lacks proper infrastructure like road connectivity and mobile network connection.
10. “ICTs are potential tools to reach the needy farmers” with a mean score of 2.96 was ranked 10th (last) among the ten statements to measure the attitude of farmers towards ICT tools. ICT is a powerful tool for dissemination of information to the farmers. In theory it is a transformative and revolutionising means through which farmers can easily have access

to important farm related information at the palm of their hands. But the ground reality on the other hand is different, especially in a state like Nagaland where infrastructure is still not upto the mark, there is gap in digital literacy, language barrier and cultural preference on farming. All these drawbacks have taken a major toll on the perception of the farmers on ICT being a perfect tool to reach every needy farmer in the state as most of the ICT tools are not able to effectively reach and empower all the farmers from progressive to marginal in an inclusive manner. Therefore, a need for an inclusive ICT tool design is necessary where, there is a priority in use of local languages and an integration of a hybrid model where both human and digital interface actively participate in delivering information to the farming community.

4.4 Factors influencing adoption of ICT tools

4.4.1 Adoption of ICT tools by the respondents

Table 4.4.1 Distribution of adoption of ICT tools by the respondents N=360

Sl. No.	Category	Frequency	Percentage	Mean	SD
1.	Non-adopters	165	45.8	0.54	0.49
2.	Adopters	195	54.2		
	Total	360	100		

Table 4.4.1 shows the distribution of respondents according to their adoption status of ICT tools. 54.2 per cent of the respondents were adopters and 45.8 per cent were non-adopters. The mean score was 0.54 with a standard deviation of 0.49. From the results it is seen that ICT tools are gaining popularity among farmers but there also remains a significant proportion (nearly 46%) who have yet to integrate them into their farming practices.

4.4.2 Extend of adoption of ICT tools by the respondents.

A binary logistic regression was conducted to examine the influence of demographic, socio-economic, knowledge level and attitude of respondents on the likelihood of adoption. The model included age, sex, primary and secondary occupation, education, family type, family size, social participation, total landholding, annual income, farming experience, source of information, knowledge, attitude, accessibility, and availability as predictors, using the enter method.

4.4.2 (a) Model fit statistics

The logistic regression model was statistically significant, $\chi^2(20) = 290.918$, $p < .001$, indicating that the predictors reliably distinguished between adopters and non-adopters. The model explained between 55.4% (Cox & Snell R^2) and 74.1% (Nagelkerke R^2) of the variance in adoption and correctly classified 85.8% of cases (sensitivity = 86.2%, specificity = 85.5%).

4.4.2 (b) Significant predictors of Adoption of ICT tools

Table 4.4.2(b) Logistic Regression Results for Factors Influencing Adoption

Predictor	B	S.E.	Wald	p-value	OR (Exp(B))	95% CI for OR
Annual income	0.000	0.000	5.831	0.016	1.000	1.000 – 1.000
Experience in farming	0.089	0.037	5.950	0.015	1.093	1.017 – 1.175
Source of information	3.150	0.822	14.673	0.002	23.340	4.659 – 116.877
Knowledge	5.025	1.048	23.004	0.002	152.170	19.510- 1186.876
Attitude	1.596	0.402	15.798	0.002	4.933	2.244 – 10.847
Availability	2.874	0.947	9.206	0.002	17.708	2.767 – 113.309
Education*	—	—	28.677	0.002	—	—

As shown in table 4.4.2(b):

- i. Annual income (B = 0.000, OR = 1.000, 95% CI [1.000, 1.000], $p = .016$). Higher income was positively associated with adoption of ICT tools by the respondents.

- ii. Experience in farming (B = 0.089, OR = 1.093, 95% CI [1.017, 1.175], p = .015). More years of farming experience for the respondents increased the odds of adoption of ICT tools.
- iii. Source of information (B = 3.150, OR = 23.34, 95% CI [4.659, 116.877], p=0.002). If the respondents are exposed to more and better information sources it will greatly increase the likelihood of adoption.
- iv. Knowledge (B = 5.025, OR = 152.17, 95% CI [19.510, 1186.876], p= 0.002). More knowledge of the respondents regarding ICT tools is likely to increase adoption odds.
- v. Attitude (B = 1.596, OR = 4.933, 95% CI [2.244, 10.847], p= 0.002). Positive attitude of the respondents towards ICT tools were associated with higher adoption. Therefore, more positive attitude more adoption.
- vi. Availability (B = 2.874, OR = 17.708, 95% CI [2.767, 113.309], p = .002). Availability of technology/resources like mobile network, internet connectivity, maintenance centre and infrastructural development more will be the increase in adoption tools.
- vii. Education (overall effect: Wald $\chi^2(4) = 28.677$, p=0.002) – significant overall, but individual category coefficients were unstable due to large standard errors.

4.4.2 (c) Non-significant predictors of adoption of ICT tools

Age, sex, secondary occupation, family type, family size, social participation, total landholding, and accessibility did not significantly contribute to the model at ($p > 0.05$).

4.4.2 (d) Forest Plot visualization of odds ratio of intervals for each predictors

A forest plot was designed to visualized the odds ratios at 95% confidence intervals for each predictor. Predictors with confidence intervals not crossing the null value (OR = 1) were statistically significant, consistent with the regression

output. Knowledge, source of information, availability, attitude, experience, and annual income showed the strongest positive associations.

4.4.2(e) ROC Curve for assessment of model performance

Model performance was assessed using a Receiver Operating Characteristic (ROC) curve. The Area Under the Curve (AUC) was 0.947, indicating excellent discrimination ability in distinguishing between adopters and non-adopters. The curve was substantially above the diagonal line of no discrimination, confirming the strong predictive performance of the model.

Table 4.4.2(e) Area Under the Curve

	Area
Test result variables: Predicted Probability	0.947

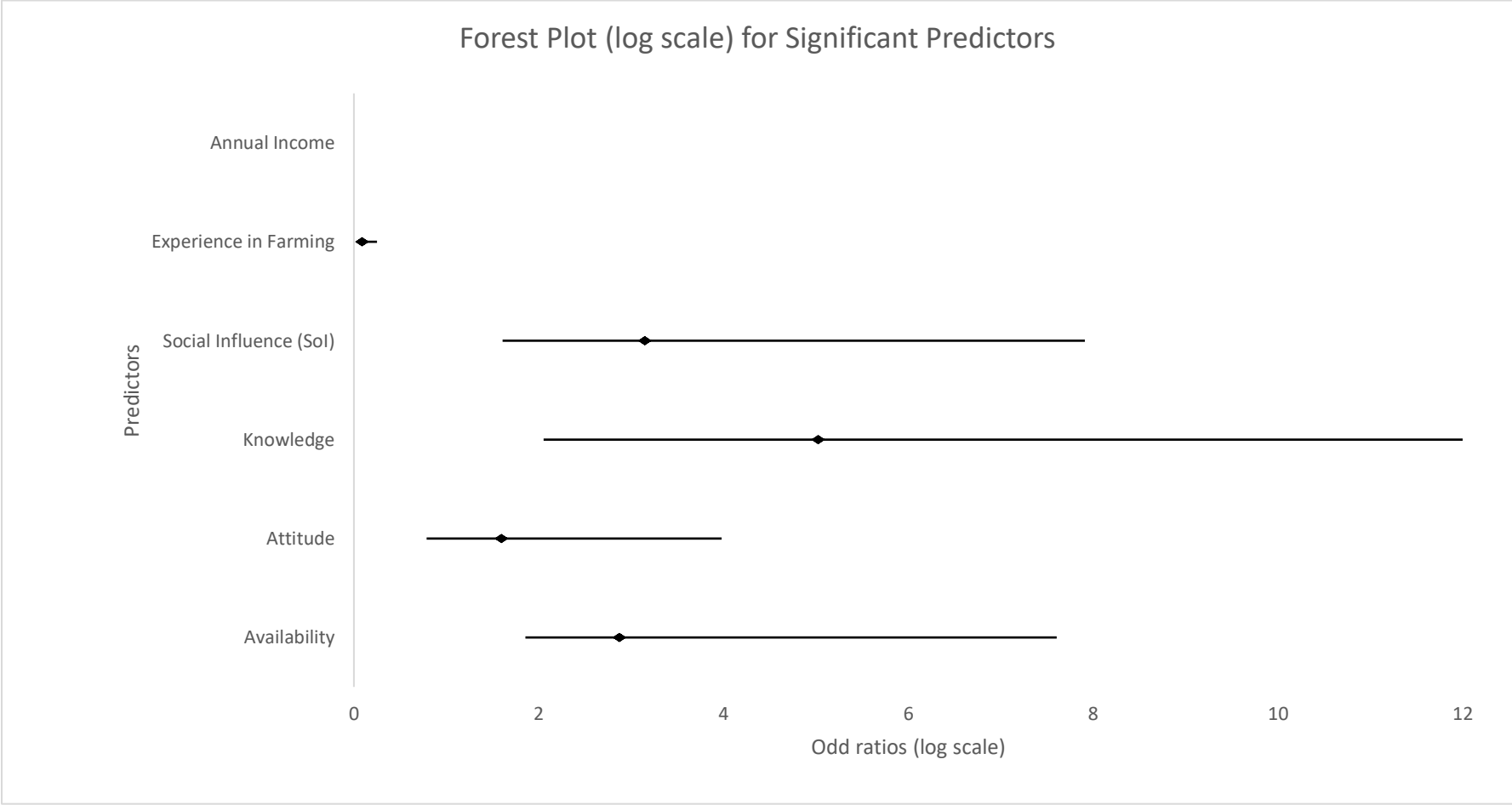


Fig 4.4.2(b): Forest Plot (log scale) for Significant Predictors

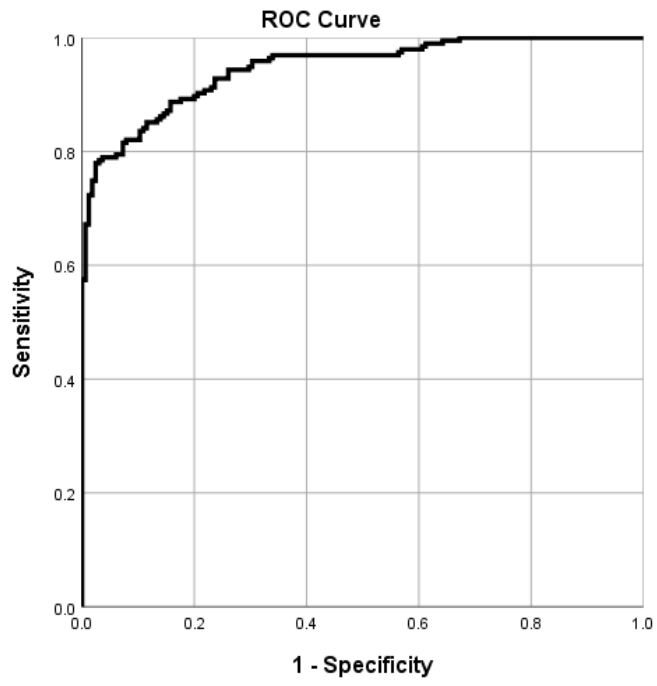


Fig 4.4.2(e): ROC curve

4.5 Constraints faced by the farmers in using ICT tools

Under this objective, the major constraints faced by farmers towards the use of ICT tools were identified based on available literature, opinion of the respondents, and expert suggestions. In this study a total of twelve major constraints were selected and ranking was done following the Garrett ranking method.

Table 4.5.1 Per cent positions and Garret values

Sl no.	$100 (R_{ij} - 0.5)/N_j$	Calculated value	Garret value
1	$100 (1-0.5)/ 12$	4.17	84
2	$100 (2-0.5)/ 12$	12.50	73
3	$100 (3-0.5)/ 12$	20.83	67
4	$100 (4-0.5)/ 12$	29.17	61
5	$100 (5-0.5)/ 12$	37.50	57
6	$100 (6-0.5)/ 12$	45.83	53
7	$100 (7-0.5)/ 12$	54.17	49
8	$100 (8-0.5)/ 12$	62.50	44
9	$100 (9-0.5)/ 12$	70.83	40
10	$100 (10-0.5)/ 12$	79.17	34
11	$100 (11-0.5)/ 12$	87.50	28
12	$100 (12-0.5)/ 12$	95.83	17

Table 4.5.2 Distribution of constraints based on ranking given by respondents**N=360**

Constraints	Ranks given by the respondents											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
High cost of ICT tools like computers, smart phones etc.	88	62	31	27	54	53	11	4	8	5	10	7
Lack of sufficient skills in usage of ICT tools by rural communities.	67	58	43	31	29	30	20	22	26	5	23	6
Lack of belief on e-sources.	101	66	23	19	32	20	18	16	3	6	11	45
Difficulty in understanding the content language of ICT gadgets.	119	78	45	22	26	11	18	13	14	5	9	0
Poor mobile/internet connectivity in rural areas.	98	53	47	30	19	21	19	11	5	17	11	29
Lack of awareness of proper functioning about ICT tools.	85	71	76	24	21	23	21	12	6	9	3	9
Inadequate infrastructural facilities for maintenance of ICT tools	103	45	21	20	56	44	30	3	15	3	7	13
Lack of uninterrupted power supply.	74	77	61	63	29	26	11	4	7	2	1	5
Lack of training of the farmers towards use of different ICT tools.	128	71	76	24	14	9	11	12	6	9	0	0
Lack of local language in handling and understanding on available agriculture apps.	96	45	31	27	29	13	26	17	20	22	18	16

Faulty communication between seller/operators and farmers about use of ICT tools.	10	16	19	21	22	11	13	31	33	51	67	66
Sometimes possibility of misleading information transmitted through internet.	68	40	33	37	35	35	33	24	21	17	10	7

Table 4.5.3 Distribution of constraints based on Garret values

N=360

Constraints	Ranks given by the respondents												Total	Percentage	Rank
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
Lack of training of the farmers towards use of different ICT tools.	128	71	76	24	14	9	11	12	6	9	0	0	25379	70.50	1
Difficulty in understanding the content language of ICT gadgets.	119	78	45	22	26	11	18	13	14	5	9	0	24548	68.19	2
Lack of uninterrupted power supply.	74	77	61	63	29	26	11	4	7	2	1	5	23974	66.59	3
Lack of awareness of proper functioning about ICT tools.	85	71	76	24	21	23	21	12	6	9	3	9	23635	65.65	4
High cost of ICT tools like computers, smart phones etc.	88	62	31	27	54	53	11	4	8	5	10	7	23133	64.26	5
Inadequate infrastructural facilities for maintenance of ICT tools	103	45	21	20	56	44	30	3	15	3	7	13	22809	63.36	6
Poor mobile/internet connectivity in rural areas.	98	53	47	30	19	21	19	11	5	17	11	29	22270	61.86	7
Lack of belief on e-sources.	101	66	23	19	32	20	18	16	3	6	11	45	21869	60.75	8

Lack of sufficient skills in usage of ICT tools by rural communities.	67	58	43	31	29	30	20	22	26	5	23	6	21781	60.50	9
Lack of local language in handling and understanding on available agriculture apps.	96	45	31	27	29	13	26	17	20	22	18	16	21761	60.45	10
Sometimes possibility of misleading information transmitted through internet.	68	40	33	37	35	35	33	24	21	17	10	7	21440	59.56	11
Faulty communication between seller/operators and farmers about use of ICT tools.	10	16	19	21	22	11	13	31	33	51	67	66	14452	40.14	12

As shown in the Table 4.5.3

1. “Lack of training of the farmers towards use of different ICT tools” scored the highest total garret score i.e. 25379 and a percentage of 70.50%, indicating a significant gap in technical knowledge among farmers therefore, it was ranked first among all the identified constraints. This can be a result of the partiality in dissemination of training given by the state government to the farmers where more focus is given on production technology and lesser importance is given to training with respect to use of information communication technologies and its importance.
2. “Difficulty in understanding the content language of ICT gadgets” was ranked the second most important constraint which scored a garret ranking of 24548 and a percentage of 68.19%. It was learned from the respondents that use of high technical language in the users’ manual of ICT tools was one of the main reasons behind reduction in full fledge use of these tools as it was difficult to understand. Farmers face language barriers when using ICT tools, which are often designed in English or non-local languages. This hinders comprehension and usability. Low educational background of the respondents coupled with lack of regional language support in app and ICT tools increased the difficulty in usage of ICT tools by farmers in the study area.
3. “Lack of uninterrupted power supply” was ranked third among the constraints with a garret score of 23974 and a percentage of 66.59. ICT usage is heavily dependent on power, and unreliable electricity supply acts as a major obstacle. Even with tools like smartphones farmers are unable to use them consistently. Many rural areas still suffer from poor electrification, especially in a state like Nagaland with its mountainous terrain and locations of villages in far off and interior areas there is still lack of proper electrical supply.

4. “Lack of awareness of proper functioning about ICT tools” with a garret ranking of 23635 with a percentage of 65.65% and ranked fourth among the constraints faced the respondents in using ICT tools. This constraint points to a significant informational and operational gap in the way ICT tools are introduced and used by farmers. Farmers possess mobile phones but they often lack the practical knowledge or technical understanding required to effectively operate agriculture-related software and mobile applications for weather forecasts, pest management, market price updates, government schemes or input subsidies online and participate in WhatsApp or Facebook groups that share farming knowledge. Tools such as Kisan Call Centers, eNAM (National Agriculture Market) are underutilized due to this lack of operational familiarity.
5. “High cost of ICT tools like computers, smart phones etc.” ranked fifth with a garret score of 23133 and a percentage of 64.26%. The high cost of ICT tools is a major economic barrier limiting their adoption by farmers, especially in rural and economically weaker sections. While the benefits of digital agriculture are well-established, such as improved access to market information, weather forecasts, and modern farming techniques, many farmers are unable to afford the devices or services required to access such resources. Farmers often prioritize essential farming inputs (like seeds, fertilizers, or labor) over digital investments. Devices are viewed as non-essential luxuries while cheaper devices have limited storage, poor battery life, or lack compatibility with advanced agricultural apps, further discouraging use.
6. “Inadequate infrastructural facilities for maintenance of ICT tools” with a garret score of 22809 and percentage of 63.36% was ranked sixth among the constraints faced by the farmers towards the use of ICT tools. Even when farmers manage to obtain ICT tools, such as smartphones, tablets, or computers, sustained use depends on the availability of reliable

maintenance services. In the study area it was found that technical support systems such as repair shops or technical service centers were either absent or highly inadequate. Delayed or costly servicing, often required the farmers to travel to distant towns, adding both time and transportation expenses. As a result, when devices malfunction or encounter issues, they often become unusable, leading to a loss of trust and discontinuation of ICT use.

7. ‘Poor mobile/internet connectivity in rural areas’ was ranked seventh among the constraints which had a garret score of 22270 and a percentage of 61.86%. Access to mobile networks and internet services is the backbone of digital agriculture, enabling farmers to use apps, receive advisory messages, browse market prices, check weather forecasts, and connect with buyers. However, poor mobile and internet connectivity in limits the effectiveness of ICT tools. Even basic tools like WhatsApp groups for farmer advisories or YouTube tutorials become ineffective in low-connectivity areas which discourages continued usage of ICT tools, even if farmers initially adopt digital tools.
8. ‘Lack of belief on e-sources’ was ranked eighth among the constraints faced by farmers with a garret score of 21869 and a percentage of 60.75%. Despite the growing availability of ICT tools and digital platforms offering agricultural information, a significant number of farmers in the study area exhibit skepticism or mistrust towards the credibility and usefulness of these e-sources due to lack of authentic information received via apps or social media and concerns about fake news, scams, or fraudulent schemes online. This lack of belief or confidence in online platforms, mobile apps, or government portals acts as a psychological and behavioural barrier to adoption.
9. ‘Lack of sufficient skills in usage of ICT tools by rural communities’ was ranked ninth in the constraints faced by farmers towards the use of ICT

tools which had a percentage of 60.50% and a garret score of 21781. One of the core challenges hindering the effective use of ICT tools in the study area is the lack of digital skills among rural communities. While the availability of smartphones and internet access has improved, the ability to operate, navigate, and utilize ICT tools effectively remains limited. Some farmers in the study area lacks the knowledge to Install or update agricultural apps or use basic functions like searching for information, uploading images, or entering queries. Digital skill-building workshops organized at the village level, ideally in collaboration with Krishi Vigyan Kendras (KVKs), local NGOs, or SHGs can help mitigate this skill gap towards the use of ICT tools.

10. “Lack of local language in handling and understanding on available agriculture apps.” which scored a garret score of 21761 and a percentage of 60.45. One of the subtle yet significant barriers to ICT adoption in the study area is the language gap; most software applications, websites, and digital tools are designed in English or Hindi, which is not understood by many farmers. Even literate farmers find technical jargon confusing if it’s not presented in their native language or a simplified form. The absence of local language options limits usability, comprehension, and comfort with the technology which reduces confidence and interest in exploring ICT tools among the farmers. Agriculture apps with integration of local languages should be developed by the state agricultural department in collaboration with the IIT department of the state.
11. “Sometimes possibility of misleading information transmitted through internet” with a garret score of 21440 and a percentage of 59.56% was ranked eleventh among the constraints faced by farmers towards the use of ICT tools. One of the growing concerns associated with digital agriculture is the risk of farmers in the study area encountering misleading, incorrect, or fraudulent information online. The open nature

of the internet allows for both credible and unverified sources to coexist and for rural farmers, limited digital and media literacy makes it difficult to distinguish between the two. This can lead to confusion, mistrust, and even financial loss.

12. “Faulty communication between seller/operators and farmers about use of ICT tools” which had garret score of 14452 and a percentage of 40.14% was ranked the least among the constraints faced by farmers towards the use of ICT tools. Although ranked the lowest among the listed constraints, faulty communication between ICT tool sellers or service operators and farmers still poses a significant issue, especially in areas where farmers are encountering digital technologies for the first time. This constraint reflects gaps in explanation, guidance, and after-sales support provided by those who sell or distribute ICT tools such as smart phones.

Conclusion and Implications of the Study

ICTs have clear potential to strengthen decision-making, advisory access, and risk management for farmers in Nagaland; however, adoption and effective use remain uneven across the region. This aligns with the study's explicit focus on knowledge, extent of use, attitudes, and constraints.

From the major findings of the present study regarding the application of Information communication technologies in agriculture the following is highlighted:

1. The present investigation establishes that Information and Communication Technologies (ICTs) possess significant potential to enhance agricultural decision-making, improve risk management, and expand access to timely information for farmers in Nagaland. At the same time, the findings reveal that adoption and effective utilization remain uneven across farmer profiles and locations. This conclusion is consistent with the study's organization around socio-economic characteristics, knowledge and extent of use, attitudes, influencing factors, and constraints, which together provide a comprehensive framework for identifying the domains where interventions are most required. From the attitude study of farmers towards ICT tools "ICT-based extension service for decision-support" was ranked the highest e.g., pest, weather, prices. This depicts a strong demand signal for actionable and context-aware advisories.
2. A prominent demographic feature highlighted by the study is the predominance of middle-aged farmers, who constitute nearly two-thirds of the respondents and are in their prime working years. This group is therefore likely to serve as the primary anchor for scaling ICT adoption, while younger and older members may require tailored engagement strategies to ensure inclusivity. The data also indicate a gender imbalance,

with men forming the majority of participants, reflecting existing patterns in agricultural decision-making. This imbalance underscores the need for deliberate and systematic inclusion of women in ICT initiatives to prevent the widening of digital and opportunity gaps.

3. Respondents emphasized the importance of mechanisms that enable rapid feedback and direct access to experts, signalling that interactive, two-way communication services are more likely to be effective than unidirectional information flows. The challenging terrain and remoteness of many agricultural areas in Nagaland further complicate the provision of face-to-face extension services, thereby reinforcing the necessity of digital alternatives such as voice-based platforms, offline-first applications, and blended radio-mobile solutions.
4. The implications of these findings are that ICT interventions in agriculture must be conceptualized as holistic, hybrid systems that embed digital tools within existing institutional, social, and extension structures, rather than as stand-alone technological fixes. Localization emerges as a critical principle, requiring that language, cropping calendars, and region-specific ecological risks be fully integrated into ICT platforms to ensure both relevance and farmer trust. Equity considerations must similarly be foregrounded, with gender-responsive design, community access points, and facilitated sessions built into program planning. Finally, the quantitative analytical approaches employed in the study, including regression and path analysis, provide a valuable lens for identifying the most influential drivers of ICT adoption. These insights can guide the development of pilot initiatives and adaptive learning cycles that emphasize practical usefulness, monitor measurable outcomes, and evolve responsively to farmer feedback.

Recommendations

1. There is an urgent need to invest in the foundational infrastructure required for reliable ICT delivery. This includes improvements in mobile network coverage, access to affordable electricity, and the establishment of community-level charging or solar solutions. Such measures are essential to ensure that ICT services become accessible in remote and rural areas. In parallel, ICT applications should be designed with offline-first functionality and complemented by voice-based or interactive systems, making them usable in low-bandwidth environments and adaptable to varying literacy levels.
2. ICT services must be tailored to the cultural and agro-ecological contexts of farmers in Nagaland. Advisory messages should be available in local languages and integrate region-specific cropping calendars, pest and disease surveillance, and weather-linked operations. Farmers demonstrated a strong demand for real-time market price information and input availability; therefore, platforms should prioritize these services, as they align directly with the decision-support functions that respondents valued most.
3. Capacity development is critical to enable effective use of ICT tools. Digital literacy programs should be structured in tiers, beginning with basic device operation and extending to the interpretation of advisories. These programs can be delivered through farmer producer organizations, self-help groups, and local institutions. Extension personnel should also be trained to facilitate digital services through methods such as group calls, mobile clinics and hotspot demonstrations. This approach ensures that ICT complements, rather than replacing, traditional extension systems.
4. The study revealed a male-dominated participation base, which necessitates deliberate efforts to foster gender inclusivity. Sessions should

be scheduled at times convenient for women, community devices should be provided and female peer educators should be recruited to enhance women's engagement. At the same time, rural youth should be mobilized as "digital champions", supporting their communities in registering for services, navigating applications and troubleshooting technical challenges, thereby accelerating ICT diffusion.

5. Mechanisms for interactive communication must be strengthened. Hotlines, call-back services, and structured expert consultations should be institutionalized to address farmers' preferences for rapid feedback and specialized guidance. This should be complemented by layered communication strategies, including broadcast advisories for large regions, narrowcast messages for specific blocks or villages and individualized nudges tailored to farmer profiles and crop stages.
6. Long-term success requires a robust framework for monitoring, evaluation and learning. This includes systematic tracking of service reach, responsiveness and tangible outcomes such as changes in yields, income, and loss reduction. Experimentation with message timing, format, and frequency should be conducted to optimize delivery. Furthermore, transparent governance mechanisms including data privacy safeguards and grievance redressal systems are essential for building trust and accountability. Grounding subsequent interventions in the most influential adoption drivers identified in the study will ensure that ICT-based agricultural development in Nagaland achieves both scale and equity while contributing meaningfully to farmer empowerment and resilience.
7. Training programs to enhance farmers' attitudes and competencies in using basic ICT tools such as mobile phones should be initiated by the state agriculture department. As, capacity-building efforts will motivate farmers to adopt higher-level ICT platforms and enable them to access

agricultural information, market data and government schemes more effectively. The state department of agriculture in collaboration with the department of information technology and communication should emphasize on developing of user-friendly, local language-based ICT applications and interactive voice response (IVR) systems to ensure inclusivity and accessibility for all farmers, including those with limited literacy or digital exposure. This collaborative approach would not only bridge the digital divide in rural areas but also foster greater technological participation, leading to improved productivity, informed decision-making and sustainable agricultural development in the region.

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APPENDICES

INTERVIEW SCHEDULE

STATUS OF APPLICATION OF INFORMATION COMMUNICATION TECHNOLOGIES IN AGRICULTURE IN NAGALAND.

Respondent no:
Date of

interview:

General Information:

1. Name of the respondent:
2. Name of the District:
3. Name of the RD Block:
4. Name of the Village:

1. Socio-economic characteristics:

1. Age:
2. Gender:
3. Occupation: (farming/employed/others)
4. Educational Qualification: illiterate/primary/middle (5-7)/high school (8-9)/Higher secondary (11-12)/Graduate
5. Marital Status: Unmarried/ Married
6. Family Type: Joint/ Nuclear
7. Family Size:
8. Type of house: 1. Katcha Bamboo + Thatch/ 2. wood + Tin/ 3 Assam type

9. Social Participation:

Do you or a member of your household involved in any political, social, rural or cultural organization? Please indicate

- a) Member of Self Help Group (SHG)..... (Y/N)
- b) Church committee member..... (Y/N)
- c) Member of the village council.... (Y/N)
- d) Office bearer of any organization.....(Y/N)
- e) Any other.....
- f) No membership.....

10. Total land holding size:.....(acre/ha)

11. Annual income (Rs) of the household:

12. Information sources utilization:

a) Mass media sources:

S no.	Sources of information	Most often	Often	Sometimes	Never
1	Mobile phones (mobile internet)				
2	Exhibition				
3	Newspaper				
4	Magazines				
5	TV				
6	Radio				
7	Print media: poster/folder/leaflet				

b) Personal Localite:

S no.	Sources of information	Most often	Often	Sometimes	Never
1	Relatives				
2	Friends				
3	Progressive Farmers				
4	Neighbors				

c) Extension Contact:

S no.	Sources of information	Most often	Often	Sometime	Never
1	Agricultural Officer				
2	Horticultural Officer				
3	VLW/ AFA				

4	KVK professionals				
5	Veterinary Officer				
6	ATMA professionals				
7	NGOs				
8	Any others				

Knowledge Level (Sayem *et al.*, 2022)

Sl. No. of Item	Items
1. REMEMBERING	
1.a	What is the dial or hotline number of the Krishi call center? a) 109 b) 16123 c) 999 d) No
1.b	Which of the following is the name of a social media site? a) Mozilla Firefox/Google Chrome/Internet explorer b) Facebook/Youtube c) Google/Yahoo d) No
1.c	Which of the following is the part of a computer? a) Multiplug b) Monitor c) Internet d) No
2. UNDERSTANDING	
2.a	What is the elaboration of ICT? a) Information and Communication Technology b) Internet and Communication Technology c) Indigenous Common Technology d) No
2.b	What is the most appropriate regarding social media? a) Social media like Facebook, YouTube, WhatsApp, etc. are the global virtual platforms that interconnected billions of people to share or get information. b) Social media is used particularly by a specific society. c) Social media is used for entertainment purposes only. d) No

2.c	<p>What is the most appropriate regarding Mobile phones?</p> <p>a) A cellular phone or cell phone that connects a wireless communication network.</p> <p>b) A device with communication techniques only.</p> <p>c) A telecommunication device that provides only voice calls.</p> <p>d) No</p>
3. APPLYING	
3.a	<p>How can you save your computer and smartphone from virus attacks?</p> <p>a) By running anti-virus.</p> <p>b) By using a cleaning agent.</p> <p>c) By covering with a cloth or back part.</p> <p>d) No</p>
3.b	<p>How can you take a photograph?</p> <p>a) By using a mobile camera.</p> <p>b) By using a digital camera.</p> <p>c) Both of the above.</p> <p>d) No</p>
3.c	<p>How can you get internet connectivity?</p> <p>a) By using a mobile data connection.</p> <p>b) By using a modem.</p> <p>c) Both of the above.</p> <p>d) No</p>
4. ANALYZING	
4.a	<p>Why is a mobile phone suitable for extension activities?</p> <p>a) Easy, cheap, and quickly accessible.</p> <p>b) Only a voice call is possible.</p> <p>c) I don't know.</p> <p>d) No</p>
4.b	<p>Why is call centers gaining popularity day by day?</p> <p>a) No technical knowledge is required to make a call.</p> <p>b) It is possible to get direct interaction with the subject matter expert.</p> <p>c)Both of the above.</p> <p>d) No</p>
4.c	<p>Why is password used in ICT-based media?</p> <p>a) To make secure use.</p> <p>b) To make it reliable.</p> <p>c)To make it easy to handle.</p> <p>d) No</p>
5. EVALUATION	
5.a	<p>What is your opinion about the present situation of ICTs in agricultural extension?</p> <p>a) It can save time, visit and money.</p>

	<p>b) It is possible to get real-time problem-solving.</p> <p>d) Both of the above.</p> <p>d) No</p>
5.b	<p>Make correct judgment of the ICT-based agricultural advisory services compared to traditional extension services.</p> <p>a) It is easy to get an expert opinion in the quickest possible time.</p> <p>b) It is possible to escape physical contact.</p> <p>c) Both of the above.</p> <p>d) No</p>
5.c	<p>What opinion is correct about the present situation of agriculture-related TV programs?</p> <p>a) Many TV channels are emphasizing telecast agricultural news/special programs for agriculture, thus motivating farmers.</p> <p>b) Once you missed a program to watch, you missed forever, it is not possible to retrieve the program from the internet.</p> <p>c) None of the above.</p> <p>d) No</p>
6. CREATING	
6.a	<p>How can you get a new mobile app (android)?</p> <p>a) Download and install through the play store.</p> <p>b) Sharing from one mobile to another mobile.</p> <p>c) Both of the above.</p> <p>d) No</p>
6.b	<p>How can you increase the storage capacity of a mobile?</p> <p>a) By inserting a memory card with more storage capacity.</p> <p>b) By installing/downloading new software.</p> <p>c) None of the above.</p> <p>d) No</p>
6.c	<p>How can you transfer data from your computer?</p> <p>a) Through pen drive/data cable/Bluetooth etc.</p> <p>b) Through modem.</p> <p>c) Through multimedia projector.</p> <p>d) No</p>

Attitude (Kumar *et al.*, 2011)

S.No.	Statement	SA	A	UD	DA	SDA
1	ICTs provide possible solutions to the present agricultural situation.					
2*	ICTs can not meet location specific needs of the farmers.					

3	ICTs are potential tools to reach the needy farmers.					
4	Farmers feed back is fast through ICTs than traditional methods					
5*	Illiteracy will not deter farmers in availing ICT services.					
6*	ICTs can not deliver personalized information.					
7	ICT based extension services assist the farmer in planning and decision making aspects in agriculture.					
8*	'ICT services' is a distant dream for resource poor farmers.					
9	Farmers can get remunerative prices to their produce through ICT based market intelligence.					
10	Expert advice makes the farmers enterprise/activities productive.					
11*	All kinds of information exchange are possible only through ICTs.					
12	Existing infrastructure of ICTs is not enough to meet the needs of the farming community.					
13*	Only resourceful farmers can get the benefit of the ICTs					
14	Access to information centre at village level is boon to the farming community.					
15	Phone-in-live with scientists gives first hand information about queries.					
16*	ICTs alone would solve the problems of farmers.					
17	ICT based Pest/disease outbreak warning system facilitate farmers to take preventive measures.					

18*	ICT extension services avoid the personal extension contact.					
19	ICTs based extension services provide new opportunity to build a skilled and knowledge community.					
20*	ICT is a valuable tool, but it will never influence farmers' own decision making.					
21	Weather forecasting through ICTs assists farmers in timely decisions.					
22*	ICT based extension services are alternative to the present extension system.					

* Negative statements.

Accessibility (Ownership)

S. No.	Category		Not Owned	Shared	Owned
1	Traditional Media	Radio			
		Television			
2	Mobile based tools	SMS			
		Whatsapp			
		Weather app			
3	Internet	You tube			
		Facebook			
		e-Mail			
		e-Books			
4	Digital Infrastructure	Computer			
		ATM			
		CD/DVD			

Availability

S. No.	Category		Not Available	Hard to access	Easily Available
1	Traditional Media	Radio			
		Television			
2	Mobile based tools	SMS			
		Whatsapp			
		Weather app			
3	Internet	You tube			
		Facebook			
		e-Mail			
		e-Books			
4	Digital Infrastructure	Computer			
		ATM			
		CD/DVD			

Extend of usage

S. No.	Category		Never	Rarely	Occasionally	Frequently	Very Frequently
1	Traditional Media	Radio					
		Television					
2	Mobile based tools	SMS					
		Whatsapp					

		Weather app					
3	Internet	You tube					
		Facebook					
		e-Mail					
		e-Books					
4	Digital Infrastructur e	Computer					
		ATM					
		CD/DVD					

Constraints

S. No.	Category
1	High cost of ICT tools like computers, smart phones etc.
2	Lack of sufficient skills in usage of ICT tools by rural communities.
3	Lack of belief on e-sources.
4	Difficulty in understanding the content language of ICT gadgets.
5	Poor mobile/internet connectivity in rural areas.
6	Lack of awareness of proper functioning about ICT tools.
7	Inadequate infrastructural facilities for maintenance of ICT tools
8	Lack of uninterrupted power supply.
9	Lack of training of the farmers towards use of different ICT tools.
10	Lack of local language in handling and understanding of software.
11	Faulty communication between seller/operators and farmers about use of ICT tools.
12	Sometimes possibility of misleading information transmitted through internet.

PHOTO GALLERY



Plate 1: Mon district



Plate 2: Mon district



Plate 3: Tuensang district



Plate 4: Tuensang district



Plate 5: Mokokchung district



Plate 6: Mokokchung district



Plate 7: Wokha district



Plate 9: Wokha district



Plate 10: Phek district