

**DIGITAL TOOLS IN HORIZONTAL SPREAD OF
AGRICULTURAL TECHNOLOGIES: A SCENARIO
ANALYSIS IN KERALA**

by

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(2017-11-061)

THESIS

**Submitted in partial fulfilment of the
requirements for the degree of**

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture

Kerala Agricultural University



DEPARTMENT OF AGRICULTURAL EXTENSION

COLLEGE OF AGRICULTURE

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KERALA, INDIA

2019

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Acknowledgements

First of all, I bow my head before Lord Almighty whose grace had endowed me the inner strength and confidence and blessed me with a helping hand at each step during the work.

*I place my profound sense of gratitude and indebtedness to **Dr. Jayalekshmi G**, Assistant Professor and Programme Coordinator, KVK Kottayam and chairman of the advisory committee for her expert guidance, valuable suggestions, constructive criticisms, enduring patience, co-operation, and constant encouragement throughout the course of my study. It was her sincerity, dedication and perfectionism which influenced me deeply to improve myself in all aspects. I extend my sincere gratitude for providing a stress free situation by the open minded approach and for the care bestowed on me throughout the study period.*

*I humbly place my gratitude to **Dr. B. Seema** Professor and Head, Department of Agricultural Extension and member of Advisory Committee for her inspiring professional guidance and timely help rendered to me for the completion of my work.*

*I thankfully remember Late **Dr. N. Kishore Kumar**, Professor & Head TSS, Department of Agricultural Extension and former member of my advisory committee for all the love and care along with his valuable support and suggestions provided throughout.*

*I express my deepest respect towards **Dr. Allan Thomas**, Assistant Professor, Department of Agricultural Extension and member of my advisory committee for his constant support, encouragement, timely guidance, help and affectionate advice.*

*I wish to extend my sincere gratitude to **Dr. Brigit Joseph**, Associate Professor and Head, Department of Agricultural Statistics, for her guidance, stimulating suggestions and whole hearted co- operation during the statistical analysis and preparation of the thesis.*

*I gratefully acknowledge **Dr. Vijayaraghava Kumar**, Rtd. Professor and Head, Department of Agricultural Statistics and former member of my advisory committee for*

his guidance, timely advice, stimulating suggestions and statistical interpretation of the experiment data.

I express my sincere thanks to **Seena chichi, Aswathy chechi** and all other non-teaching staff of Department of Agricultural Extension for their sincere cooperation and kindly approach and inspiration offered during the study period.

I wish to place my deep sense of gratitude towards all the **beneficiary farmers and Agricultural Extension Officers** of Kannur, Thrissur and Thiruvananthapuram Districts for their timely support in rendering all the data concerning Digital Tools and its usage.

Words are inadequate to express my special thanks to **Nithishettan, Akhilettan, Arjunettan, Afna Itha, Mamtha Chechi, Dhanusha Chechi, Namitha Chechi and Preethu Chechi**, for their sincere love, encouragement, care, help, emotional support and affection during these days without which my work wouldn't have been completed.

I would like to express special thanks to my classmates, **Susan, Safna, Vinod, Pooja, Geethu, Sreenath, Santhosh, Charan and Deini**, for their constant support, love and continued motivation.

I am grateful to my friends especially **Aisu and Tiju** for all the love, support and motivation provided throughout these days

I express my thanks and wholehearted cheers to all my friends especially **Amal, Reni, Melvin, Lakshmi, Neethumol, Namitha, Shilpa, Navya, Ankitha, 7/9 inmates Eldho chettan, Nyshanthettan, Gibin, Ajin, Pavan, Akshay** and all other friends for their help, love, encouragement and support which made my days more colourful.

I am thankfully remembering Agricultural officers **Abhimanuettan, Vineethettan, Athulettan, Jithinettan, Vishnuettan** for providing their valuable service for the fulfilment of this work.

It's my pleasure to express my special thanks to **Reshma chechi, Anju chechi, Reshma Angel chechi, Shilpa chechi, Shahalas itha, Navitha chechi, Mano chettan, Nibinettan** and all other seniors for their valuable advices and support throughout the study period.

*With deep sense of gratitude I wish to thank my entire juniors **Asha, Krishnan Unni, Ashika, Devapriya, Rin, Reshma, Kavya, Dini, Chippy and Rahalya** who have helped and supported me during the course of my study.*

*Mere words cannot express my profound indebtedness to my beloved **Achachan Jolly Sebastian, Amma Jessy Jolly, Ammachi Elikutti Sebastian, Older Brother Amal, Younger Brother Ajay, Sister in Law Sruthy, Nephew Vihaan** and other family members for their unconditional love, sacrifices and support bestowed on me during my hard periods.*

I once again express my sincere gratitude to all those who helped me in one way or another in the successful completion of this venture.

ALAN JOLLY SEBASTIAN

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LIST OF ABBREVIATIONS

Abbreviations	Full form
%	Percentage
ICT	Information and Communication Technology
m-tools	Mobile tools
e mail	Electronic mail
e newspaper	Electronic newspaper
m-extension	Mobile extension
<i>et. al</i>	Co-workers
GoI	Government of India
ToT	Transfer of Technology
SDA	State Department of Agriculture
IT	Information and Technology
SSLC	Secondary School Leaving Certificate
KCC	Kisan Call Centre
KVK	Krishi Vigyan Kendra
KAU	Kerala Agricultural University
No.	Number
VHSE	Vocational Higher Secondary School

Introduction

I. INTRODUCTION

Digital technology has expanded radically over the past half century, making every sector of life easier. Digital tools helps communities in different manners from storing, accessing and sharing information for communication purposes in a faster way than ever before. Evolution of the digital age is exponential in nature helping the mankind to reap the benefits of digitalization in every area and agriculture is no exception from it. Expansion of digital data and advancement in Information and Communication Technology (ICT) can benefit farmers as well as the stake holders to achieve a rapid development. Digitalizing the agricultural sector can help to provide instant information about crop production and management, accurate market information and moreover can keep farmers in touch with extension personnel. Modernization of agriculture with usage of digital technologies will definitely transform each and every component of agribusiness value chain.

The National Commission on Farmers noticed that deficit of knowledge is a major constraint that affect the productivity of agriculture in India. It was identified that the application of digital tools especially in the field of agricultural extension was the key to the information requirements of the farmers. In order to bridge the gap, we need to supplement farmers and extension personnel with various digital tools. Use of digital tools in agriculture can help in speedy transfer of information which can be exclusively opted for various agricultural activities. The role of digital tools in crop production starts from the very early stage such as deciding type of crop, planting of crops till its harvesting and marketing. Digital tools can facilitate the transfer of information of various operations to be carried out at each stages of the crop and also can provide answers to various queries by the farmers. The crop protection role of the digital tools includes surveillance and monitoring of pest and diseases and providing information for various preventive and protection measures. Marketing of the produced crops can also be facilitated by using digital tools through providing the latest market

information, on demand of the product, digital transaction of commodities and cash etc. The role of digital tools also extend to the area of agricultural research through quick access to various information, storing bulk data and analyzing it with different software etc. The flagship programme like Digital India that was introduced by Government of India in 2015 was to empower individuals to access various digital technologies to make a positive impact and improve the potential in agriculture. The integration of digital technologies in agriculture will be instrumental for encouraging data generation along with the advanced analytics which will allow the farmers to make smooth choices on farming and to get advantage through a reasonable use of inputs and labour.

1.1 Objectives of the study

To analyse the use of digital tools in horizontal spread of agricultural technologies among farmers and extension agents, to identify the preference of various digital tools among the respondents with regard to its content and to identify the constraints faced by them in usage of digital tools.

1.2 Scope and importance of the study

The role of digital technology in information dissemination is irreplaceable in the present world. Digitalization make fast access to data and communication. The future agricultural development is in line with the integration of digital technology. Since there is significant role for digital tools in agriculture, the present status of these tools as well as the future usage should be taken into consideration. Even though there are numerous digital tools developed for application in agriculture, the awareness and preference for the tools among the farmers as well as other stake holders are found to be restricted among a few tools.

The present study entitled digital tools in horizontal spread of agricultural technologies: a scenario analysis in Kerala mainly focus on how well the farmers and extension personnel know about digital tools and what are the preferences of the

respondents over various digital tools. It also focuses on the use of various digital tools by the respondents with respect to the contents like crop production, crop protection and marketing and thereby to identify the horizontal spread of the technology among the users. The study will be useful for the farmers as well as extension agents by identifying the various digital tools which has not been explored by them even if it has a potential to benefit the users. It will also help us to find the preference of the respondents among the tools and selecting the tools which provides appropriate information and consultation services. Further the constraints experienced by the farmers and extension personnel in using the digital tools can be identified.

1.3 Limitations of the study

The study had some limitations like time and limited resources and the work was done as part of PG programme by a single researcher. The study was conducted with great care in order to avoid any sort of peculiar favoritism since the research was totally based on the awareness and preference of the respondents. The study was restricted to three representative districts from the three zones of Kerala due to the limitation in time and resource. Within all these limitations, a lot of effort was taken in order to make this research as efficient as possible.

Review of Literature

II. REVIEW OF LITERATURE

A literature review is an organized text which contains a deep evaluation of the past researches. Literatures are secondary sources which will help us to access knowledge about a particular research topic. An organized literature review is portrayed with flow of rational ideas, existing and pertinent references with suitable reference styles and appropriate usage of the terminologies with unbiased and inclusive view of the past research on the topic. A summary of the previous research studies similar to the research theme is used for the creation of the hypothesis. A suitable literature review provides suitable ideas for the interpretation of the results obtained.

This chapter is categorized into the following heading

- 2.1. Profile characteristics of the respondents using digital tools
- 2.2. Awareness of respondents about digital tools
- 2.3. Preference for various digital tools among the respondents
- 2.4. Constraints faced by the respondents in using digital tools

2.1. Profile characteristics of the respondents using digital tools.

2.1.1. Profile characteristics of Farmers

2.1.1.1. Age

Kabir (2015) in his study on knowledge level and attitude of farmers on ICT for farming pointed out that majority (60.00%) of the ICT based farming farmers belonged to young age group which is followed by middle age (27.80%) and old age (12.20%) group.

Ali *et al.* (2016) in their study about the impact of information and communication technology on agricultural productivity reported that majority of the wheat growing farmers (66.66%) were above 40 years old.

Dhaka and Chayal (2016) in their study on experience of farmers with ICTs for transfer of technology in varying agri-rural environment revealed that most (46.67 %) of the ICT using farmers belonged to middle age group followed by young age (38.67 %) and old age (14.67 %) group.

Reddy (2017) in his study about the pattern of utilization for Information and Communication Technologies (ICTs) among the dairy farmers found that majority of the farmers belonged to middle aged (70.00%) category.

Swaroop (2016) in his study about the accessibility and extent of utilization of Information and Communication Technologies for the adoption of enhanced agricultural practices found that most of the respondents were middle aged (54.17%).

Naik (2018) in his study on usage of ICT tools by the farmers of Anantapur district revealed that more than half of the farmers are middle aged (67.50%) which was followed by old age (18.33%) category and young age (14.17%) category.

Singh and Kameswari (2019) in their study about association between the characteristics of farmers and influence of ICT enabled web portal (Krishinet) found that majority of the respondents (48.57%) were middle aged (38-51 years) which was followed by young aged (37.50%) and old aged (13.93%).

2.1.1.2. Education

Chauhan (2016) in his study about the perception of farmers about the application of ICT in Gujarat revealed that majority (45 %) of farmers were having high school and higher secondary level of education.

Dhaka and Chayal (2016) in their study found that the educational status of respondent as half (50.67 %) of the of respondents were functionally illiterate followed by high school (42.67 %) and graduate (6.67 %).

Hayati and Bijani (2018) in their study found that most of the respondents were with middle school (23.5%) and primary school (23%) education respectively, followed by secondary school education (20.2%) higher secondary education (18.6%) and illiterate (14.8%).

Naik (2018) reported that most (35.00%) of the farmers had high school education, which was followed by illiterate (17.51%), primary school (14.17%), middle school (14.17%), intermediate (13.33%), graduation (4.16%) and functionally literate (1.66%).

Lahan and Deka (2019) in their study concluded that most (41.66%) of the respondents were educated up to high school followed by primary school (40.00%), higher secondary (10.0%) and graduate (8.33%).

Singh and Kameswari (2019) in their study reported that about one third (33.93%) of the farmers were having high school as their highest educational classification followed by higher secondary (24.64%), graduate Level (16.07%), primary level (13.93%) and middle level (11.43%).

2.1.1.3. Innovativeness

Dhaka and Chayal (2016) in their study reported that most (42.67%) of the farmers had medium level of innovativeness whereas high (34.67%) and low (22.67%) innovativeness was reported to follow.

Kafura *et al.* (2016) in their study found that more than two third (68%) of the farmers were Medium innovative in nature followed by equal amount of respondents for High (16%) and Low (16%) level of innovativeness.

Koshy and Kumar (2017) in their study about the farmers' attitude about Kisan Call Centres stated that the innovativeness of the farmers was found to be low (59%) because most of the respondents preferred to take some own time to now about the innovation before accepting an innovation.

Verma (2016) in his study revealed that majority (82.50%) of farmers had medium innovativeness followed by slight difference between low (9.16%) and high (8.33%) levels of innovativeness.

Alam and Uddin (2018) in their study, reported that levels of innovativeness was found to be as most (67.30%) of the farmers had medium level of innovativeness which was followed by low (17.30%) and high (15.40%) levels of innovativeness.

Pudke (2018) in his study on farmers' attitude about the usage of mobile phone services for transferring agricultural technologies found that three fourth (75.84%) of farmers were having medium level of innovativeness accompanied by low (15.83%) and high (8.33%) levels of innovativeness.

2.1.1.4. Cosmopolitaness

Kafura *et al.* (2016) in their study about farmers' usage of information and communication technologies as an extension tool in Gazipur district of Bangladesh reported that most (65%) of the respondents have medium followed by low (21%) and high (14%) levels of cosmopolitaness.

Tomar (2016) in his study pointed out that majority (70.83%) of respondents have medium level of cosmopolitaness followed by low (20%) and high (9.17%) levels of cosmopolitaness.

Verma (2016) in his study about attitude of farmers towards e-choupal revealed that majority (72.50%) of the farmers had medium cosmopolitaness followed by low (23.33%) and high (4.16%) cosmopolitaness.

Patil (2017) in his study on efficiency of agricultural programmes telecasted in DD kisan channel as based on farmers' perspective reported that more than half (58.53%) of the respondents had medium level of cosmopolitaness succeeded by low (22.96%) and high (18.51%) levels of cosmopolitaness.

Alam and Uddin (2018) in their study on the usage of Information and communication technologies by the farmers for the delivery of agricultural information revealed that majority (55.70%) have medium level of cosmopolitaness followed by low (22.70%) and high (21.60%) levels of cosmopolitaness.

Pudke (2018) in his study revealed that majority (74.16%) of farmers have medium cosmopolitaness accompanied by low (20%) and high (5.84%) levels of cosmopolitaness.

Naik (2018) in his study found that most (65%) of the farmers have medium level of cosmopolitaness, followed by high (18.34%) and remaining (16.66%) had low level of cosmopolitaness.

2.1.1.5. Computer Proficiency

Sarala (2008) in her study about the perception of agricultural officers and progressive farmers about communication facilitated by computer found that majority (80 %) of the respondents were having moderate level of computer usage.

Burke and Sewake (2008) in their study on the adoption of internet and computer technologies by small agricultural firms with special reference to the flower growers of Hawaii found that most (82%) of the respondents were using computer for their business, while eighteen per cent of the respondents never used a computer.

Madhusudhan (2009) in his study about participation and effectiveness of farmers on e-Extension with the help of raitamitra.kar.nic.in website observed that majority (58.34%) of farmers had low computer use efficiency followed by medium (33.13%) and high (8.54%) computer use efficiency.

2.1.1.6. Extend of knowledge about digital tools

Agwu *et al.* (2013) in their study reported that more than half of the farmers (56.70%) had low knowledge on ICTs followed by medium (26.70%) level of knowledge and high (16.60%) level of knowledge.

Raghuprasad *et al.* (2013) in their study on the analysis about farmers knowledge level and utilization of ICT tools aimed at farm communication found that nearly seventy per cent of farmers had high to medium level of knowledge on utilization of ICT tools and about thirty per cent of respondents had low level of knowledge about utilization of ICT tools.

Kabir (2015) in his study revealed that half of the respondents (50.0%) had medium level of knowledge on various ICT tools followed by low (26.7%) and high (23.3%) level of knowledge respectively.

Ajayi *et al.* (2018) in their study found that majority (76.0%) of the farmers had low knowledge on ICT tools which was followed by moderate (16.7%) knowledge on ICT tools and (7.3%) had high knowledge on ICT tools.

Vishwatej *et al.* (2018) in their study for identifying the knowledge of farmers in Karnataka about various projects on information and communication technology

reported that most of the respondents had high level of knowledge on Kisan Call Center (40%) followed by e- Choupal (39.29%) and Krishi Marata Vahini (37.14%) with least knowledge on Raith Mitra Kendra (30.71%).

2.1.1.7. Attitude towards Digital Tools

Kabir (2015) in his study indicated that more than half (58.90 %) of the respondents had highly favourable attitude towards ICTs followed by moderately favourable (41.10 %) attitude towards ICTs.

Palaiah *et al.* (2016) in their study about farmer's attitude on the usage of ICT tools for communication on farm information revealed that more than forty per cent (40.83 %) of the farmers were having favourable attitude towards ICT tools followed by least favourable attitude (31.67 %) and most favourable attitude (56.67 %) for ICT tools.

Koshy and Kumar (2017) in their study measured the attitude of farmers towards Kisan Call Centers. Fifty eight per cent of the farmers had favourable attitude followed by twenty six per cent of respondents with more favourable and fifteen per cent with less favourable attitude towards Kisan Call Centers.

Pudke (2018) in his study about the farmer's attitude on the use of mobile phones for transferring agricultural technologies reported that majority (70 %) of the farmers had moderately favourable attitude towards the use of mobile phones.

Wadkar *et al.* (2018) in their study on knowledge and attitude of farmers for accessing aaqua - an e-agriservice platform recognized that about than half (56.67 %) of the respondents had more favourable attitude to the e- agriservices.

Kumar and Kumari (2019) in their study about the attitude on usage of mass media ICTs among the farmers reported that nearly forty per cent (39.88 %) of the users found the farm broadcasts more favourable followed by favourable (35 %) and less favourable (25.12%).

2.1.1.8. Accessibility to digital tools

Syiem and Raj (2015) in their study about the usage and access of information and communication technologies for agriculture and rural development stated that all the respondents were accessible to mobile phones.

Adejoh *et al.* (2016) in their study by accessing the accessibility and usage of media channels recognized that majority of the respondents from urban area (98 %) followed by rural area (86.13 %) was accessible to television.

Kumar (2016) in this study conducted in Haryana about the impact of information and communication technologies on agriculture reported that all the farmers (100 %) were accessible for mobile phones.

Kumari (2017) in her analytical study about the role of ICTs in agricultural development found out that ninety per cent (90 %) of the respondents who were progressive farmers were accessible to television.

Luqman *et al.* (2019) on their study on the various factors which influences the use of ICTs pointed out that the accessibility to ICT tools was very low for majority (56.7%) of the respondents and only low (15.3%) of farmers reported a high level of availability of ICT tools.

2.1.1.9. Adoption of digital tools

Tomar *et al.* (2016) in their study about the relationship between extent of use of ICTs and the socio-demographic profile of the farmers found that majority of the farmers owned television (90 %) and mobile phones (95 %).

Warthi (2017) studied about the usage of mobile phones by the dairy entrepreneurs and reported that all the entrepreneurs (100%) who were the respondents of the study were using mobile phone to gather information about various veterinary services and similar sectors.

Darsan *et al.* (2017) in their study about the socio-economic background and usage of social media by farmers identified that majority (90%) of the farmers were using facebook and more than seventy per cent (77.50%) of the farmers were using whatsapp as a social media platform.

Naik (2018) in his study about the use of ICT tools by the farmers found that all farmers (100 %) have adopted television and majority (81.66 %) of the respondents owned a smart phone for their own.

Pal (2018) in his study about the perception of farmers on the use of social media for gathering agricultural information reported that mobile phone and television was owned by all the farmers. Majority of the respondents were using social media such as Facebook, WhatsApp, and YouTube for accessing agricultural information.

2.1.2 Profile characteristics of Extension Personnel

2.1.2.1. Age

Oladele (2011) in his study on the influence of ICTs in accessing agricultural information on farmers, extension personnel and researchers found that majority of the researchers and extension agents were under the age category of 31–40 years.

Omotesho *et al.* (2012) in their study on the accessibility of ICTs among the agricultural extension personnel found that majority (70 %) of the respondents belonged to the below mean age of 42.5.

Gangadharan (2015) studied about capacity building strategies for extension agents on improving the usage of ICTs revealed that nearly fifty per cent (48.66 %) of the respondents were middle aged followed by old (34.66 %) and young (16.66%) respondents.

Thomas and Laseindeage (2015) in their study about the evaluation of the usage of social media by the extension agents pointed out that the mean age of the respondents was found to be 38 years and majority of the respondents were between 28 to 49 years old.

Raksha and Meera (2015) studied about the determinants of ICT and reported that more than half (51.67%) of the extension agents were found to be young followed by middle age (28.33%) and old age (20.00%).

Umar *et al.* (2015) studied about the awareness and usage of ICTs by extension personnel recognized that more than forty per cent (42.7%) of the extension agents were 31-40 years old which was followed by thirty per cent (30.1%) of respondents in the category 41-50 years and only twenty per cent (21.4%) of respondents were 21-30 years old.

2.1.2.2. Education

Bahgat and Antar (2007) in their study about the knowledge and level of usage of ICT tools by extension officers found that more than half (56%) of the respondents possessed a diploma in agriculture from secondary schools.

Ravikishore (2014) in his study about the diffusion as well as adoption of expert systems in agriculture by the extension personnel revealed that exactly half of the respondents were post-graduates followed by doctoral degree (26%) and graduates (24%) respectively.

Gangadharan (2015) found that more than most of the extension workers had BSc. Agriculture and MSc Agriculture qualifications with 46.66 per cent and 41.33 per cent respectively.

Raksha and Meera (2015) in their study on the determining factors affecting information and communication technologies on extension system of agriculture disclosed that majority of the extension workers were having post-graduation (60.56 %) followed by doctoral degree (21.11 %) and degree (18.33 %) qualification.

Harshadbhai (2017) in his study about the attitude of agricultural extension professionals found that more than half (52 %) of the respondents has MSc qualification followed by BSc (34 %) and PhD (14 %) qualification.

2.1.2.3. Attitude towards digital tools

Nagalakshmi and Swamy (2011) studied about the awareness, attitude, knowledge and perception of extension agents on ICT tools found that majority (73.53%) of extension workers had positive attitude towards information and communication tools.

Samansiri and Wangigasundera (2014) in their study on the usage of ICT tools by the extension personnel recorded that majority of the respondents had favourable attitude towards the use of ICT tools to get required information.

Kabir and Roy (2015) in their study about the preference of agricultural extension officers on ICT tools found that more than ninety per cent (93.8%) agricultural officers had highly favorable attitude towards the use of ICT tools whereas 6.3 per cent of the respondents had moderately favourable attitude and there were no respondent with slightly favorable attitude for ICT tools.

Gangadharan (2015) indicated that majority of the extension agents (86.66%) had medium level of attitude towards ICT tools and its usage.

Kumari (2016) in her work about the problems and prospects of m- extension tools and services revealed that more than two third (77.40 %) of the extension officers had medium level of attitude for m- extension tools followed by 13.30 per cent with low level of attitude and 9.30 per cent with high attitude level.

Srichandana (2017) studied about the extent of utilization of ICTs by agricultural officials found that more than thirty per cent (31.66%) of the officers were having neutral attitude for the use of ICT tools which was followed by 20.84 per cent of the respondents with moderately unfavourable attitude, 19.16 per cent respondents with moderately favourable attitude and 15.84 per cent respondents with highly unfavourable attitude. Only 12.50 per cent officers with highly favourable attitude towards the use of ICT tools.

2.1.2.4. Innovativeness

Manty (2011) in the study about the accessibility and usage of ICT tools for transferring technology by extension agents found that about half (50%) of the respondents were highly innovative.

Ravikishore (2014) recorded that more than forty per cent (44%) of the extension officers from Kerala were having moderate level of innovativeness which was followed by 37 per cent of officers with high level of innovativeness and 20 per cent respondents with low level of innovativeness.

Baig (2015) studied about the field veterinarians and the extent of use of ICTs by them. The study indicated that more than half (54.17%) of the field veterinarians

had a medium level of innovativeness, followed by nearly thirty per cent (29.17%) with high level and only 16.67 per cent with low level of innovativeness.

Gangadharan (2015) reported that nearly two-third of the extension agents (71.33%) had medium level proneness for innovation which was followed by high level innovation proneness by only 14.66 per cent extension agents.

Kumari (2016) in her study revealed that forty per cent (40%) of the agricultural extension officers belonged to imitator category when considering the adoption of new technologies. Respondents who were fabians were 38.60 per cent followed by 12.70 per cent of innovators and 8.70 per cent of drones respectively.

2.1.2.5. Accessibility to digital tools

Samansiri and Wanigasundera (2014) in their study found that mobile phones were accessible to all the extension officers which was used as a general tool for communication.

Gangadharan (2015) revealed that the results obtained from analyzing the access to various ICT tools by extension agents found to be more than 85 per cent of the respondents were accessible for different ICT tools like television, computer, mobile phones, internet and e mail which implies that accessibility for the ICT tools was high in general.

Kabir and Roy (2015) in their study found that ICT tools like mobile phones and internet were ranked as the mostly accessible tools by the respondents for transferring agricultural information with scores 2.71 and 2.25 respectively.

Raksha and Meera (2015) reported that personnel computers and laptops were accessible to majority (93 %) of the agricultural extension personnel. It was observed that computer or laptops with internet connection were accessible to 84 per cent extension agents.

Enwelu *et al.* (2017) studied about the accessibility and usage of ICT by extension agents and data obtained revealed that tools like mobile phones and television were highly accessible to the respondents.

2.1.2.6. Perceived effectiveness of digital tools

Ganesan *et al.* (2013) in their study revealed that mobile phone based agricultural advisory system used by farmers was providing the most appropriate information about pests and diseases (90.83 %). Majority of the respondents reported that mobile mediated advisories were most appropriate in providing the information about package of practices as well as details about the agricultural inputs with 69 per cent and 62.45 per cent respectively. Weather information such as rainfall, humidity and temperature was found to be most appropriate by nearly half on the respondents (47.16 %).

Naik (2014) studied about impact and effectiveness of innovative ICT based extension models and found that more than one third (36.66 %) of respondents agreed that extension advisories based on mobile phones were effective which was followed by highly effective (22.70 %) and less effective (22.70 %). Ten per cent respondents expressed that agro advisories based on mobile phones were very highly effective and about eight per cent responded that the services were very less effective.

Irungu *et al.* (2015) reported that use of information and communication technologies were found to improve efficiency of agriculture. ICT tools has the

potential to deliver weather forecasts, information on farming practices, facilitate farm input purchases and provide information, on pricing.

Dhaka and Chayal (2016) reported that among the various information obtained through ICTs, information about various weather parameters like humidity, rainfall and temperature was found to be the most appropriate by nearly half (49.33 %) of the respondent. While considering the importance of improvement in crop production and crop management practices more than half (54.67 %) of the respondents responded as the information with respect to the packages of practices for different cultivated crops in the area was found to be most appropriate.

2.2. Awareness of respondents about digital tools

2.2.1. Awareness of farmers about digital tools

Yadav (2011) in his study about the modern ICT tools and its accessibility and awareness by the farmers found that substantial number of the farmers (45.83%) developed medium level awareness on modern communication media followed by 33.33 per cent respondents with low awareness and 20.83 per cent respondents with high level of awareness.

Moon *et al.* (2016) studied about the awareness of farmers about the farm information obtained through ICT services and reported that nearly one-fourth of the respondents had high level of awareness about extension service facilitated by ICT whereas 68 percent farmers had medium level of awareness and merely 6 percent respondents were poorly aware about ICT mediated extension system and its efficiency.

Kumar (2018) in his study on social media and its role in disseminating innovations in agriculture found that majority of the respondents (80.80 %) were aware about whatsapp, most (66.67 %) of the farmers were having awareness on Facebook, likewise 65 per cent of the farmers were aware about YouTube.

Patil *et al.* (2018) in their study about the awareness of farmers about ICT tools reported that more than half of the farmers were having medium level of awareness for ICT tools. Most of the farmers having awareness on mobile advisory services.

Khidir *et al.* (2019) studied about the famer's usage of mobile phone applications and found that all the respondents (100%) were aware about the call application and nearly all the respondents (97%) were aware about the SMS application.

2.2.2. Awareness of extension agents about digital tools

Mabe and Oladele (2012) studied about the awareness level and usage of information and communication technologies among the extension workers and stated that more than eighty per cent of the extension agents were well aware about various digital tools such as mobile phones, computer and internet.

Umar *et al.* (2015) in their study on awareness of ICTs by the extension agents found that most of the extension personnel were aware about television (94.30 %) and mobile phones (91.40 %) as common ICT tools.

Panda (2017) in the study on effectiveness of information and communication technology for extension services stated that significant number of respondents (41 %) were aware about ICT tools.

were having medium awareness followed by low awareness (34 %) and about one fourth (25 %) of the respondents were of high level of awareness.

Srichandana (2017) found that majority (87.22%) of the respondents were aware about the various websites which was related to agriculture especially websites related to agricultural extension.

Lakshmi and Purnima (2018) revealed that all the respondents were aware about mobile phones and majority (98.40%) were aware about television. Most (60.20%) of the respondents were aware about various web portals.

Nwabugwu *et al.* (2019) reported that mobile phone was the main e-resource tool known by majority (94.2%) of the extension agents, whereas 62.3 per cent respondents were aware about computer. Most (69.6%) of the respondents were aware about facebook and email services.

2.3. Preference for various digital tools among the respondents

2.3.1. Preference for various digital tools among the farmers

Ganesan *et al.* (2013) studied about the usage of mobile phones by Indian farmers as advisory systems. The findings from the study shows that significant number (32 %) of respondents frequently used mobile phone mediated advisory services for agriculture.

Sobalaje and Adigun (2013) in their study about the usage of information and communication technologies by the yam farmers found that mobile phone was the most preferred ICT tool by majority (63.5%) of the yam farmers to access information about

agriculture. However, on the other hand computer (38.9%) was considered as the least preferred ICT tool by the respondents.

Temba *et al.* (2016) studied about the access and usage of information and communication technologies by the farmers and found that mobile phones and television are the most frequently used tools by the farmers.

Kumar (2018) in his study found that television (92.50%) was the most frequently used ICT tool. Mobile phone was frequently used by majority (91.67%) of the farmers. More than half (59.17 %) of the respondents used internet very frequently.

Kumar and Lal (2018) studied about the usage of ICT tools by the farmers and reported that most (89.16%) of the farmers were using the mobile phones regularly to communicate with their relatives and friends. Most (85.00%) of the farmers were watching television on a regular basis.

2.3.2. Preference for various digital tools among the extension agents

Yakubu *et al.* (2013) studied about the use of information and communication technology among the extension personnel. It was found that nearly all the respondents used television (99.6%) and mobile phones (98.2%) frequently. Majority (78.3%) of the extension agents always used computer for various purposes. However the usage of internet, search engines and email services was frequently used by nearly forty per cent of the respondents.

Laxman (2016) studied about the accessibility and usage of ICT tools by extension workers and revealed that majority (60 %) of the extension agents had medium level of usage on various ICT tools. About 20 per cent each of the extension

personnel were found to have very high as well as low levels of usage of ICT tools for information dissemination.

Sulibhavimath (2017) studied about the extension agents of the KVK and their usage of information and communication technologies. It was reported that more than seventy per cent of the extension workers were using smartphones, whatsapp and SMS services all the time for diagnosing and problems raised by farmers.

Agha *et al.* (2018) studied about the use of ICT by extension agents for transferring agricultural information and found that majority (83.3 %) of the respondents were found to be using WhatsApp regularly.

Sulibhavimath and Sharma (2018) revealed that majority of the respondents (94.52%) always used mobile phones for various purposes. Most of the (73.90 %) respondents were using whatsapp groups for communication and sharing information. About half of the extension agents used facebook (52.05%) as well as email groups (50.68 %) regularly.

2.4. Constraints faced by the respondents in using digital tools

Agwu and Elizabeth (2013) studied about the accessibility and usage of information communication technologies among the women staff extension service. Among the various constraints listed out, lack of opportunities for trainings, insufficient facilities and availability of ICTs and shortage of technical knowledge were found to be the major constraints faced by the by the respondents.

Agha *et al.* (2018) found that inadequate knowledge of the farmers about the information and communication technologies followed by lack of trainings about ICTs

and its use, lack of interest of farmers in using ICT tools, insufficient infrastructural facilities were found to be the most serious problems faced by the farmers in the usage of ICT for agricultural purposes.

Gangadharan (2015) found that among the various constraints faced by the respondents lack of proper training programmes was recognized as the most important constraint which was followed by very low technical knowledge about various ICT tools and trainings conducted at inappropriate times.

Kabir (2015) studied about the various constraints faced by the respondents in connection with the use of ICT and found that inadequate supply of electricity was the major constraint related to the application of ICT for getting viable information. Lack of technical knowledge on various ICT tools as well as inadequate availability of various ICT service farmers of rural area were the other serious problems put forward by the respondents.

Lahan and Deka (2019) found that farmers faced various problems in the use of information and communication technologies. The important constraints identified in the study includes poor computer proficiency, insufficient number extension agents for help, erratic and uneven supply of power.

Methodology

III. METHODOLOGY

This chapter gives an idea on various methods and procedures used in the study. It focus on the methodology of research adopted for the current investigation, which mainly includes the details on research design, sampling procedure, selection of various digital tools, variables and their empirical measurement, data collection methods and the usage of statistical tools. Description of the chapter is done under the following sub headings:

3.1 Research design

3.2 Sampling procedure

3.3 Selection of the digital tools

3.4 Methods and tools for data collection

3.5 Operationalization of variables and their empirical measurement

3.6 Statistical tools used for the study

3.1. RESEARCH DESIGN

Research design is the plan, structure and strategy which gives a direction for how a research should be carried out. It provides guidelines like for data collection so as to obtain answers to research questions and control variance.

Ex-post-facto research design was used for the study of this research. In an *ex-post-facto* research the researcher do not have any control over the independent variables since the research is done only after the occurrence of the phenomenon.

3.2 SAMPLING DESIGN

Purposive random sampling was followed in which the respondents selected were experienced with the usage of any of the digital tool.

3.2.1 Selection of districts

The study was confined to the Kerala state of India. Three districts representing the three zones of Kerala was selected. The three representative districts includes Kannur from the northern zone, Thrissur from the central zone and Thiruvananthapuram from the southern zone. The selected districts are graphically given in Figure 3.1.

3.2.2 Selection of Respondents

The group of respondents selected for the study includes both farmers and extension personnel. 40 farmers and 10 extension agents who were using various digital tools was selected randomly from one district. Farmers were identified based on the details provided by the respective agricultural officers. Thus a total of 120 farmers and 30 extension agents were selected for the study.

3.3 SELECTION OF DIGITAL TOOLS

A total of 13 digital tools were identified which had the potential to be used by farmers as well as extension agents. These tools are used for agricultural purposes as well as various other purposes like communication, information sharing entertainment and so on. The various digital tools includes television, mobile phone (SMS, call services), computer, internet, social media (facebook, whatsapp, youtube), agricultural information kiosk, e mail, search engines, video conferencing, agricultural websites, agricultural expert systems, mobile agricultural applications and e newspapers.

3.4 METHODS AND TOOLS FOR DATA COLLECTION

An interview schedule was developed based on the scope and objectives of the study for farmers as well as extension personnel after consulting with the experts. Required modification was done based on the suggestions given by the experts and the

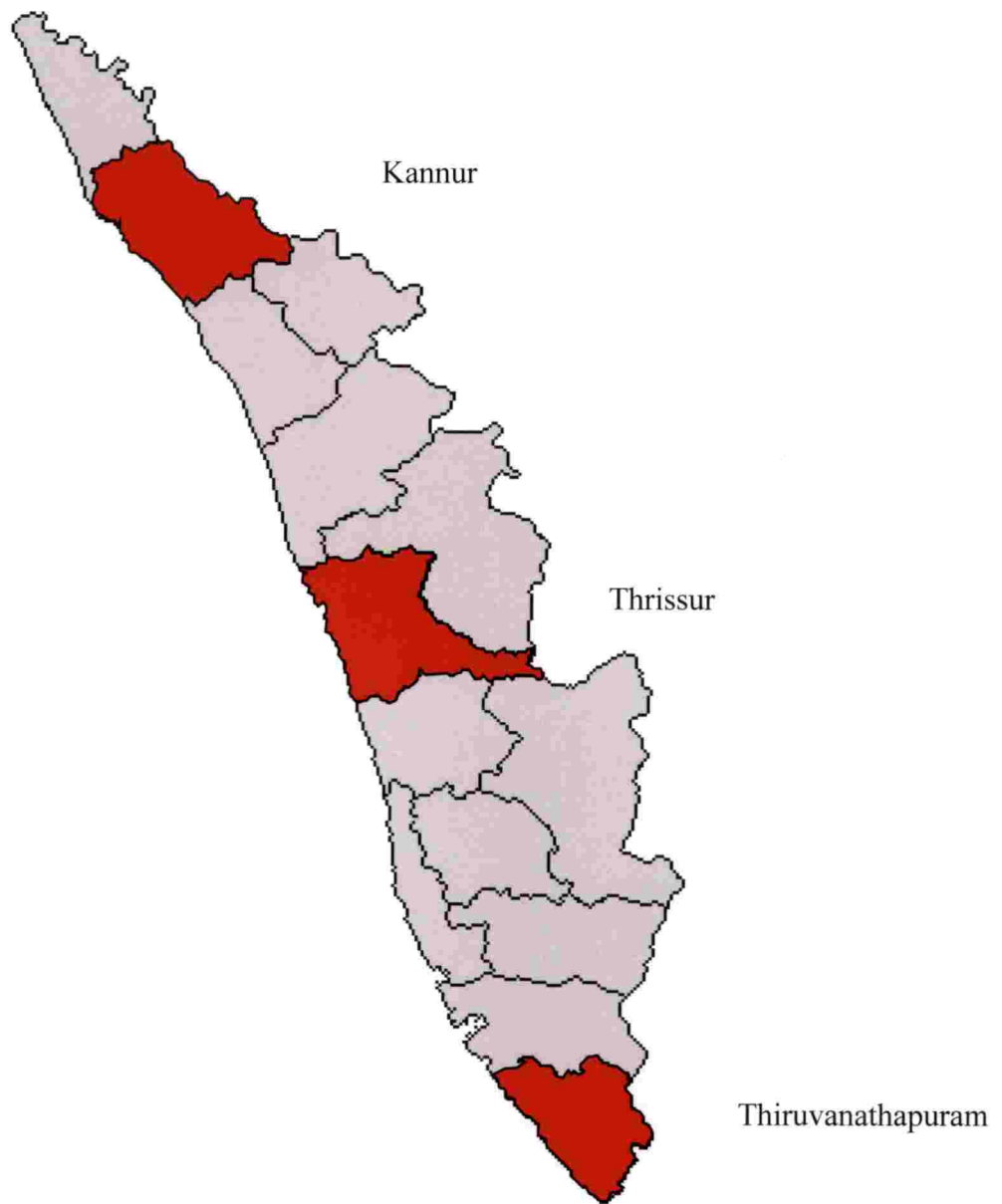


Fig 3.1: Map showing the area of study

final schedule was given to the respondents (Appendix II and III). Profile characteristics of the respondents, awareness and preference of respondents on various digital tools were measured.

3.5 OPERATIONALIZATION AND MEASUREMENT OF VARIABLES

3.5.1 Measurement of dependent variables

Awareness of farmers and extension agents on digital tools as well as preference of digital tools by farmers and extension agents were the two dependent variables selected for the study based on the objectives.

3.5.1.1 Awareness on digital tools

Awareness on digital tools was operationalized as the level of extent to which the respondents are familiar with the various digital tools available. Scale followed by Reghunath (2016) with sufficient modification was used. The scale consisted of thirteen digital tools for the investigation. The respondents were advised to mark the degree of awareness about the innovations in a dichotomous scale viz; aware and unaware with scores 1 and 0 respectively.

SI No.	Digital Tool	Aware	Unaware
1	Television		
2	Mobile phone (SMS, Call services)		
3	Computer		
4	Internet		
5	Social media (Facebook, Whatsapp, Youtube)		
6	Information Kiosk		
7	E mail		
8	Search Engines		
9	Agricultural websites and web portals		
10	Video conferencing		
11	Agricultural Expert systems		
12	Mobile agricultural applications		
13	E newspaper		

The total score was computed for each respondent. The minimum to maximum score attainable was 0 to 13. Percentage analysis was done to interpret the data.

3.5.1.2 Preference for digital tools

It refers to the preference of the respondents on various digital tools used. Procedure developed by Madhusudhan (2009) was adopted with required modifications.

Preference in usage of digital tools was found by listing out the digital tools and asking the respondents to choose from a three point continuum 'Always', 'Sometimes' and 'Never'. The assigned scores are 3, 2 and 1 respectively. The minimum and maximum score attainable for each respondent was 13 to 39. The total score obtained was taken as the preference for the digital tools. Interpretation of data was done using frequency and percentage analysis.

SI No.	Digital Tool	Always	Sometimes	Never
1	Television			
2	Mobile phone (SMS, Call services)			
3	Computer			
4	Internet			
5	Social media (Facebook, Whatsapp, Youtube)			
6	Information Kiosk			
7	E mail			
8	Search Engines			
9	Agricultural websites and web portals			
10	Video conferencing			
11	Agricultural Expert systems			
12	Mobile agricultural applications			
13	E newspaper			

3.5.2 Measurement of independent variables

Based on the literature collected and the results obtained from judge's rating, ten independent variables for farmers and seven independent variables for extension agents were selected.

3.5.2.1 Independent variables for farmers

The following ten independent variables were selected for farmers.

3.5.2.1.1 Age

Refers to number of chronological years attained by the farmers at the time of interview. It was measured as the total years in number completed by the farmers and was classified based on the Census report (2011) of Government of India. The results on categorization of respondents based on age was expressed in frequency and percentage analysis.

Sl. No.	Age Category	Years	Code
1	Young	Less than 35	1
2	Middle aged	35-55	2
3	Old	More than 55	3

3.5.2.1.2 Education

It was conceptualized as the number of years of formal education completed by the farmer. Education was measured with the modification of scoring procedure developed by Trivedi (1963), followed by Sobha (2013) where the respondents were categorized into various groups based on the educational qualification. Frequency and percentage analysis was performed to interpret the data. The scoring procedure used are given below.

Sl. No.	Category	Score
1	Illiterate	1
2	Write and read	2
3	Primary	3
4	High school	4
5	Higher secondary	5
6	College level	6

3.5.2.1.3 Experience in handling digital tools

It was defined as the number of years of experience in the usage of various digital tools among the respondents. It was measured by asking the farmers about the total number of years of experience in the usage of digital tools such as television, computer, mobile phone and social media. Ranking will be done with respect to the figures obtained. From the ranking we can identify the most experienced to least experienced tools by the farmers.

Sl. No.	Digital tool	Years of experience
1	Television	
2	Mobile Phone	
3	Computer	
4	Social Media	

3.5.2.1.4 Cosmopolitaness

Cosmopolitaness was operationally defined as the degree to which a farmer visited the social system which is outside to the social system of the farmer.

Scale used by Naik (2018) with slight modification was used. It was obtained by measuring the frequency of visit to the nearest town during last one month. Percentile analysis was done to interpret the resultant data. Scoring procedure is as followed.

Sl. No.	Visit to nearest town	Score
1	Never	0
2	Seldom	1
3	Once in 15 days	2
4	Once in a week	3

3.5.2.1.5 Attitude towards digital tools

It refers to the degree to which the respondents had a favourable or unfavourable view towards the digital tools and its usage.

Farmers attitude was measured using the scale followed by Devaraja (2011) with slight modification which suits to the objectives of the study was used. The following ten statements were selected and rated in a four point continuum such as 'Strongly Agree', 'Agree', 'Disagree', and 'Strongly Disagree' with scores of 4,3,2,1 respectively for the positive statements and the reverse for the negative statements. The minimum and maximum score attainable for each respondent was 10 and 40. The respondents were categorized into low, medium and high attitude based on range.

Sl. No.	Statements	SA	A	DA	SDA
1	It is very easy to get information from digital tools				
2	Digital tools provide need based information.				
3	Digital tools provide timely information.				
4	Digital usage is socially and economically feasible.				
5	Interactive discussion is possible through digital tools.				
6	Digital tools are suitable to illiterate people.				
7	Digital tools are complex to operate*				
8	Without any assistance I can't get information from digital tools.*				
9	Information provided through digital tools are not in local language.*				
10	Digital tools need additional knowledge and skills to operate*				

3.5.2.1.6 Innovativeness

Innovativeness was defined as the earliness of farmers in adoption of the new ideas when compared to other members of the society. It was measured by observing the responses which was recorded in a four point continuum namely; strongly agree, agree, disagree and strongly disagree. The score 4, 3, 2, 1 was assigned for positive statements and 1, 2, 3 and 4 for negative statements. The total score was calculated for each respondent with possible minimum to maximum score of 6 to 24. Respondents were further classified as low, medium and high level of innovativeness based on range.

Sl. No.	Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I have interest to know about modern digital tools				
2	I have interest to upgrade to latest gadgets when they are released				
3	I feel the oldest ICT tools is the best among all*				
4	I know about latest technologies, but not interested to try them*				
5	I think digital technologies can help me in obtaining information on farming practices				
6	I have tried several digital technologies from time to time in past years				

3.5.2.1.7 Extend of knowledge about digital tools

Extend of knowledge about digital tools was defined as the degree to which farmers know about the digital tools. A test consisting of ten questions was made for measuring the knowledge of the respondents about various digital tools used in the field of agriculture. Correct answers were given a score of 1 and incorrect answers were given 0 score. Knowledge score of each farmer was calculated by total number of items

correctly answered by the farmer with score range of 0 to 10. Respondents were categorized into high, medium and low based on range.

3.5.2.1.8 Computer proficiency

Computer proficiency is conceptualized as the experience in the use of computer among the respondents. Scoring procedure by Madhusudhan (2009) was followed with required modification. Scale consist of six statements and the positive responses were given one score and negative responses were given zero score so that the score ranges from zero to six for an individual. Results were categorized as low, medium and high level of computer proficiency based on range.

Sl. No.	Statements	Yes	No
1	I can transfer data to pen drives/CD		
2	I can search information in a computer		
3	I know how to access social media through computer		
4	I can download information from internet		
5	I can take print out of a page		
6	I know how to access agriculture related websites.		

3.5.2.1.9 Accessibility to digital tools

It is the degree to which various digital services like computer, internet and other digital tools are accessible for the farmer. Scale used by Gangadharan (2015) was followed with slight modification. To find out accessibility, various digital tools was listed out and responses was taken as either “Accessible” or “Not Accessible” and given scores as 1 and 0 respectively. Frequency and percentage analysis was used to interpret the results.



Sl. No.	Digital Tool	Accessible	Not Accessible
1	Television		
2	Mobile phone		
3	Computer		
4	Internet		
5	Social media access		
6	Information Kisok		
7	E mail		
8	Search Engines		
9	Agricultural websites and web portals		
10	Video conferencing		
11	Agricultural Expert systems		
12	Mobile agricultural applications		
13	E newspaper		

3.5.2.1.10 Adoption of digital tools

It was referred as the extent to which farmers have adopted the various digital tools available for agricultural purpose.

Sl. No.	Digital Tool	Adopt	Non Adopt
1	Television		
2	Mobile phone		
3	Computer		
4	Internet		
5	Social media		
6	Information Kisok		
7	E mail		
8	Search Engines		
9	Agricultural websites and web portals		
10	Video conferencing		
11	Agricultural Expert systems		
12	Mobile agricultural applications		
13	E newspaper		

Selected digital tools were listed to measure the response. Dichotomous scale consisting of adopt and non-adopt categories with scores of 1 and 0 respectively was used. Interpretation of the data was done using frequency and percentage analysis.

3.5.2.2 Independent variables for extension agents

The following seven independent variables were selected for extension agents.

3.5.2.2.1 Age

Age referred to the number of chronological years attained by the extension agent at the time of survey. It was measured as the total years in number completed by the extension personnel based on the Census report (2011) of Government of India. The categorization of data was done with frequency and percentage analysis.

3.5.2.2.2 Education

Education was defined as the number of years of formal education completed by the extension personnel. Educational qualification of the extension agents were measured by using the scoring system followed by Gangadharan (2015). Percentage analysis was used to interpret the data.

Sl. No.	Qualification	Score
1	Diploma	1
2	Degree	2
3	Bsc. Agriculture	3
4	Msc. Agriculture	4
5	PhD	5



3.5.2.2.3 Experience in handling digital tools

Experience in handling digital tools was defined as the number of years of experience in the usage of various digital tools by extension agents. Experience was measured by asking the respondents about the total number of years of experience in selected digital tools and ranking them with respect to the values obtained.

3.5.2.2.4 Attitude towards digital tools

Operationalized as the degree to which the extension agents had a favourable or unfavourable approach towards the digital tools and its use in agricultural activities. Attitude was measured using the scale followed by Devaraja (2011) with required modification which suits to the objectives of the study. Ten statements were selected and rated on a four point continuum 'Strongly Agree', 'Agree', 'Disagree', and 'Strongly Disagree' with scores of 4,3,2,1 respectively for positive statements and the reverse for negative statements.

Sl. No.	Attitude	SA	A	D	SD
1	Digital tools facilitate quick access to current data				
2	Digital tools improve the quality of services				
3	Digital tools help to improve communication				
4	Digital tools makes an integration within the office				
5	Digital tools increase job satisfaction of extension personnel				
6	Using digital tools requires additional knowledge and skills*				
7	Digital tools helps in reducing workload and easy data retrieval				
8	Digital affects the regular budgeting provision*				
9	Use of digital tools provide clarity with regard to plant protection measures				
10	Digital tools will hinder routine official work*				

Total score was obtained for each respondent with possible minimum and maximum score of 10 to 40. Further the data was categorized into low, medium and high level of attitude based on range.

3.5.2.2.5 Innovativeness

Innovativeness was defined as the earliness of extension agent in adoption of the new ideas when compared to other members of the society. It was measured by observing the responses which was recorded in a four point continuum namely; strongly agree, agree, disagree and strongly disagree. The score 4, 3, 2, 1 was assigned for positive statements and 1, 2, 3 and 4 for negative statements. The data generated was then classified as low, medium and high level of innovativeness based on range.

3.5.2.2.6 Accessibility to digital tools

Accessibility to digital tools was the degree to which various digital services are accessible for the extension agents. To find out accessibility the scoring procedure was developed in such a way that various digital tools were listed out and responses were taken as either "Accessible" or "Not Accessible" and given scores as 1 and 0 respectively. The data obtained was interpreted using frequency and percentage analysis.

3.5.2.2.7 Perceived effectiveness of digital tools

Defined as the degree to which the information obtained through various digital tools are successful in producing a desired result in solving various agriculture related problems in the field for the extension personnel.

Measurement of effectiveness was done based on the statements developed by Naik (2014). The response was collected in a three point continuum consisting of highly appropriate, appropriate and in appropriate with scores of 3, 2 and 1 respectively. Result generated was interpreted using frequency and percentage analysis.

Sl. No.	Farm information	HA	A	IA
1	Land preparation			
2	Variety/seed			
3	Sowing time			
4	Manures and fertilizers			
5	Water management			
6	Plant protection measures			
7	Weed management			
8	Harvesting			
9	Storage			
10	Weather related information			
11	Market based information			

3.5.3 Constraints in using digital tools

Constraints were operationalized as the factors which limits the respondents or system to experience the scope and extend of activity from achieving the potential usage of the digital tools with reference to its goals. Constraints were identified based on the discussion with the experts and from the review collected. Ranking was given to each constraints by the respondents from which the weighted average was taken to identify the most important constraints faced by the respondents.

3.6 Statistical tools used for the study

The data collected through survey was tabulated and analyzed using appropriate parametric and non-parametric tools.

3.6.1 Mean

Mean value was obtained by dividing the sum of scores with the number of respondents. It was used to compare the respondents with various frequencies obtained for the corresponding categories.

3.6.2 Range

It was the difference between the maximum value and minimum value obtained from the scores obtained. Range helps to identify the dispersion of the data obtained from the study.

3.6.3 Percentage Analysis

Percentage analysis was done to categorize the respondents when and were required. It was obtained by dividing the frequency of response of each category with the total number of responses and dividing it with hundred.

3.6.4 Weighted Average

It is mean value obtained when the average value is multiplied with a number or weight based on the relative importance of the item. Weighted average is useful to categorize the constraints based on the rank given by the respondents and weighted score obtained for each constraint.

3.6.5 Correlation Analysis

Simple correlation analysis was done to find the relationship between dependent and independent variables of the respondents. The correlation coefficient was found by measuring the degree of relationship between the variables.

3.6.6 Spearman's Rank Correlation

The relative correlation to the order of preference for various digital tools between the farmers and extension agents were found by working out the Spearman's rank correlation (r_s).

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2-1)}$$

Where, r_s = Spearman's rank order correlation coefficient

d = difference between two sets of values

n = number of ranks

3.6.7 Mann-Whitney U Test

This test was used to check whether there is any significant difference between the values obtained for two types of samples. In this study the comparative analysis between the extent of preference for digital tools of farmers and extension agents was worked out using the Mann-Whitney U test.

$$U_1 = R_1 - \frac{n_1 - (n_1 + 1)}{2}$$

$$U_2 = R_2 - \frac{n_2 - (n_2 + 1)}{2}$$

Where, R = Sum of ranks in the sample

n = number of items in the sample

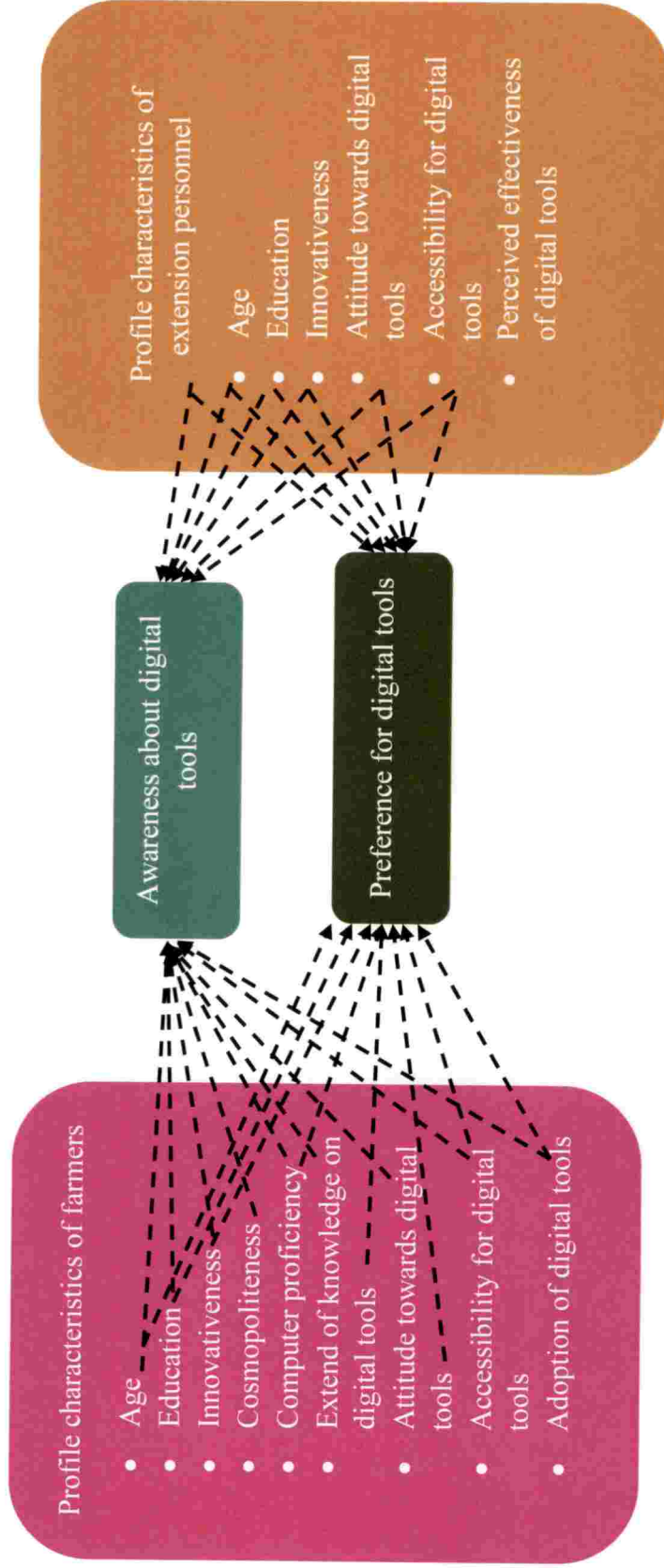


Fig 3.2 Conceptual framework for the study

Results & Discussions

IV. RESULTS AND DISCUSSION

This research is planned to study the use of digital technologies among the farmers and extension personnel for the horizontal spread of agricultural technologies by focusing on the accessibility and user preference of various digital tools, the constraints faced by the respondents and suggestions to overcome it. Considering the objectives of the study the data collected were subjected to suitable statistical tools for obtaining the results. The findings of the study were then interpreted and discussed in this chapter based on the objectives set forth.

The findings along with the discussion based on the objectives are presented in the following subheadings:

- 4.1 Profile characteristics and distribution of respondents
- 4.2 Awareness of respondents about various digital tools
- 4.3 Preference for various digital tools among the respondents
- 4.4 Comparative analysis of dependent variables between farmers and extension agents
- 4.5 Correlation between awareness and independent variables
- 4.6 Correlation between preference and independent variables
- 4.7 Categorization of the digital tools based on agricultural crop production, protection and marketing aspects
- 4.8 Constraints faced by the respondents in the use of digital tools
- 4.9 Suggestion for improvement

4.1 Profile characteristics of the respondents

The profile characteristics of the farmers as well as the extension personnel are discussed below.

4.1.1 Profile characteristics of the farmers

4.1.1.1 Age

Age was operationally defined as the number of chronological years attained by the farmer at the time of survey. The farmers were classified into three categories such as young, middle and old age based on frequency and percentage analysis. Distribution of farmers according to their age is given in Table 4.1.

Table 4.1 Distribution of farmers based on age (n=120)

Sl No.	Categories	Frequency	Percentage
1	Young Age (<35)	16	13.33
2	Middle Age (35-55)	80	66.67
3	Old Age (>55)	24	20

From table 1.2 it is clear that more than half of the farmers (66.67 per cent) were middle aged followed by old aged (20 per cent) and young farmers (13.33 per cent)

Majority of the farmers belonged to middle and old aged category with less number of young farmers which is common among the agricultural sector since the interest of youth towards agriculture is relatively low due to the low social status of the profession. The results were on par with the earlier studies done by Swaroop (2016) and Naik (2018). The result are represented in figure 4.1.1

4.1.1.2 Education

Education refers to the number of years of formal education completed by the farmers. Categorization of the farmers according to the educational background is given in table 4.2.

Table 4.2 Distribution of farmers based on education (n=120)

Sl No.	Categories	Frequency	Percentage
1	Illiterate	0	0
2	Read and write	0	0
3	Primary	6	5
4	High school	28	23.33
5	Higher secondary	53	44.17
6	College level	33	27.50

Majority of the farmers (44.17 per cent) were educated up to higher secondary level which was immediately followed by college level (27.50 per cent) and high school level (23.33 per cent) educational status. Only five per cent of the respondents were having primary education and none of the respondents belonged to read and write as well as illiterate category (Fig4.1.2).

The results shows that majority of the farmers were well educated which totally reflects the higher literacy rate of the state. Some of the farmers are retired government employees and some are business persons. This might have also contributed to the higher number educationally qualified respondents. The result also shows that farmers who were using digital tools were highly literate. The findings were in line with the studies of Reghunath (2016), Singh and Kameswari (2019)

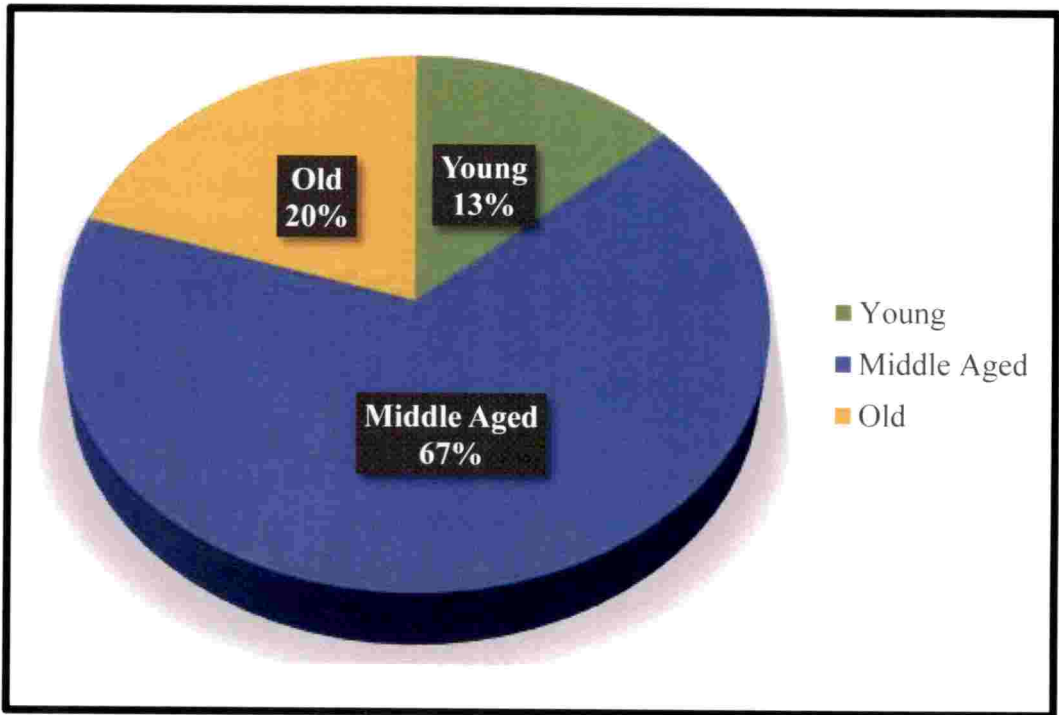


Fig 4.1.1. Distribution of farmers based on age

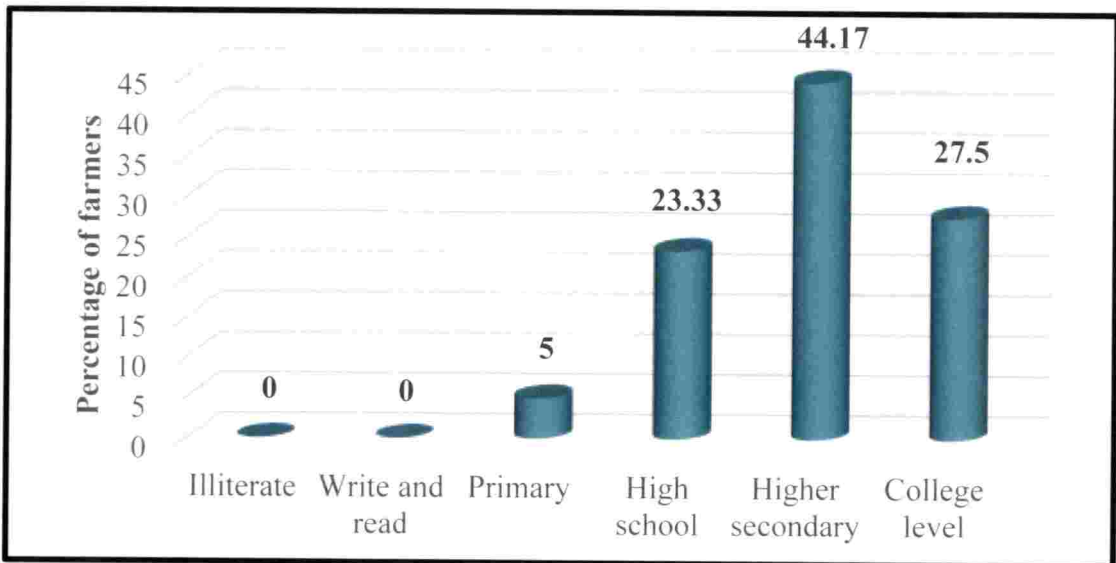


Fig 4.1.2. Distribution of farmers based on education

4.1.1.3 Cosmopolitanness

Cosmopolitanness refers to the degree to which farmer visits the social system which is outside the social system of the farmer. It gives an idea on how much farmers are familiar with the external world around them. Categorization of respondents according to their cosmopolitan nature is given in table 4.3.

Table 4.3 Distribution of farmers based on cosmopolitanness (n=120)

SI No.	No. of times visited	Frequency	Percentage
1	Never	0	0
2	Seldom	6	5
3	Once in 15 days	30	25
4	Once in a week	84	70

From table 4.3 it is clear that majority (70 per cent) of the farmers were visiting the nearest town at least once in a week which indicated a high level of cosmopolitanness followed by one fourth (25 per cent) of the respondents who visits the town once in fifteen days and five per cent of the farmers who seldom visits the town. All the respondents visited the nearby town at least once in a month (Fig 4.1.3). The findings were in agreement to the results put forward by Tomar *et al.*, (2016) in that farmers who used various digital tools had higher cosmopolitan nature.

4.1.1.4 Attitude toward digital tools

Attitude towards digital tools refers to the degree to which the farmers have a favourable or unfavourable approach towards the use of digital tools. It was categorized based on range as low, medium and high levels of attitude towards digital tools by the farmers. The results obtained were categorized and given in table 4.4.

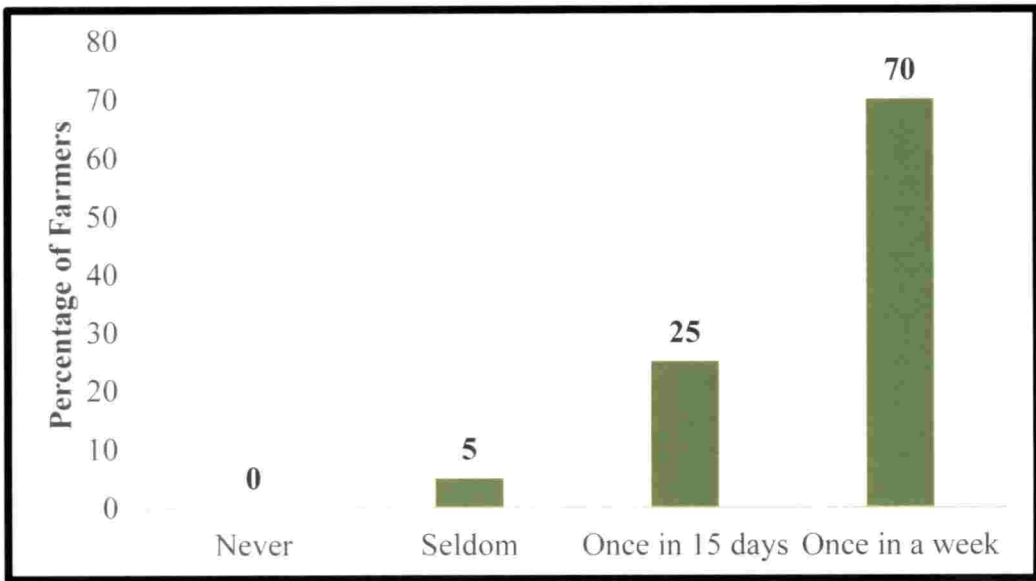


Fig 4.1.3. Distribution of farmers based on cosmopolitaness

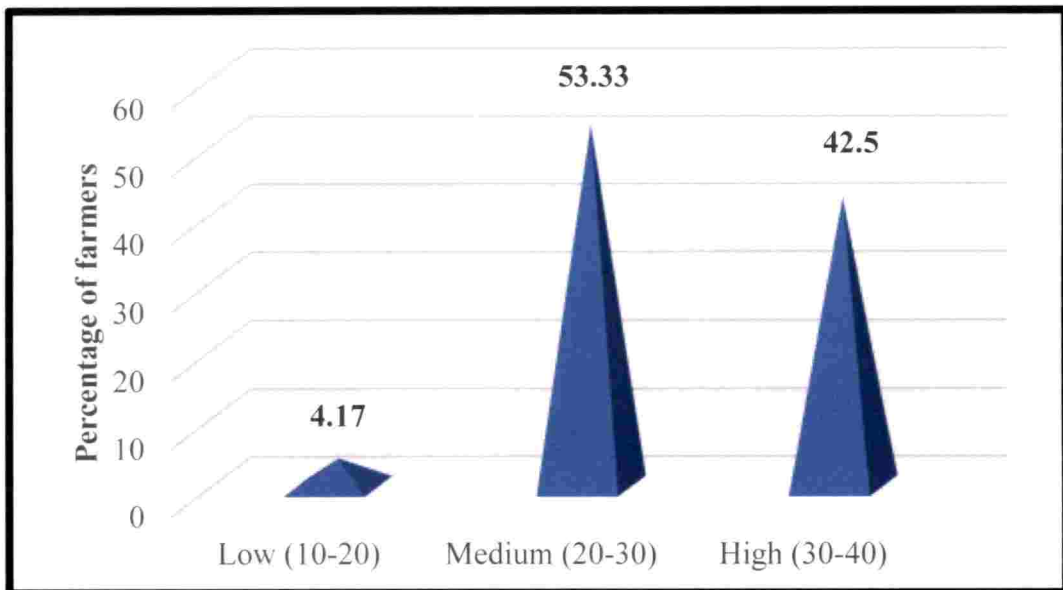


Fig 4.1.4. Distribution of farmers based on the attitude towards digital tools

Table 4.4 Distribution of farmers based on attitude towards digital tools (n=120)

SI No.	Categories	Frequency	Percentage
1	Low (10-20)	5	4.17
2	Medium (20-30)	64	53.33
3	High (30-40)	51	42.50
4	Average	28.37	

From the table 4.4 it is clear that more than half of the respondents (53.33 per cent) were having moderate attitude towards the use of digital tools followed by high (42.50 per cent) and low (4.17 per cent) levels of attitude towards the usage of digital tools. High attitude towards the digital tools may be due to prior usage of various tools such as television, mobile phone and social media among the respondents and they might be actually benefiting from the technology used. The results were found to be in agreement with the findings of Kabir (2015) .The results are presented in figure 4.1.4.

4.1.1.5 Innovativeness

Innovativeness was defined as the earliness of farmers in adoption of the new ideas when compared to other members of the society. Innovativeness is an inevitable factor in the study of digital tools to know how fast various digital technologies are penetrating the farming community. It was categorized into three groups such as low, medium and high level of innovativeness based on range and are given in Table 4.5.

Table 4.5 Categorization of farmers based on innovativeness (n=120)

SI No.	Categories	Frequency	Percentage
1	Low (6-12)	4	3.33
2	Medium (12-18)	48	40.00
3	High (18-24)	68	56.67
4	Average	17.91	

From table 4.5 it is clear that more than half of the population (56.67 per cent) had higher level of innovativeness followed by medium (40 per cent) and low (3.33 per cent) levels of innovativeness. Higher level of innovativeness indicates the tendency to adopt various digital technologies as earlier when they are known to them (Fig 4.1.5). Higher level of innovativeness for digital tools may be due to the exposure of the respondents in ICT technologies mainly in communication, entertainment and other purposes along with agricultural purposes. Overall there was a high to medium level of innovativeness among the respondents which was similar to the findings of Dhaka and Chayal (2016).

4.1.1.6 Experience in handling digital tools

Experience in handling digital tools was found by measuring the number of years of usage of various digital tools and ranking the same. Digital tools such as television, mobile phone, computer and social media were analyzed based on the experience and usage of the same. The experience in the use of digital tools is given in the table 4.6.

Table 4.6 Ranking of experience on digital tools by farmers

Sl No	Digital Tool	Weighted Average	Rank
1	Television	4	1
2	Mobile phone	2.85	2
3	Computer	1.467	4
4	Social media	1.66	3

From the table it is clear that television was the most experienced digital tool used by the farmers followed by mobile phone and social media. Computer and related devices were the least experienced digital tools. Television was introduced in India during 1959 and presently each and every house hold in Kerala owns a television. This might be the reason for higher experience for the same compared to other tools.

4.1.1.7 Extend of knowledge about digital tools

Extend of knowledge was expressed as the degree to which farmers know about digital tools. Knowledge about digital tools will give an idea on how much farmers are inclined towards the tools. The average extend of knowledge about digital tools was estimated and two categories were formed as above and below mean. Distribution of respondents based on extend of knowledge about digital tools are given in table 4.7.

Table 4.7 Distribution farmers based on extend of knowledge about digital tools (n=120)

SI No.	Categories	Frequency	Percentage
1	Below Mean (<6.22)	68	56.67
2	Above Mean (>6.22)	52	43.33
3	Mean score	6.22	

The mean value obtained is 6.22 and from the table 4.7 it can be inferred that more than half of the farmers (56.67 per cent) were below mean category and the remaining respondents (43.33 per cent) belonged to above mean category. This implies the need to create knowledge among the farming community about the digital tools. The results were in agreement with study done by Agwu *et al.* (2018) and Ajayi *et al.* (2018).

4.1.1.8 Computer proficiency

Computer proficiency was defined as the working knowledge of the farmers to operate a computer. Knowledge on computer can be an integral part in the usage of various other digital tools. Here the farmers were classified into three groups as high, medium and low based on the scores obtained indicating the actual level of knowledge on computer based on range. The result are given in table 4.8.

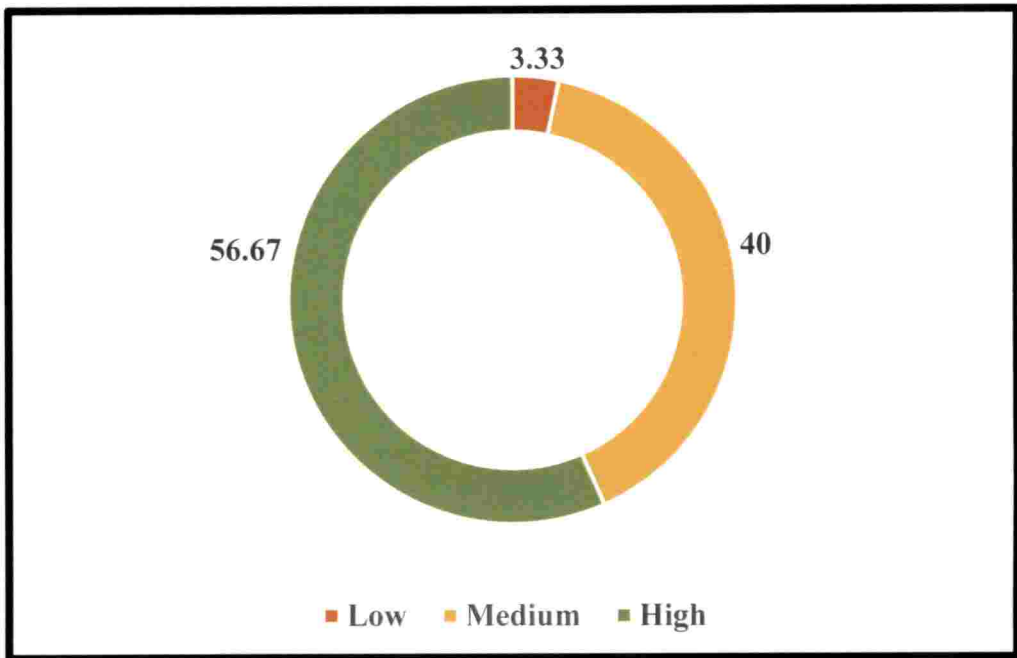


Fig 4.1.5. Distribution of farmers based on the innovativeness

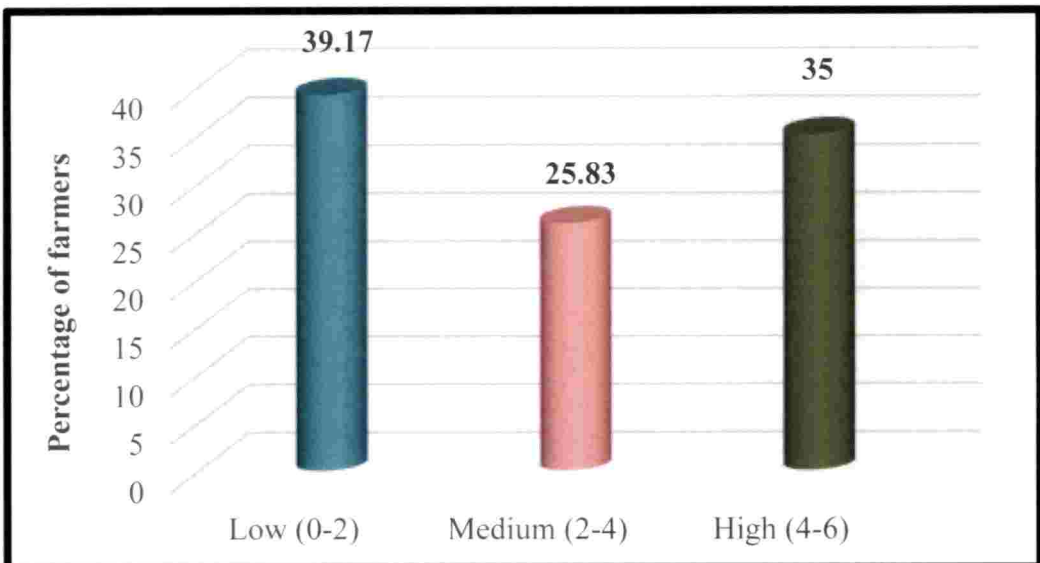


Fig 4.1.6. Distribution of farmers based on computer proficiency

Table 4.8 Categorization of farmers based on Computer proficiency (n=120)

SI No.	Categories	Frequency	Percentage
1	Low (0-2)	47	39.17
2	Medium (2-4)	31	25.83
3	High (4-6)	42	35
4	Mean score	2.44	

The mean score was found to be 2.44. Almost forty per cent farmers were having low level of computer proficiency followed by thirty five percent of the respondents with high level and more than twenty five per cent with medium level of computer proficiency. The results were having a similar trend with the findings given by Madhusudhan (2009). The data is graphically represented in figure 4.1.6

4.1.1.9 Accessibility to digital tools

Accessibility is the degree to which various digital services like computer, internet and other digital tools are accessible for the farmer. The accessibility for various digital tools are given in table 4.9

The result obtained from table 4.9 shows that cent per cent farmers (100 per cent) were accessible to various tools such as television, mobile phone, internet services, social media, e mail and search engines, which were accessible with a smartphone with internet connection. This was followed by e newspaper (90.83 per cent) and mobile agricultural applications (90 per cent), computer (58.33 per cent), video conferencing (51.67 per cent), agricultural websites (47.50 per cent), and agricultural expert systems (25.83 per cent). Information kiosk was least accessible (7.5 per cent) for farmers. The findings were having similarity with the results put forward by Kumar (2016) which stated that all farmers were accessible to mobile phones. The graphical representation of the results are given in figure 4.1.7.

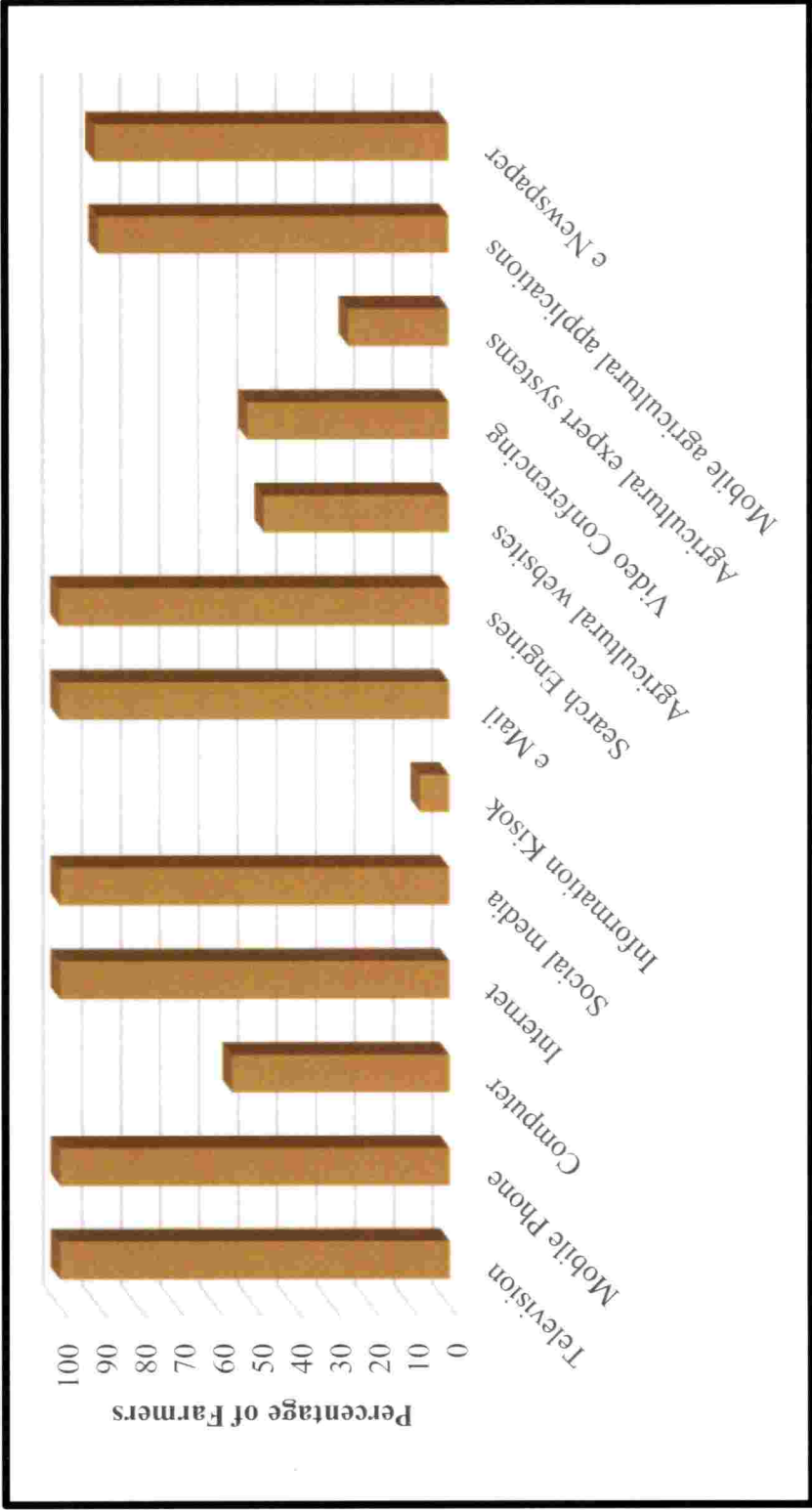


Fig 4.1.7. Distribution of farmers based on accessibility to digital tools

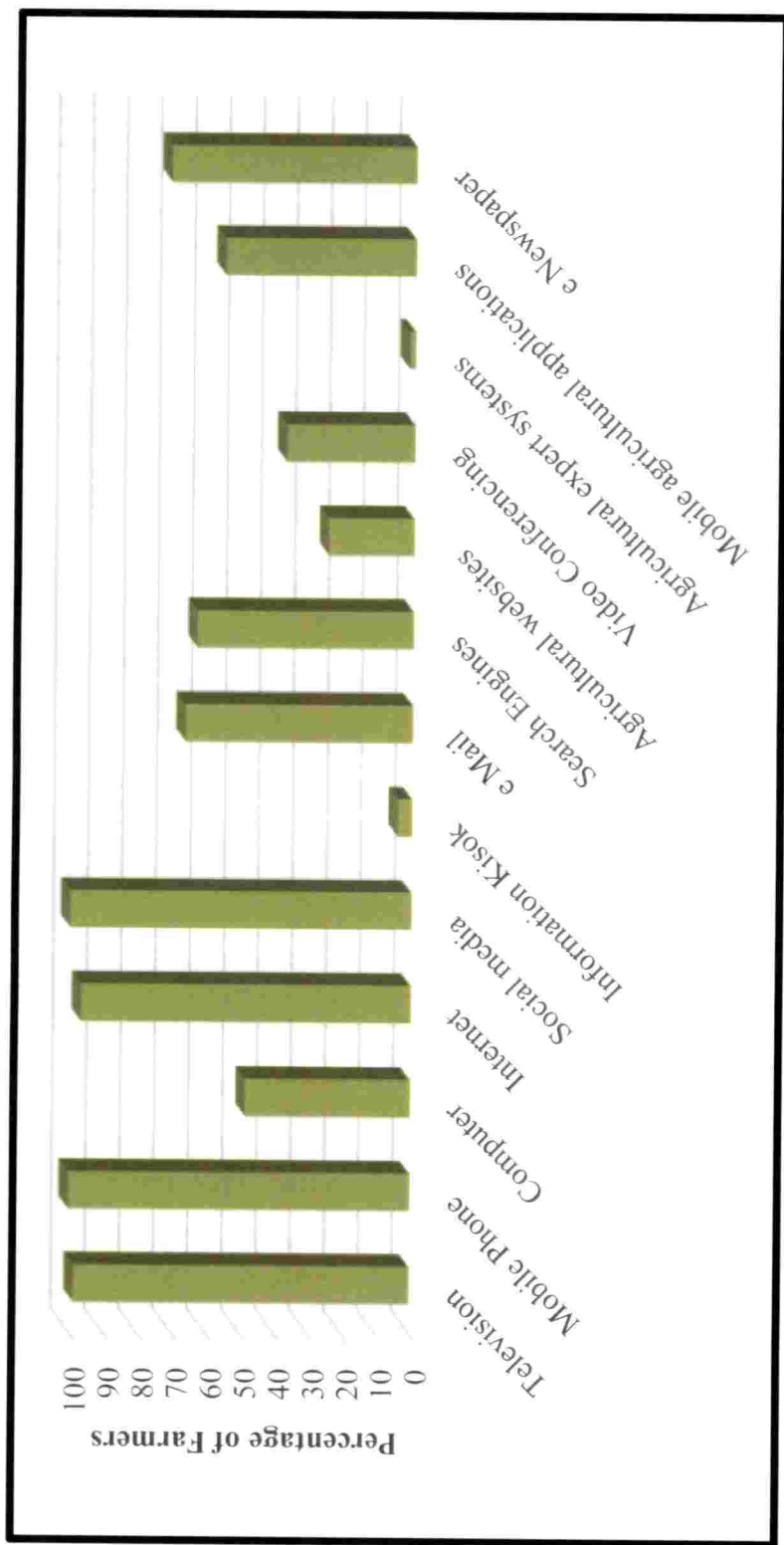


Fig 4.1.8. Distribution of farmers based on adoption of digital tools

Table 4.9 Distribution of farmers based on accessibility and adoption for various digital tools (n=120)

Sl No.	Digital Tools	Accessibility				Adoption			
		Accessible		Not Accessible		Adopt		Non Adopt	
		Freq	Per (%)	Freq	Per (%)	Freq	Per (%)	Freq	Per (%)
1	Television	120	100	0	0	118	98.33	2	1.67
2	Mobile Phone	120	100	0	0	120	100	0	0
3	Computer	67	58.33	53	44.17	58	48.33	62	51.66
4	Internet	120	100	0	0	116	96.67	4	3.33
5	Social media	120	100	0	0	120	100	0	0
6	Information Kiosk	9	7.5	111	92.5	5	4.17	115	95.83
7	e Mail	120	100	0	0	80	66.67	40	33.33
8	Search Engines	120	100	0	0	76	63.33	44	36.67
9	Agricultural websites	57	47.50	63	52.50	30	25	90	75
10	Video Conferencing	62	51.67	58	48.33	45	37.50	75	62.5
11	Agricultural expert systems	31	25.83	89	74.17	2	1.67	118	98.33
12	Mobile agricultural applications	108	90	12	10	67	55.83	53	44.17
13	e Newspaper	109	90.83	11	9.17	86	71.67	34	28.33

4.1.1.10 Adoption of digital tools

Adoption is measured as whether or not the farmers had adopted various digital tools. The distribution of adoption of various digital tools by farmers are given in table 4.9. It was perceived that mobile phone and social media were adopted by all the respondents whereas more than ninety per cent of the farmers adopted television and internet. Search engines, e mail and e newspapers were adopted by more than sixty per cent of the respondents and more than half of the respondents adopted mobile agricultural applications followed by computer (48.33 per cent), video conferencing (37.50 per cent) and agricultural websites (25 per cent). Information kiosk and agricultural expert systems were adopted by 4.17 and 1.67 per cent respondents. Higher level of adoption of digital tools like mobile phone and social media may be due to the ease of use and access of these tools. The results were in agreement with the study of Pal (2018). Visual representation of data is given in figure 4.1.8.

4.1.2 Profile characteristics of extension agents

4.1.2.1 Age

The number of chronological years attained by the extension personnel during the study is given in the table 4.10. Based on the data age was classified as young, middle aged and old. From the table it is concluded that most (53.33 per cent) of the extension agents were middle aged followed by young aged (46.67 per cent) whereas none of the respondents belonged to old aged category (Fig 4.1.9). The respondents were agricultural officers, agricultural assistants and subject matter specialists. The results were in agreement with the findings of Thomas and Laseindeage (2015).

Table 4.10. Distribution of extension agents based on age (n=30)

SI No.	Categories	Frequency	Percentage
1	Young (<35)	14	46.67
2	Middle Aged (35-45)	16	53.33
3	Old (>55)	0	0

4.1.2.2 Education

Based on educational qualification, extension agents were classified and given in table 4.11. It was found that more than forty per cent (43.33 per cent) of the extension agents were having degree qualification followed by post-graduation in agriculture (23.33 per cent), diploma (20 per cent), graduation in agriculture and PhD with two per cent respectively.

Majority of the respondents were found to have degree qualification and belonged to the category of agricultural assistants. Most of the agricultural officers had post-graduate degree in one of the agricultural subjects. The results were having similar trend with the findings of Bahgat and Antar (2007). Diagrammatic representation is given in figure 4.1.10

Table 4.11 Categorization of extension agents based on education (n=30)

SI No.	Categories	Frequency	Percentage
1	Diploma	6	20
2	Degree	13	43.33
3	BSc. Agriculture	2	6.67
4	MSc. Agriculture	7	23.33
5	PhD	2	6.67

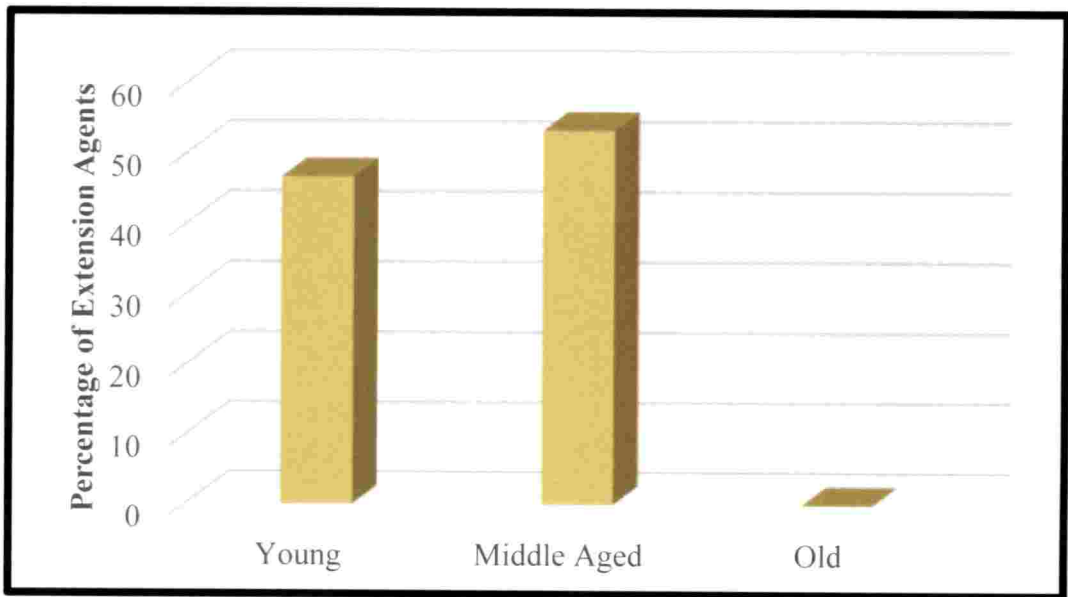


Fig 4.1.9. Distribution of extension personnel based on age

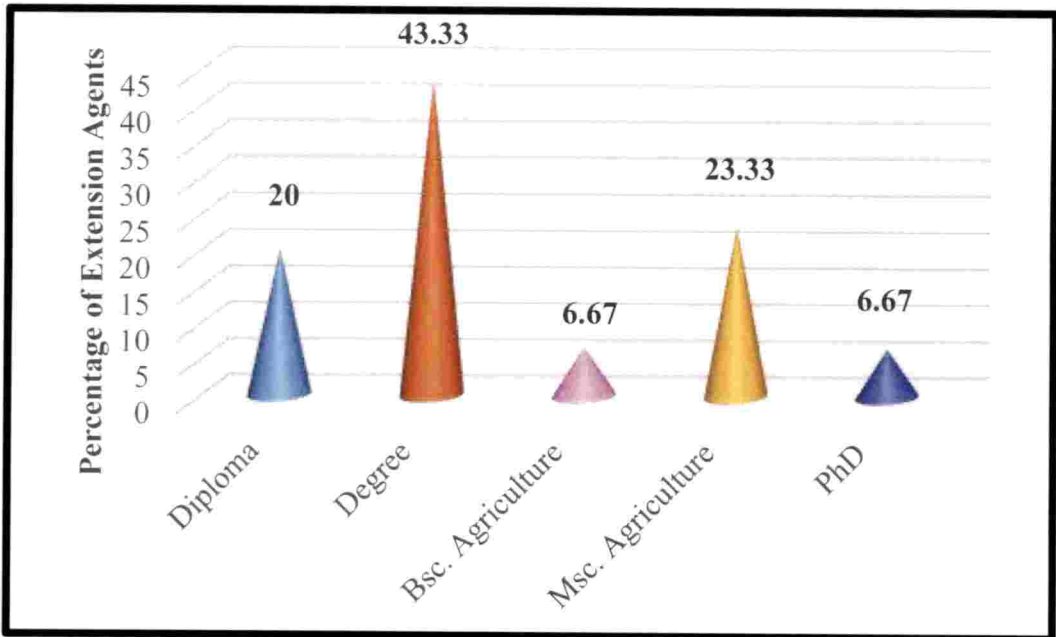


Fig 4.1.10. Distribution of extension personnel based on education

4.1.2.3 Attitude towards digital tools

Attitude of the extension agents towards digital tools was defined as the degree of favorable or unfavorable approach towards the use of various digital tools in the agricultural activities. Table 4.12 shows the categorization of extension agents based on the attitude towards digital tools. Graphical representation of data is displayed in figure 4.1.11.

Table 4.12 Categorization of extension agents based on attitude towards digital tools (n=30)

SI No.	Categories	Frequency	Percentage
1	Low (10-20)	0	0
2	Medium (20-30)	9	30
3	High (30-40)	21	70
4	Average	31.57	

The table shows that majority (70 per cent) of the extension agents were having high level of attitude followed by medium level of attitude (30 per cent). None of the respondents were having low level of attitude towards digital tools. The higher level of attitude towards digital tools by extension agents may be due to the ease of doing work with digital tools. The results were related to the findings of Kabir and Roy (2015) who reported that majority (93.8%) of the agricultural officers had highly favourable attitude towards the use of ICT tools.

4.1.2.4 Innovativeness

Innovativeness of extension agents was defined as the earliness in adoption of the new ideas when compared to other members of the society. The result was categorized into three categories such as low, medium and high and is given in table 4.13.

Table 4.13 Categorization of extension agents based on innovativeness (n=30)

SI No.	Categories	Frequency	Percentage
1	Low (6-12)	0	0
2	Medium (12-18)	4	13.33
3	High (18-24)	26	86.67
4	Average	19.03	

From the table it is clear that majority (86.67 per cent) of the extension agents were having a higher level of innovativeness followed by medium (13.33 per cent) and none of them were having low level of innovativeness (Fig 4.1.12). The higher level of innovativeness shows their access to the latest digital technologies in use. The study is in conformity with the results put forward by Manty (2011).

4.1.2.5 Experience in handling digital tools

Experience in handling digital tools by extension agents were ranked and presented in table 4.14. The results indicates that television was the most experienced tool followed by mobile phone, computer and social media. The higher experience in using computer than social media may be due to the familiarity with computers for office works.

Table 4.14 Ranking of experience on digital tools by extension agents (n=30)

SI No	Digital Tool	Weighted Value	Weighted Average	Rank
1	Television	120	4	1
2	Mobile phone	84	2.8	2
3	Computer	55	1.83	3
4	Social media	41	1.37	4

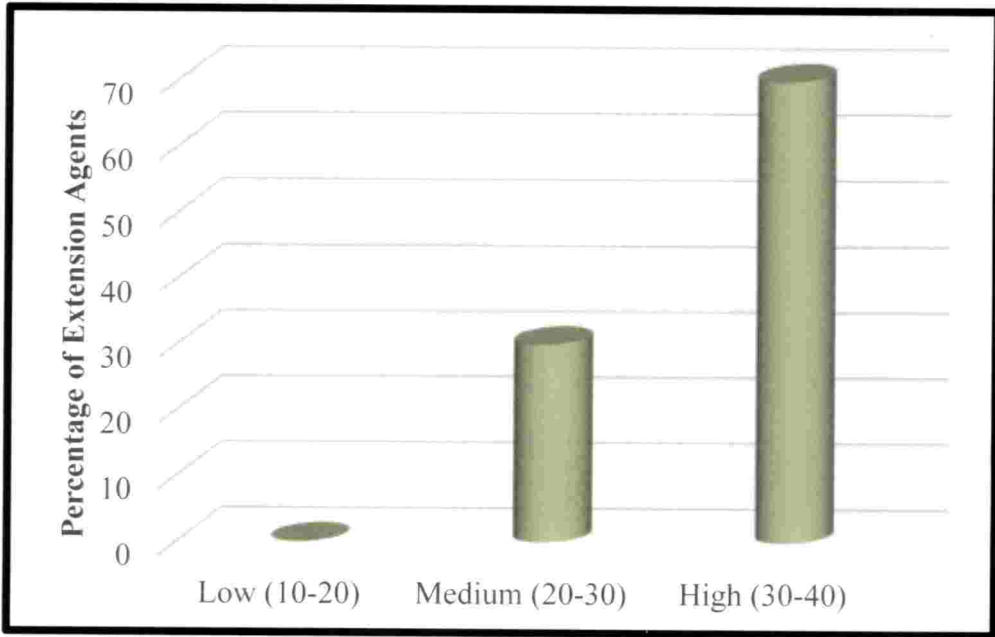


Fig 4.1.11. Distribution of extension agents based on the attitude towards digital tools

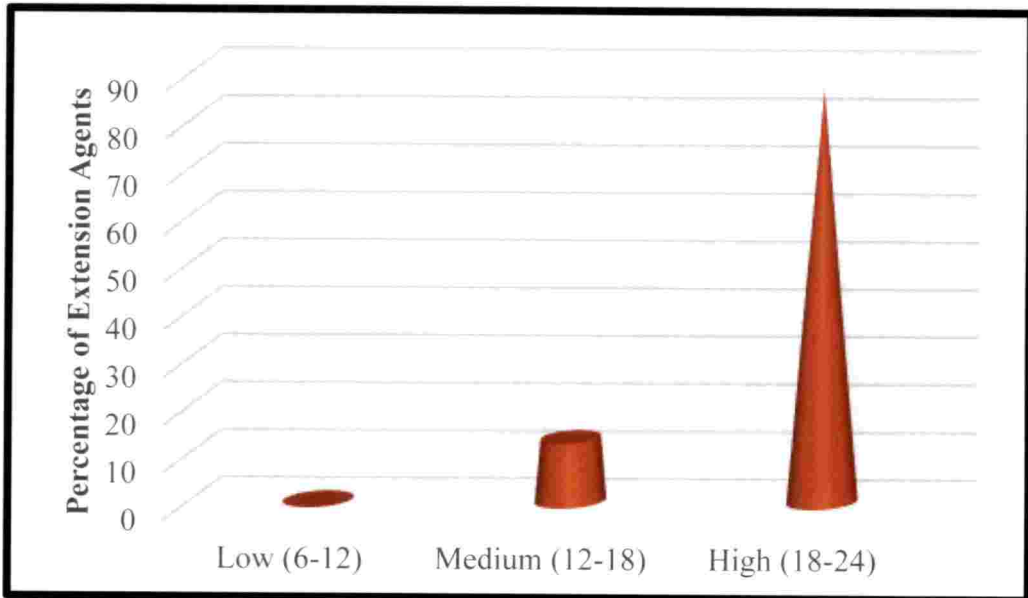


Fig 4.1.12. Distribution of extension agents based on the innovativeness towards digital tools

4.1.2.6 Accessibility to digital tools

Accessibility to digital tools is the degree to which various digital services like computer, internet and other digital tools that are accessible for the extension personnel. Accessibility for various tools by the respondents are given in table 4.15.

Tools like television, mobile phone, computer, internet, social media, e mail, search engines, agricultural websites, mobile agricultural applications, e newspapers were accessible for all the respondents. These tools were also found to be the most popular tools available to the respondents at the time of investigation. Information kiosk was the least accessible digital tool for the extension agents. Accessibility towards information kiosk was observed in 16.67 per cent of respondents (Fig 4.1.13). Related findings were observed in the study of Gangadharan (2015).

Table 4.15 Distribution of extension agents based on accessibility for various digital tools (n=30)

SI No.	Digital Tools	Accessibility			
		Accessible		Not Accessible	
		Freq	Per (%)	Freq	Per (%)
1	Television	30	100	0	0
2	Mobile Phone	30	100	0	0
3	Computer	30	100	0	0
4	Internet	30	100	0	0
5	Social media	30	100	0	0
6	Information Kiosk	5	16.67	25	83.33
7	e Mail	30	100	0	0
8	Search Engines	30	100	0	0
9	Agricultural websites	30	100	0	0
10	Video Conferencing	21	70	9	30
11	Agricultural expert systems	22	73.33	8	26.67
12	Mobile agricultural applications	30	100	0	0
13	e Newspaper	30	100	0	0

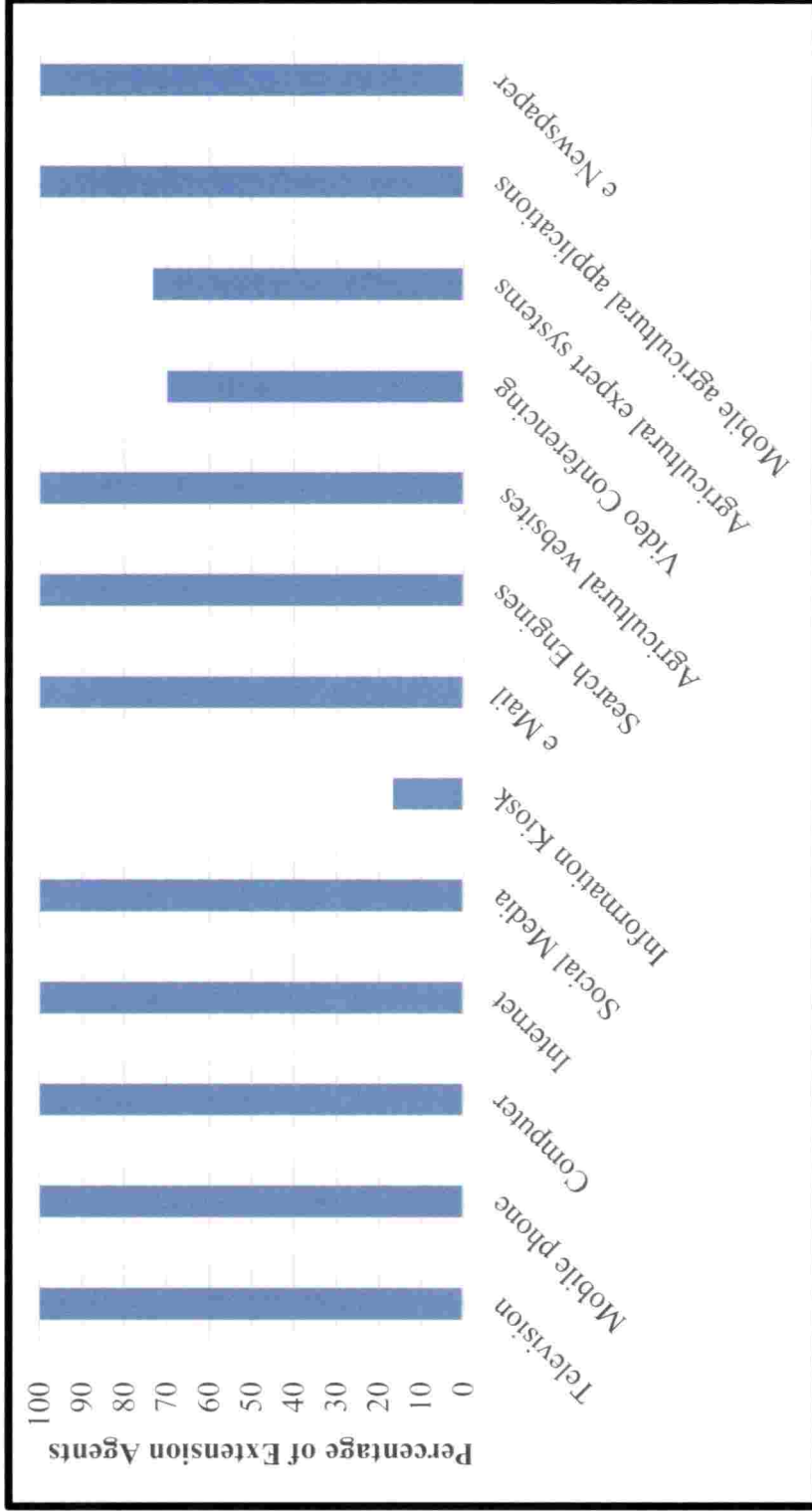


Fig 4.1.13. Distribution of extension agents based on accessibility to digital tools

4.1.2.7 Perceived effectiveness of digital tools

Effectiveness of digital tools in solving agricultural problems is defined as the degree to which the information obtained through various digital tools were successful in producing a desired result in solving various agriculture related problems. Graphical representation of the data is given in figure 4.1.14.

Table 4.16. Distribution of efficiency of agricultural information obtained through digital tools used by extension agents (n=30)

Sl. no	Farm info	Highly Appropriate	Appropriate	Inappropriate
1	Land preparation	0	76.67	23.33
2	Seed/variety	36.67	60	3.33
3	Sowing time	16.67	70	13.33
4	Manures & fertilizers	50	50	0
5	Water management	0	53.33	46.67
6	Plant protection	46.67	53.33	0
7	Weed management	6.67	73.33	20
8	Harvesting	6.67	66.67	26.67
9	Storage	3.33	43.33	53.33
10	Weather information	26.67	70	3.33
11	Market information	26.67	70	3.33

Table 4.16 reveals that most appropriate information were obtained for manures and fertilizers (50 %) as well as plant protection measures (46.67 %). The data obtained for water management and storage were the least appropriate information from digital tools. The results obtained were similar to the findings of Irungu *et al.* (2015).

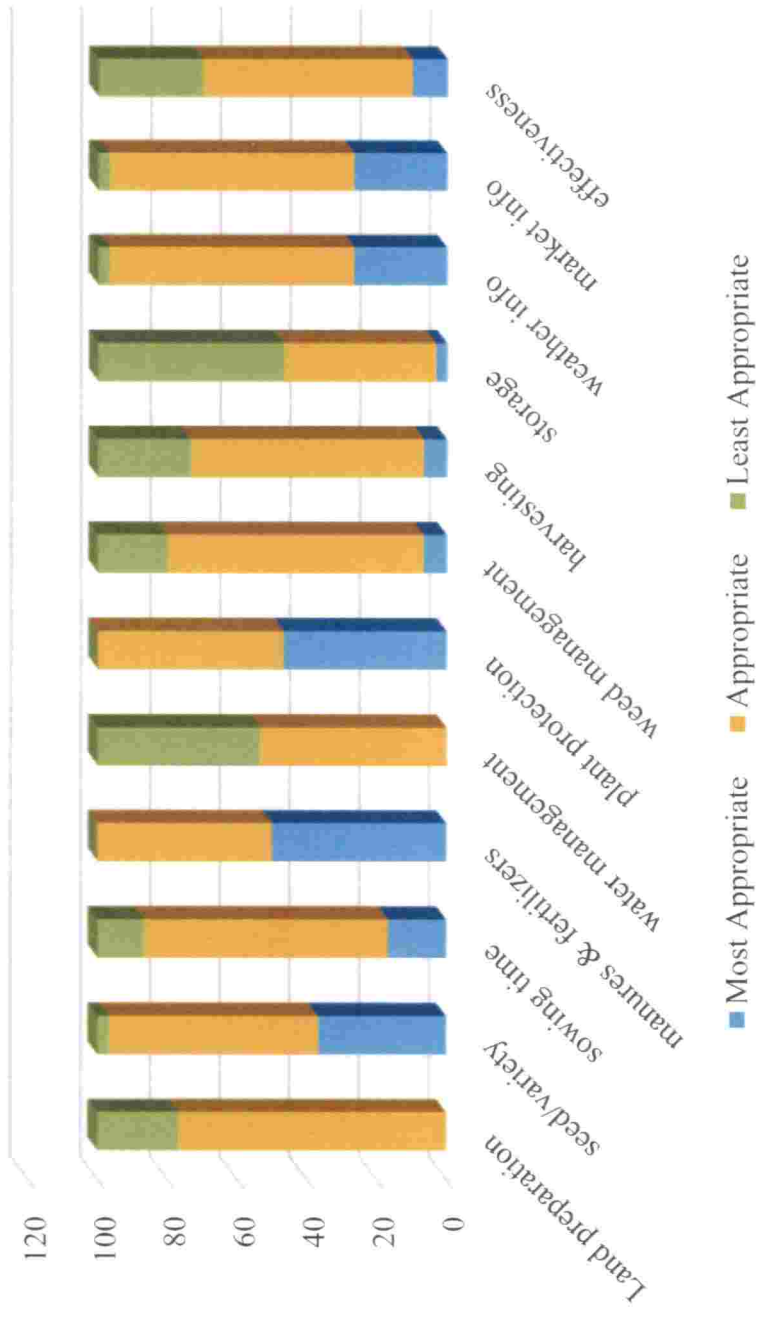


Fig 4.1.14. Distribution of efficiency on agricultural information obtained through digital tools used by extension agents

4.2. Awareness of respondents about digital tools

4.2.1 Awareness of farmers about digital tools

Awareness of farmers on digital tools is explained as whether the farmers were familiar with various digital tools or not. Awareness of farmers on various digital tools are given in Table 4.17.

Table 4.17 Distribution of farmers based on awareness about digital tools (n=120)

Sl No.	Digital Tools	Awareness			
		Aware		Un Aware	
		Freq	Per (%)	Freq	Per (%)
1	Television	120	100	0	0
2	Mobile Phone	120	100	0	0
3	Computer	69	57.50	51	42.50
4	Internet	116	96.67	4	3.33
5	Social media	120	100	0	0
6	Information Kisok	19	15.83	101	84.17
7	e Mail	102	85	18	15
8	Search Engines	97	80.83	23	19.17
9	Agricultural websites	33	27.50	87	72.50
10	Video Conferencing	60	50	60	50
11	Agricultural expert systems	9	7.50	111	92.50
12	Mobile agricultural applications	71	59.16	49	40.83
13	e Newspaper	91	75.83	29	24.17

It was observed that all the respondents were aware about tools like television, mobile phone and social media which were the popular digital tools at the time of investigation. The results were in agreement with findings of Kumar (2018) and Khidir *et al.* (2019). On the other hand Information kiosk (15.83 per cent) and agricultural expert systems (7.50 per cent) were the tools which were having least awareness by farmers (Fig 4.1.15).

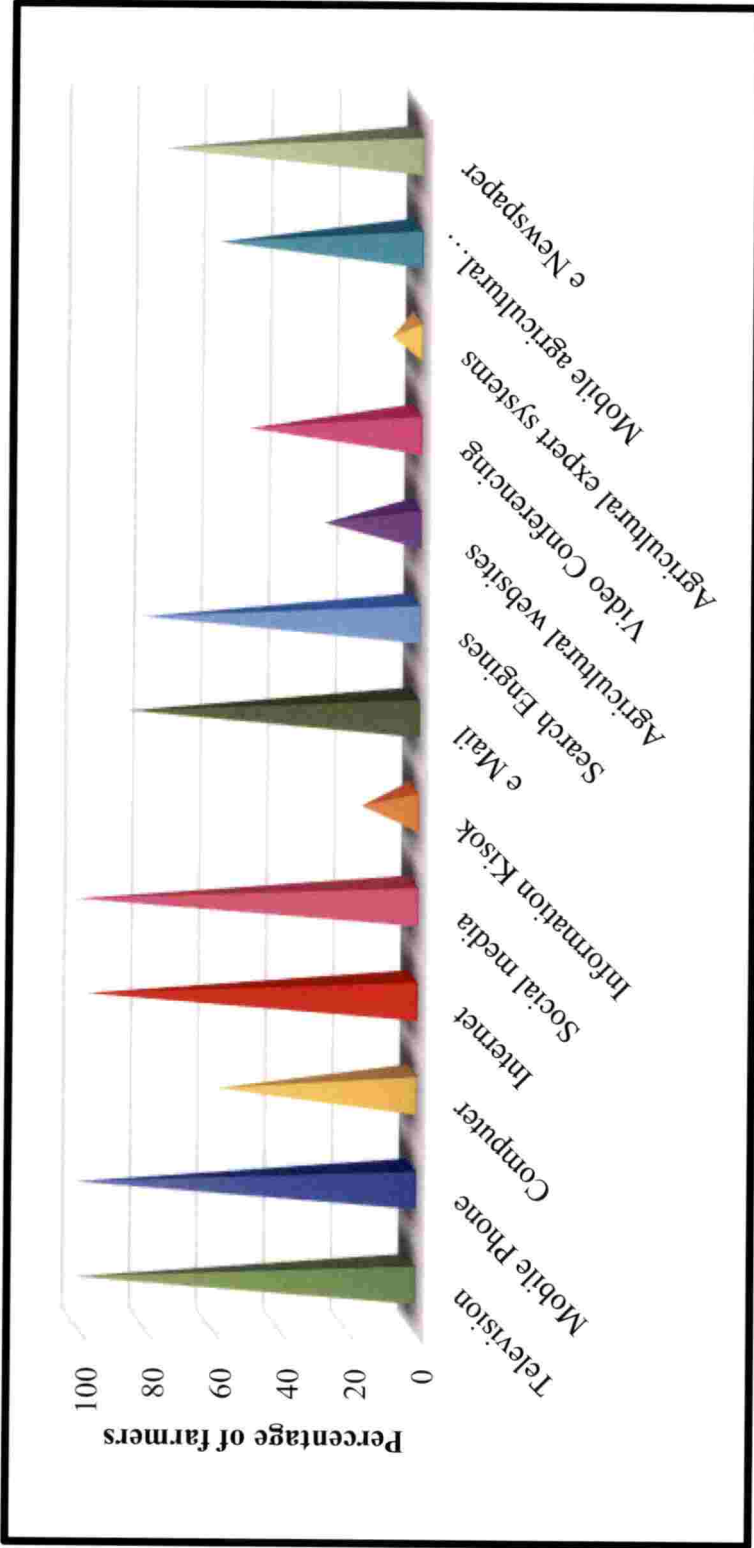


Fig 4.1.15. Distribution of farmers based on awareness about digital tools

4.2.2 Awareness of extension agents about digital tools

Awareness of extension agents on digital tools is explained as whether the extension personnel are aware about various digital tools or not. Awareness of extension agents on various digital tools are given in table 4.18.

Table 4.18. Distribution of extension agents based on awareness about digital tools (n=30)

SI No.	Digital Tools	Awareness			
		Aware		Un Aware	
		Freq	Per (%)	Freq	Per (%)
1	Television	30	100	0	0
2	Mobile Phone	30	100	0	0
3	Computer	30	100	0	0
4	Internet	30	100	0	0
5	Social media	30	100	0	0
6	Information Kiosk	10	33.33	20	66.67
7	e Mail	30	100	0	0
8	Search Engines	30	100	0	0
9	Agricultural websites	28	93.33	2	6.67
10	Video Conferencing	19	63.33	11	36.67
11	Agricultural expert systems	10	33.33	20	66.67
12	Mobile agricultural applications	28	93.33	2	6.67
13	e Newspaper	23	76.67	7	23.33

It was identified that cent per cent of the extension personnel were aware about digital tools like television, mobile phone, computer, internet, social media, e mail and search engines. The interpretations are similar to the findings of Umar *et al.* (2015), Srichandana (2017) and Nwabugwu *et al.* (2019) in which most respondents were aware about mobile phones, television, internet, websites and social media. Only 33.33 percent of the respondents were aware about information kiosks and agricultural expert systems (Fig 4.1.16).



Fig 4.1.16. Distribution of extension agents based on awareness about digital tools

4.3. Preference for digital tools among the respondents

4.3.1. Preference for digital tools by farmers

Preference of farmers among various digital tools were identified and presented in in table 4.19.

Table 4.19 Distribution of farmers based on preference for various digital tools (n=120)

Sl. No.	Digital Tool	Always		Sometimes		Never	
		Freq	Per (%)	Freq	Per (%)	Freq	Per (%)
1	Television	61	50.83	54	45	5	4.17
2	Mobile phone	106	88.33	13	10.83	1	0.83
3	Computer	9	7.5	43	35.83	68	56.67
4	Internet	50	41.67	65	54.17	5	4.17
5	Social Media	77	64.17	42	35	1	0.83
6	Information Kiosk	0	0	5	4.17	115	95.83
7	e Mail	5	4.17	59	49.17	56	46.67
8	Search Engines	5	4.17	71	59.17	44	36.67
9	Agricultural websites	0	0	27	22.5	93	77.5
10	Video Conferencing	0	0	27	22.5	93	77.5
11	Agricultural expert systems	0	0	2	1.67	118	98.33
12	Mobile agricultural applications	7	5.83	54	45	59	49.17
13	e Newspaper	41	34.17	44	36.67	35	29.17

From the table it is clear that mobile phone (88.33 %) was the most preferred tool by the farmers followed by social media (64.17 %) and television (50.83 %) (Fig 4.1.17). Agricultural expert systems and information kiosks were identified as the least preferred digital tools. Social media and mobile phone are more accessible to extension agents compared to information kiosk and expert systems, which may have resulted in the higher preference of these tools. The results are having similarity with the findings of Kumar (2018) and Kumar & Lal (2018).

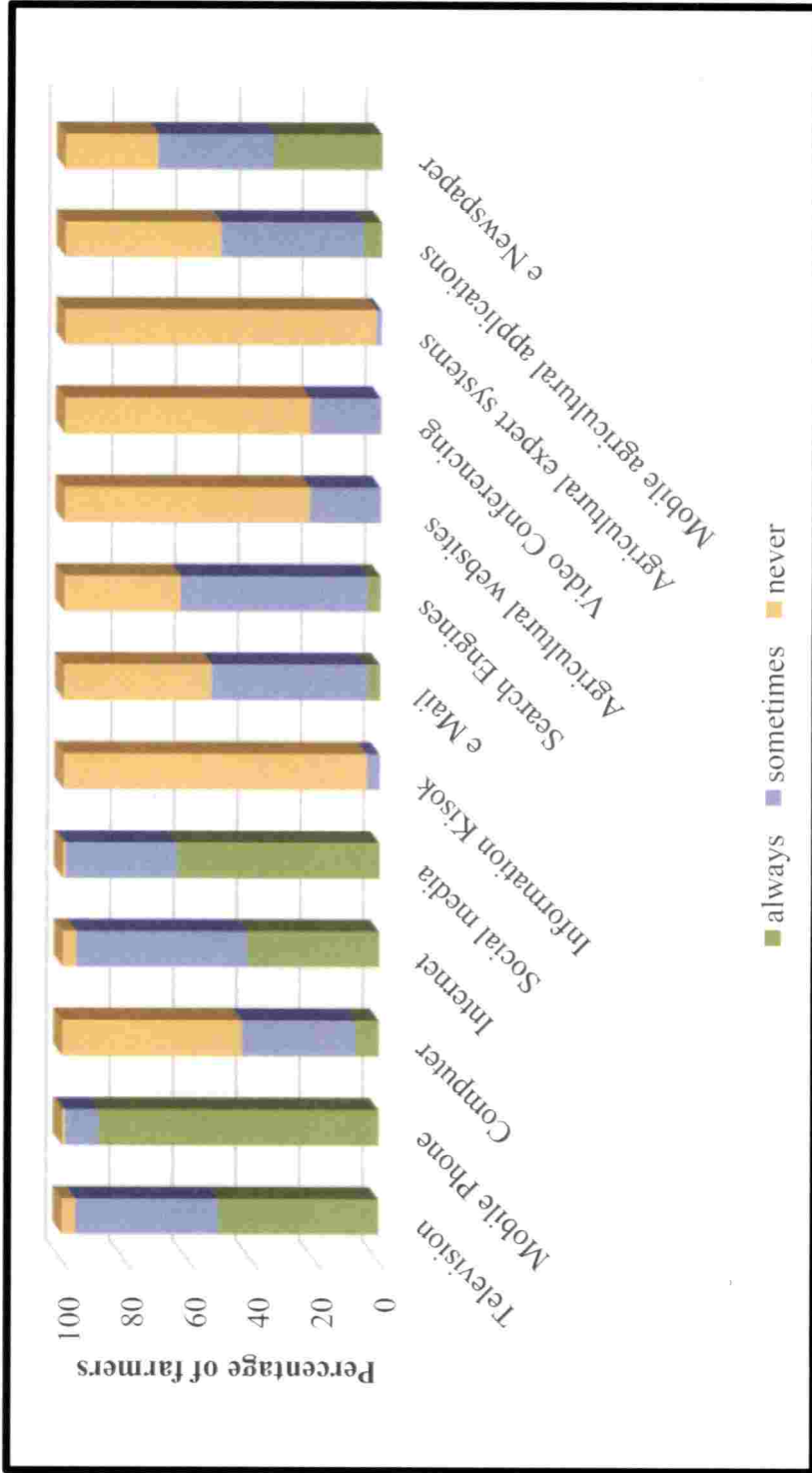


Fig 4.1.17. Distribution of farmers based on preference for digital tools

4.3.1. Preference for various digital tools by extension agents

Preference of various digital tools among extension agents were identified and presented in table 4.20.

Table 4.20 Distribution of extension agents based on preference for various digital tools (n=30)

Sl. No.	Digital Tool	Always		Sometimes		Never	
		Freq	Per (%)	Freq	Per (%)	Freq	Per (%)
1	Television	11	36.67	18	60	1	3.33
2	Mobile phone	30	100	0	0	0	0
3	Computer	9	30	21	70	0	0
4	Internet	22	73.33	8	26.67	0	0
5	Social Media	26	86.67	4	13.33	0	0
6	Information Kiosk	0	0	4	13.33	26	86.67
7	e Mail	15	50	15	50	0	0
8	Search Engines	9	30	21	70	0	0
9	Agricultural websites	4	13.33	24	80	2	6.67
10	Video Conferencing	1	3.33	13	43.33	17	56.67
11	Agricultural expert systems	1	3.33	7	23.33	23	76.67
12	Mobile agricultural applications	4	13.33	24	80	2	6.67
13	e Newspaper	10	33.33	12	40	8	26.67

From the table 4.20 it was found that mobile phone (100 %) followed by social media (86.67 %) were the most preferred tools by extension personnel, whereas information kiosk followed by expert systems were the least preferred tools used by extension agents Fig (4.1.18). The findings were in agreement with the results put forward by Agha *et al.* (2018) and Sulibhavimath & Sharma (2018).

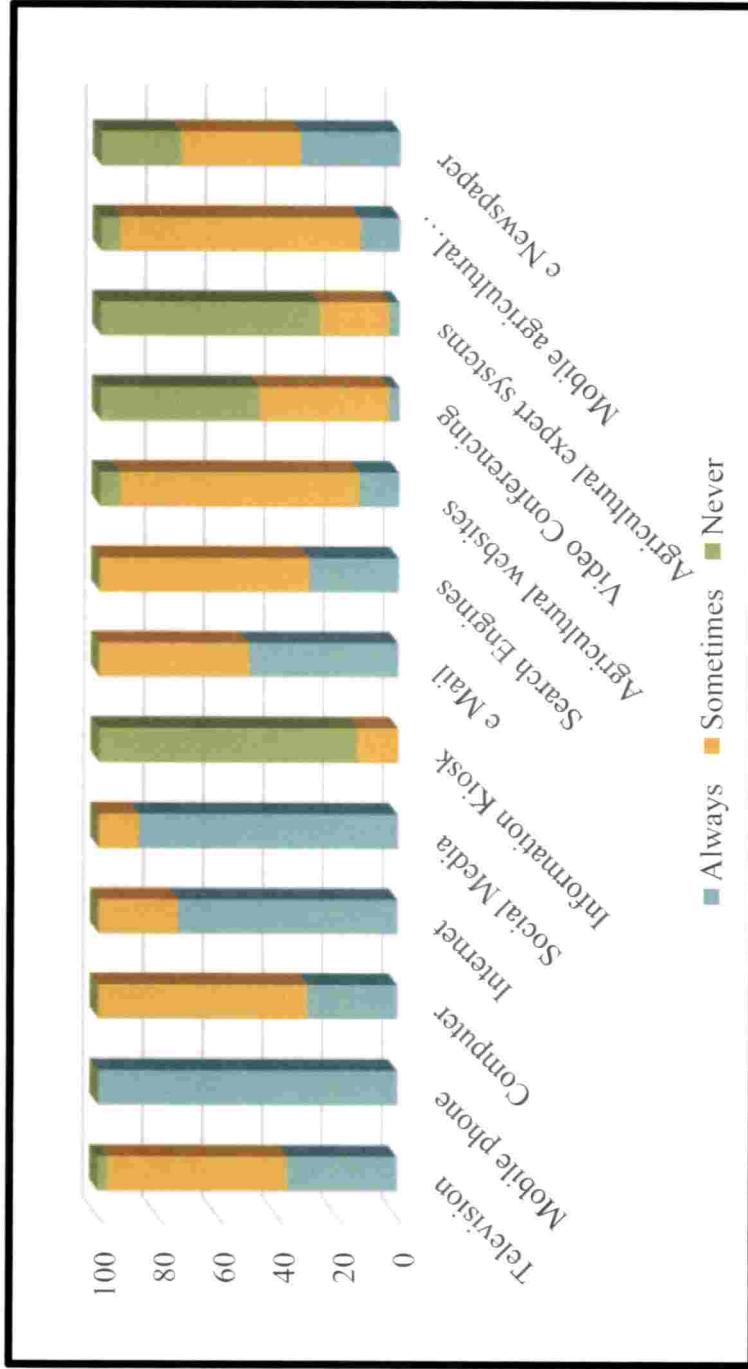


Fig 4.1.18. Distribution of extension agents based on preference for digital tools

4.4 Comparative analysis of dependent variables between farmers and extension Agents

4.4.1 Comparative analysis on order of preference for digital tools between farmers and extension agents

A comparative analysis on the order of preference among the various digital tools was done with the help of Spearman's Rank correlation to find out whether there is similarity in the preference for various digital tools between farmers and extension personnel and is displayed in table 4.21.

Table 4.21 Order of preference of digital tools by respondents

Sl No	Digital Tools	Wt. Avg	Rank (Farmers)	Wt. Avg	Rank (Extn Agents)
1	Television	2.47	3	2.33	5
2	Mobile Phone (SMS, Call service)	2.88	1	3.00	1
3	Computer	1.51	9	2.30	6.5
4	Internet	2.38	4	2.73	3
5	Social media (Facebook, Whatsapp, Youtube)	2.63	2	2.87	2
6	Information Kiosk	1.04	12	1.13	13
7	e Mail	1.58	7	2.50	4
8	Search Engines	1.68	6	2.30	6.5
9	Agricultural websites	1.23	10.5	2.07	9
10	Video Conferencing	1.23	10.5	1.53	11
11	Agricultural expert systems	1.02	13	1.33	12
12	Mobile agricultural applications	1.57	8	2.07	9
13	e Newspaper	2.05	5	2.07	9
r=0.856					

From table 4.21 it is clear that the rank correlation value obtained between the orders of preference for digital tools by the respondents were nearer to one, which indicated that there is a similarity between the order of preference for the digital tools by farmers and extension agents. The similarities for the order of preference between the respondents may be due to the popularity of the tools which were commonly used

for communication and to gather and share information. It also gives an indication that information dissemination through digital media will be easy through this preferred tools as both category prefer same.

4.4.2 Comparative analysis on extent of awareness and preference for digital tools between farmers and extension agents

Table 4.22 Comparative analysis of extent of awareness between farmers and extension agents

	Low (13-22)	Medium (22-31)	High (31-39)	Average score
Farmers (%)	5.83	37.50	56.67	8.57
Extension Agents (%)	0	3.33	96.67	10.93
Z value				5.095
p value				0.000

Table 4.23 Comparative analysis of extent of preference between farmers and extension agents

	Low (13-22)	Medium (22-31)	High (31-39)	Average score
Farmers (%)	31.67	67.5	0.83	23.39
Extension Agents (%)	0	66.67	33.33	28
Z value				5.064
p value				0.000

From the table 4.22 and table 4.23 it was found that the calculated p value is less than 0.05, which implies that there was significant difference between the awareness and preference for digital tools between farmers and extension agents. The average score obtained for awareness and preference on digital tools were found to be

more for extension agents. This indicates that extension agents were more aware about various digital tools and preferred to use the same compared to farmers.

4.5 Correlation between awareness and independent variables

4.5.1 Correlation between awareness and independent variables of farmers

Correlation between awareness on digital tools and independent variables of farmers was presented in table 4.24

Awareness on digital tools was positively correlated with variables like education, cosmopolitaness, attitude towards digital tools, innovativeness, extend of knowledge about digital tools, computer proficiency, accessibility and adoption of digital tools at one per cent significance level. Awareness was negatively correlated with age at one per cent significance level. Extent of knowledge about digital tools as well as computer proficiency of the respondents were found to be crucial to have better awareness on digital tools

Table 4.24 Comparative analysis of awareness and independent variables of farmers

SI No.	Independent variable	Correlation coefficient
1	Age	-0.29**
2	Education	0.64**
3	Cosmopolitaness	0.35**
4	Attitude towards digital tools	0.59**
5	Innovativeness	0.62**
6	Extend of knowledge about digital tools	0.69**
7	Computer proficiency	0.64**
8	Accessibility for digital tools	0.61**
9	Adoption of digital tools	0.40**

*** significant at 1 per cent level, ** significant at 5 per cent level

From table 4.24 it is evident that age was negatively correlated with awareness at one per cent level of significance. Compared to aged group, young group are more aware about digital tools which may be due to their way of thinking and lifestyle. The results were in agreement with the findings of Fawole and Olajide (2012).

Education was positively correlated and significantly correlated to awareness on digital tools which implies that education had an important role in obtaining information about various digital tools. The results were in agreement with the study of Okello *et al.* (2014).

Relationship between cosmopolitanism and awareness was significantly and positively correlated. The respondents who frequently visited the outside social system were more aware about digital tools. The results were in agreement to the findings of Lakshmi *et al.* (2018).

Attitude towards digital tools was positively correlated with awareness on digital tools. This indicated that respondents with higher attitude were more aware about the digital tools. The results were in agreement with the findings of Palaiah *et al.* (2016).

Innovativeness was positively correlated with awareness on digital tools. Innovative people were more likely to know about various digital tools. The results were in agreement to the findings of Lakshmi *et al.* (2018).

Relationship between the extent of knowledge on digital tools and attitude was positive and significant. This indicated that knowledge on digital tools is really important for being aware of various digital tools.

Computer proficiency was positively correlated to awareness on digital tools. Respondents with computer knowledge might be actually more aware about digital tools since digital formats are already know for them.

Accessibility was positively correlated with awareness on digital tool. Farmers are more aware about the tools which are more accessible to them. The findings were in contradiction to the results of Muatha *et al.* (2017).

Adoption of digital tools by the farmers was found to be positively and significantly related to awareness about digital tools. This implies that the awareness on digital tools was leading to the actual adoption of the tool by the respondents. The results were in tune with the findings of Yakubu *et al.* (2013).

4.5.2 Correlation between awareness and independent variables of extension agents

Relationship between awareness about digital tools and independent variables of extension agents were tabulated and is given in table 4.25. Awareness of extension agents on digital tools were positively correlated with education, attitude toward digital tools, accessibility to digital tools and effectiveness of digital tools in solving agricultural problems at one per cent level of significance and innovativeness was positively correlated at five per cent level of significance. Age and awareness were negatively correlated at five per cent level of significance.

Table 4.25 Comparative analysis of awareness and independent variables of extension personnel

SI No.	Independent variable	Correlation coefficient
1	Age	-0.39*
2	Education	0.81**
3	Attitude towards digital tools	0.67**
4	Innovativeness	0.38*
5	Accessibility for digital tools	0.53**
6	Perceived effectiveness of digital tools	0.54**

“**” significant at 1 per cent level, “*” significant at 5 per cent level

From Table 4.25 it is clear that age was negatively correlated with awareness at five per cent level of significance. Aged extension personnel were not much aware of digital tools compared to young extension agents which might be due to the traditional perception. The results were in agreement to the findings of Mabe and Oladele (2012).

Education was positively and significantly correlated with awareness on digital tools. More educated extension agents had better awareness about various digital tools. The findings were in contradiction with the study of Mabe and Oladele (2012).

Attitude of extension agents towards digital tools was positively correlated with awareness on digital tools. This indicated that respondents who were more aware on digital tools had higher attitude towards digital tools. The findings were in tune with the results given by Nagalakshmi and Swamy (2011).

Innovativeness was positively correlated with awareness on digital tools. Innovative extension agents were more likely to know about various digital tools than extension agents who were less innovative. The results were similar to the findings of Baig (2015).

Accessibility was positively and significantly correlated to awareness on digital tool. The availability of the tools was important to create awareness among the respondents. The findings were in tune with the result of Mabe and Oladele (2012).

Perceived effectiveness of digital tools was positively correlated with awareness on digital tools. This indicated that extension personnel who were more aware about digital tools know to use the tools in an effective manner.

4.6 Correlation between preference and independent variables

4.6.1 Correlation between preference and independent variables of farmers

Correlation between preference on digital tools and independent variables of farmers were done and is given in table 4.26.

Table 4.26 Comparative analysis of preference and independent variables of farmers

Sl No.	Independent variable	Correlation coefficient
1	Age	-0.25**
2	Education	0.57**
3	Cosmopolitaness	0.28**
4	Attitude towards digital tools	0.54**
5	Innovativeness	0.59**
6	Extend of knowledge about digital tools	0.67**
7	Computer proficiency	0.65**
8	Accessibility for digital tools	0.58**
9	Adoption of digital tools	0.22*

“***” significant at 1 per cent level, “*” significant at 5 per cent level

From the table it was found that preference of various digital tools by farmers was positively correlated with education, cosmopolitaness, innovativeness, extend of knowledge about digital tools, attitude towards digital tools, computer proficiency and accessibility of digital tools at one per cent significance level and adoption of digital tools at five per cent significance level. Awareness was negatively correlated with age at one per cent significance level.

Age of the farmers was negatively and significantly correlated with preference of digital tools which shows that more the age of an individual stronger is the inclination toward traditional perception. The results were in agreement with the findings of Samatha (2011).

Education had positive and highly significant relationship with preference of digital tools which implies that use of these tools were highly dependent on the

educational status of the respondents. The results were having similarity with the findings of Rudroju (2013).

The relationship between cosmopolitanness and preference of digital tools was positive and significant. It indicated that people who interacted more outside their social system are more likely to prefer digital tools. The results were in tune with the findings of Hagemanty (2011) and Tomar *et al.* (2016).

Attitude towards digital tools was positively and significantly correlated with preference for digital tools. Respondents with favourable attitude were found to use of digital tools more frequently. The results were in agreement with the findings of Palaiah *et al.* (2016).

Relationship between innovativeness and preference was positive and significant. Innovators were more likely to use and prefer novel ICT tools than less innovative respondents. The findings were in agreement with the results obtained by Samantha (2011) and Kafura *et al.* (2016).

Extent of knowledge about digital tools was positively and significantly correlated with preference of digital tools. The more knowledge obtained might be helping the respondents to choose the most useful tools. The results were similar to the findings of Raghuprasad *et al.* (2013).

Computer proficiency and preference was positively and significantly related. This implies that respondents with computer knowledge are more inclined to prefer and use digital tools.

Accessibility and preference were positively and significantly correlated, which indicated that proper infrastructure and availability of the tools were important for the use of digital tools by respondents. The result was in agreement with the findings of Rudroju (2013).

Relationship between adoption of digital tools and preference for digital tools was found significant and positive. It indicated that the respondents who adopted various digital tools further preferred to use those tools.

4.6.2 Correlation between preference and independent variables of extension agents

Relationship between preference of digital tools and independent variables of extension agents was presented in table 4.27.

There exists a positive correlation between preference for digital tools by extension agents with education, attitude towards digital tools and efficiency of digital tools in solving agricultural information at one per cent level of significance while accessibility and innovativeness at five per cent level of significance. Age had negative and significant influence on preference at five per cent significance level.

Table 4.27 Comparative analysis of preference and independent variables of extension personnel

Sl No.	Independent variable	Correlation coefficient
1	Age	-0.36*
2	Education	0.81**
3	Attitude towards digital tools	0.67**
4	Innovativeness	0.35*
5	Accessibility for digital tools	0.45*
6	Perceived effectiveness of digital tools	0.48**

*** significant at 1 per cent level, ** significant at 5 per cent level

From table 4.27 it is clear that age of the extension personnel was negatively and significantly correlated with preference on digital tools. As age increases the respondents will not prefer to have a change and will stick on to the practices which they have followed earlier. The findings were in agreement with the findings of Thomas and Laseindeage (2015).

Education was positively and significantly related to preference on digital tools. Usage of digital tools might be more by highly educated extension agents. The results were having similarity with the findings Bahgat and Antar (2007).

Relationship between attitude of extension agents towards digital tools and preference for digital tools was positive and significant. Extension agents with favourable attitude towards digital tools were found to have an increased use of digital tools. The results were in agreement with the findings of Samansiri and Wangigasundera (2014).

Innovativeness of extension agents was positively and significantly correlated to preference for digital tools. Innovative extension agents were more likely to use and prefer digital tools than less innovative respondents. The results were having similarity with the findings of Manty (2011).

Accessibility for digital tools and preference by extension agents were positively and significantly correlated. This indicated that proper infrastructure and availability of the tools were important for the use of digital tools by extension personnel.

Perceived effectiveness of digital tools was positively correlated with preference for digital tools. Extension personnel who preferred to use digital tools was able to solve agricultural problems in a highly effective manner. The results were in tune with the findings of Irungu *et al.* (2015).

4.7. Categorization of the digital tools based on agricultural crop production, protection and marketing aspects

4.7.1. Categorization of the digital tools based on usage of farmers

Selected digital tools were categorized into crop production, crop protection and marketing based on the use of the farmers. It was realized that mainly television, mobile phones, computer and related services and social media were the main tools used for these purposes. Categorization of the selected tools with regard to crop production, crop protection and marketing aspects are given in Table 4.28.

Table 4.28 Categorization of the digital tools based on usage of farmers

SI No	Digital Tools	Crop Production		Crop Protection		Marketing	
		Freq	Per (%)	Freq	Per (%)	Freq	Per (%)
1	Television	35	29.17	34	28.33	0	0
2	Mobile phone	47	39.17	70	58.33	84	70
3	Computer	0	0	27	22.5	3	2.5
4	Social Media	36	30	69	57.5	99	82.5

The importance of digital tools on crop production, crop protection and marketing was analyzed in terms of frequency and percentages. The table 4.28 shows that mobile phone was the tool used by most of the farmers for getting information on crop production (39.17 %) as well as crop protection (58.33 %) purposes, while majority (82.50 %) of the farmers used social media for marketing the produce made. Whatsapp and facebook were used for marketing of products by farmers.

4.7.2. Categorization of the digital tools based on usage by extension agents

The usage of digital tools by extension personnel was studied in order to find the distribution of usage of digital tools on various purposes by them. Categorization of the tools by extension agents was analysed and presented in table 4.29.

Table 4.29 Categorization of the digital tools based on usage of extension agents

SI No	Digital Tools	Crop Production		Crop Protection		Marketing	
		Freq	Per (%)	Freq	Per (%)	Freq	Per (%)
1	Television	14	46.67	11	36.67	0	0
2	Mobile phone	13	43.33	26	86.67	5	16.67
3	Computer	8	26.67	21	70	0	0
4	Social Media	25	83.33	28	93.33	11	36.67

Percentage of each category was determined by dividing the actual observed number with the total number of respondents. Extension agents used social media predominantly for gathering information about crop production (83.33 %), crop protection (93.33 %) and marketing aspects (36.67 %). Use of digital tools for marketing by extension agents were mainly confined to purchase of agricultural products from farmers through social media.

4.8 Constraints faced by the respondents in the use of digital tools

Various constraints were identified and listed out and the respondents were asked to rank the constraints. The total score for each constraint was calculated and weighted average was found to rank the constraints which is presented in table 4.30.

Table 4.30 Constraints faced by the respondents

SI No	Constraints	Wtd Avg	Rank
1	Lack of familiarity with modern digital tools	4.94	8
2	Unavailability of the contents in local language	6.18	3
3	Lack of upgradation	6.00	4
4	Lack of training programmes	6.81	2
5	Expensive technologies	4.54	9
6	Complexity of the tools	4.98	7
7	Erratic internet connectivity	5.18	6
8	Inadequacy of contents related to agriculture	7.04	1
9	Technical and infrastructural problems	3.54	10
10	Difficulty in clarification of data obtained through digital tools	5.79	5

From table 4.30 it is clear that inadequacy of contents related to agriculture was the major constraint faced by the respondents. Even though there are a lot of technologies to disseminate agricultural information the contents related to the needs of the farmers and extension agents were found to be limited. Lack of training programme was the next important constraint faced by the respondents. The usage and knowledge about various digital tools by the respondents was found to be really high but the respondents felt lack of hands on training programmes in using the various digital tools.

Unavailability of the contents in local language was ranked third by the respondents. The availability of contents in local language will help the respondents to easily clarify their doubts and save time in clearing the meaning of the information obtained so that they can make quick decisions. Lack of up gradation of the tools and services was also an important constraint faced by the respondents. Most of these digital services was found to be initiated and aided by the help of projects implemented by various departments. These projects are time bound and up gradation after the project period is not regular so that the farmers are not getting updated recent technologies

Clarification of the data obtained through digital tools, erratic and poor internet connectivity, complexity of the tools to use, lack of familiarity with the modern digital tools, expensiveness of the technology and technical and infrastructural problems were some other constraints identified.

4.9 Suggestion to improve the usage of digital tools in agriculture

Based on the constraints identified, certain suggestions were put forward to overcome these constraints. The suggestions made by the respondents as well as the opinions from the experts were also included.

Important suggestions from respondents includes providing proper trainings for using various digital tools in the field of agriculture. Training programmes should be conducted by experts by providing guidance for using digital tools. Farmers and extension personnel should be familiarised with the modern digital tools like various mobile agricultural applications, websites related to agriculture and expert systems and must be made available for them to use. Use of digital tools for marketing was another important aspect to be considered for improvement. Even though digital tools were providing adequate information on crop production and crop protection, marketing was only confined to certain social media groups. Farmers and extension agents must be trained in e-marketing facilities. Improving the usage of digital tools for better marketing can be done by creating new platforms to market the products which has the potential to directly link the buyers to producers of nearby area. Through this proper negotiations can be done benefiting both buyers and sellers by cutting the transportation cost and cost incurred by middlemen.

Updating the contents of digital tools related to agriculture with latest available technologies must be done. Digital content creation must not be restricted to time bound projects so that users will not discontinue the technology after certain time. Proper maintenance and repair of equipments such as computers, information kiosk and other accessories must be done to ensure uninterrupted services for the users.

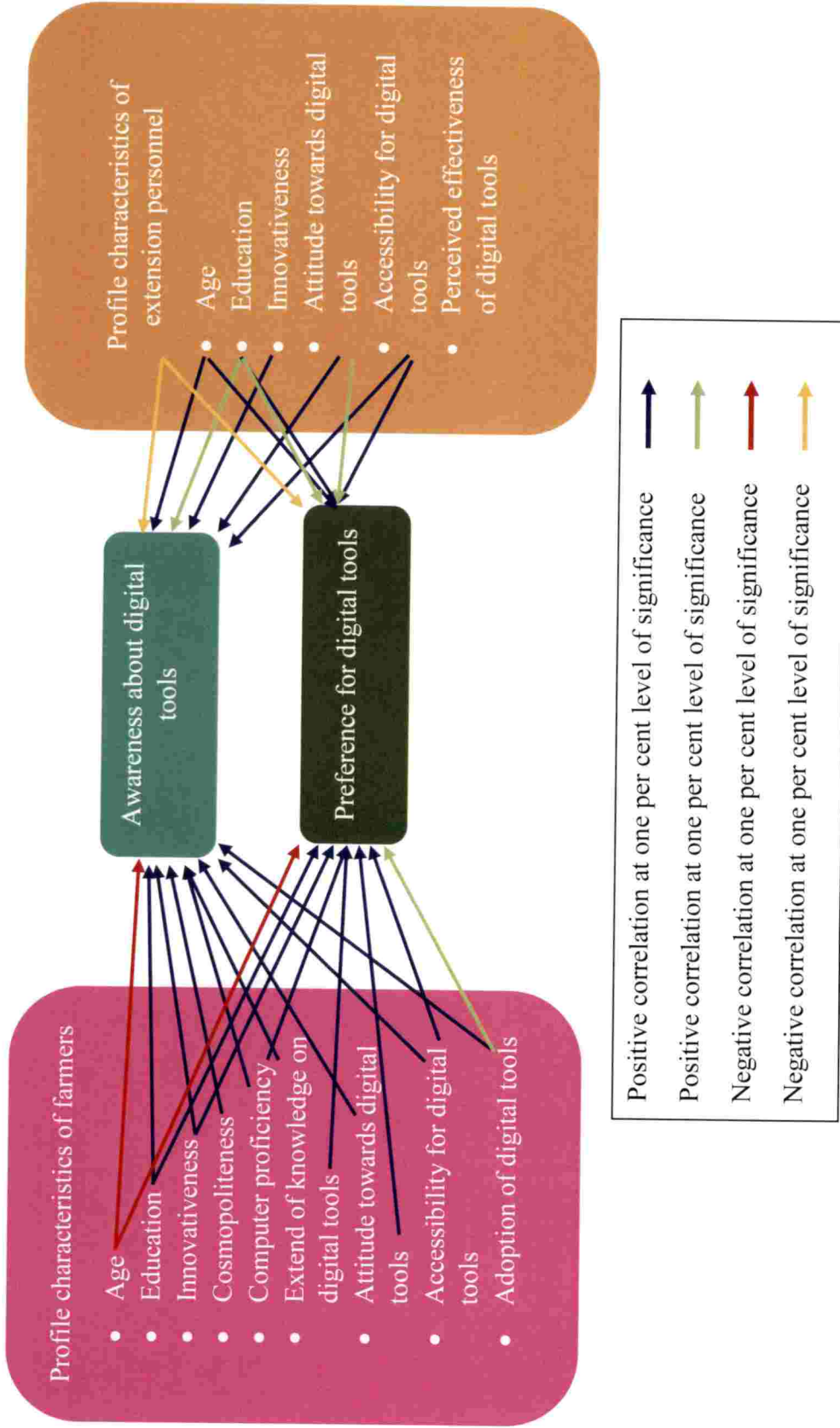


Fig 4.1.19 Empirical model for the study

Summary

V. SUMMARY

In this digital era, integration of digital tools is common in almost all sectors and agriculture is not an exception from it. Digital tools are emerging in the field of agriculture as well as rural development. Integration of modern ICT tools can be done in crop production, crop protection and marketing sectors of agriculture. Through the digital world instant and fast access for communication and sharing of information is made possible. In the present context the study about the usage of various digital tools by the farmers and extension personnel are important to know how far digital technologies have penetrated among the users and the impact created by these tools to decide about the future line of action.

Digital tools in the field of agriculture mainly includes television, mobile phones, computer, internet services, mobile applications, agricultural websites, expert systems, information kiosk, e newspaper, search engines, e mail facilities and so on. Information is necessary for accelerating the socio economic development and digital tools are exclusively used to encourage and disseminate novel and existing vital information about agriculture in various developing as well as developed countries. Shortage of extension agents who act as the intermediaries between farmers and technocrats in farming sector is a serious problem faced by an agrarian country like India. Digital tools can compensate the gap between the farmers and extension agents by providing timely information to the end users without any physical presence. Information dissemination through digital tools are relatively inexpensive, rapid and requires less human force when compared to the traditional methods for disseminating information.

Extension agents who act as the intermediaries should also be aware of these technologies since they are the one to guide the farmers. The usual duties done by the extension personnel of India are only limited to the office works due to the work load

for regular duties of implementing welfare schemes of government, insufficient number of extension agents and lack of time to devote for clinical and field works. In this context use of digital tools can fasten the office work by digitalizing various paper documents and instant dispatching of documents through internet and thereby taking quick actions. Apart from office works, use of digital tools can also help in clinical and field works. Various digital tools are nowadays found to be used to identify the soil nutrient status, water management, pest and disease management and so on. Agricultural extension personnel can now communicate with farmers as individual or groups and also provide remedies for the problems raised by the farmers without giving their physical presence. Considering the importance of digital tools mentioned above usage of digital tools by farmers and extension agents was studied. The present study was structured with the following objectives.

1. To analyze the use of digital tools in horizontal spread of agricultural technologies among farmers and extension agents.
2. To identify the preference of various digital tools among the respondents with regard to its content.
3. To identify the constraints faced by the respondents in using various digital tools and provide suggestions to overcome the constraints.

The study was conducted in three districts namely Kannur, Thrissur and Thiruvananthapuram representing the three zones of Kerala. A representative sample of 40 farmers and 10 extension agents from each districts comprising of 120 farmers who were using various digital tools and 30 extension personnel were selected.

Personal and psychological variables including age, education, experience in handling digital tools, innovativeness, attitude towards digital tools, adoption of digital tools, cosmopolitaness, accessibility to digital tools, computer proficiency, extent of

knowledge on digital tools and effectiveness of digital tools in solving agricultural problems as independent variables, while awareness and preference were the dependent variables. The data collection was done using a pre tested interview schedule. Variables were selected based on the judges rating scores. Mean, range, percentile analysis, weighted average, correlation analysis, Spearman's rank correlation and Mann-Whitney U test were the statistical tools used for analyzing and interpreting the data.

The major findings from the studies are given below:

- ❖ Majority of the farmers belonged to middle age (66.67 %) followed by old age (20 %) and young age (13.33 %).
- ❖ More than forty per cent of the farmers were having higher secondary education (44.17 %) followed by college level (27.50 %) and high school education (22.33 %).
- ❖ Majority of the farmers visited the nearby town once in a week (70 %) indicating highly cosmopolitan nature of the respondents.
- ❖ More than half of the farmers (53.33 %) had medium level of attitude towards digital tools followed by high level of attitude (42.50 %) and low level of attitude (4.17 %) towards digital tools.
- ❖ More than half of the farmers were having high level of innovativeness (56.67 %) followed by medium level of innovativeness (40 %) and low level of innovativeness (3.33 %).

- ❖ Among the various digital tools used by the farmers, television was the most experienced digital tool followed by mobile phone, social media and computer.
- ❖ More than half of the farmers (56.67 %) belonged to the below mean score of 6.22 for the extent of knowledge about digital tools.
- ❖ Nearly forty per cent of the farmers had low level of computer proficiency (39.17 %) followed by thirty five per cent high level of computer proficiency and medium level of computer proficiency (25.83 %).
- ❖ Television, mobile phone, internet, social media, search engines and e mail were found to be accessible for all the farmers.
- ❖ Social media and mobile phones were the tools found to be adopted by all the farmers.
- ❖ Cent per cent of the farmers were aware about digital tools like television, mobile phone and social media
- ❖ Mobile phone was found to be the most preferred tool (88.33 %) by the farmers followed by social media (64.17 %) whereas agricultural expert systems was the least preferred tool (98.33 %) by farmers followed by information kiosk (95.83 %)

- ❖ Among the various digital tools, mobile phone was found to be used mostly for crop production (39.17 %) and crop protection (58.33 %) purposes whereas social media was mainly used for marketing purpose (82.50 %).

- ❖ More than half of the extension personnel were middle aged (53.33 %) followed by young age category (46.67 %).

- ❖ More than forty per cent of the extension agents had degree qualification (43.33 %) followed by MSc. Agriculture (23.33 %), diploma (20 %), BSc Agriculture (6.67 %) and PhD (6.67 %) qualifications.

- ❖ Majority of the extension agents were having high level of attitude (70 %) towards digital tools followed by medium level of attitude (30 %) towards digital tools.

- ❖ Majority of the extension officers had high level of innovativeness (86.67 %) followed by medium level of innovativeness (13.33 %).

- ❖ Television was the most experienced tool used by the extension agents among the various digital tools followed by mobile phone, computer and social media.

- ❖ Digital tools like television, computer, mobile phone, internet, social media, search engines, e mail, agricultural websites, mobile agricultural applications and e newspapers were accessible to all the extension personnel.

- ❖ Use of digital tools was found to be most effective for obtaining information on manures and fertilizers (46.67 %) followed by plant protection measures (36.67 %). Obtaining information on water management practices (46.67 %) was found to be least effective.

- ❖ Television, mobile phone, computer, internet, social media, email and search engines were the tools aware by all of the extension personnel

- ❖ Mobile phone (100 %) and social media (86.67 %) was the most preferred tool by extension agents and information kiosk was found to be the least preferred (86.67 %) tool by the extension personnel.

- ❖ Social media was mostly used for crop production (83.33 %), crop protection (93.33 %) and marketing (36.67 %) purposes of the extension agents.

- ❖ Inadequacy of contents related to agriculture in digital media was found to be the major constraint with a mean rank value of 7.04 by the respondents followed by lack of training programmes (6.81).

From the study it was clear that there were potential farmers and extension agents who were confident enough to use various digital technologies in agricultural sector but utilization of these technologies was not up to mark. Most of the respondents were aware about recent technologies but used only limited number of digital tools only for specific purposes. Lack of training as well as proper content up gradation and adding more contents related to agriculture can fasten the growth of digital technologies in agriculture.

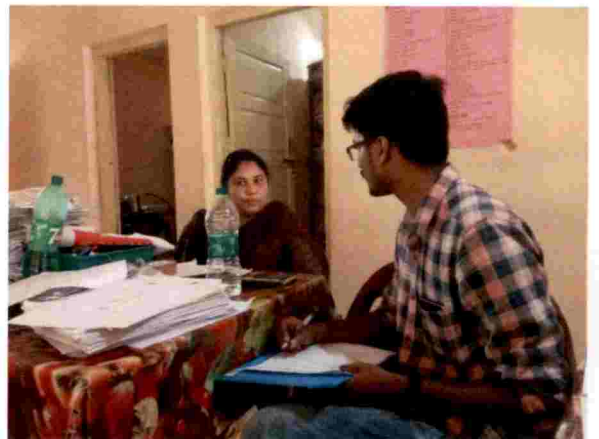
Suggestions given to overcome the challenges faced:

- ❖ Providing proper awareness and training programmes for farmers as well as extension agents by experts and there by create awareness on new digital technologies and its integration in agriculture

- ❖ Improving the usage of digital tools for better marketing by creation of new platforms for marketing of the products which has the potential to directly link the buyers to producers of nearby area where proper negotiations can benefit both of them by cutting down the transportation cost and also cost incurred by middlemen.

- ❖ Provide adequate contents related to agriculture with proper updation of latest technologies. Data regarding answers for agricultural queries was found to be insufficient by the users. Wide range of data should be given based on the requirement of the users. Methods should be implemented to ensure that information received by the end users are up to date and are in usable form.

- ❖ Service and maintenance of hardware should properly be done in order to ensure uninterrupted flow of information. Maintenance of computers and information kiosk as and when required can make easy for the users in using these technologies



Data collection from the respondents

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Reference

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Appendices



APPENDIX I

KERALA AGRICULTURAL UNIVERSITY
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Sir/Madam,

Mr. Alan Jolly Sebastian (Ad.No. 2017-11-061), the post graduate student in the Department of Agricultural Extension, College of Agriculture, Vellayani is undertaking a research study entitled "Digital tools in horizontal spread of agricultural technologies: A scenario analysis in Kerala" as part of his research work. Variables supposed to have close association with the study have been identified after extensive review of literature.

Considering your vast experience and knowledge on the subject, I request you to kindly spare some of your valuable time for examining the variables critically as a judge to rate the relevancy of them. Kindly return the list duly filled at the earliest in the self-addressed stamped envelope enclosed with this letter.

Thanking you

Yours faithfully

Dr. Jayalekshmi.G

DIGITAL TOOLS IN HORIZONTAL SPREAD OF AGRICULTURAL TECHNOLOGIES: A SCENARIO ANALYSIS IN KERALA

Objectives

To analyse the use of digital tools in horizontal spread of agricultural technologies among farmers and extension agents, to identify the preference of various digital tools among the respondents with regard to its content and to identify the constraints faced by them.

Personal, Socio-psychological variables taken for the study

Variables are given in bold cases and their respective meaning is explained for easy understanding of intended meaning. You may please rate the statement with a tick mark in the appropriate column against the statement with special reference to its importance to meet the objectives of the study

Independent variables for farmers

Sl. No.	Variable	Operational definition	Relevancy rating (R - relevant)				
			Most R	More R	R	Less R	Least R
1	Age	Refers to number of chronological years attained by the respondents at the time of survey					
2	Education	Defined as the number of years of formal education completed by respondents					
3	Size of land holding	Referred as the extend of land area which is under cultivation by the farmer					
4	Farming experience	Refers to the number of years completed in farming experience by the farmer					
5	Annual income	Total yearly income of the family obtained through various sources					
6	Attitude towards use of digital tools	Refers to the degree to which the respondent have a favourable or unfavourable approach towards the digital tools and its use in agricultural					

		activities					
7	Extend of Knowledge on digital tools	It is defined as the degree to which farmers know about the digital tools					
8	Adoption of digital tools	Defined as the extent to which farmers adopts available digital tools					
9	Extension agency contact	Defined as the frequency of contact with extension agencies by the farmers to gather information					
10	Cosmopolitaness	Defined as the degree to which respondent visits the social system which is outside to the social system of the respondent.					
11	Training received	Training programmes undergone by respondents with respect to the familiarisation of various digital information tools					
12	Accessibility for various digital tools	Defined as the degree to which various digital services like computer, internet and other digital tools are accessible for the farmer.					
13	Innovativeness	Defined as the earliness of farmers in adoption of the new ideas when compared to other members of the society.					
14	Mass media participation	It is the degree to which farmers are exposed to various mass media communication systems such as television, radio, newspaper, magazines and other social medias.					
15	Economic motivation	It refers to the extent to which the respondent is oriented for achieving the maximum economic yield					
16	Computer proficiency	Refers to the experience in the use of computer among the respondents					
17	Information seeking behaviour	Referred as the urge of the respondents to seek information about existing and upcoming digital tools					

18	Decision making ability	It is the ability of the farmer to choose the most efficient means from the available alternatives without depending on others.					
19	Acceptance of innovation	It is the degree to which the farmer is ready to accept an innovation from any reliable sources.					
20	Major Source of Agricultural Information	It is defined as the information source which is used most to gather the information about agriculture and allied information by the farmer					
21	Relevance of Information	Refers to the quality of information provided through various digital tools which are used by the farmers.					
22	Institutional support	It is defined as the assistance provided by various public, private institutions and other agencies for the use of various digital tools					
23	Experience in handling of digital tools	It is defined as the number of years in the use of various digital tools among the respondents					
24	If any other, specify						

Independent variables for extension personnel

Sl. No.	Variable	Operational definition	Relevancy rating (R - relevant)				
			Most R	More R	R	Less R	Least R
1	Age	Refers to number of chronological years attained by the respondents at the time of survey					
2	Education	Defined as the number of years of formal education completed by respondents					
3	Attitude towards use of digital tools	Refers to the degree to which the extension agent have a favourable or unfavourable approach towards the digital tools and its use in agriculture					

4	Accessibility for various digital tools	Defined as the degree to which various digital services like computer, internet and other digital tools are accessible for the extension agent					
5	Training received	Training programmes undergone by extension agent for providing further information and trainings on the use of various digital information tools to the farmer.					
6	Computer proficiency	Refers to the experience in the use of computer by the extension workers					
7	Mass media participation	It is the degree to which extension personals are exposed to various mass media communication systems such as television, radio, newspaper, magazines and other social medias.					
8	Information seeking behaviour	Referred as the urge of the respondents to seek information about existing and upcoming digital tools					
9	Innovativeness	Defined as the earliness in adoption of the novel practical ideas for various farming techniques by the extension agent and providing the ideas to the farmers					
10	Experience in handling of digital tools	It is defined as the number of years in the use of various digital tools among the respondents					
11	Infrastructure Facilities available	Refers to resource facilities and infrastructure facilities available for the extension personnel for the performance of their duties.					
12	Job Experience	Defined as the number of years completed as an extension agent in the respective department					
13	Major Source of Agricultural Information	It is defined as the information source which is used most to gather the information about agriculture and allied information by extension personnel					

14	Decision making ability	It is the ability of the extension personnel to choose the most efficient means from the available alternatives.					
15	Relevance of Information	Refers to the quality of information provided through various digital tools which are used by the extension agents.					
16.	Effectiveness of agricultural information in solving agricultural problems	Defines as the degree to which the information obtained through various digital tools are successful in producing a desired result in solving various agriculture related problems on field for the extension personnel					
17	Knowledge Enhancement	Refers to the increase in acquisition of new information through the usage of digital tools by the extension agent					
18	Institutional support	It is defined as the assistance provided by various public, private institutions and other agencies for the use of various digital tools					
19	If any other, specify						

APPENDIX II

Digital tools in horizontal spread of agricultural technologies: A scenario analysis in Kerala

Interview schedule for farmers

No.

Date:

1. Name and address of the respondent:

2. Age :

3. Academic qualification :

Sl no	Category	score
1	Illiterate	
2	Write and read	
3	Primary	
4	High school	
5	Higher secondary	
6	College level	

4. Cosmopolitaness:

Frequency of visit to nearby town	
Once in a week	
Once in 15 days	
Seldom	
Never	

5. Attitude towards Digital Tool :

Indicate your response to the following statements in appropriate columns (Strongly Agree- SA, Agree- A, Disagree-D, Strongly Disagree - SD)

Sl no	Statements	SA	A	D	SD
1	It is very easy to get information from digital tools				
2	Digital tools provide need based information.				
3	Digital tools provide timely information.				
4	Digital usage is socially and economically feasible.				
5	Interactive discussion is possible through digital tools.				

6	Digital tools are suitable to illiterate people.				
7	Digital tools are complex to operate				
8	Without any assistance I can't get information from digital tools.				
9	Information provided through digital tools does not consist of localized contents.				
10	Digital tools need additional knowledge and skills to operate				

6. Experience in handling digital tools:

Number of years in using available digital tools:

Sl no.	Digital Tool	No. of Years
1	Television	
2	Mobile Phone	
3	Computer	
4	Social Media	
5	Others	

7. Innovativeness:

Please express your response about statements by indicating degree of your agreement or disagreement (SA- Strongly Agree, A- Agree, DA-Disagree, SDA- Strongly Disagree)

Sl no	Statements	SA	A	DA	SDA
1	I have interest to know about modern digital tools				
2	I have interest to upgrade to latest gadgets when they are released				
3	I feel the oldest ICT tools is the best among all				
4	I know about latest technologies, but not interested to try them				
5	I think digital technologies can help me in obtaining information on farming practices				
6	I have tried several digital technologies from time to time in the past years				

8. Extend of Knowledge about Digital Tools:

Please select the suitable answer from the following questions given below

- Are you aware about various farming community groups in Facebook?
 - Yes
 - No
- Do you share agricultural information through Whatsapp?
 - Yes
 - No

3. Internet access can be obtained through mobile phones
 - a) Yes b) No
4. Have you ever operated an Information Kiosk?
 - a) Yes b) No
5. Youtube contains videos related to agricultural practices
 - a) Yes b) No
6. Mobile applications can be obtained through Play store
 - a) Yes b) No
7. Mobile applications can be used to identify pest and disease
 - a) Yes b) No
8. Do you know to send SMS from your mobile phones?
 - a) Yes b) No
9. Have you ever purchased or sold commodities through online?
 - a) Yes b) No
10. Digital tools can be used to control pest and diseases.
 - a) Yes b) No

9. Computer proficiency:

Please give your response about each of the following statements

Sl no	Statements	Yes	No
1	I can transfer data to pen drives/CD		
2	I can search information in a computer		
3	I know how to access social media through computer		
4	I can download information from internet		
5	I can take print out of a page		
6	I know how to access agriculture related websites.		

10. Accessibility for Digital tools

Indicate your response to the following digital tools in appropriate columns

Sl No.	Digital Tool	Accessible	Not Accessible
1	Television		
2	Mobile phone		
3	Computer		
4	Internet		
5	Social media		
6	Information Kiosk		
7	E mail		
8	Search engines		
9	Agricultural Websites and web portals		
10	Video conferencing		

11	Agricultural Expert systems		
12	Mobile agricultural applications:		
13	E newspaper		

11. Adoption of Digital Tools

Indicate your response to the following digital tools in appropriate columns

Sl No.	Digital Tool	Adopt	Inconsistent	Discontinued	Non Adopt
1	Television				
2	Mobile phone				
3	Computer				
4	Internet				
5	Social media: a) Facebook b) WhatsApp c) Youtube				
6	Information Kiosk				
7	E mail				
8	Search engines				
9	Agricultural Websites and web portals				
10	Video conferencing				
11	Agricultural Expert systems				
12	Mobile agricultural applications: a) FEM @ Mobile b) Plantix c) Pestoz d) Karshika vivara sanketham e) Krishi App f) E Vipani g) Krishi sparsham h) Others				
13	E newspaper				

12. Awareness on Digital tools

Indicate your response to the following digital tools in appropriate columns

Sl No.	Digital Tool	Aware	Unaware
1	Television		
2	Mobile phone		
3	Computer		
4	Internet		
5	Social media: a) Facebook		

	b) WhatsApp c) Youtube		
6	Information Kiosk		
7	E mail		
8	Search engines		
9	Agricultural Websites and web portals		
10	Video conferencing		
11	Agricultural Expert systems		
12	Mobile agricultural applications: a) FEM @ Mobile b) Plantix c) Pestoz d) Karshika vivara sanketham e) Krishi App f) E Vipani g) Krishi sparsham h) Others		
13	E newspaper		

13. User Preference:

Please express your response about digital tools by indicating degree of response

Sl No.	Digital Tool	Always	Sometimes	Never
1	Television			
2	Mobile phone			
3	Computer			
4	Internet			
5	Social media: a) Facebook b) WhatsApp c) Youtube			
6	Information Kiosk			
7	E mail			
8	Search engines			
9	Agricultural Websites and web portals			
10	Video conferencing			
11	Agricultural Expert systems			
12	Mobile agricultural applications: a) FEM @ Mobile b) Plantix c) Pestoz d) Karshika vivara sanketham e) Krishi App			

	f) E Vipani g) Krishi sparsham h) Others			
13	E newspaper			

14. Constraints faced by respondents

Please rank the following statements in descending order according to your experience

Sl No.	Constraint	Rank
1	Lack of Familiarity with modern tools	
2	Unavailability of the contents in local language	
3	Lack of system Up gradation	
4	Lack of training programs	
5	Expensive technologies	
6	Complexity of the tools	
7	Erratic Internet connectivity	
8	Inadequacy of contents related to agriculture	
9	Technical and infrastructural problems	
10	Difficulty in clarification of data obtained through digital tools	
11	Social stigma faced by the farmer in use of digital tools	
12	Any other	

15. Suggestions for improvement:

What are you expecting from digital tools in development of agricultural sector?

- i)
- ii)
- iii)

APPENDIX II

Digital tools in horizontal spread of agricultural technologies: A scenario analysis in Kerala

Interview schedule for extension personnel

No.

Date:

1. Name and address of the respondent:

2. Age :

3. Academic qualification :

Sl no	Category	score
1	Diploma	
2	Degree	
3	Bsc. Agriculture	
4	Msc. Agriculture	
5	PhD	

4. Attitude towards Digital Tool :

Indicate your response to the following statements in appropriate columns (Strongly Agree- SA, Agree- A, Disagree-D, Strongly Disagree - SD)

Sl no	Statements	SA	A	D	SD
1	Digital tools facilitate quick access to current data				
2	Digital tools improve the quality of services				
3	Digital tools help to improve communication				
4	Digital tools makes an integration within the office				
5	Digital tools increase job satisfaction of extension personnel				
6	Using digital tools requires additional knowledge and skills				
7	Digital tools helps in reducing workload and easy data retrieval				
8	Digital affects the regular budgeting provision				
9	Use of digital tools provide clarity with regard to plant protection measures				
10	Digital tools will hinder routine official work				

5. Experience in handling digital tools:

Number of years in using available digital tools:

Sl no.	Digital Tool	No. of Years
1	Television	
2	Mobile Phone	
3	Computer	
4	Social Media	
5	Others	

6. Innovativeness:

Please express your response about statements by indicating degree of your agreement or disagreement (SA- Strongly Agree, A- Agree, DA-Disagree, SDA- Strongly Disagree)

Sl no	Statements	SA	A	DA	SDA
1	I have interest to know about modern digital tools				
2	I have interest to upgrade to latest gadgets when they are released				
3	I feel the oldest ICT tools is the best among all				
4	I know about latest technologies, but not interested to try them				
5	Digital technologies can help me in obtaining information on farming practices				
6	I have tried several digital technologies from time to time in the past years				

7. Accessibility for Digital tools

Indicate your response to the following digital tools in appropriate columns

Sl No.	Digital Tool	Accessible	Not Accessible
1	Television		
2	Mobile phone		
3	Computer		
4	Internet		
5	Social media		
6	Information Kiosk		
7	E mail		
8	Search engines		
9	Agricultural Websites and web portals		
10	Video conferencing		
11	Agricultural Expert systems		
12	Mobile agricultural applications:		
13	E newspaper		

8. Effectiveness of agricultural information in solving agricultural problems using digital tools

Indicate your response to the following statements in appropriate columns

Sl No.	Farm information	Highly appropriate	Appropriate	In appropriate	Highly In appropriate
1	Land preparation				
2	Variety/seed				
3	Sowing time				
4	Manures and fertilizers				
5	Water management				
6	Plant protection measures				
7	Weed management				
8	Harvesting				
9	Storage				
10	Weather related information				
11	Market based information				
12	Any others				

9. Awareness on Digital tools

Indicate your response to the following digital tools in appropriate columns

Sl No.	Digital Tool	Aware	Unaware
1	Television		
2	Mobile phone		
3	Computer		
4	Internet		
5	Social media: a) Facebook b) WhatsApp c) Youtube		
6	Information Kiosk		
7	E mail		
8	Search engines		
9	Agricultural Websites and web portals		
10	Video conferencing		
11	Agricultural Expert systems		
12	Mobile agricultural applications: a) FEM @ Mobile b) Plantix		

	c) Pestoz d) Karshika vivara sanketham e) Krishi App f) E Vipani g) Krishi sparsham h) Others		
13	E newspaper		

10. User Preference:

Please express your response about digital tools by indicating degree of response

Sl No.	Digital Tool	Always	Sometimes	Never
1	Television			
2	Mobile phone			
3	Computer			
4	Internet			
5	Social media: a) Facebook b) WhatsApp c) Youtube			
6	Information Kiosk			
7	E mail			
8	Search engines			
9	Agricultural Websites and web portals			
10	Video conferencing			
11	Agricultural Expert systems			
12	Mobile agricultural applications: a) FEM @ Mobile b) Plantix c) Pestoz d) Karshika vivara sanketham e) Krishi App f) E Vipani g) Krishi sparsham h) Others			
13	E newspaper			

11. Constraints faced by respondents

Please rank the following statements in descending order according to your experience

Sl No.	Constraint	Rank
1	Lack of Familiarity with modern tools	

2	Unavailability of the contents in local language	
3	Lack of System Up gradation	
4	Lack of knowledge updating programs	
5	Expensive technologies	
6	Complexity of the tools	
7	Difficulty in convincing farmers about the benefits of modern digital tools	
8	Erratic Internet connectivity	
9	Inadequacy of contents related to agriculture	
10	Technical and infrastructural problems	
11	Difficulty in clarification of data obtained through digital tools	
12	Any other	

12. Suggestions for improvement:

What are you expecting from digital tools in development of agricultural sector?

- i)
- ii)
- iii)

Abstract

**DIGITAL TOOLS IN HORIZONTAL SPREAD OF
AGRICULTURAL TECHNOLOGIES: A SCENARIO
ANALYSIS IN KERALA**

by

ALAN JOLLY SEBASTIAN

(2017-11-061)

Abstract of the thesis

**Submitted in partial fulfillment of the
requirements for the degree of**

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture

Kerala Agricultural University



DEPARTMENT OF AGRICULTURAL EXTENSION

COLLEGE OF AGRICULTURE

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2019

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ABSTRACT

Digital tools in horizontal spread of agricultural technologies: A scenario analysis in Kerala

The study titled 'Digital tools in horizontal spread of agricultural technologies: A scenario analysis in Kerala' was conducted during the year 2018- 2019 with the objectives; to analyse the use of digital tools in horizontal spread of agricultural technologies among farmers and extension agents, to identify the preference of various digital tools among the respondents with regard to its content and to identify the constraints faced by the respondents. The study consisted of 40 farmers and 10 extension agents each from Kannur, Thrissur and Thiruvananthapuram representing the three zones of Kerala resulting a total of 120 farmers and 30 extension agents.

The detailed investigation of profile characters of the farmers pointed out that, majority of the farmers (66.67%) were middle aged and less than half (44.17%) had higher secondary level of education; most (70%) of the farmers had high level of cosmopolitaness and more than half of the farmers (53.33%) had medium level of attitude towards digital tools. Innovativeness of most of the farmers (56.67%) was observed to be high whereas the computer proficiency of 39.19 per cent of farmers was found to be low. Most (56.67%) of the farmers belonged to below mean category of knowledge about digital tools. Television was the most experienced digital tool used by the farmers. Almost all the farmers had accessibility towards tools such as television, mobile phone, internet, social media, e mail and search engines. All the farmers were found to adopt mobile phone and social media.

Analysis on the profile characteristics of the extension agents revealed that most (53.33%) of the extension agents were middle aged and 43.33 per cent of the extension agents had degree qualification. Television was the most experienced tool by the extension agents. Most (70%) of the extension agents had high level of attitude and

majority (86.67%) had high level of innovativeness. The use of digital tools was found to be most effective for manures and fertilizers application (50%) and plant protection measures (46.67%). Tools like television, mobile phone, internet, social media, e mail, search engines, agricultural websites, mobile agricultural applications and e newspapers were accessible to all extension agents.

The results of the study revealed that all farmers were aware about television, mobile phone and social media. Majority of the farmers preferred to use mobile phones (88.33%) followed by social media (64.17%). Mobile phone was found to be the tool mostly used for production purpose by 39.17 per cent farmers. Mobile phone was used by 58.33 per cent of the farmers for plant protection purpose and social media was mostly (82.50%) used for marketing purpose. All extension agents were aware about tools like television, mobile phone, internet, social media, e mail and search engines. Preference was found to be higher for mobile phone (100%) and social media (86.67%) by extension agents. Social media was used mostly by the extension agents for production (83.33%), protection (93.33%) and marketing purposes (36.67%). Correlation between awareness and user preference on age was found to be negatively correlated at one per cent significance for farmers and five per cent significance for extension agents. Awareness and preference of farmers were positively correlated with education, cosmopolitaness, attitude, innovativeness, computer proficiency and accessibility with one per cent significance. Adoption was positively correlated with awareness at one per cent level of significance and preference at five per cent significance. For extension agents awareness and preference were positively correlated with education, attitude and effectiveness at one per cent significance. Accessibility was positively correlated with awareness at one per cent significance and preference at five per cent level of significance.

The study revealed that both the farmers and extension agents preferred to use mobile phone and social media as a general digital tool. The use of digital tools by farmers was mainly for marketing purposes whereas extension agents were more

inclined towards the crop protection purposes. Lack of contents related to agriculture and lack of training programmes were the major constraints identified. From the findings of this study it can be concluded that there is significant role for digital technologies in the development of agricultural sector in Kerala which is not utilized at the fullest. Proper training programmes for farmers and extension agents with proper content updates and tapping the opportunities of digital tools for marketing can benefit the agricultural sectors in various dimensions.

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