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Research Article

Impact Of ICT On Productivity, Market Access, And Risk Management In Agriculture

I Gopi Naik[1*], Dr. B. Navaneetham[2]

[1*]Research Scholar, School of Agricultural Sciences, Karunya Institute of Technology and Sciences (Deemed to be University), ORCID ID: 0009-0002-8971-7368 , Email: Gopinayak9696@gmail.com
[2]Assistant Professor, School of Agricultural Sciences, Karunya Institute of Technology and Sciences (Deemed to be University), ORCID ID: 0000-0002-6472-6797, Email: navaneetham@karunya.edu

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ABSTRACT

The great potential of information and communication technologies (ICTs) to change agriculture is limited by low adoption rates in limited resources places. This mismatch reduces farmers' market access, maximizes output, and restricts good farm management. To close this gap, this study investigates the influence of ICTs on farm management, product marketing, and overall advantages for farmers in Telangana, India. A descriptive research design with a survey methodology was used, with 80 farmers chosen through a convenience sampling method. According to data analysis, the majority of respondents were between the ages of 35 and 55 and had completed secondary school. The majority of participants had fewer than ten acres of land and grew cotton and soybeans. Drones were the most commonly used ICT application, followed by smartphone apps and precision farming techniques. After using ICTs, a sizable percentage (61.3%) reported no change in farm productivity, whereas 27.5% saw gains. In a similar vein, the majority (86.3%) reported steady income, with only a small minority (6.3%) claiming a rise. Limitations were highlighted by the poor (67.5%) ICT utilization for market access. Nonetheless, a significant positive connection (p-value = 0.000) was discovered between the use of ICT and climate change risk management. Farmers cited enhanced decision-making (35.0%) and increased market access (51.2%) as the two main possible advantages of ICTs. These results indicate that although ICT use is rising, its effects on income and productivity are still uneven. To optimize the potential advantages for resource-poor farmers, further work is required to close the digital gap, increase access to ICTs, and better their incorporation into farming methods.

Keywords: Information Communication Technology (ICT), Agriculture, Market Access, Farm Productivity.

Introduction

Information and Communication Technologies (ICTs) use in agriculture has started a worldwide revolution (FAO, 2024). Empowering farmers with knowledge is an important driver of this change. Farmers benefit from ICT applications that provide access to important agricultural data such as real-time weather updates, optimal crop production practices, and market trends (FAO, 2024). Farmers who have this knowledge can make informed decisions that optimize resource use, improve yields, and improve revenue (Xcube Labs, 2024). Because less water and energy are wasted, the environmental effect is minimized. Furthermore, by decreasing the need for dangerous pesticides, ICTs enable the adoption of crop rotation, organic farming practices, and targeted pest management—all of which improve ecosystem health (FAO, 2024). Technological progress is rapidly transforming several industries, including agriculture (International Fund for Agricultural Development, 2023). There are opportunities and difficulties for farmers worldwide as a result of this broad technological transformation. Promoting effective integration requires an understanding of the challenges farmers face as well as how they adjust to this changing technology (World Bank, 2023). By looking at how information and communication technologies (ICTs) are being adopted in agriculture, this study seeks to close this knowledge gap. Unveiling the transformative potential of ICTs in agriculture is crucial for navigating the sector's evolving landscape (Mitra et al., 2020). This study delves into the practical consequences of ICT adoption, offering valuable insights to policymakers, agricultural organizations, and farmers themselves (Lee & Seo, 2022). By analyzing the economic impacts, improved market access, and optimized decision-making facilitated by ICTs, the research aims to inform the development of data-driven agricultural strategies and policies (Dutta et al., 2021). Ultimately, this knowledge empowers farmers and agricultural actors to embrace a technology-driven future, fostering informed decision-making, efficiency gains, and the adoption of innovative practices. For agricultural professionals to succeed in the industry's changing landscape, it is essential to find the transformative potential of ICTs (Mitra et al., 2020). According to Lee and Seo (2022), this study explores the real-world effects of ICT adoption and provides insightful information for farmers, agricultural organizations, and policymakers. The research intends to inform the development of data-driven agricultural plans and policies by examining the economic benefits, enhanced market access, and optimized decision-making enabled by ICTs (Dutta et al., 2021). Ultimately, by accepting a technology-driven future and making informed decisions, increasing efficiency, and implementing new techniques, this knowledge equips farmers and other agricultural workers. Based on the above study the following research questions have been framed.

1. How does the incorporation of ICT tools and platforms into agricultural operations affect farm management efficiency, production optimization, and market access for farmers?
2. What are the known benefits and challenges of implementing ICT technology in agriculture, particularly in terms of improving farm management practices, agricultural product marketing strategies, and providing overall value to farmers?

Review of literature

Abdulrahman Saidu et al. (2017) studied the use of ICT in agriculture, showing its potential for economic sustainability and self-sufficiency Opportunities include enhanced market access, information sharing, profit growth, and global networking. However, factors such as limited infrastructure, manpower, and farmer perception hinder its uptake. The paper goes on to emphasize the need for additional research to bridge these gaps and maximize ICT's impact on agricultural growth.

In a study conducted in Zambia, Urooj Afshan Jabeen, Meela Nikhitha, et al. (2016) discovered a favorable correlation between ICT use and agricultural productivity, with television having the most significant impact. Young farmers aged 25 to 40 are the ones who profit the most. Although ICTs, seeds, fertilizers, and loans increased productivity, their effect on net profit was not statistically significant. The report recommends building an agricultural information system and improving ICT skills for extension staff and farmers.

Shawn Cole & Garima Sharma (2017) This study analyses how ICT can enhance fertilizer use in South Asia. While soil testing procedures exist (such as soil health certificates in India), interpreting the data can be challenging. The initiative investigates using mobile phones with audio/video to communicate test results and prescribe fertilizer applications. It highlights traditional extension programs and inherent prejudices by local sales representatives.

The impact of ICT on developing agriculture was studied by Maximo Torero et al. (2014), who found that there has been a notable decade-long transition. Mobile phones have had a significant influence on the sector because of the availability gap that exists between rural and urban locations. Large-scale Research indicates improved market performance, although the effects on specific farmers differed. There is a need for more research in these areas because the scant evidence on mobile-based information systems and extension programs shows variable and varying outcomes.

Adhiguru and Vimala Devi (2012) studied how information and communication technologies can support Indian farmers facing market pressure. Globalization necessitates more diversity and quality, which increases farmers' requirements for reliable information about crops, technologies, and markets. Both public and private ICT projects meet this need by providing data access and cutting transaction costs. The study emphasizes the importance of implementing appropriate technology, institutional, and regulatory measures to optimize ICT's impact on agricultural efficiency and management, ultimately leading to success in the global market.

Rebekka Syiem and Saravanan Raj (2015) conducted a study on ICT access and usage among 120 Meghalayan farmers in 2013-2014. Mobile phones were the most widely utilized ICT for communication, marketing, and agricultural advice. While radio and TV Low ICT literacy, unreliable infrastructure, and a lack of information about ICT's potential in agriculture were among the issues identified. This research demonstrates the potential of mobile phones for agricultural communication but also emphasizes the need to solve restrictions.

Deven J. Patel; Kapil K. Shukla (2014) Indian agriculture is crucial to the country's economy, but it also has marketing challenges due to price swings different crop production and distribution channels, and a scarcity of current marketing and cost-effective solutions. Traditional extension functions are insufficient to address the difficulties at hand, notwithstanding their abundance. This article analyses the potential use of ICT-mediated services for agricultural marketing, identifying both challenges and opportunities.

According to Shalendra, Sharma et al. (2011), limited access to modern inputs and knowledge has limited productivity in India's agriculture, a significant economic sector. Initiatives in information and communication technology (ICT) are expected to foster the growth of social media platforms and digital technologies. The model must consider literacy, infrastructure, and user needs. Mobile phones enable community members to act as facilitators, making them the most effective method. Suggestions include integrating all sectors, creating user-friendly material, and improving infrastructure to elevate ICT's role in agricultural development.

The results of Nain M.S., Subhrajyoti et al. (2019) show that there is a cycle of loan rationing in maize farming, which is caused by distrust and a lack of knowledge. Rural poverty is resolved with Digital Information Systems (DIS) by building relationships, fostering trust, and promptly addressing issues related to farms. Effective DIS can be accomplished even though farmers' availability to technology and assistance has a significant influence on it. DIS fosters communal bonds, but it also requires careful adaption and ongoing assessment. The study's findings suggest that DIS is a useful tool for optimizing maize farming systems through ongoing adjustments.

Pooja Jain and Rekha (2017) assess how different demographic groups contribute to farmers' use of cell phones for farming activities. They address the problem by highlighting the impact of gender, age, income, and education on farm cell phone use through the use of the Technology Acceptance Model. Apart from marital status, the results showed that these explanatory criteria unquestionably have a major impact on the acceptance of mobile technology. This recognizes the need for policymakers' objectives to be shaped into customized plans to encourage mobile phone use among farmers from various backgrounds in a way that boosts agricultural productivity and enhances welfare in rural areas.

In (2008), V.C. Patil, Ehud Gelb, et al. investigated the internet connection of things in agriculture. However, this research has expanded beyond farm management utilities. In-farm information systems, automation, and data analytics are giving birth to the transformation of the agricultural industry. These improvements lead to unequal dispersion, limiting their full potential. Analyse user demands, including farmers, extension workers, and academics, to identify information gaps and optimize ICT apps.

Surabhi Singh et al. (2017) analyze the challenges that Indian agriculture faces, despite its significant contribution to GDP. It highlights the need to effectively inform farmers about new technology, taking into consideration factors like land size soil type, and crops. The study aims to use ICT for information exchange, technology transfer, input procurement, and output sales to benefit farmers. Farmers can benefit from timely access to relevant information and solutions to implement best practices, choose appropriate inputs, and schedule crops effectively.

Sayyed I.U. and Sami Patel (2014) provide agricultural technology solutions, including information centers for rural services like expert decision-making and crop management systems. It explores farm-level decision assistance for machines. Technology can estimate agricultural outcomes based on plant physiology research and management. This overview provides a general perspective, but more information on specific applications and research findings is necessary.

Jayita Pramanik, Bijan Sarkar, et al. (2017) explore ICTs as a tool for rural development in developing countries. The study focuses on how ICT may improve access to information and communication in several fields, such as education, agriculture, and healthcare government. This aligns with the focus on ICTs as a driver of socioeconomic development in rural regions and for farmers.

Anju John and Francis P. Barclay (2017) investigated the relationship between ICT use and access to agricultural information in Thiruvarur, India. However, there was no correlation found between mobile phone use and media consumption. Overall, media consumption was positively correlated with newspapers were the most effective way to communicate agricultural knowledge to farmers, despite limited information availability. This approach prioritizes traditional media while examining how mobile technologies can improve existing information sources.

Lokeswari's (2016) study examines how ICT might improve Indian agriculture, particularly for small farmers. Research suggests that ICT can address production, marketing, and profit challenges by improving resource access. Technologies, markets, and financial services. Overall, shows the role of ICT in agriculture.

Addul Razaque Chhachhar, Barkatullah Qureshi, et al. (2014) studied the impact of ICT on agricultural development in various categories. Farmers in emerging countries have access to the internet, cell phones, radio, and television. Information and direct market access. The radio transmits agricultural developments in rural areas, but television provides broader information. Mobile phones facilitate communication between farmers and buyers, provide weather reports, and offer real-time market prices. ICT improves agricultural growth by bridging knowledge gaps and benefiting diverse groups.

Statement of the Problem

There is an absence between the enormous opportunity for Information and Communication Technologies (ICT) tools and platforms to transform agriculture and their actual use on farms, especially in resource-poor areas. Farmers' access to markets, productivity optimization, and effective farm management are all hampered by this discrepancy. By understanding the unique advantages and difficulties of integrating ICTs in agriculture, this problem statement emphasizes the need to close the gap between potential and reality. It is critical to determine how ICTs might enhance agricultural product marketing tactics and farm management techniques, ultimately providing farmers with higher value.

Objectives

The specific objectives for this study are the following:
1. To Assess the effects of ICT on farm management and production
2. To Examine the impact of ICT on the marketing of agricultural Products
3. To Determine the overall benefits of ICT for farmers.

Methodology

The investigation was carried out in Telangana's Kamareddy district, one of the most advanced agricultural districts. Four villages, Baswapoor, Edgi, Jukkal, and Khandebalur relatively good infrastructure amenities, were specifically chosen. A list of innovative farmers was produced with the help of village officials from each of the selected villages. In this study, we employed a descriptive research design with a survey approach to gather information on farmers' perspectives on information and communication technology (ICT) use in agriculture. A non-probability convenience sampling approach was adopted. Thus, the study was confined to 80 farmers. Data were collected using a structured interview schedule tailored particularly to the study's objectives. The data was analyzed using statistical approaches such as the frequency and chi-square test.

Data Analysis and Interpretation

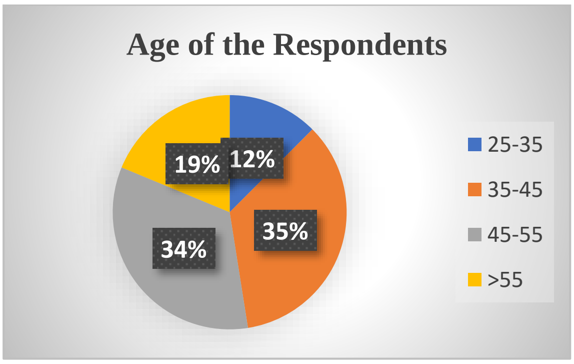


Fig:1 Age of the respondents

The above chart represents the age of the farmers who are respondents to the survey. The majority percent of the respondents (35%) are aged between 35-45 years of age. The next major percentage (34%) are people of age 45-55 years. 19% of the respondents are the aged one i.e., more than 55 years. The young aged people are very less in farming i.e., only 12% of age between 25-35 years

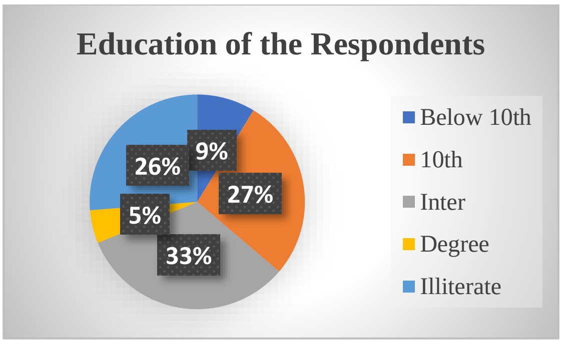


Fig:2 Education of the Respondents

The above chart represents the education of the people who are respondent for the survey. Majority (33%) of them were educated up to inter,29% of the people are completed their 10th grade. The people who had a degree are very less with only 5% and 8% of them are below tenth class. 5% of the people are illiterates. Maximum people know how to write and read.

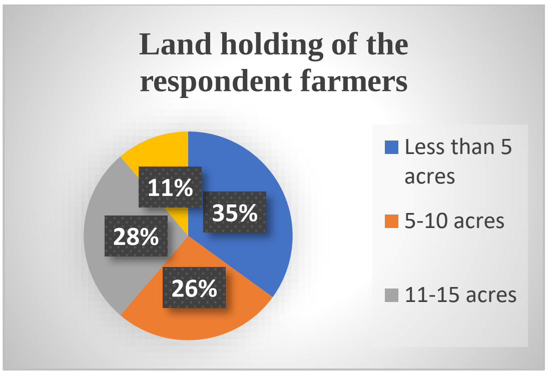
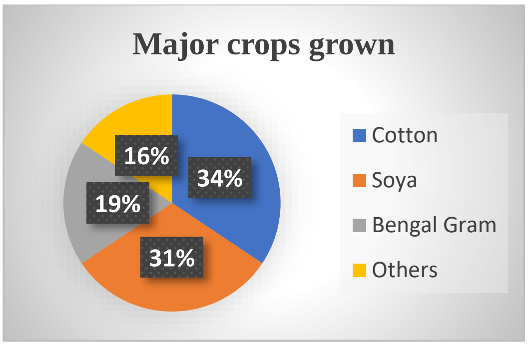


Fig:3 Land

Above pie chart represents the total acres of land that is hold by the farmers. 35% of the respondents have less than 5 acres of land. 28% of them have the land between 11-15 acres, 26% of them are the owners for 5-10 acres of land. The people with more amount of land are less in number i.e., the people having more than 15 acres are only 11%. The majority of the them are with the landholding of less than 5 acres



From the above pie chart, we can interpret that 34% of them are growing Cotton, 31% of them are growing soya, 19% of them are cultivating Bengal gram and 16% of them are growing other crops including red gram, sesame, paddy, etc., Major percentage are growing cotton crop along with soya beans.

Frequency Analysis

Kind of Applications you are familiar with

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Drones	53	66.3	66.3	66.3
	Mobile Apps, Drones	15	18.8	18.8	85.0
	Precision Farming	10	12.5	12.5	97.5
	None	2	2.5	2.5	100.0
	Total	80	100.0	100.0	

Drones are used by the majority of responders (66.3%). A significant proportion of respondents (18.8%) utilize drones in addition to mobile apps. 12.5% of responders, or comparatively fewer, employ precision farming methods. Just 2.5% of respondents said they don't utilize any of the technologies on the list.

How has the use of ICT in your agriculture methods affected your overall farm productivity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increased	22	27.5	27.5	27.5
	Remains Constant	49	61.3	61.3	88.8
	None	9	11.3	11.3	100.0
	Total	80	100.0	100.0	

Despite using ICT, the majority of respondents (61.3%) said that their overall farm production stayed the same. This implies that the adoption of ICT may not have directly raised output for a sizable percentage of farmers, but rather preserved levels of productivity already attained. According to 27.5% of respondents, using ICT increased their total output on the farm. This implies that a sizable percentage of farmers saw increases in productivity as a result of implementing ICT methods and tools. A lesser proportion of respondents (11.3%) stated that their overall farm output was unaffected by the use of ICT.

The majority of respondents (67.5%) stated that they used ICT for agricultural purposes at very low levels. This implies that access to and use of ICT tools and technology in farming operations may be restricted for a sizable percentage of farmers. Only 32.5% of respondents indicated they used ICT at high levels. This suggests that a portion of farmers have greater access to and use of ICT tools and technologies in their farming operations.

In your experience, how has the implementation of ICT benefitted your farm's income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increased	5	6.3	6.3	6.3
	Remain Stable	69	86.3	86.3	92.5
	None	6	7.5	7.5	100.0
	Total	80	100.0	100.0	

How has ICT helped you gain access to marketplaces for marketing your agricultural products

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	54	67.5	67.5	67.5
	High	26	32.5	32.5	100.0
	Total	80	100.0	100.0	

For most of the respondents (86.3%), technology use stayed consistent. This implies that a sizable section of the populace hasn't experienced a substantial change in how they use technology. Just 6.3% of respondents said they used technology more frequently. This suggests that people are becoming more and more dependent on technology. Just 7.5% of respondents said their usage of technology had not changed. Those who have never used technology before or whose usage hasn't changed could be represented by this category.

How ICT helps farmers in managing risks related to climate and unpredictable weather changes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very effectively	64	80.0	80.0	80.0
	Moderately Impacted	3	3.8	3.8	83.8
	No Impact	13	16.3	16.3	100.0
	Total	80	100.0	100.0	

According to the majority of respondents (80.0%), ICT is a very useful tool for helping farmers manage risks associated with climate change and unpredictable weather patterns. This suggests that farmers are widely aware of the benefits of using ICT technologies to address climate-related issues and improve risk management procedures. Just 3.8% of those surveyed said that ICT has a moderate impact on risk management. Though they are smaller in number, these respondents do accept that ICT can be somewhat successful in mitigating climate hazards, albeit not as much as those who think it can be extremely beneficial. Remarkably, only 16.3% of respondents said that ICT does not affect risk management

In your opinion, What are the potential benefits f of using ICT in Agriculture?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increased productivity	10	12.5	12.5	12.5
	Better Market Access	41	51.2	51.2	63.7
	Improved decision making	28	35.0	35.0	98.8
	Enhanced risk management	1	1.3	1.3	100.0
	Total	80	100.0	100.0	

With 51.2% of the observations falling into this category, Better Market Access is the most frequent result. The two most significant factors are better decision-making and better market access: Better decision-making (35%) and better market access (51.2%) are the two most significant reasons, according to the "Valid Percent" column. Positive results are influenced by all of the following: The result in the "Valid Percent" column is larger than 0 for all categories except "Enhanced risk management". This implies that, at least in part, each of the above elements influences favorable results.

In your opinion, how has ICT helped in decision-making regarding market fluctuations and all farming activities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly influenced	13	16.3	16.3	16.3
	Moderately influenced	36	45.0	45.0	61.3
	No influence	31	38.8	38.8	100.0
	Total	80	100.0	100.0	

Only 16.3% of respondents said they give weather and climate a lot of thought when making agricultural decisions. This implies that certain farmers' farming practices and strategies are greatly influenced by weather patterns and climatic circumstances. The majority of respondents (45.0%) said that the weather and climate have a moderate impact on them. This suggests that although climate and weather have an impact, it might not be as great or deterministic as it would be for other factors. Notably, 38.8% of respondents said that their agricultural decisions are unaffected by the weather or environment. This suggests that these farmers' farming techniques give other considerations—like market trends, input availability, or technology advancements—priority over weather considerations.

Chi-Square Tests

How has the use of ICT in your agriculture methods affected your overall farm productivity * How has ICT helped you in gaining access to marketplaces for marketing your agricultural products

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.194[a]	2	.000
Likelihood Ratio	48.915	2	.000
Linear-by-Linear Association	34.017	1	.000
N of Valid Cases	80		

a. 1 cells (16.7%) have an expected count of less than 5. The minimum expected count is 2.93. The chi-square test statistic is 47.194, meaning that it is less than 0.05, with an asymptotic significant p-value of.000. In other words, we determine that there is a statistically significant correlation between the variables and reject the null hypothesis.

How ICT helps farmers in managing risks related to climate and unpredictable weather changes * How has the use of ICT in your agriculture methods affected your overall farm productivity

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.191[a]	4	.000
Likelihood Ratio	43.074	4	.000
Linear-by-Linear Association	7.054	1	.008
N of Valid Cases	80		

a. 5 cells (55.6%) have an expected count of less than 5. The minimum expected count is .34. We reject the null hypothesis with a p-value of.000, a chi-square value of 46.191, and 4 degrees of freedom, and evidence of a statistically significant relationship between the variables. With four degrees of freedom and a p-value =.000, the likelihood ratio chi-square value is 43.074. This suggests that there is a statistically significant correlation between the variables, much like the Pearson Chi-Square test. The linear trend in contingency tables is evaluated using this test. We reject the null hypothesis once more with a chi-square value of 7.054, 1 degree of freedom, and a p-value of.008, indicating a statistically significant linear connection between the variables.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.699[a]	6	.458
Likelihood Ratio	6.385	6	.381
Linear-by-Linear Association	.595	1	.440
N of Valid Cases	80		

In your opinion, What are the potential benefits of using ICT in Agriculture * In your experience, how has the implemetation of ICT benefitted benefitted your farms income

a. 9 cells (75.0%) have an expected count of less than 5. The minimum expected count is .06. With six degrees of freedom, the likelihood ratio chi-square value is 6.385, and the p-value is.381. Once more, there is no statistically significant correlation between the variables, therefore we are unable to reject the null hypothesis. The linear trend in contingency tables is evaluated using this test. We are unable to rule out the null hypothesis with a p-value of.440, a chi-square value of 0.595, and one degree of freedom. This indicates that the variables do not have a statistically significant linear association.

Conclusion:

This study investigated how a group of farmers used information and communication technologies (ICT). Interesting information about farmer demographics, technology adoption, and the perceived influence of ICT on multiple aspects of agricultural practices was uncovered by the analysis. There were fewer younger farmers represented among the respondents, who were mostly in the 35–55 age bracket. The majority only held a secondary education or less, and smaller holdings of land were preferred. Drones were the most widely used technology tool, followed by a drone-plus-mobile application combo. It is noteworthy that a sizable percentage of respondents stated they did not use ICT for farming purposes. It seemed that ICT had a mixed effect on farm productivity. A sizable fraction of farmers reported an increase in productivity, even though a sizable minority reported no change. This implies that while ICT might not be a universally applicable way to increase yields, it might be advantageous for some. In a similar vein, most farmers said that using ICT had little effect on their income. Just a tiny portion of respondents said their income had increased. These results imply that the financial gains from ICT in agriculture can be restricted or dispersed unevenly. Risk management is one area where ICT seems to have a distinct benefit. The overwhelming majority of respondents said that information and communication technology (ICT) is very helpful in assisting them in managing weather- and climate-related hazards. This suggests that measures to increase farmers' access to markets through technology may be necessary.

References:

1. Afshan, S. A. U., Jabeen, A., & Meela Nikhitha. (2016). IMPACT OF ICTs ON AGRICULTURAL PRODUCTIVITY. In European Journal of Business, Economics and Accountancy (Vol. 4, Issue 5, p. 82). Progressive Academic Publishing, UK.https://idpublications.org/wp content/uploads/2016/05/Full-Paper IMPACT-OF-ICTs-ON AGRICULTURAL PRODUCTIVITY.pdf
2. Agyekumhene, C., Vries, J. D., Paassen, A. V., Macnaghten, P., Schut, M., & Bregt, A. (2018). The role of ICTs in improving smallholder maize farming livelihoods: the mediation of trust in value chain financing.
3. Citation 2: Lee, J., & Seo, S. (2022). The effects of ICT adoption on agricultural productivity in developing countries: A panel data analysis. Sustainability (Switzerland), 14(9), 5602. https://www.mdpi.com/2071-1050/13/10/5570
4. Cole, S., & Sharma, G. (2017, July). The promise and challenges of implementing ICT in Indian agriculture. In *India Policy Forum* (Vol. 14, pp. 173-240).
5. Eduardo Nakasone, Maximo Torero,and Bart Minten International Food Policy Research Institute (IFPRI), Washington, DC 20006; https://www.annualreviews.org/doi/pdf/10.1 146/annurev-resource-100913-012714
6. Food and Agriculture Organization of the United Nations. Information and Communication Technology (ICT) in Agriculture. https://www.fao.org/family-farming/detail/en/c/1200067/
7. Gummagolmath, K. C., & Sharma, P. (2013). User centric ICT model for supply chain of horticultural crops in india. *Agricultural Economics Research Review*, *26*(1), 91-100.
8. International Fund for Agricultural Development. (2023, February 22). Digitalization for agricultural transformation. https://www.ifad.org/en/web/latest/-/harnessing-digital-technologies-and-experiences-to-accelerate-agricultural-and-rural-development-in-asia-and-the pacific?p_l_back_url=%2Fen%2Fweb%2Flatest%2Fevents%3Fdelta%3D100'
9. Jain, P. (2017). Impact of Demographic Factors: Technology Adoption in Agriculure. *SCMS Journal of Indian Management*, *14*(3).
10. John, A., & Barclay, F. P. (2017). ICT usage and effects among rural farming communities. *J. Media Commun*, *1*(1), 100-136.
11. Lokeswari, K. (2016). A study of the use of ICT among rural farmers. *International Journal of Communication Research*, *6*(3), 232.
12. Mitra, S., George, B., Hoffmann, V., & Mukhopadhyay, S. (2020). Digital transformation in agriculture: A literature review and agenda for future research. Technological Forecasting and Social Change, 158, 110107. https://www.sciencedirect.com/science/article/abs/pii/S2352550922002676
13. Panda S, Modak S, Devi YL, Das L, Pal PK, Nain MS. Access and usage of Information and Communication Technology (ICT) to accelerate farmers' income.
14. Patel, D. J., & Shukla, K. K. (2014). Challenges and opportunities for ICT initiatives in agricultural marketing in India. *Oriental Journal of Computer Science and Technology*, *7*(3), 377-381.

15. Patel, S., & Sayyed, I. U. (2014). Impact of information technology in agriculture sector. *International Journal of Food, Agriculture and Veterinary Sciences*, *4*(2), 17-22.
16. Patil, V. C., Gelb, E., Maru, A., Yadaraju, N. T., Moni, M., Misra, H., & Ninomiya, S. (2008, August). Adoption of information and communication technology (ICT) for agriculture: An Indian case study. In *IAALD AFITA WCCA 2008. World Conference on Agricultural Information and IT*.
17. Pramanik, J., Sarkar, B., & Kandar, S. (2017). Impact of ICT in rural development: perspective of developing countries. *American Journal of Rural Development*, *5*(4), 117-120.
18. Saidu, A., Clarkson, A. M., Suleiman H. Adamu & Mohammed Mohammed, & Jibo, I. (2017). Application of ICT in agriculture: Opportunities and challenges in developing countries. In International Journal of Computer Science and Mathematical Theory (Vol. 3, Issue 1). https://www.iiardjournals.org/get/IJCSMT/VOL.%203%20NO.%201%202017/Application%20of%20ICT.pdf
19. Singh, S., Ahlawat, S., & Sanwal, S. (2017). Role of ICT in Agriculture: Policy implications. *Oriental Journal of Computer Science and Technology*, *10*(3), 691-697.
20. Syiem, R., & Saravanan, R. (2015). Access and Usage of ICTs for Agriculture and Rural Development by the tribal farmers in Meghalaya State of North-East India. Agrárinformatika Folyóirat, 6(3). https://doi.org/10.17700/jai.2015.6.3.190
21. Syiem, R., & Saravanan, R. (2015). Access and Usage of ICTs for Agriculture and Rural Development by the tribal farmers in Meghalaya State of North-East India. Agrárinformatika Folyóirat, 6(3). https://doi.org/10.17700/jai.2015.6.3.190
22. Vimala Devi, S., and. (2012). ICT in Indian agriculture: learnings and a way ahead. In International Journal of Extension Education (Vol. 8, Issues 1–4, pp. 1 4). https://www.inseeworld.com/jsite/download/injee_v8/No1.pdf
23. World Bank. (2023, April 14). Digital technologies in agriculture and rural development. https://collaboration.worldbank.org/content/sites/collaboration-for-development/en/groups/digital-and-data-driven-agriculture-cop.html
24. Xcube LABS. The Role of ICT in Agriculture. https://www.xcubelabs.com/industries/agriculture/