American Journal of Smart Technology and Solutions (AJSTS)

ISSN: 2837-0295 (ONLINE)

VOLUME 4 ISSUE 2 (2025)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Smart Technology and Solutions (AJSTS)

Volume 4 Issue 2, Year 2025
ISSN: 2837-0295 (Online)
DOI: https://doi.org/10.54536/ajsts.v4i2.4541
https://journals.e-palli.com/home/index.php/ajsts

Adoption of E-technology for Agricultural Advancement in Jamalpur, Bangladesh

Md. Yeakub Ali[1*], Murad Ahmed Farukh[1], Md Azharul Islam[1], Yeasin Arafat[1], Runa Laila[2]

Article Information

Received: February 12, 2025

Accepted: March 16, 2025

Published: October 25, 2025

Keywords

Agricultural Empowerment, Farmer Adaptation, Rural Development, Socio-Economic Improvement, Technology Adopt

ABSTRACT

Adopting e-technology is a transformative approach to enhancing agricultural productivity, optimizing resource utilization, and improving market access in Bangladesh. However, its adoption remains low among farmers in flood-prone areas like Jamalpur due to inadequate digital infrastructure, limited digital literacy, and financial constraints. This study examines the factors influencing e-technology adoption in Charpara Block, Laxirchar Union, Jamalpur District, through structured interviews with 50 farmers. The findings indicate that only 30% of farmers use e-technology, primarily due to poor mobile network coverage, lack of awareness, and affordability issues. Farmers with larger landholdings, higher education levels, and organizational involvement demonstrated a greater likelihood of adoption. To address these barriers, this study proposes key policy interventions, including government-led subsidies for smartphones and internet services, expansion of digital literacy programs, and investment in rural network infrastructure to enhance accessibility. Additionally, technological solutions such as mobile-based advisory platforms (e.g., Krishoker Janala), AI-driven decision-support systems, and precision agriculture tools can improve climate resilience and optimize farm management. By integrating these measures, policymakers can bridge the digital divide and enhance agricultural sustainability. Addressing these barriers and implementing targeted interventions can drive widespread e-technology adoption, leading to socio-economic empowerment and improved climate adaptation for smallholder farmers.

INTRODUCTION

The agricultural sector worldwide faces various intricate challenges consisting of environmental changes, increasing populations, scarce resources, and the need for sustainable farming approaches (Ahmed, 2023; Hasan *et al.,* 2023). Print-on-demand technology that merges Information and Communication Technologies (ICTs) including mobile applications and internet platforms and digital advisory tools, functions as a transformative method to increase agricultural productivity and operational efficiency and disaster resilience (Mumuni *et al.,* 2023) demonstrates that e-technology supplies mobile extension information to farmers in developing countries through tools that manage resources to support crop development and pest control and market trend analysis. The worldwide increase in agricultural needs has revealed that digital solutions must become the standard because Bangladesh as an agricultural nation bases its GDP on farm output and labor distribution (Ali & Roknuzzaman, 2013).

Bangladesh farmers practice agriculture as both their life-supporting activity and their basic sustenance system by conducting farming on a small scale. Bangladesh suffers from declining agricultural territory alongside growing pest outbreaks because irrigation methods need updated technologies and modern infrastructure and farmers experience limited access due to population growth and environmental changes (Sarker *et al.,* 2021). E-technology introduces a breakthrough method which enables farmers to acquire time-sensitive valuable solutions without intermediaries from their agricultural landscapes. Mobile applications (Plantix, Krishoker Janala) as well as government programs (Krishi Batayon) offer two examples of digital tools that enable farmers to improve their decision-making process in crop cultivation while decreasing production expenses (Mohammad & Dey, 2024). E-technology serves as an important solution because it delivers information equality to farmers from disadvantaged locations so they can acquire high-yielding plant species together with fertilizer optimization and pest defense measures that create sustainable agricultural development (Niti, 2019; Sheela & Chakravarthi, 2019). Implementing e-technology systems would act as a vital connection for farmers to retrieve extension services together with market information and disaster preparedness resources. The worldwide implementation of e-technology produces real advantages because Sub-Saharan African farmers see yield boosts of 20-30% through mobile platforms (Misaki, 2024) and Indian farmers gain market opportunities via e-Choupal (Kambar, 2023). The potential of e-technology to transform agricultural progress has established that its adoption in Bangladesh is vital for achieving agricultural development.

Research investigations in the present time have shown increasing focus on how e-technology influences agricultural practices. E-technology represents an emerging technology discipline that pumps up rural development through better information management,

[1] Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[2] Department of Anthropology, Jagannath University, Dhaka-1100, Bangladesh
[*] Corresponding author's e-mail: yeakub.sdf@gmail.com

according to Mumuni *et al.* (2023). Research conducted by Misaki (2024) demonstrates how information and communication technology boosts agricultural productivity through mobile phone expansion that results in 1.5% yearly agricultural output increases across 62 developing nations. ICTs have the potential to provide rural information in Bangladesh according to Ali and Roknuzzaman (2013) yet the adaptation rates remain inconsistent. Anandaraja *et al.* (2013) discuss how digital content for farmers needs validation as they reference the TNAU Agri Tech Portal platform which requires user centered design. Digital literacy and internet access limitations as well as economic restrictions continue to act as barriers for rural areas. Research evidence shows that e-technology brings opportunities but shows different system implementation challenges in diverse contexts (Kambar, 2023).

The evolution of e-technology meets numerous challenges which restrict its adoption in Bangladesh. Farmers in Jamalpur must struggle because they lack smartphone and internet access while their education levels remain low and they do not know about digital tools. Local dealers provide traditional pest and fertilizer advisory services to farmers who practice conventional agriculture methods. Moreover, systemic issues—such as inadequate infrastructure, high device costs, and insufficient training—compound these challenges, leaving farmers ill-equipped to leverage e-Technology's benefits (Mumuni *et al.,* 2023). The government launched Krishoker Janala and Pesticide Prescriber apps while showing commendable initiative but they reach only a small number of areas where Laxirchar Block falls.

Research about micro-level e-technology adoption in Jamalpur Bangladesh demonstrates necessary study by filling gaps that emerge from broad rural ICT adoption studies (Sarker *et al.,* 2021) and urban-centric digital initiatives (Altarturi *et al.,* 2023). Research about e-technology adoption lacks focus on socio-economic factors and environmental challenges which exist exclusively in flood-prone riverine areas while quantitative assessments linked to adoption variables are also rare. The existing research gap obstructs authorities from creating specific policies to promote basic agricultural development. The study investigates three essential questions which center around (1) Which factors prevent e-technology adoption among Jamalpur farmers? (2) What proportion of farmers in Charpara village uses e-technology and are there any demographic differences alongside farm characteristics that influence adoption? (3) What policy actions should Bangladesh implement to boost the adoption of e-technology among rural areas? This study investigates barriers to adoption and establishes adoption rates at Charpara while building recommendations for enhancing e-technology adoption in Bangladesh farming.

Research variables concerning farm size and e-technology perception together with organizational involvement make essential contributions to digital agriculture knowledge in developing areas. This research evaluates government apps like Krishoker Digital Thikana while comparing e-technology user groups with those who have resisted digital solutions to establish an uncommon research model across Bangladeshi academic papers. The study presents applicable policy recommendations, which include device subsidies and doorstep e-platform service provisions to support worldwide efforts to use technology for sustainable agriculture. E-Technology's massive power for agricultural progress in Jamalpur rests on its ability to overcome existing obstacles while developing solutions for local farmers to match rural development and agricultural sustainability objectives.

MATERIALS AND METHODS

Study Area

This study was conducted in Charpara village, which is part of Laxirchar Block and Sadar Upazila in Jamalpur District Bangladesh, situated near the Old Brahmaputra River along the rural area. Jamalpur District in northern Bangladesh consists of seven upazilas with fertile flood-prone soils, allowing researchers to study e-technology adoption. The 568,726 residents in Sadar Upazila earn 57.48% of its total income from agricultural activities that focus on cultivating paddy, jute, wheat, potato, vegetables and mango and banana fruits (BBS, 2022). Laxirchar Block obtained its segments from the Department of Agricultural Extension (DAE) because the entity received continuous e-technology support from government and foreign aid programs. The combination of productive land with the problems of seasonal waterlogging as well as the distribution of small farm ownership (55.76% owners and 44.24% landless) and scarce infrastructure (28.70% electricity coverage) affects the region. The block offers communication infrastructure, which includes 110 km of pucca roads together with 185 km of semi-pucca roads as well as 690 km of mud roads while providing 48.5 km of railway.

Population and Sampling

Farm families permanently living in Charpara village of Laxirchar Block constituted the research population since they engaged in agricultural production. The researchers employed purposive sampling because surveying every household was impractical according to Goode & Hatt (1952). With the assistance of the Assistant Agriculture Officer and local leaders (Matobbor), the sampling framework was constructed by obtaining e-technology user lists. Each household had one primary operator pickled as the survey participant. The target group consisted of participants who utilized e-technology services like Krishoker Janala together with individuals who did not use these services from the same community. The research utilized random selection methods to obtain 50 participants from within their subject groups in Jamalpur Sadar Upazila, Laxirchar Block, Charpara village.

Data Collection

Fifty face-to-face interviews were conducted with a pre-tested, structured questionnaire capturing demographic information, including age, education, income, farm physical characteristics like farm land size and crops, and e Technology usage such as mobile phones and apps usage. The questionnaire was piloted with five farmers from a neighboring village and the language improved. The respondents were interviewed, in Bengali, by trained enumerators, lasting 30-45 minutes at the respondents' homes or fields. Open ended questions were used to gather qualitative data on barriers and motivations. Data from secondary sources came from DAE (2015).

Variables and Measurement

Independent Variables

Age (years), education (schooling years), farm size (hectares), income (BDT/year), occupation (agriculture, business, service), attitude toward e-technology (1-5 scale), organizational participation (yes/no), and e-technology availability (frequent/occasional/rare).

Dependent Variable

E-technology adaptation level (low, medium, high), based on usage frequency and services accessed. Age was self-reported, education scored by completed years (e.g., 1-5 = primary), farm size included owned/leased land, and annualized income. Mobile use was classified as traditional, smartphone, or none.

Data Analysis

Microsoft Excel was used to compile data and SPSS (Version 25) was used to analyze SPSS. Characteristics and adoption levels were summarized in the descriptive statistics (means, frequencies, and percentages) and shown in tables and figures. We evaluated the association of independent variables with adaptation by using Chi-square tests ($p<0.05$).

RESULTS AND DISCUSSION

Socio-Demographic and Farm Characteristics

The adoption of e-technology in Charpara village, Laxmichar Block, was studied through a survey of 50 farmers who gave their socio-demographic background alongside their farm characteristics (Figure 1). The farmers selected in Charpara village mainly belonged to the following age groups: Under 20 years (12%) and 21–30 years (18%), 31–40 years (32%), 41–50 years (26%),

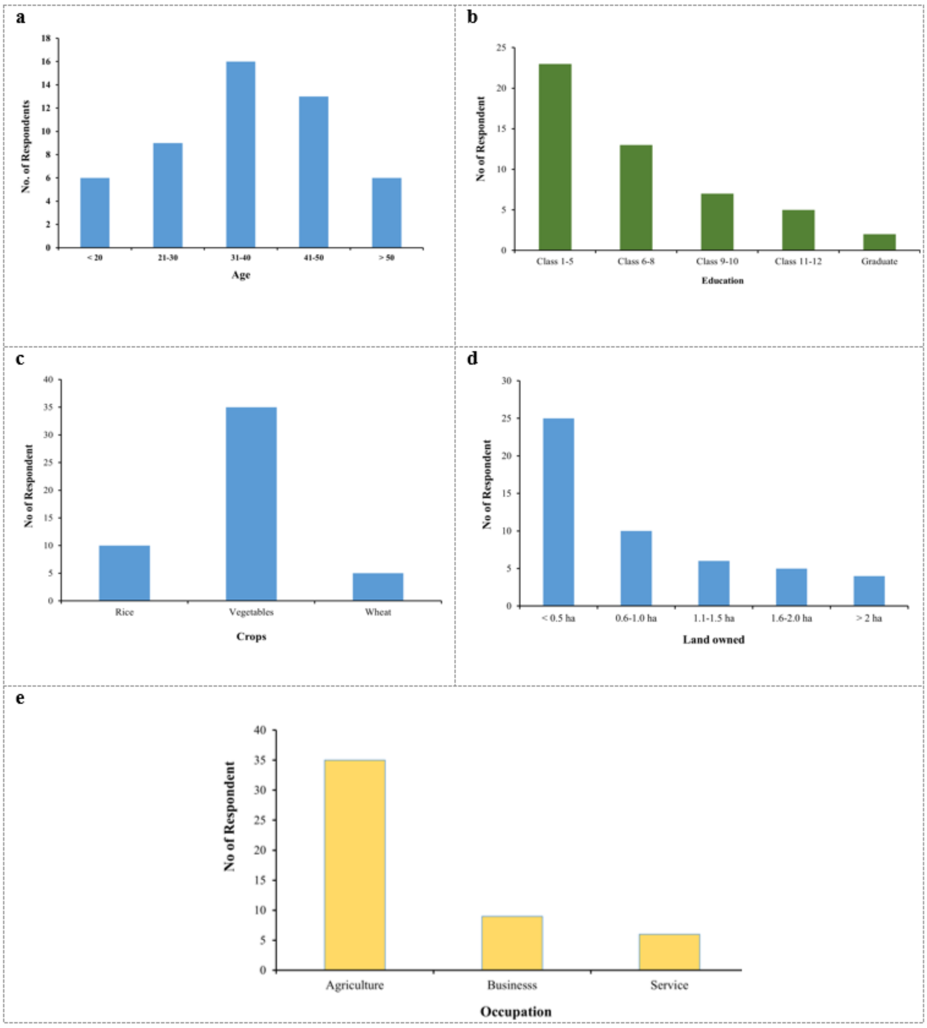

Figure 1: Socio-demographic and farm characteristics (a. Age, b. Education, c. Vegetation, d. Land owned, e. Occupations) of Jamalpur

and Above 50 years (12%) (Figure 1a). The participants' educational levels largely consisted of farmers who had 1–5 years of schooling (46%) while 13 participants (26%) completed 6–8 years of education and 7 people (14%) finished 9–10 years of schooling and 5 participants (10%) obtained 11–12 years of schooling and two individuals (4%) finished university (Figure 1b). Figure 1c demonstrates that farm size differences existed between the farmers since 25 respondents (50%) maintained fields of ≤0.5 hectares while 10 others (20%) possessed 0.6–1 hc, 6 participants (12%) cultivated 1.1–1.5 hc and 5 (10%) controlled 1.6–2 hc and 4 subjects (8%) controlled >2 hc. The survey revealed that rice cultivation occurred in 20% of farms, vegetables were grown in 70% of farms, and wheat cultivation existed in 10% of operated land. Farmers worked with annual incomes ranging from 40,000–45,000 BDT (50%) and 60,000–100,000 BDT (26%) and 110,000–150,000 BDT (12%) while 160,000–200,000 BDT (8%) was also present and >200,000 BDT (4%) (Figure 1d & e).

Statistics confirmed the existence of meaningful relationships between social and demographic profiles and the adoption of e-technology. Results indicated e-technology adoption strengthened as farmers became younger ($\chi^2 = 8.12$, $p < 0.05$) obtained higher education levels ($\chi^2 = 10.34$, $p < 0.01$) worked on larger farms ($\chi^2 = 6.78$, $p < 0.05$) and earned higher income ($\chi^2 = 7.45$, $p < 0.05$).

The age characteristics demonstrate how younger farmers between 21 to 40 years (50% of those surveyed) show greater willingness to adopt digital technologies because they grew up using these tools and accept changes more readily. Youth populations act as the primary drivers of ICT integration in agriculture across global regions because they actively pursue innovative approaches for enhancing flood-affected agricultural areas like Jamalpur (Kashem *et al.,* 2013; Akter & Tan, 2023). The majority of farmers above 40 years exhibited lower adoption rates since they depended on traditional practices and exhibited doubts about new strategies which is a typical resistance point in rural areas. Education and adoption show a robust relationship which demonstrates how literacy enables people to use digital platforms according to Mumuni *et al.* (2023). The app Krishoker Janala loses its impact because most farmers (72% of the sample) possess less than eight years of education and struggle to understand its functionalities (Akter & Tan, 2023).

The reduction of Bangladesh's fertile land area due to population growth explains why many farms measure less than one hectare. Most of Charpara's agricultural area (70%) consists of vegetables because vegetable cultivation takes advantage of the region's excellent productive soil enriched by floods. These high-priced crops miss market performance improvement potential because they lack digital support methods (Chowhan & Ghosh, 2020). The adoption gaps worsen because farmers with incomes higher than the 100,000 BDT/year threshold are more likely to use technology. In contrast, disadvantaged farmers have limited resources for agricultural development.

E-technology Adoption Patterns

Figure 2 reveals adoption patterns which show mobile phone structure among the farmers, as 30% used smartphones, 50% used traditional cell phones, and another 30% did not possess a phone (Figure 2a). Of the study participants who used smartphones to access e-technology for agriculture purposes there were 15 farmers but 20 traditional phone users used their devices for personal communication (Figure 2b). Twelve farmers out of the total 50 participants (24%) signed up for Krishoker Janala applications whereas only 3 farmers (6%) joined Krishi Batayon (Figure 2c). The primary influencers for using these e-technology apps were recommendations from extension officers at 20% and friends or relatives at 6% and self-interests at 4% (Figure 2d). Among 50 interviewed farmers only 15 (30%) used e-technology services, while the rest (35 or 70%) did not (Figure 2e). The services allowed access through text messages for 10 users (20%) and email for 2 people (4%) and social media for 3 people (6%) (Figure 2f). Figure 2g demonstrates the low, medium, and high adaptation categories corresponded to 70%, 30%, and 0%, respectively. Non-adopters make up 70% of the population and half of all phones remain traditional used for non-farm needs because of limited awareness and unaffordability which increases due to low literacy and limited income. Thirty percent of participants adopted app membership while it matched government initiatives Krishi Batayon (Mohammad & Dey, 2024) yet adoption remained restricted due to insufficient extension services and poor promotional efforts since most adopters came from extension officer influence. Text messaging appears preferred (20%) above email or social media because such user-friendly interfaces suit contexts where literacy is low (Mumuni *et al.,* 2023) which should guide future tool design.

Systemic problems become visible when no respondents show high adaptation (0%) because they face costly devices alongside connectivity issues along with training deficiencies (FAO, 2005). The low rate of technology adoption in Jamalpur's flood-prone area presents a wasted chance to boost productivity and resilience despite successful examples like India's e-Choupal (Chowhan & Ghosh, 2020; Sheela & Chakravarthi, 2019).

Impacts of E-technology Adoption

Table 1 indicated that 30% of 50 farmers received e-technology services in their farming activities. A total of 40% of farmers employed e-technology for production support service while 26.67% chose fertilizer services and 33.33% adopted HYV (High-Yield Variety) technology. The survey revealed that no farmers employed e-technology for marketing, price information, storage, transportation or disaster management services. These services showed complete adoption lack since

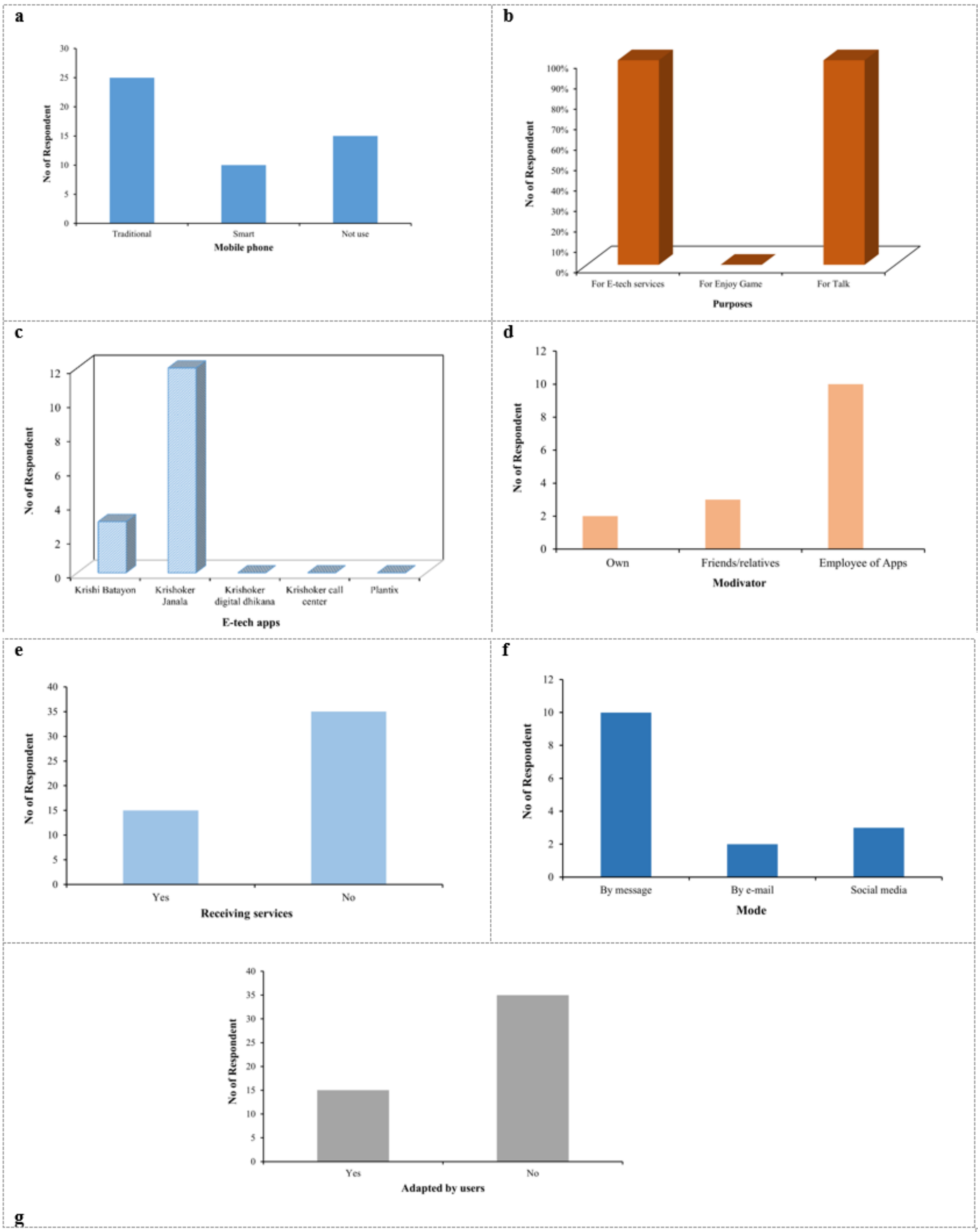

Figure 2: E-technology adoption pattern

rates were 0%. Astaapuram region's e-technology adopters saved money (66.67%) and achieved success rates of 80% for their satisfaction with the services. Non-adopters constituted 70% of the total who continued with traditional approaches which resulted in no digital advantages. The E-technology system demonstrated significant effects on its users because production advancement (40%) assisted pest regulation and weed suppression and fertilizer solutions (26.67%) enhanced nutrition management and cut costs while decreasing ecological impact (World Bank, 2011). A small proportion of farmers (33.33%) reported using HYV technology to boost their production volumes which proves necessary for small-scale agricultural food security although this number points to limited awareness about its benefits. The 66.67% of money savings indicate global efficiency gains (Beguedou *et al.,* 2023) yet Jamalpur's flood-vulnerable region shows a surprising absence of monetary-saving uses for disaster management or marketing. The high satisfaction rate shows user approval of e-technology yet the moderate success rate indicates profit limitations because the system provides only limited range of services (Akter & Tan, 2023). Traditional farming practices used by non-adopters created higher production expenses and reduced outputs but demonstrated the potential advantages of e-technology to close economic divisions between groups. Astonishing usage gap between farmers demonstrates the requirement to increase the adoption of e-technology to optimize agricultural development in the high-value vegetable systems characteristic of Charpara (Kambar, 2023).

Environmental Implications

Adopters of technology applied compound fertilizers accurately (26.67%) and better pest control practices (40%), thus reducing chemical pollution. Yet HYV technology (33.33%) improved their crop production yields. The group of unadopters, who totaled 70%, failed to realize any positive effects on their methods and kept using their outdated procedures (Table 1).

Educational scientific data show that e-technology provides precise fertilizer application and pest control, which reduces flood-caused water contamination in Jamalpur's river basin and prevents soil destruction (Chowhan & Ghosh, 2020). HYV use optimizes soil productivity by improving land productivity and addressing land shortages and changing climate conditions. Operation non-adoption increases environmental strain in this flood-prone area with a mounting population because it wastes resources (Ali & Roknuzzaman, 2013). The application of e-technology shows potential as a sustainability framework to support development goals through conservation measures, which have worked in global ICT implementations (Rahman *et al.,* 2020). This achievement demands successful barrier removal since the ecological advantages of this technology need to be maximized for this susceptible agricultural system.

Table 1: Environmental implications

Support type	Farmers using e-tech (%)	Farmers not using e-tech (%)
Production Technology Support	40	60
Fertilizer Services Support	26.67	73.33
Saving Money by Adopting E-Tech	66.67	33.33
HYV Adoption Support	33.33	66.67
Other Problems Support	0	100
Irrigation Support	13.33	86.67
Marketing Support	0	100
Price Information Support	0	100
Storage Support	0	100
Transportation Support	0	100
Disaster Issue Support	0	100
Success of E-Tech Services	66.67	33.33
Satisfaction of E-Tech Users	80	20

Implications for Adoption of E-Technology for Agriculture

This investigation within Charpara village in Laxirchar Block, Jamalpur District provides extensive insights regarding how e-technology can develop farming practices in Bangladesh by utilizing research frameworks and methodologies, demonstrating results, and suggesting strategies. Rural communities experience dual disadvantages of low smartphone availability and inadequate education alongside weak infrastructure but achieve better yields and cost reductions when using digital tools, thus creating multiple theoretical and policy effects and economic and environmental implications that limit scalability. Theoretical analysis indicates it is essential for current adoption models to consider distinct rural contingencies, which include minimal farming operations coupled with low reading skills and weather threats, including floods. Younger farmers who possess updated knowledge combined with better access to resources currently implement such practices, indicating their potential to guide larger-scale changes in the future. Stronger policy intervention calls for better electricity and mobile infrastructure, affordable technology, and digital centers in rural areas to make digital tools accessible to farmers. The adoption rate would increase when designers create basic programs that match local requirements (Kashem *et al.,* 2013; Misaki, 2024).

Through improved e-technology implementation, society has an opportunity to bridge gaps by providing economic well-being to poor farmers, thus giving them competitive advantages above traditional practices. When farmers combine their knowledge and resources through group sharing, their development accelerates while strengthening community bonds. The study identifies potential ecological benefits for the flood-prone Jamalpur region through smarter land management methods yet non-adopters limit the potential advantages from reaching scale. The likelihood of e-technology expansion grows strong since devoted farming tools for vegetables need development alongside research to monitor its long-term outcomes in various Bangladeshi regions. E-technology can transform agriculture in Jamalpur by directing policy decisions while empowering farmers and protecting the environment if officials eliminate existing implementation challenges. The study provides the necessary foundations to achieve the potential of digital transformation in agriculture.

CONCLUSION

This study investigates the adoption of e-technology for agricultural advancement in Jamalpur, Bangladesh, focusing on Charpara village, Laxirchar Block. Through a three-month study involving 50 farmers, the findings reveal that most farmers rely on traditional practices. At the same time, e-technology adoption remains low due to limited digital infrastructure, financial constraints, and a lack of digital literacy. Farmers who adopt e-technology experience improved productivity, cost reductions, and better resource management, particularly in fertilizer application and pest control. However, a significant gap exists between adopters and non-adopters, perpetuating inefficient farming practices and exacerbating environmental stress. Non-adopters continue using excessive agrochemicals, outdated irrigation methods, and inadequate land management, contributing to soil degradation, water contamination, and increased vulnerability to climate change impacts. To bridge this gap, targeted interventions are necessary, including government subsidies for smartphones and internet services, expansion of digital literacy programs, and the development of localized mobile advisory services. Additionally, integrating AI-driven decision-support systems and precision agriculture tools can enhance resource efficiency and climate resilience. By addressing these challenges, policymakers can promote widespread adoption of e-technology, fostering agricultural sustainability and reducing environmental degradation in vulnerable farming communities. The study underscores the urgency of adopting digital agricultural solutions to enhance farming efficiency, minimize ecological risks, and empower rural farmers socio-economically. Future research should focus on the long-term impacts of e-technology adoption, scalability of digital tools, and policy frameworks that facilitate a more inclusive digital transformation in agriculture.

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