



Exploring the Strategies, Utilisation and Limitations of Digital Tool Adoption in Sugarcane Farming

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HIGHLIGHTS

- The use of digital technology in sugarcane farming may be increased by removing obstacles via better education and early mentoring.
- Social, economic, and technological limitations impede the use of digital in farming operations.
- Mobile technology access and training substantially help sugarcane growers.

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ABSTRACT

The study investigates how sugarcane farmers are currently using digital technologies, identifies the obstacles to their efficient use, and suggests ways to improve the digitalization of sugarcane farming methods. The research was carried out during 2024 in Deoria (district) Sugarcane Committee's Jaura Bazar centre "A", Uttar Pradesh, which is the Deoria Sugarcane Committee's highest-producing sugarcane centre. Purposive sampling was used to choose the sugarcane committee and centre, while random sampling method was used to select the villages and respondent farmers. Garrett's ranking approach was used to assess the constraints of digital tools and technology as perceived by sugarcane cultivators. Data was collected from 230 respondents using a pre-structured interview schedule, revealing that mobile applications are mostly used for seed treatment and pest control in sugarcane farming, and they are less frequently used for other tasks. The primary barriers include technological challenges, budgetary limitations, and societal concerns. It is suggested to use strategies like offline apps, training, free subscriptions, and local language assistance to boost acceptability.

INTRODUCTION

Sugarcane and sugar play a crucial role in the Indian economy, trade, and lifestyle. India is the second-largest producer of sugarcane globally, following Brazil, and is the world's largest consumer of sugar. According to a government estimate, Uttar Pradesh is India's second-largest producer of sugarcane, after Maharashtra. As information and communication technologies (ICT) and precision agriculture instruments are integrated, agricultural management techniques are being enhanced. Through improved input applications, communication across various hardware and datasets, and reduced production costs, this integration intends to improve

the sustainability of the sugarcane crop production system (Molin et al., 2024). The government of India's "Digital India" program intends to provide e-access to government services that are linked to daily living to individuals in urban and rural areas. One method for improving productivity and revenue in agriculture throughout the world is digital agriculture (Beriya, 2020). Digital transformation in agricultural and rural areas is becoming a key priority for global policymakers (Trendov et al., 2019; World Bank, 2017, 2019). Farmers have seen significant advantages from information and communication technologies (ICTs), particularly with the integration of mobile apps and digital technologies into agriculture and related sectors. Agro-advisory service delivery through mobile phones has

been the subject of several experiments in India over the past few years, including Fisher Friend, M-Krishi, IFFCO Kisan Sanchar Limited (IKSL), Reuters Market Light (RML), Kisan Sanchar, and the most recent initiative, the Digital Agriculture Mission 2021–2025 (Shanthi et al., 2022). The ability of ICT to meet farmers' information and knowledge demands and assist them in making timely decisions that eventually result in a considerable increase in their livelihood has once again been demonstrated by the Paddy Expert System mobile application. (Karthikeyan and Kumar, 2022). Pandey (2017) found that 99 per cent of farmers use some form of media, whether it is traditional or folk media, electronic media, or new media. ICTs are essential for providing farmers with information that helps them make decisions about cropping patterns, selecting high-yielding seeds, applying fertilizers, managing pests, and marketing their products, among other aspects (Meera et al., 2004). Recently, the expansion of ICTs has led to heightened expectations that these technologies will provide quick, reliable, and accurate information in a user-friendly format (Shalendra et al., 2011). ICT has the power to transform farming methods, boost production, and improve farmers' livelihoods in the setting of India's dynamic and diversified agrarian economy (Adu, 2020). The degree of ICT adoption in agriculture is also significantly influenced by technical limitations, such as the accessibility of infrastructure, technical expertise, and support services (Patra et al., 2020). ICT supports farming communities by offering information on input availability, advanced technologies, early warning systems for pests, diseases, and natural disasters, as well as credit, market prices, and competition (Yekini & Hussein, 2008). Digital transformation is widely viewed as the key solution to the challenges faced by agriculture and rural areas (Trendov et al., 2019; World Bank, 2019). With this in mind, the study explores the strategies, utilisation and limitations of digital tool adoption in sugarcane farming.

METHODOLOGY

The Department of Agriculture and Farmers Welfare's Government of India 2023 report states that Uttar Pradesh is India's second-largest producer of sugarcane after Maharashtra. In Uttar Pradesh, Jaura Bazar center "A" was selected purposively as it is the highest sugarcane-producing centre situated in the Deoria Sugarcane Committee (Cooperative Sugarcane Development Committee Limited 2024, Deoria). Random sampling procedure was used to select villages and respondents. Data collection was done through interviewing respondents using a pre-structured interview schedule with 230 respondent farmers. The study collected both primary as well as secondary data. The secondary data were collected through different sources like portals/websites and other exiting records of the National and State Agriculture portal and the Indian Council of Agricultural Research reports on sugarcane farming. The other relevant data was collected from official records, research papers, the internet, journals, news articles, etc. The farmers who are growing sugarcane, as well as both male and female farmers, were included in this study; farm labourers who are working on sugarcane farms were excluded from this study. Jaura Bazar centre 'A' has a total of sixteen villages, out of which eight villages were selected randomly for the study, namely Jaura Khas, Jaura Muglahi,

Noniyapatti, Hanumanganj, Kanaura, Vishunpur Upadhyay, Dohari Patti, and Saraiya Mahant Patti. Twenty-eight respondents were selected from each village randomly, which made a total of 230 respondents. After tabulating the responses, basic statistical methods such as percentages, frequency, and Garrett's ranking method were used to analyze the data, and the results were then analyzed. Considering the above limitations, farmers were requested to prioritize the challenges faced by them. The Garrett Ranking Technique is used to determine the final ranking of restrictions, which are expressed as numerical ratings. Compared to a simple frequency distribution, it offers a benefit since it distributes the constraints based on the respondents' numerical relevance. According to this, limitations with an equal number of responses may be given different rankings. The ranks were converted into percentages using Garrett's method.

RESULTS

The results related to the utilization of digital tools as well as challenges encountered while using digital tools associated with sugarcane farming and strategies for enhancing the digitalization in sugarcane agricultural practices are discussed in this section.

Table 1. Use of mobile applications/digital tools for agricultural assistance in agriculture activities

Activities	Percentage
Land preparation	12.1
Selection and purchase of seeds	35.6
Seed treatment	71.3
Plantation	4.8
Managing irrigation	18.7
Fertilization	5.2
Weeding	8.7
Arrangements for protection against pests & diseases	72.6
Monitoring and maintenance	13.1
Harvesting	0.7
Storage and marketing	3.8
All stages	13.1

Table 1 shows the distribution of respondents (n=230) who use digital tools or mobile applications to help with different agricultural tasks. An emphasis on maintaining crop health and production is shown in the large majority of respondents' reliance on digital technologies for seed treatment (71.3%) and pest and disease prevention (72.6%). The significance of seed selection and purchasing (35.6%) and irrigation management (18.7%) in early and mid-stage farming operations is reflected in their moderate utilization. Activities such as weeding (8.7%), fertilizing (5.2%), and land preparation (12.1%) have comparatively low levels of participation. The steps that are least utilized are harvesting (0.7%) and storage/marketing (3.8%), which indicate that post-harvest procedures have not fully incorporated digital technology. Notably, just 13.1% utilize digital technologies throughout all phases of agriculture, indicating potential for further implementation across the agricultural continuum. This data demonstrates farmers focused yet unequal adoption of digital technology.

Table 2. Constraints faced by sugarcane cultivators in adoption of digital tools (n = 230)

Category	Specific Limitations	Mean Score value	Rank
Social Limitations	Lack of education and training	76.96	II
	Lack of early guidance (understanding and using digital tools)	72.49	III
	Lack of self-confidence	67.89	IV
	Security of personal and agricultural related data	63.63	V
	Language-related problems	35.33	VI
	Concerns about security and fraud	78.45	I
Financial Limitations	Lack of trust in online banking systems	75.07	I
	Complex documentation processes	51.92	VI
	Limited branch network	60.76	V
	Lack of financial literacy or awareness	74.2	II
	Lack of knowledge about the use of online banking	69.89	III
	Insufficient loan amount	29.04	VIII
	High interest rates	38.38	VII
Technical Limitations	Inadequate customer support	68.43	IV
	Lack of access to the Internet	37.81	III
	Smart phone technological inaccessibility	57.83	I
	Limited internet access in rural areas	39.17	II

Table 3. Strategies to enhance the utilization and accessibility of digital devices in the farming community

Strategies	Percentage
Customized services (person or Location) like Mandi, village, etc	20.0
Subscription to digital services should be made available free of cost/Access without internet	80.3
Mobile application available in local language	39.3
Agricultural applications that can run even without internet	39.0
Free training and workshops on using digital tools	71.0
Audio-based digital devices	19.3
Others	01.7

Constraints in the adoption of digital tools in sugarcane cultivation and related work

In terms of social, economical, and technological limits, the table lists the several obstacles that sugarcane farmers have while implementing digital tools. Regarding “social limitations,” the biggest obstacle is fears about fraud and security (mean score: 78.45), which comes in first, followed by lack of education and training (76.96) and lack of early guidance (72.49). Further impeding the usage of digital technologies include lack of self-confidence (67.89) and language-related problems (35.33). As the top-ranked concern in this area, the “financial limitations” draw attention to the lack of trust in online banking systems (75.07). Lack of understanding about internet banking (69.89), lack of financial literacy (74.2), and lack of knowledge about online banking (69.89). Farmers’ capacity to access and successfully use digital technologies is also impacted by complex documentation procedures (51.92), limited branch networks (60.76), and problems like high interest rates (38.38) and inadequate loan amounts (29.04) are further financial limitations. The most significant issue in the technical constraints category is the absence of a smart phone technological inaccessibility (57.83), which limits farmers’ digital involvement. This is followed by

limited internet connection in rural regions (39.17) and no access to the Internet (37.81). For farmers looking to use digital technologies to enhance their farming methods, these obstacles pose serious challenges. In short, farmers’ use of digital technology would be greatly increased if these problems were resolved by better instruction, direction, and infrastructural support-such as increased internet connection and device availability.

Table 3 outlines several strategies meant to improve the agricultural community’s use and accessibility to digital devices. Offering free digital service subscriptions/Access without internet was the most popular strategy, as indicated by 80.3 per cent of respondents. The proposal for free workshops and training on digital technologies comes next, with 71 per cent of participants supporting it. Additional noteworthy strategies include making sure agricultural applications can operate without internet access (39%), offering mobile applications in local languages (39.3%), and offering person-based services provided to particular areas, such as Mandi villages (20%). Only 19.3 per cent supported audio-based digital gadgets, which received a smaller amount of focus. Less than 6 per cent of participants proposed other strategies, such as monthly campaigns with government assistance. These results collectively show a high need for easily available, free digital materials and instructional assistance to promote increased use of digital technologies in agriculture.

DISCUSSION

The study highlights the increasing but inequitable usage of digital technologies among sugarcane producers while exploring the challenges and strategies needed for greater integration. This trends in farmers usage of digital tools for different agricultural tasks are consistent with research finding of Jadhav (2024) on the use of digital technology in farm families in Hiware Bazar, India. He found that although farmers use digital tools extensively for weather forecasting and crop monitoring, they still participate in few post-harvest activities such as marketing and storage. This implies that although digital technologies are improving productivity in specific

phases of agriculture, their incorporation into the full farming process is still developing. An analysis of the effects of digital revolution on Indian agriculture was also published in the International Journal of Advanced Multidisciplinary Research. According to Prakash et al., (2024), farmers who used digital tools to maintain soil health, forecast weather, and monitor crops reported increased productivity and yield. It also pointed out that post-harvest phases like marketing and storage had a comparatively low use of digital solutions. To fully benefit from digital agriculture, these studies highlight the necessity of focused interventions that encourage the use of digital technologies at every stage of the farming process, including post-harvest operations.

The report also identifies significant challenges that sugarcane growers have when integrating digital technologies. Social barriers, including concerns about fraud and data security (mean score: 78.45), reflect the need for building trust in digital platforms, which was also highlighted by Tsai et al., (2021). The underutilization of mobile banking has also been linked to security concerns in other studies, including those by Gomathinayagam et al., (2019) & Singh et al., (2019). These issues are made worse by a lack of awareness and early support, as farmers often lack the skills needed to effectively deploy digital solutions. Adoption can be hampered by financial constraints, as seen by onerous administrative processes (51.92) and a phobia of online banking (mean score: 75.07). Similar to Mahalakshmi et al., (2015), who identified a lack of technical expertise as a key obstacle to ICT adoption, technological limitations are also important. Two examples are limited smart phone availability (57.23%) and poor internet access (39.17%). The study recommends many strategies to address these problems, including free training sessions (71%), free digital service subscriptions (80.3%), and offline-capable apps (39%).

A complete approach to promoting digital adoption is also emphasized in the paper. Important initial steps include early digital guidance programs, targeted interventions to increase confidence, and affordable internet and phone connectivity. Initiatives such as integrating online business facilitation and market data into digital platforms are essential for satisfying the unique needs of agricultural communities. These results are consistent with Lokeswari (2016), who suggested improving ICT infrastructure and training farmers to use market data more effectively. In keeping with Rohit et al., (2023), who noted that awareness-raising campaigns are required to maximize the use of ICT technologies, the research also emphasizes the value of education and training in enhancing digital literacy. Overall, the findings indicate that digital technologies have the potential to significantly increase sugarcane output by fostering better information exchange and decision-making. Targeted programs that offer instruction in digital skills and basic technical knowledge are essential to bridging the digital divide in agriculture. Farmers may boost output and adopt more sustainable farming practices by using all-encompassing solutions that tackle social, economic, and technical challenges.

CONCLUSION

The findings suggest a potential for wider adoption across all phases of agriculture, since digital technologies are extensively used for crop health and early-stage agricultural operations but becoming

less common in post-harvest procedures. The usage of digital instruments is hampered primarily by technological, financial, and social barriers. While social issues like fraud concerns, a lack of education, and early mentorship score highest, financial issues include things like a lack of financial literacy, limited access to low-cost loans, and mistrust of online banking systems. The absence of cell phones and poor internet connectivity remain significant technical obstacles. To overcome these challenges, farmers support initiatives like regional training programs, offline-capable applications, free digital service subscriptions, and mobile apps in local languages. These regulations improve accessibility and utility for farmers while addressing financial and infrastructural concerns. By tackling these issues holistically through education, specialist support, and infrastructure improvements, the adoption of digital technology will accelerate and eventually allow farmers to update their practices and increase agricultural productivity.

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