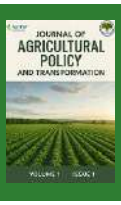

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Production and Export Challenges of Banana Farmers: The Role of Digital Agricultural Solutions in Afgoi District, Somalia

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ABSTRACT

Banana production is an important source of income and food security in Somalia, particularly in Afgoi District. However, farmers face numerous production and export constraints that limit productivity and market competitiveness. This study assessed the key challenges affecting banana farming and explored the potential of digital agricultural technologies to improve production and export performance. Using a descriptive quantitative research design, data were collected from 80 respondents, including large-scale farmers, small-scale farmers, and consultants, through structured questionnaires. The findings identified limited mechanization, inadequate access to improved banana varieties, improper input use, poor infrastructure, security challenges, and climate-related shocks as major constraints. Respondents also recognized the benefits of digital technologies, particularly weather forecasting and mobile-based information services, for enhancing farm management and market access. The study concludes that improving agronomic practices, infrastructure, and adoption of digital technology is essential for strengthening banana production and export performance in Afgoi District.

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1. INTRODUCTION

Agriculture remains a cornerstone of economic development and food security in many developing countries, and Somalia is no exception (Mohamud et al., 2023; Abdullahi & Arısoy, 2022; Osman et al., 2025). In Somalia, agriculture accounts for approximately 60% of the national GDP and provides livelihoods for most of the rural population, particularly in fertile regions such as Lower Shabelle (Osman et al., 2025; Mohamed et al., 2025; Ali et al., 2025; Hassan & Mohamed, 2024). The Afgoi District is especially notable for its agricultural productivity, benefiting from fertile soils and reliable irrigation water from the Shabelle River (Weli, 2021; Amir et al., 2024). Among its principal crops, bananas represent the second most important agricultural export product in Somalia after sesame, historically contributing significantly to export earnings and rural incomes (World Bank & FAO, 2018; FAO, 2020).

Despite the strategic importance of banana production, farmers in Afgoi District confront multifaceted challenges that constrain both productivity and export performance. These challenges span agronomic deficiencies, inadequate rural infrastructure, persistent insecurity and political instability, and climate-related hazards including recurrent floods and droughts. Furthermore, limited market access and inefficient value chain linkages reduce the competitiveness of Afgoi's banana sector in regional and international markets (Ali & Ahmed, 2024).

Digital agricultural technologies encompassing mobile advisory services, weather information systems, and digital market platforms have emerged as promising instruments for addressing such constraints in developing-country agricultural systems (Abiri et al., 2023; FAO, 2019; World Bank, 2021). Evidence from Sub-Saharan Africa and Asia suggests that mobile technology can reduce transaction costs, improve farmers' access to market information, and enhance decision-making in input management (Aker, 2011; Paul Jr et al., 2024). However, the applicability of these technologies in fragile-state contexts such as Somalia, where infrastructure is weak and connectivity is limited, remains insufficiently explored.

Research Gap

Although previous studies have examined agricultural challenges and the role of digital technologies in improving agricultural productivity in Sub-Saharan Africa and other developing regions, limited empirical research focuses specifically on the production and export challenges of banana farmers in Afgoi District, Somalia. Existing studies (e.g., Weli, 2021; Amir et al., 2024; Ali & Ahmed, 2024) provide contextual insights but do not systematically assess how digital agricultural solutions can address the specific agronomic, infrastructural, and climatic constraints faced by banana producers in a fragile-state environment. This study addresses that gap.

Research Objectives

This study is guided by the following objectives:

1. To identify the major agronomic constraints affecting banana production in Afgoi District.
2. To examine the environmental, infrastructural, and security challenges limiting banana export in Afgoi District.
3. To assess the potential role of digital agricultural technologies in improving banana production and export performance.

Research Questions

1. What are the major agronomic constraints affecting banana production in Afgoi District?
2. What environmental, infrastructural, and security challenges limit banana export in Afgoi District?
3. To what extent can digital agricultural technologies improve banana production and export performance in Afgoi District?

Hypotheses

H_1: Agronomic constraints (improper pesticide use, inadequate fertilization, poor plant spacing, lack of improved varieties, and limited mechanization) significantly hinder banana production in Afgoi District.

H_2: Environmental, infrastructural, and security challenges (poor roads, flooding, drought, insecurity, and checkpoints) significantly limit banana export performance.

H_3: Digital agricultural technologies (mobile information services, weather forecasting, digital market platforms, and advisory services) have the potential to improve banana production and export outcomes in Afgoi District.

2. LITERATURE REVIEW

Agronomic Constraints in Banana Production

Agronomic constraints are among the most significant determinants of banana yield variability in developing countries (Nofal & Rezk, 2021). Improper use of pesticides and fertilizers can cause direct crop damage or fail to address pest and nutrient deficiencies, respectively (Barraza et al., 2011; Bukomeko et al., 2023). Khalequzzaman et al. (2009) and Daniells et al. (2024) demonstrate that sub-optimal plant spacing reduces light interception and air circulation, increasing disease incidence and lowering bunch weights. Similarly, limited access to improved high-yielding varieties and the near absence of mechanization perpetuate low-productivity farming systems (Atuhaire, 2024; Feleke et al., 2025; Nikam et al., 2025).

Infrastructure and Market Challenges

Poor road infrastructure is consistently identified as a binding constraint on agricultural market integration in Sub-Saharan Africa (World Bank, 2019; Jouanjean, 2013; Mtombeni et al., 2019). In Somalia, inadequate rural roads increase transportation costs and post-harvest losses, reducing the quality and price competitiveness of exported bananas (Abdullahi, 2025; Ali & Ahmed, 2024; Ibrahim et al., 2025). Security checkpoints and political instability introduce additional transaction costs and supply disruptions that further erode market efficiency (Ayenew, 2023).

Climate Change Impacts

Climate variability particularly recurrent flooding and drought poses an escalating threat to banana production in East Africa (Nega, 2025; Habib-ur-Rahman et al., 2022; Yuan et al., 2024). Studies by UNDP (2021) indicate that Somalia's agricultural output has been progressively undermined by climate-related shocks, calling for adoption of climate-resilient varieties and adaptive management practices. Omokpariola et al. (2025) and Liu et al. (2024) further document the compounding effects of drought on food security across Sub-Saharan Africa.

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Digital Agriculture in Developing Countries

Digital agricultural technologies have demonstrated transformative potential in improving productivity and market access in developing-country contexts (Abiri et al., 2023; Ashoka et al., 2023; Bocean, 2024). Aker (2011) found that mobile information services reduced price dispersion and improved market outcomes for smallholders across West Africa. FAO (2019) highlights that digital weather forecasting tools improve input scheduling and reduce weather-related crop losses. More recently, Paul Jr et al. (2024) documented that digital platforms in the Central and West Asia and North Africa (CWANA) region enhanced market access and climate adaptation simultaneously. However, adoption constraints including low digital literacy, poor connectivity, and high device costs continue to limit the reach of such tools in fragile states (World Bank, 2021; Stupina et al., 2021).

3. MATERIALS AND METHODS

Research Design

This study employed a descriptive quantitative research design to examine the production and export challenges faced by banana farmers in Afgoi District and to evaluate the role of digital agricultural solutions in addressing these challenges. A quantitative approach was selected because it allows systematic measurement and comparison of perceived constraints and opportunities across a representative sample, enabling generalizable findings (Tejada & Punzalan, 2012).

Study Area

The study was conducted in Afgoi District, located in the Lower Shabelle region of southern Somalia. Afgoi is one of Somalia's most agriculturally productive districts, benefiting from alluvial soils and year-round irrigation from the Shabelle River. Banana farming is the dominant commercial activity in the district, supporting thousands of farmers, laborers, traders, and agribusiness operators (Weli, 2021; FAO, 2020).

Study Population and Sampling

The study population consisted of 100 participants directly engaged in banana production and marketing in Afgoi District, comprising 60 large-scale farmers, 30 small-scale farmers, and 10 agricultural consultants. The sampling frame was constructed from lists of registered banana producers and agribusiness operators obtained from local agricultural extension offices and farmer cooperatives.

A stratified proportionate random sampling technique was applied to ensure adequate representation of each respondent category. Using Slovin's formula ($n = N / [1 + N(e)^2]$) with a 0.05 margin of error, the sample size was calculated as: $n = 100 / [1 + 100(0.05)^2] = 80$. Proportionate allocation yielded 48 large-scale farmers (60%), 24 small-scale farmers (30%), and 8 consultants (10%).

Data Collection Instrument

Data were collected through a structured questionnaire adapted from Tejada and Punzalan (2012). The questionnaire comprised four thematic sections: (1) respondent demographic characteristics; (2) agronomic constraints; (3) environmental, infrastructural, and security challenges; and (4) perceptions of digital agricultural technologies. Survey items in sections (2)–(4) were rated on a five-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree (Oso & Onen, 2008).

Content validity was established through expert review by three agricultural researchers and one digital technology specialist familiar with the Somali context. Minor wording revisions were incorporated prior to final data collection. The questionnaire was administered in person by trained research assistants to ensure response completeness.

Data Analysis

Quantitative data were analyzed using descriptive statistics, including frequency distributions, percentages, means, and standard deviations. Mean scores were computed for each Likert-scale item and ranked to identify the most critical constraints and opportunities. Mean score interpretation followed a five-point scale: 1.00–1.80 = very low; 1.81–2.60 = low; 2.61–3.40 = moderate; 3.41–4.20 = high; 4.21–5.00 = very high. All analyses were conducted using Microsoft Excel.

4. RESULTS

Demographic Characteristics of Respondents

Table 1 shows that most respondents were male (72.50%), consistent with the predominantly male-dominated nature of commercial agriculture in the region. The largest age group was 26–31 years (36.25%), indicating that the banana farming workforce is relatively young. Slightly more than half of respondents (53.75%) were married, and most had attained at least secondary education (41.25%), suggesting a reasonably literate sample capable of engaging with digital technologies.

Table 1: Demographic Characteristics of Respondents (n = 80)

Category / Response	Frequency	Percent (%)
Gender		
Male	58	72.50
Female	22	27.50
Total	80	100.00
Age Group		
20–25 years	16	20.00
26–31 years	29	36.25
32–37 years	12	15.00
38–43 years	13	16.25
44+ years	10	12.50
Total	80	100.00
Marital Status		
Single	36	46.25
Married	44	53.75
Total	80	100.00
Education Level		
Primary	21	26.25
Secondary	33	41.25
University	26	32.50
Total	80	100.00

Table 2 indicates that large-scale farmers constituted the largest respondent group (60%), followed by small-scale farmers (30%) and consultants (10%), consistent with the study's sampling framework. Almost half of respondents (46.25%) had 2–5 years of experience, while 26.25% had ten or more years, providing a cross-section of practitioner perspectives.

Table 2: Respondent Category and Work Experience (n = 80)

Category / Response	Frequency	Percent (%)
Respondent Category		
Large-scale Farmer	48	60.00
Small-scale Farmer	24	30.00
Consultant	8	10.00
Total	80	100.00
Work Experience		
Less than 1 year	4	5.00
2–5 years	37	46.25
6–9 years	18	22.50
10+ years	21	26.25
Total	80	100.00

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Agronomic Constraints

Table 3 reveals that all five agronomic constraints were rated at high to very high mean levels. Limited mechanization was ranked first (M = 4.30), followed by lack of improved banana varieties (M = 4.31). Improper fertilizer use (M = 4.26) and improper pesticide application (M = 3.97) also received high ratings, indicating widespread input management deficiencies. Poor plant spacing (M = 3.89) was rated the least critical among agronomic constraints, though still reflecting a substantial challenge. Collectively, these findings suggest systemic agronomic knowledge and resource gaps among banana farmers in Afgoi District.

Table 3: Mean Scores and Ranking of Agronomic Constraints (n = 80)

Variable	SA n(%)	A n(%)	N n(%)	D n(%)	SD n(%)	Mean	Rank
Improper pesticide application	29(36.25)	38(47.50)	0(0.00)	8(10.00)	5(6.25)	3.98	4
Improper fertilizer use	39(48.75)	33(41.25)	0(0.00)	6(7.50)	2(2.50)	4.26	3
Poor plant spacing	23(28.75)	43(53.75)	0(0.00)	10(12.50)	4(5.00)	3.89	5
Lack of improved varieties	41(51.25)	33(41.25)	0(0.00)	4(5.00)	2(2.50)	4.34	2
Limited mechanization	46(57.50)	25(31.25)	0(0.00)	5(6.25)	4(5.00)	4.30	1

SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree; | n = frequency | () = (%)

Environmental and Infrastructural Challenges

Table 4 shows that poor road infrastructure (M = 4.46) and security checkpoints (M = 4.44) were the most highly rated challenges, both falling within the 'very high' range. Insecurity and political instability (M = 4.40) and security threats during transportation (M = 4.35) were also perceived as major constraints, reflecting the volatile security environment in the region. Climate-related challenges—flooding (M = 4.30) and drought (M = 4.29)—were ranked fourth and fifth, respectively, consistent with evidence of increasing climate variability in the Lower Shabelle region (UNDP, 2021; Yuan et al., 2024). Rainy season market delays (M = 4.32) further compound post-harvest losses, particularly when combined with poor road conditions.

Table 4: Mean Scores and Ranking of Environmental and Infrastructural Challenges (n = 80)

Variable	SA n(%)	A n(%)	N n(%)	D n(%)	SD n(%)	Mean	Rank
Security checkpoints affect banana quality	46(57.50)	29(36.25)	0(0.00)	4(5.00)	1(1.25)	4.44	1
Rainy season market delays	43(53.75)	30(37.50)	0(0.00)	5(6.25)	2(2.50)	4.34	3
Poor road infrastructure	47(58.75)	28(35.00)	0(0.00)	4(5.00)	1(1.25)	4.45	1
Insecurity and political instability	46(57.50)	28(35.00)	0(0.00)	4(5.00)	2(2.50)	4.40	2
Security threats during transportation	43(53.75)	31(38.75)	0(0.00)	4(5.00)	2(2.50)	4.36	3
Flooding damages banana farms	42(52.50)	30(37.50)	0(0.00)	6(7.50)	2(2.50)	4.30	4
Drought reduces banana production	40(50.00)	33(41.25)	0(0.00)	5(6.25)	2(2.50)	4.30	5

SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree; | n = frequency | () = (%)

Role of Digital Agricultural Solutions

Table 5 indicates that digital technologies are broadly perceived as beneficial, with mean scores ranging from 3.88 to 4.05. Digital weather information to aid farming planning was ranked highest (M = 4.05), followed by digital technologies for enhancing banana export opportunities (M = 4.00). Mobile agricultural information (M = 3.96), digital market platforms (M = 3.93), and digital advisory services (M = 3.88) were also rated positively. However, the relatively higher disagreement rates (approximately 20–21%) for all digital technology items suggest that access and adoption barriers remain significant. This is consistent with the fragile-state context of Somalia, where infrastructure, connectivity, and digital literacy constraints limit technology diffusion.

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Table 5: Mean Scores and Ranking of Digital Agricultural Technology Perceptions (n = 80)

Variable	SA n(%)	A n(%)	N n(%)	D n(%)	SD n(%)	Mean	Rank
Mobile agricultural information improves farm decisions	35(43.75)	28(35.00)	0(0.00)	10(12.50)	7(8.75)	3.92	4
Digital weather information aids farming planning	37(46.25)	29(36.25)	0(0.00)	9(11.25)	5(6.25)	4.05	2
Digital market platforms improve banana marketing	34(42.50)	30(37.50)	0(0.00)	11(13.75)	5(6.25)	3.96	3
Digital advisory services improve farm management	36(45.00)	27(33.75)	0(0.00)	12(15.00)	5(6.25)	3.96	3
Digital technologies enhance banana export opportunities	38(47.50)	26(32.50)	0(0.00)	10(12.50)	6(7.50)	4.00	1

SA = Strongly Agree; A = Agree; D = Disagree; SD = Strongly Disagree; | n = frequency | () = (%)

5. DISCUSSION

Agronomic Constraints and Their Implications

The high mean scores for limited mechanization (M = 4.30) and lack of improved varieties (M = 4.31) align with well-documented patterns across Sub-Saharan African banana-producing regions. Suri and Udry (2022) observe that mechanization adoption remains critically low in African smallholder agriculture due to capital constraints, fragmented landholdings, and weak rental markets. Similarly, Feleke et al. (2025) document that the limited distribution of superior banana varieties in East Africa is a principal driver of yield gaps, a finding mirrored by the present study's respondents in Afgoi. The widespread perception of improper fertilizer and pesticide use (M = 4.26 and 3.97, respectively) echoes findings from Barraza et al. (2011) and Bukomeko et al. (2023), who emphasize that inadequate extension guidance leads to suboptimal input application with negative consequences for both yield and environmental sustainability.

Notably, the ranking of mechanization as the foremost agronomic constraint differs from some East African studies where varietal limitations rank first (e.g., Atuhaire, 2024). This may reflect the particularly labor-intensive nature of large-scale banana farming in Afgoi's alluvial plains, where high labor costs and seasonal labor shortages make mechanization especially salient. These findings collectively support Hypothesis H_1, confirming that agronomic constraints significantly impede banana production in Afgoi District.

Environmental, Infrastructural, and Security Challenges

The very high ratings for poor road infrastructure (M = 4.46) and security checkpoints (M = 4.44) underscore findings by Abdullahi (2025) and the World Bank (2019), who identify rural infrastructure deficits as a binding constraint on Somalia's agricultural development. In the banana export context, inadequate roads translate directly into increased transit times, vibration damage, and premature ripening—quality deteriorations that reduce export competitiveness (Jouanjean, 2013; Ali & Ahmed, 2024). The prominence of security checkpoints as a quality-degrading factor is a context-specific finding with limited parallel in the broader African banana literature, reflecting Somalia's unique political economy.

Climate-related challenges, flooding and drought, were also highly rated, consistent with Habib-ur-Rahman et al. (2022) and Nega (2025), who document accelerating climate risks for East African agriculture. The compound effect of climate shocks on already-degraded infrastructure (e.g., roads washed out during floods) creates multiplicative vulnerabilities that are particularly difficult for smallholders to manage (UNDP, 2021). These findings provide robust empirical support for Hypothesis H_2.

Digital Agricultural Technologies: Opportunities and Constraints

The positive perceptions of digital agricultural technologies, particularly weather forecasting (M = 4.05) and export opportunity enhancement (M = 4.00), are broadly consistent with the global evidence base. Aker (2011) demonstrated that mobile information services reduced agricultural price dispersion by up to 10% in Niger's grain markets, while Paul Jr et al. (2024) found that digital platforms in the CWANA region improved both market access and climate adaptation. The present study extends these findings to a fragile-state banana export context, suggesting that the value proposition of digital tools is recognized even among farmers in challenging operating environments.

However, the substantial disagreement rates (20–21%) indicate that technology adoption is constrained by factors beyond awareness. Bocean (2024) and Stupina et al. (2021) note that digital adoption in agriculture requires

complementary investments in connectivity, electricity, device affordability, and digital literacy, preconditions that remain largely absent in rural Afgoi. This creates a risk of a digital divide, wherein better-resourced large-scale farmers disproportionately benefit from digital tools while small-scale farmers are excluded. These results partially support Hypothesis H_3, affirming the perceived potential of digital technologies while highlighting persistent adoption barriers.

Strategic Analysis: SWOT Assessment

To systematically integrate the empirical findings, a SWOT analysis was conducted based on the study's quantitative results and supported by the existing literature. This analytical framework, applied post-analysis to synthesize internal capabilities and external environmental factors, provides a structured basis for policy and investment recommendations (Dyson, 2004).

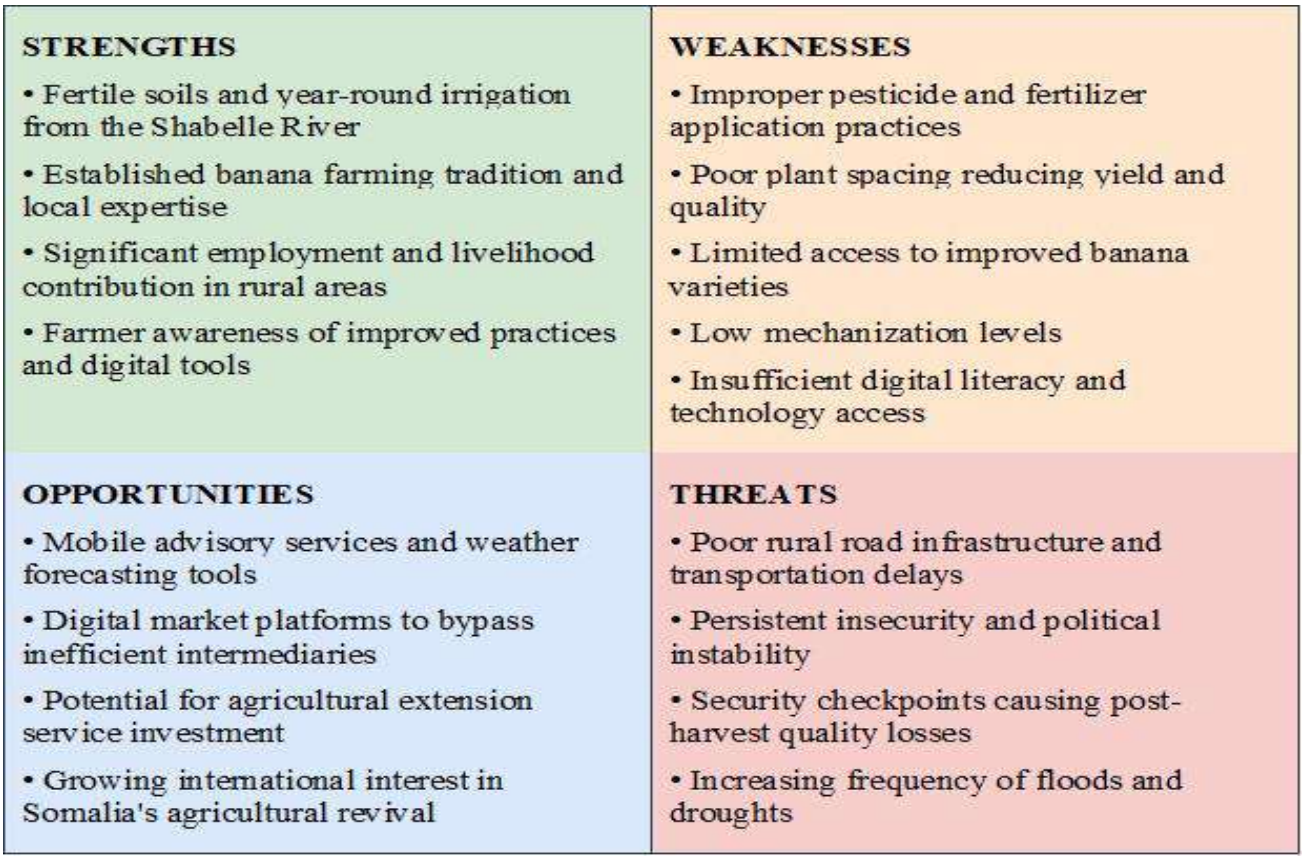

Figure 1: SWOT Analysis of Banana Production and Export in Afgoi District

The SWOT analysis highlights that Afgoi's natural endowments, fertile soils and reliable irrigation, provide a durable competitive foundation for banana production. However, systemic agronomic weaknesses and the district's fragile-state context constitute serious internal and external constraints. Digital agriculture represents the most accessible near-term opportunity for productivity improvement, given the relatively high awareness levels among respondents (Tables 3.3–3.5). Policymakers and development organizations should prioritize interventions that simultaneously address infrastructure deficits, promote input access, and expand digital connectivity to unlock the sector's export potential.

6. CONCLUSION

This study examined the production and export challenges faced by banana farmers in Afgoi District, Somalia, and assessed the potential role of digital agricultural solutions in addressing these constraints. Using descriptive quantitative methods and mean score ranking, the study identified limited mechanization, lack of improved varieties, poor road infrastructure, security checkpoints, and climate shocks as the most critical constraints, while affirming that digital agricultural technologies are broadly perceived as beneficial despite significant adoption barriers.

The findings contribute to the limited empirical literature on agricultural challenges and digital technology adoption in fragile-state contexts, extending theoretical insights from the broader digital agriculture and smallholder development literature to a previously understudied setting. Practically, the study underscores that improving banana production and export in Afgoi District requires a multi-pronged strategy: strengthening agricultural extension services, promoting access to improved inputs and mechanization, investing in rural infrastructure, fostering climate-

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resilient farming practices, and creating enabling conditions for adoption including rural connectivity, device affordability, and digital literacy programs.

Future research should employ inferential statistical techniques such as regression analysis or structural equation modelling to quantify the relative contribution of each constraint category to production and export outcomes. Qualitative follow-up studies using key informant interviews and focus group discussions would further enrich understanding of the contextual mechanisms underlying the quantitative findings reported here.

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