Factors influencing the adoption of digital platforms for accessing agricultural marketing information in Mbarali District, Tanzania

Charles Nchimbi[1*]
Eliaza Mkuna[2]

[1*]nchimbi.charles@yahoo.com

[1]Ministry of Agriculture Training Institute, Mtwara, [2]Department of Economics, Faculty of Social Sciences, Mzumbe University, [1,2]Tanzania

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ABSTRACT

This study examines factors influencing the adoption of digital platforms and their effect on smallholder onion farmers' access to agricultural marketing information in Tanzania's Mbarali District, specifically at the Igomelo Irrigation Scheme. A cross-sectional research design was employed, and data were collected using structured questionnaires administered to a target population of smallholder onion farmers registered at the Igomelo Irrigation Scheme. Simple random sampling was used to select 399 respondents; with the sample size determined using Cochran's formula at a 95% confidence level. The study is grounded in Transaction Cost Theory (TCT), which explains how digital platforms reduce the costs of searching for and accessing agricultural marketing information (AMI), thereby improving farmers' decision-making and market participation. The study applied the Double Hurdle Model to estimate both the determinants and the extent of digital platform adoption. Key findings revealed that smartphone ownership ($p = 0.043$), internet access ($p = 0.025$), and digital training ($p = 0.046$) positively and significantly influenced adoption. Conversely, off-farm income ($p = 0.045$), household size ($p = 0.041$), extension services ($p = 0.016$), and marital status ($p = 0.018$) were negatively associated with adoption. The study concludes that digital platforms hold considerable potential to improve smallholder farmers' access to agricultural marketing information; however, their successful adoption depends critically on adequate digital infrastructure, targeted training programmes, and enabling policy environments. The study recommends investments in rural connectivity, digital literacy education, integration of platforms with formal markets, and the provision of affordable digital tools to maximize the transformative impact on rural agricultural development.

Keywords: Agricultural Marketing Information, Digital Platforms, Digital Tools, Smallholder Farmer, Transaction Cost

I. INTRODUCTION

In recent years agricultural marketing information has undergone substantial transformation in the world, where it has been influenced by the integration of digital technologies and the growing demand for efficient data dissemination(Abate et al., 2023; Fatih Atli, 2024; Solekan et al., 2024). Agricultural marketing information (AMI) refers to the collection, processing, and dissemination of data related to prices, market demand, supply conditions, and trade opportunities that enable farmers, traders, and policymakers to make well-informed production and marketing decisions (Food and Agriculture Organization (FAO), 2021). Access to timely and accurate AMI generates significant benefits for all actors along the agricultural value chain. Marketing information further provides farmers with timely market insight, pricing trends, and consumer preferences for more effective production planning and aligning with the market's needs(Thakur et al., 2023; Villar et al., 2023). The integration of digital solutions into the agricultural information ecosystem has therefore emerged as a critical pathway toward reducing market inefficiencies and improving farmers' livelihoods (Emeana et al., 2020).

Although the effect of market information asymmetry is felt worldwide, developing nations bear a disproportionate share of the burden since most people don't have access to appropriate market information sources (Piabuo et al., 2020). In developing countries where 27% of their people have the internet compared to 65% of the global population, they often rely on old technologies like 2G and 3G networks making it harder to access timely and relevant information (United Nations (UN), 2023). Dissemination of information in Sub-Saharan Africa (SSA) faces a lot of limitations and challenges; one of the big issues is the lack of timely access to proper agricultural information, which results in poor decision-making among farmers (Choruma et al., 2024). This is influenced by poor communication infrastructure, which hinders the dissemination of key market information to remote and rural areas (Aker & Mbiti, 2010). Additional lack of effective collaboration between extension agents and government bodies affects the flow of information to farmers resulting in fragmented and inconsistent information dissemination (Choruma et al., 2024).

Tanzania has witnessed significant improvement in its marketing information system (MIS) through the integration of digital solutions like M Kilimo, Tanzania Mercantile Exchange (TMX), and Agricultural Trade Management System (ATMIS) these digital platforms were designed to enhance agricultural activities by providing farmers with essential information and to trade agricultural commodities (Kitole et al., 2024). However, mobile phones have become essential tools for farmers offering them access to market information, financial services, and weather forecasts (Choruma et al., 2024). Digital transformation has improved the reach of marketing information enabling farmers to make informed decisions about their activities.

Agriculture remains central to Tanzania economy, contributing 26.7% of the Country's Gross Domestic Product (GDP) and employing 65.37% of its working population (United States Agency for International Development (USAID), 2023). The agriculture sector, however, continues to face significant challenges particularly the lack of reliable marketing information for price trends and market demand which in turn affect farmer's profit (Kitole et al., 2024).). Timely and accurate information is essential for farmers to make informed decisions and improve their returns (Walelign & Kassie, 2024). Nevertheless, prevailing conditions of information imperfection leave many farmers struggling to maximize their incomes and sustain their livelihoods (Piabuo et al., 2020). The room created by insufficient access to AMIS has encouraged the increase of intermediaries who exploit their superior knowledge of consumer demand and market dynamics with reliable market information, farmers can decide when, where, and whom to sell their produce, plan their production activities, and produce products per market demand (Magesa et al., 2021; Piabuo et al., 2020). This study therefore intends to examine the factors influencing adoption of digital platforms for accessing agricultural marketing information among onion producers at Igomelo irrigation scheme in Mbarali district Tanzania. By generating evidence-based insights the study aims to inform policymakers and government agencies on the importance of investing in digital infrastructure, expanding farmers training programmes and inspiring the adoption of technology in the agricultural sector

1.1 Research Objective

To examine the factors influencing the adoption of digital platforms for accessing agricultural marketing information among smallholder onion farmers at the Igomelo Irrigation Scheme in Mbarali District, Tanzania.

II. LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Transaction Cost Theory (TCT)

Transaction Cost Theory (TCT) was first developed by Ronald Coase in 1937 and later improved by Oliver Williamson. It explains why companies exist and why certain operations are conducted internally while others are delegated to the market (Nagle et al., 2020). The theory suggests that the cost of completing a transaction through the market may, in some cases, exceed the expense of carrying it out within the company (Yousuf, 2017). Importantly, transaction costs extend beyond the price of goods, they also include the costs of searching for information, negotiating contracts, and enforcing agreements (Barzel, 1985; Shahab & Lades, 2024; Yousuf, 2017). Williamson categorized transaction costs into two main types, ex-ante costs, which occur before a transaction, and ex-post costs, which arise after a transaction has taken place.

TCT has been widely applied by researchers to explain how digital platforms reduce transaction costs and reshape market systems, particularly in the context of agricultural marketing information (AMI). Through the use of mobile applications, farmers can now obtain price information without visiting physical markets or making multiple phone calls (Baumüller et al., 2023; Klerkx et al., 2019; Kos & Kloppenburg, 2019). This reduction in costs especially searches and information expenses provide farmers with more accurate and timely data. As a result, access to marketing information becomes faster, cheaper, and more reliable, enabling farmers to make better-informed decisions. In this study, TCT is used to explain how digital platforms lower transaction costs through accessing (AMI). Specifically, the theory helps to examine how digital platforms reduce ex-ante costs (e.g., searching for market prices) and ex-post costs (e.g., monitoring contracts), leading to improved access to timely and accurate AMI. This improvement in information flow strengthens farmers' decision-making processes and enhances profitability. Thus, study combines number of factors which influence adoption of digital platform for accessing agriculture marketing information.

2.2 Empirical Review

Numerous studies have identified several factors, including gender, extension services, age, cooperative groups, and farming experience, that significantly influence the adoption of digital platforms for accessing agricultural marketing information. Cooperative groups play a crucial role, as they enable members to access digital training, facilitating easier technology adoption compared to individual farmers.

Kitole et al. (2024a) in their study which examined the interplay between digitalization and agriculture transformation in Tanzania. By employing Two-stage Least Squares (2SLS) to estimate determinant and extent of digitalization adoption they found that access to credit, extension service education and government support are the key determinants for agricultural digitalization. Authors emphasized on integration of educational services with digital literacy and encouraging public private partnership to create incentive for sustainable agricultural development

Addison et al. (2024) conducted a study to analyze the drivers and intensity of adoption of digital technologies in agriculture. The study used a multi-stage stratified research design to collect data from 525 across Northern, middle and southern Ghana. The findings indicated that higher education attainment, better perception of digitalization, group/cooperative membership, number of economically active household members, access to reliable electricity, internet and mobile money services significantly influence the use and intensity of digital technologies in agriculture activities. The study advised on the expansion of access to and the uptake of digital technologies in agriculture to reinforce rural development in Ghana. Maina et al. (2024) conducted a study to evaluate the extent of commercialization of potato farming through Digital Agricultural Marketing platforms (DAMPs) with a specific focus to M shamba platform in Kenya. A total number of 375 potato farmers were involved in this study. By employing probit and Tobit model through the conditional mixed approach, the findings revealed that total farm income, price per kilogram of output, access to credit and, size of farm dedicated to potato farming and age of the household head influenced the use of M shamba platform. While the extent of commercialization through M shamba platform was influenced significantly by the total livestock unit, marketing decision maker, having potato farming as a primary enterprise, farm income, access to credit, membership to agricultural group and age of the house head. The study recommended on the importance of farmers to participate in collective digital marketing efforts.

III. METHODOLOGY

3.1 Research Design

This study employed a cross-sectional research design to collect quantitative data from smallholder onion farmers at the Igomelo Irrigation Scheme in Mbarali District. A cross-sectional design was deemed appropriate because it enables data to be collected at a single point in time from a diverse sample, facilitating the analysis of relationships between variables of interest without the need for longitudinal follow-up.

3.2 Study Area

The study was conducted at the Igomelo Irrigation Scheme in Mbarali District, Mbeya Region, Tanzania. Mbarali District is one of Tanzania's leading onion-producing areas, and the Igomelo Irrigation Scheme is a significant hub of smallholder agricultural activity in the region. The scheme was specifically selected because it has benefited from targeted interventions by projects such as Feed the Future Mboga na Matunda and Kibowavi, which have supported productivity improvement, post-harvest loss reduction, and agricultural marketing enhancement. Furthermore, farmers in this scheme have received training on the use of digital platforms, including social media, e-Kilimo, and the Kilimo Fresh web portal, to search for and access agricultural marketing information.

3.3 Target Population

The target population for this study comprised all smallholder onion farmers registered and actively farming at the Igomelo Irrigation Scheme in Mbarali District. These farmers were selected because of their direct engagement with onion production and marketing, as well as their exposure to digital platform training programmes facilitated by development projects operating within the scheme.

3.4 Sampling and Sample Size

Probability sampling was employed in this study, using simple random sampling to select individual smallholder onion farmers from the target population. Simple random sampling was chosen to ensure that every farmer within the scheme had an equal chance of being selected, thereby minimizing selection bias and enhancing the representativeness of the sample. The sample size was calculated using Cochran's formula which is suitable when the total population is not known. This method is designed to achieve a specific level of precision in the study's findings. The formula used to estimate the required sample size is:

$$n = \frac{z^2 p(1-p)}{e^2}$$

Whereby, n=required sample size; Z=Z-score (based on the desired confidence level)
95% confidence level (Z=1.96); Expected proportion (p=0.5); Margin of error (e=0.05)

$$n = \frac{(1.96)^2 \times (0.5)}{(0.05)^2}$$

$$n = 384.16$$

Rounding up, the sample size was set at 399 households. This adjustment was made to ensure statistical reliability and to compensate for potential non-responses or incomplete data. The chosen sample size offers adequate statistical power to identify meaningful associations between digital adoption, agricultural marketing and returns on investment in the target area.

3.5 Data Collection Tools and Procedure

Primary data were collected using structured questionnaires administered to selected smallholder onion farmers. The questionnaire was designed to capture socioeconomic characteristics, household attributes, digital platform usage patterns, and contextual factors influencing adoption decisions. Research assistants fluent in Swahili were trained and deployed to administer the questionnaires through face-to-face interviews, ensuring clarity of questions and reducing misunderstanding among respondents.

3.6 Data Analysis

This study employed double hurdle model to analyze the determinants and extent of digital platforms adoption among smallholder onion farmers, were its viewed as separate hurdles to be crossed that is two-step process. This model is used in this study due to its ability in investigating two decisions of participants in the digital platforms adoption (Kitole et al., 2024). Also, due to its ability to provide reliable and asymptotically efficient estimates for all the parameters (Haile et al., 2022) The model involves two different stages, where each stage addresses a different side of the digital platform, with the first stage measuring determinants of digital platform adoption and the second stage measuring the extent of digital platform adoption.

Stage 1: First hurdle, determinants of digital platform adoption decision

In the first step, we model the binary decision of whether a smallholder onion farmer adopts digital platforms or not. Let's denote the binary outcome as Y_{1i} = 1 if smallholder onion farmer adopts digital platforms and Y_{1i} = 0 if not, given the set of independent variables X_i that influence the adoption decision, Therefore, the probit regression model equation which can be used for this model is in equation 1.

$$Pr(Y_{1i} = 1 \mid X_i) = \emptyset(\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik}) \quad \ldots\ldots 1$$

Where $\emptyset$ is the standard normal cumulative distribution function, β_0 is the intercept of the probit model which represents the estimated impact on the log-odds of the occurring event when all independent variables are equal to zero $\beta_1, \beta_2, \ldots\ldots, \beta_k$ are the coefficient of the independent variables $X_{i1}, X_{i2}, \ldots, X_{ik}$.

Stage 2: Second hurdle- the extent of digital platform adoption among smallholder onion farmers

In the second stage, we look on smallholder onion farmers who adopted digital platforms Y_{1i} = 1 and analyze their proportion of number of using digital platforms per season. And the continuous outcome is denoted as Y_{2i}. Therefore, the linear regression model for hurdle is given by

$$Y_{1i} = \beta_0 + \beta_2 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_2 X_{ik} + \in_{2i} \quad \ldots\ldots 2$$

Whereby β_0 is the intercept of the linear regression model, βs' are the coefficients of the independent variables X_{i1}, X_{i2}, …, X_{ik} and $\in_{2i}$ is the error term.

The log-likelihood function for the double hurdle model that grids Probit model and linear regression model is given as.

$$\boldsymbol{LogL} = \sum \boldsymbol{ln}\left[\mathbf{1} - \emptyset(z_i'\alpha)\left(\frac{\beta X_i'}{\delta}\right)\right] + \sum \boldsymbol{ln}\left[\emptyset(z_i'\alpha)\frac{1}{\delta}\lambda\left(\frac{Y_i - \beta X_i'}{\delta}\right)\right] \quad \ldots\ldots 3$$

Where $\emptyset$ and λ refers to the standard normal probability and density functions, respectively, Z_i and X_i represents independent variables for the probit model and the linear regression model respectively, β, α and δ are the parameters to be estimated in each model.

3.7 Ethical Considerations

Prior to data collection, ethical clearance was obtained from the Regional Administrative Secretary, Mbeya office (Reference No. DA.191/228/71). All respondents were fully informed of the purpose of the study, their right to withdraw at any time, and the confidentiality of their responses. Verbal informed consent was obtained from each participant before commencement of the interview. No personal identifying information was disclosed in the study reports.

IV. FINDINGS & DISCUSSION

4.1 Findings

Table 1 presents the descriptive statistics of continuous variables for smallholder onion farmers in the study area. The average age of respondents is 34.05 years, with a minimum of 18 and a maximum of 49 years while the average years of schooling is 12.30 years. Moreover, the average household size is 3.01 with some household having 1members and others 11. Additionally, the average distance to the nearest market is 1.36 km, while the average landholding is 2.71 hectares. On the other hand, the average onion yields are 83.54 bags per season but with a wide spread from 45 to 138 bags, suggesting significant variation in productivity levels, while average price per bag is 47834.586 Tsh and farming experience ranged from 5 to 20 years with the average of 12.09 years, showing that both novice and veteran farmers were included.

Table 1

Characteristics of Smallholder Onion Farmers' using Digital Platforms

Variable	Observations	Mean	Std. Dev.	Min	Max
Age	399	34.045	8.692	18	49
years schooling	399	12.297	1.908	6.207	17.054
Distance Market	399	1.356	.776	1	5
Proportion to using digital	399	2.253	1.305	0	10
Household size	399	3.01	1.903	0	11
Land size	399	2.712	1.478	1	7
Number Bags	399	83.541	14.041	45	138
Income 1	399	309649.12	134642.64	37000	650000
Price Bags	399	47834.586	5862.127	40000	75000
Experience Farming	399	12.09	2.527	5	20

Table 2 provides an overview of the distribution of key categorical variables relevant to the study. These variables offer insights into the demographic and technological characteristics of the respondents, which are essential for understanding the factors influencing digital adoption and related behaviors. The variables included are marital status, sex, digital adoption, smartphone ownership, off-farm income, landownership, access to electricity, digital training, extension services, digital information, and willingness to pay.

Table 2

Distribution of Categorical Variables for Smallholder Onion Farmers

Variable Name	Categories	Frequency	Percentage
Marital Status	0 (Not Married) 1 (Married)	289 110	72% 28%
Sex	0 (Female) 1 (Male)	282 117	71% 29%
Digital Adoption	0 (No) 1 (Yes)	68 331	17% 83%
Smartphone Ownership	0 (No) 1 (Yes)	147 252	36.8% 63.2%
Off-Farm Income	0 (No) 1 (Yes)	195 204	48.9% 51.1%
Landownership	0 (No) 1 (Yes)	175 224	43.9% 56.1%
Access to Electricity	0 (No) 1 (Yes)	61 338	15.3% 84.7%
Digital Training	0 (No) 1 (Yes)	118 281	29.6% 70.4%
Extension Services	0 (No) 1 (Yes)	111 288	27.8% 72.2%
Digital Information	0 (No) 1 (Yes)	134 265	33.6% 66.4%
Willingness to Pay	0 (No) 1 (Yes)	257 142	64.4% 35.6%

Regarding marital status, 72% of respondents were married, while 28% were unmarried, suggesting that most farming households in the study area operate under family-based organizational structures. The gender distribution shows that 71% of respondents were female and 29% were male, indicating that women play a dominant role in onion farming at the Igomelo Irrigation Scheme. This finding is consistent with broader evidence from smallholder agriculture in sub-Saharan Africa, where women constitute a substantial share of the agricultural labour force.

In terms of digital engagement, 83% of farmers reported adopting at least one digital platform, while the remaining 17% had not adopted any. Smartphone ownership was reported by 63.2% of respondents, although over one-third still lacked this foundational tool for mobile-based digital access. Off-farm income was reported by 51.1% of respondents, while 56.1% reported owning the land they cultivated, providing some degree of tenure security that may facilitate long-term investment decisions, including technology adoption. Electricity access was relatively high, with 84.7% of respondents reporting household electricity connections, which is a facilitating condition for regular digital tool use. A significant proportion (70.4%) of farmers reported having received digital training, underscoring the role of institutional capacity-building efforts in advancing digital literacy. Furthermore, 72.2% of respondents reported having received extension services, broadening their exposure to improved farming and marketing practices. In contrast, only 35.6% expressed willingness to pay for digital applications, which may reflect financial constraints or limited perceived value of such tools.

Table 3 presents the results of the double hurdle model, which analyzes the factors influencing the extent of digital platform usage.

Table 3

Double Hurdle Results

Variable name	**Hurdle I (Determinant)**			**Hurdle I (Determinant)**		
	Coefficient	**Robust std err.**	**P>z**	**Coefficient**	**Robust std err.**	**P>z**
Age	0.004	0.015	0.793	0.016**	0.007	0.045
Marital status	-0.721**	0.304	0.018	0.034	0.159	0.832
Years of schooling	-0.238	0.156	0.127	0.300**	0.136	0.028
Distance Market	-0.183	0.135	0.174	0.07	0.116	0.547
Sex	-0.464	0.312	0.138	0.123	0.192	0.52
Off farm Income	-0.523**	0.204	0.045	-0.578***	0.178	0.001
Smartphone Ownership	0.464**	0.229	0.043	-0.185	0.16	0.247
Household size	-0.218**	0.107	0.041	0.152**	0.069	0.044
Land ownership	0.208	0.389	0.593	-0.166	0.353	0.638
Land size	0.105	0.146	0.472	-0.076	0.146	0.605
Access Electricity	-0.393	0.45	0.383	0.022	0.241	0.928
Digital training	0.446**	0.243	0.046	0.443***	0.168	0.008
Extension services	-0.717**	0.298	0.016	0.339**	0.156	0.03
Internet Access	0.009**	0.004	0.025	-0.005	0.004	0.239
Access Credit	-0.364	0.25	0.146	-0.047	0.147	0.749
Experience Farming	-0.042	0.045	0.345	0.036	0.034	0.29
LNPRICE	-0.032	0.397	0.935	0.018	0.2	0.929
_cons	4.655	3.811	0.222	0.409	2.135	0.848
Number of observations	399	Wald chi2(17)	53.94	Sigma		
Log pseudolikelihood =	-644.733	Prob > chi2	0.000	_cons 1.296	0.175	0.000

**** p<.01, ** p<.05, * p<.10*

Table 3 reveal that age was positively and marginally significantly associated with the extent of digital platform usage in second hurdle. This finding suggests that older farmers are more likely to use digital platforms to access agricultural marketing information. The positive coefficient implies that with age, farmers may have more experience in utilizing digital tools or may have a greater interest in exploring digital platforms as they seek to improve agricultural outcomes. In first hurdle marital status was negatively and significantly associated with digital platform adoption. This indicates that married farmers are less likely to adopt digital platforms compared to unmarried farmers. This may be attributed to more complex household decision-making processes, competing financial responsibilities, or lower individual autonomy in exploring new technologies within marital units. In second hurdle years of schooling was positively and significantly associated with the extent of digital platform usage. This suggests that more educated farmers are likely to use a wider range of digital platforms. Higher education levels improve digital literacy and confidence, making it easier for farmers to explore and use diverse tools.

In both tiers Off-farm income was negatively and significantly associated with digital adoption and intensity. This suggests that farmers engaged in other income-generating activities outside agriculture are less likely to adopt digital platforms, possibly because they are less dependent on farming outcomes and less motivated to integrate new agricultural technologies. In both tiers household size was significantly associated with digital adoption and the extent of usage though in first tier was negatively and significantly associated with digital adoption, implies that farmers from larger households are less likely to adopt digital platforms. While in second tier it was positive, indicating that once adoption occurs, farmers in larger households tend to use more digital platforms. In both tiers access to extension services was significantly associated with digital adoption and extent of usage though, in first tier it was negative associated with digital platform adoption implying that farmers who receive support from extension officers are less likely to adopt digital platforms. And it was positively associated with the extent of platform use This means that although extension services may reduce initial adoption, among those who do adopt, extension support enhances usage

In first hurdle smartphone ownership was positively and marginally significantly associated with digital platform adoption. This finding suggests that farmers who own smartphones are more likely to adopt digital platforms for accessing agricultural marketing information. Access to digital training was positively and significantly associated with digital platform adoption and extent usage in both hurdles. This suggests that farmers who have received training are more likely to adopt and use digital platforms extensively. Training likely increases awareness, skill, and confidence, enabling deeper and more consistent engagement with multiple platforms. Access to the internet was positively and significantly linked to digital adoption in the first hurdle, indicating that farmers with internet connectivity are more likely to adopt digital platforms. Internet access is a necessary condition for engaging with most digital agricultural tools, making it a foundational requirement for inclusion in digital agriculture.

4.2 Discussion

Age was found to be positively and significantly associated with the intensity of digital platform usage in the Second Hurdle. This finding suggests that older farmers in the study area tend to engage more extensively with digital platforms once adoption occurs, potentially because their greater farming experience gives them a more acute awareness of the value of market information. This result is consistent with Awuor and Rambim (2022), who observed that older farmers in Kenya showed greater inclination toward agricultural technology adoption, and with findings by Maina et al. (2024) and Gizachew et al. (2024), who demonstrated that age combined with experience enhances digital engagement when platforms offer clear financial benefits. Nonetheless, this result contrasts with studies by Wossen et al. (2017) and Cimino et al. (2024), who reported that younger farmers were more likely to adopt digital tools owing to their superior technological adaptability and higher smartphone familiarity. Mwangi and Kariuki (2015) similarly noted that younger farmers exhibit more favorable attitudes toward innovation and a higher tolerance for digital risk. The divergence may reflect the specific context of Igomelo, where older farmers may have accumulated greater social capital and economic motivation to use information-intensive platforms.

Years of formal schooling had a strong and positive effect on the intensity of digital platform usage. This finding aligns with Gizachew et al. (2024) and Maina et al. (2023), who confirmed that education significantly enhances individuals' capacity to navigate, interpret, and utilize information obtained through digital agricultural platforms. Cimino et al. (2024) further demonstrated that education strengthens effort expectancy and performance perception, both of which increase usage intention and sustained engagement. Higher educational attainment therefore reduces perceived complexity and improves the cognitive capacity of farmers to extract value from digital tools. Marital status was negatively and significantly associated with digital platform adoption in the First Hurdle. Married farmers were less likely to adopt digital platforms compared to their unmarried counterparts. This outcome may be attributed to the more complex household decision-making processes, competing financial responsibilities, and potentially lower individual autonomy in exploring new technologies that characterize married farming units in the study area. This finding echo results from Mhlanga (2023), who reported that married farmers in Nigeria tended to deprioritize digital tools when faced with competing household financial demands.

Household size had a negative and significant effect on the probability of digital platform adoption in the First Hurdle, suggesting that farmers from larger households are less likely to initially adopt digital platforms. This result is consistent with Maina et al. (2023), who found that larger households often prioritized essential expenditures over investment in digital tools, and with Mhlanga (2023), who attributed reduced digital adoption in large households to economic strain and elevated dependency ratios. In contrast, household size had a positive and significant effect on the extent of digital platform usage in the Second Hurdle. Once adoption occurs, larger households may benefit from a broader pool of labour and diverse skill sets, enabling more regular and sustained engagement with digital platforms. This finding aligns with Abdulai et al. (2023), who observed that larger families in Ghana contributed to consistent digital participation by delegating information and communication technology (ICT) tasks to more technologically proficient household members.

Smartphone ownership was a significant positive predictor of digital platform adoption in the First Hurdle. Farmers who owned smartphones had direct access to mobile applications, SMS-based services, and internet

platforms, enabling real-time market participation and informed decision-making. This finding is consistent with Gizachew et al. (2024) and Wossen et al. (2017), who established that smartphone access increases both the intention and the capacity to adopt digital agriculture services. Zulu et al. (2024) similarly emphasized that smartphone and ICT access is a prerequisite for meaningful engagement with digital agricultural innovations. Internet access significantly increased the likelihood of digital platform adoption. Farmers with internet connectivity demonstrated a greater propensity to adopt digital platforms, as connectivity enables access to diverse content, real-time price information, market comparisons, buyer communication, and timely agricultural updates. This finding corroborates the conclusions of Addison et al. (2024) and Abdulai et al. (2023), who confirmed that internet access is positively and robustly associated with digital adoption in agricultural settings. Maina et al. (2024) similarly identified internet connectivity as a central enabler for the use of platforms such as M-Shamba.

Digital training had a statistically significant and positive effect on both the probability of adoption and the intensity of platform use, indicating that training enhances farmers' awareness of digital tools, reduces technophobia, and builds the confidence necessary for sustained engagement. This is consistent with Gizachew et al. (2024) and Maina et al. (2023), who emphasized that targeted training demystifies digital tools and fosters a sense of agency among smallholder farmers. Aker (2011) similarly found that trained agricultural professionals demonstrated higher ICT adoption rates due to increased perceived usefulness and reduced complexity. Krell et al. (2021) further underscored the importance of tailoring training programmes to the demographic, social, economic, and institutional characteristics of smallholder beneficiaries to maximize uptake and impact.

Off-farm income had a negative and significant effect on both digital platform adoption and the intensity of usage. Farmers who derived income from non-agricultural activities were less reliant on farming outcomes and consequently less motivated to invest time and resources in agricultural digital technologies. This finding is consistent with Mhlanga (2023), who observed that off-farm earners are more selective in their agricultural investments, and with Maina et al. (2024), who reported that farmers with diversified income streams tend to treat farming as a secondary occupation and exhibit lower engagement with digital marketing platforms.

Extension services demonstrated a negative and significant effect on digital platform adoption in the First Hurdle, indicating that farmers who receive regular support from extension officers are paradoxically less likely to initially adopt digital tools. This observation is supported by Mhlanga (2023), who found that reliance on conventional agricultural support systems reduced ICT adoption in Nigeria, and by Takahashi et al. (2019), who reported that trust in traditional extension channels delayed the uptake of digital market solutions in Ethiopian farming communities. The likely explanation is that extension services partially fulfil the information needs of farmers, thereby reducing their perceived urgency to seek out digital alternatives. However, in the Second Hurdle, extension services had a positive and significant effect on the intensity of digital platform usage among adopters. This suggests that once a farmer crosses the adoption threshold, extension officers act as complementary facilitators, providing follow-up support, digital troubleshooting, and encouragement for more regular platform use. Maina et al. (2024) confirmed that extension contact increases digital literacy and promotes more consistent use of agricultural platforms, while Aker (2011) noted that extension agents often serve as intermediaries who simplify digital tools and build user confidence

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study examined the factors influencing the adoption of digital platforms for accessing agricultural marketing information among smallholder onion farmers at the Igomelo Irrigation Scheme in Mbarali District, Tanzania. The Double Hurdle Model results reveal that smartphone ownership, internet access, and digital training significantly and positively influenced the likelihood of digital platform adoption. Conversely, off-farm income, household size, marital status, and extension services were negatively associated with initial adoption. With respect to the extent of usage among adopters, age, years of schooling, household size, digital training, and extension services were positively associated with more intensive platform engagement, while off-farm income continued to exert a negative influence.

The evidence demonstrates that digital platforms hold considerable transformative potential for smallholder agriculture in Tanzania. By facilitating real-time access to pricing trends, market demand signals, and buyer networks, these platforms can substantially reduce transaction costs, as theorized under the Transaction Cost Theory framework, and strengthen farmers' market position. However, their full potential is contingent on the presence of an enabling ecosystem that addresses connectivity gaps, digital literacy deficits, affordability constraints, and institutional alignment.

5.2 Recommendations

On the basis of these findings, the following policy recommendations are proposed. First, the government and development partners should prioritize investment in rural digital infrastructure, including the expansion of reliable

mobile and internet networks in underserved farming communities such as Igomelo. Public-private partnerships with telecommunications providers should be encouraged to build network towers, extend 4G coverage, and reduce the cost of mobile data in remote agricultural zones. Second, targeted digital training programmes should be designed and scaled to cover a wider proportion of smallholder farmers, with particular attention paid to tailoring content to the educational levels, cultural contexts, and specific information needs of women farmers and older respondents. Third, to enhance the market utility of digital platforms, investments should be made in complementary systems, including digital logistics coordination, cold chain infrastructure, and mobile payment services, to convert information access into tangible market power. Fourth, farmer cooperatives should be leveraged as institutional intermediaries to aggregate smallholder demand, facilitate collective digital access, and negotiate better prices with buyers.

Fifth, extension services should be reoriented to incorporate digital literacy components into their advisory mandate, positioning extension officers as facilitators of both digital adoption and sustained usage, particularly in communities where traditional extension channels remain dominant. Bridging the digital divide in rural Tanzania will require coordinated, multi-stakeholder action that simultaneously addresses access, affordability, capacity, and policy coherence. The findings of this study provide an empirical foundation for such action, and future research should explore the long-term income and welfare effects of digital platform adoption among smallholder farmers across diverse agro-ecological and socioeconomic contexts.

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