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Effect of digital platforms on Return on Investment [1]

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Abstract: This study investigates the effect of digital platform usage on Return on Investment (ROI) among smallholder onion farmers at the Igomelo Irrigation Scheme in Tanzania. Using a cross-sectional survey of 399 farmers, the Two-Stage Least Squares (2SLS) model was applied to account for endogeneity between digital adoption and ROI. Results reveal that digital platforms such as WhatsApp, Facebook, Instagram, E-Kilimo, and Fresh Kilimo significantly enhance ROI by improving market access, reducing transaction costs, and increasing marketing efficiency. Instagram and Facebook demonstrated the strongest positive effects, highlighting their role in connecting farmers to premium buyers and transparent pricing systems. Household size, land ownership, and access to credit and extension services were also positively associated with higher ROI, reflecting the importance of socioeconomic and institutional support. The findings underscore that digital platforms are vital for transforming smallholder agriculture by fostering informed decision-making, lowering marketing inefficiencies, and promoting inclusive growth. Policy efforts should focus on improving digital literacy, connectivity, and financial inclusion to sustain ROI growth.

Keywords: Agricultural marketing Information, Digital platforms, Return on Investment, Transaction Cost, M-Kilimo, Market

Efeito das plataformas digitais no Retorno sobre o Investimento

***Resumo**: Este estudo investiga o efeito da utilização de plataformas digitais no Retorno sobre o Investimento (ROI) entre pequenos produtores de cebola no Esquema de Irrigação de Igomelo, na Tanzânia. Com base numa pesquisa transversal com 399 agricultores, foi aplicado o modelo Two-Stage Least Squares (2SLS) para considerar a endogeneidade entre a adoção digital e o ROI. Os resultados revelam que plataformas digitais como WhatsApp, Facebook, Instagram, E-Kilimo e Fresh Kilimo aumentam significativamente o ROI ao melhorar o acesso ao mercado, reduzir os custos de transação e aumentar a eficiência de marketing. O Instagram e o Facebook mostraram os efeitos positivos mais fortes, destacando o seu papel em ligar os agricultores a compradores premium e sistemas de preços transparentes. O tamanho da família, a posse de terra e o acesso a crédito e serviços de extensão também se associaram positivamente a um ROI mais elevado, reflectindo a importância do apoio socioeconómico e institucional. Os resultados destacam que as plataformas digitais são essenciais para transformar a agricultura de pequenos agricultores, ao promover decisões mais informadas, reduzir ineficiências no marketing e incentivar um crescimento inclusivo. As políticas devem concentrar-se em melhorar a literacia digital, a conectividade e a inclusão financeira para sustentar o crescimento do retorno sobre o investimento.*

***Palavras-chave:** Informação sobre marketing agrícola, Plataformas digitais, Retorno sobre o Investimento, Custo de Transação, M-Kilimo, Mercado*

Efecto de las plataformas digitales en el Retorno sobre la Inversión

***Resumen:** Este estudio investiga el efecto del uso de plataformas digitales en el Retorno sobre la Inversión (ROI) entre pequeños agricultores de cebolla en el Esquema de Riego Igomelo en Tanzania. Utilizando una encuesta transversal de 399 agricultores, se aplicó el modelo de Mínimos Cuadrados en Dos Etapas (2SLS) para tener en cuenta la endogeneidad entre la adopción digital y el ROI. Los resultados revelan que plataformas digitales como WhatsApp, Facebook, Instagram, E-Kilimo y Fresh Kilimo mejoran significativamente el ROI al facilitar el acceso al mercado, reducir los costos de transacción y aumentar la eficiencia del marketing. Instagram y Facebook demostraron los efectos positivos más fuertes, destacando su papel en conectar a los agricultores con compradores de alto nivel y sistemas de precios transparentes. El tamaño del hogar, la propiedad de la tierra y el acceso a crédito y servicios de extensión también se asociaron positivamente con un ROI más alto, reflejando la importancia del apoyo socioeconómico e institucional. Las plataformas digitales son vitales para transformar la agricultura de pequeños productores al fomentar la toma de decisiones informada, reducir las ineficiencias en el marketing y promover un crecimiento inclusivo. Los esfuerzos de política deberían centrarse en mejorar la alfabetización digital, la conectividad y la inclusión financiera para sostener el crecimiento del ROI.*

***Palabras clave:** Información de marketing agrícola, Plataformas digitales, Retorno de la inversión, Costo de transacción, M-Kilimo, Mercado.*

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Introduction

In recent years, agricultural marketing information (AMI) has undergone substantial transformation globally, 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). The use of digital platforms has enhanced access to market data, pricing trends, and consumer preferences, allowing farmers to plan production more effectively and align with market demands (Thakur et al., 2023; Villar et al., 2023). Access to reliable marketing information has strengthened economic sustainability by helping farmers understand supply chain dynamics such as transportation and sales strategies, which are crucial for maintaining product quality and maximizing profit (Addison et al. 2024). However, despite global progress in digitalization, developing countries still face limited access to modern digital infrastructure, which affects the availability of timely and relevant market information (Uy et al. (2024).

In Sub-Saharan Africa (SSA), the dissemination and utilization of agricultural marketing information face major challenges, including poor communication networks, limited access to digital platforms, and weak collaboration between government agencies and extension services (Mapiye et al., 2023; Tollens, 2006). These challenges result in delayed access to agricultural information, leading to poor decision-making and low productivity. Yet, access to digital platforms and timely marketing information has the potential to reduce risks associated with market volatility and increase farmers' income (FAO, 2002; Magesa et al., 2020).With effective digital systems, farmers can improve efficiency, allocate resources better, and increase competitiveness for both domestic and international markets (Magesa et al., 2021). In developed countries, the adoption of digital marketing has become central to improving ROI, showing how the integration of digital platforms with traditional marketing systems can enhance profitability (Nwangwu et al. 2024)

Tanzania has made significant progress in integrating digital solutions into its marketing information systems (MIS), improving data collection, dissemination, and decision-making among farmers (Jadhav & Collins, 2023). Mobile phones now serve as vital tools, providing farmers with access to market information, financial services, and weather forecasts (Mapiye et al., 2023). Government initiatives such as Kilimo Kwanza, Big Results Now (BRN), and partnerships through SAGCOT have aimed to strengthen infrastructure, access to credit, and technology adoption, all of which are essential for enhancing farmers' ROI (Kiarie, 2020; Gizachew et al. 2024). Despite these developments, most smallholder farmers continue to rely on low-input technologies and face limited access to digital tools, resulting in low productivity and profitability (Abioye et al. 2024); Abioye et al. 2024). Although agriculture contributes 26.7% of Tanzania's GDP and employs over 65% of its population (Maina et al. 2024)the lack of digital awareness and overreliance on middlemen continue to limit farmers' returns (Magesa et al., 2021)

Although digital platforms such as M-Kilimo, Tanzania Mercantile Exchange (TMX), and Agricultural Trade Management Information System (ATMIS) were developed to improve access to marketing information, their usage among smallholder farmers remains low due to inadequate digital literacy, poor infrastructure, and limited awareness (Kitole et al., 2024). Several studies have examined agricultural marketing information, ICT, and digital adoption (M. Magesa, 2021; Tollens, 2006; Walelign & Kassie, 2024), yet few have linked digital platform directly to Return on Investment (ROI) in agriculture. This gap limits understanding of how digital platforms contribute to improved marketing decisions and profitability among smallholder farmers. Therefore, this study analyzes the effect of digital platform on ROI among onion farmers at the Igomelo Irrigation Scheme in Mbarali District, to provide insights for policymakers and stakeholders on strengthening digital infrastructure, improving farmers' digital literacy, and promoting the adoption of technology to enhance ROI in Tanzania's agricultural sector

Theoretical framework

This study is grounded on the Transaction Cost Theory (TCT), which was first developed by Ronald Coase in 1937 and later improved by Oliver Williamson. The theory explains why companies exist and why certain operations are conducted internally while others are delegated to the market (Nagle et al., 2020). It 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, 2016; Shahab & Lades, 2024; Yousuf, 2017). Williamson categorized these 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.

The TCT has been widely applied by researchers to explain how digital platforms reduce transaction costs and reshape market. Through the use of mobile applications, farmers can 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 search and information expenses—provides 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 and ultimately achieve a higher Return on Investment (ROI) for their crops.

In this study, TCT is used to explain how digital platforms can lower transaction costs and increase farmers' profitability. 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). This improvement in information flow strengthens farmers' decision-making processes and enhances profitability.

Empirical literature review

Levi et al. (2020) conducted a study in Ethiopia and India to assess the relationship between profit and new two stage auction on states online Agri-platforms. The author used Difference-in-Difference method (DID)and the findings revealed that the implementation of online Agri-platforms has yield a significant 3.6% price increase (corresponding to 55%-94% profit gain) for over 10,000 farmers who traded in treatment market. Findings from this study provide a tangible lesson on how innovative price discovery mechanism could be enabled by online Agri-platforms in resource constrained environment and the success of these depends behavioral factors that affect trades in physical markets.

The increasing influence of digital platforms has attracted significant attention in the context of agricultural transformation. Akinwale et al. (2023) provide an analysis of the substantial impact of digital platforms on improving farmers' profitability and investment outcomes, with notable effects on economic and operational efficiency. The utilization of online agricultural platforms by smallholder farmers has been observed to exhibit a positive relationship with improved financial performance, as evidenced by increased market access, reduced post-harvest losses, and enhanced access to inputs and financing. These outcomes collectively demonstrate that engagement with digital platforms contributes to higher returns on investment by enabling farmers to make informed marketing decisions and allocate resources more effectively.

Ahmad et al. (2024) conducted a qualitative study in Jordan to analyze the ROI of paid advertising campaigns in digital marketing and its effect on business profitability. The findings from study indicated that measuring ROI is complex and is influenced by factors such as add spent, conversion rate and customers life time value, The results keep on highlighting that while initial

costs can be high a data driven approach can lead to significant profitability improvement for business. Findings from this study provides valuable insights for advertising strategies and drive improved financial performance

Moreover, Yogesh, (2023) conducted a study in Tamil Nadu India, to analyze association of IT literacy of farmers and their profitability through online sales of fresh organic fruits and vegetables during COVID 19 pandemic. The study involved 271 farmers who sell their products through online stores. By employing multiple regression model results revealed that farmers' attitude towards organic farming and their IT literacy correlate with profitability of online sales and COVID 19 as moderating factor positively were found to increase the profitability. This study recommended training to farmers to facilitate better engagement I E-commerce hence increasing their income.

Materials and method

This study employed a cross-sectional study design to collect data from smallholder onion farmers at Igomelo Irrigation scheme in Mbarali District. The study used primary data which was collected through a structured questionnaire as its research instrument to collect data as it enables to gather information's which are more relevant about this study topic. Probability sampling was used, to obtain a sample from population specifically simple random sampling method to obtain sample form smallholder onion farmers to be used for data collection. Smallholder onion farmers at the Igomelo Irrigation scheme have been selected because interventions from several projects like feed the future mboga na matunda and Kibowavi that support productivity, reduce post-harvest losses, and improve marketing. Additionally, these farmers have been trained on using digital platforms like social media, e kilimo and kilimo fresh web to search for agriculture marketing information.

Measurement of Key Variables

Each digital platform (WhatsApp, Facebook, Instagram, E-Kilimo, and Fresh Kilimo) was operationalized as a binary variable, coded 1 if the farmer used the platform to access agricultural marketing information and 0 otherwise. These variables therefore capture platform adoption (use versus non-use) rather than the frequency or intensity of use; consequently, the reported coefficients represent the effect of using a given platform on Return on Investment, not the effect of using it more or less often.

Return on Investment (ROI) was computed for each farmer as the ratio of net returns to total investment cost, expressed as a percentage, using the following formula:

ROI = [(Total Revenue − Total Cost of Production) / Total Cost of Production] × 100

Where Total Revenue is the value of onion output (quantity sold multiplied by farm-gate price), and Total Cost of Production includes all variable and fixed costs incurred during the production season (inputs, labor, land preparation, irrigation, and post-harvest handling). The natural logarithm of ROI (LnROI) was used as the dependent variable in the 2SLS regression to normalize its distribution and reduce heteroskedasticity, consistent with the "LNROI" notation reported in Table 3.

Sample Size

The sample size for this research was calculated using Cochran's formula (1977), 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)

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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. The 399 respondents were allocated proportionately across the production blocks of the Igomelo Irrigation Scheme using proportional to size stratified sampling, whereby the number of respondents drawn from each block was proportional to its share of registered onion farmers. Within each block, respondents were then selected using simple random sampling from the scheme's farmer register. This procedure ensured adequate representation of farmers with differing landholding sizes, farming experience, and access to digital infrastructure across the scheme.

Estimated results on effect of digital platforms on Return on Investment

This study employed Two-stage least square (2SLS) model to examine the effect of digital platforms usage on Return on Investment (ROI) among smallholder onion farmers. The study has employed this model due to possible endogenous between digital platform usage and return on investment when estimating the impact of digital platform usage and return on investment. The 2SLS require two progressive steps effectively separating the effect of the endogenous variable on the outcome variable while considering the potential influence of correlated instruments and control variables. Additionally, 2SLS enable the identification of casual relationship between digital platform usage and ROI, accounting for potential endogeneity and enhancing the validity of estimation (Kitole et al., 2024).

In first stage the instrumental variable (distance to market) Z_i is influencing digital platforms adoption. Distance to market is chosen as an IV because it strongly influences digital platform adoption farmers in remote areas are more likely to rely on digital solutions for price information and market access. At the same time, distance to market does not directly affect ROI except through its impact on digital platform usage, satisfying the exogeneity condition (Aker, 2011; Xu et al., 2019).Mathematically, this step can be represented in equation (1)

Digital platform adoption = $\beta_0 + \delta Z_i + \gamma X + \varepsilon_i$…….....1

Where β_0, δ and γ are estimated parameters ε_i is error term, X control variables (i.e. education, age and digital literacy) and Z_i is the instrumental variable

In the second stage digital platform usage is used as explanatory variable in the regression of ROI among smallholder onion farmers. This stage account for the endogeneity of digital platform usage and address the bias introduced by omitted variables. Mathematically, this step can be represented in equation (2)

ROI = $\beta_0 + \delta \widehat{D} + \gamma X + \varepsilon_i$…….....2

Where ROI is return on investment, $\beta_0$and δ are estimated parameters ε_i is error term, X control variables (i.e. education, age and digital literacy) and $\widehat{D}$ represent predicted value of digital platform adoption.

Results

Table 1 presents the socio-economic characteristics of onion farmers, showing that the average respondent is 34 years old (ranging from 18 to 49 years), representing a youthful to mid-

aged group typically more receptive to digital technologies. The mean education level is 12.3 years, indicating that most farmers have attained at least primary or secondary education—an essential factor for information absorption and digital tool use. Average household size is 3 members, with a range of 1 to 11, reflecting differences in labor availability that may influence production intensity. Farmers are relatively close to markets, with an average distance of 1.36 km (ranging from 1 to 5 km), suggesting favorable market access and reduced transaction costs. The mean landholding size is 2.71 hectares (minimum 1, maximum 7), consistent with the smallholder classification. Average onion yield is 83.54 bags per season (ranging from 45 to 138), while income averages TSh 309,649, varying widely between TSh 37,000 and TSh 650,000, alongside a price range of TSh 40,000–75,000 per bag. Farming experience averages 12.09 years, with values from 5 to 20 years, indicating a mix of novice and experienced farmers

Table1: Descriptive characteristics of smallholder farmers

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	399	309649.12	134642.64	37000	650000
Price of Bags	399	47834.586	5862.127	40000	75000
Farming Experience	399	12.09	2.527	5	20

Table 2 Characteristics of smallholder onion farmers' using digital platforms

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

Table 2 summarizes categorical characteristics of onion farmers at the Igomelo Irrigation Scheme, showing that 72% are married and 28% unmarried, indicating predominantly family-based farming systems. Women represent 71% of respondents, underscoring their central role in onion production and potential influence on digital engagement. Overall, 83% of farmers use at least one digital platform, while 63.2% own smartphones, suggesting moderate digital accessibility. About 51.1% earn off-farm income, and 56.1% own their land, reflecting varied economic and tenure conditions. Electricity access is high at 84.7%, and 70.4% have received digital training, with

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72.2% benefiting from extension services. However, only 35.6% expressed willingness to pay for digital applications, signaling possible affordability or trust constraints.

Figure 1 shows the distribution of digital platforms used by onion farmers to access agricultural marketing information. WhatsApp leads with 25.8% of users, attributed to its low data cost, ease of use, and group communication features. Facebook follows at 21.3%, reflecting its growing role in market networking and information sharing. Instagram accounts for 10.5%, mainly among digitally literate farmers leveraging visual marketing. Agricultural-specific platforms like E-Kilimo (13.5%) and Fresh-Kilimo (11.8%) show moderate uptake, likely constrained by limited awareness and usability challenges. However, 17% of farmers do not use any digital platform, indicating a persistent digital divide, likely driven by barriers such as affordability, digital illiteracy, or lack of access to infrastructure.

Figure 1: Digital channel distribution usage

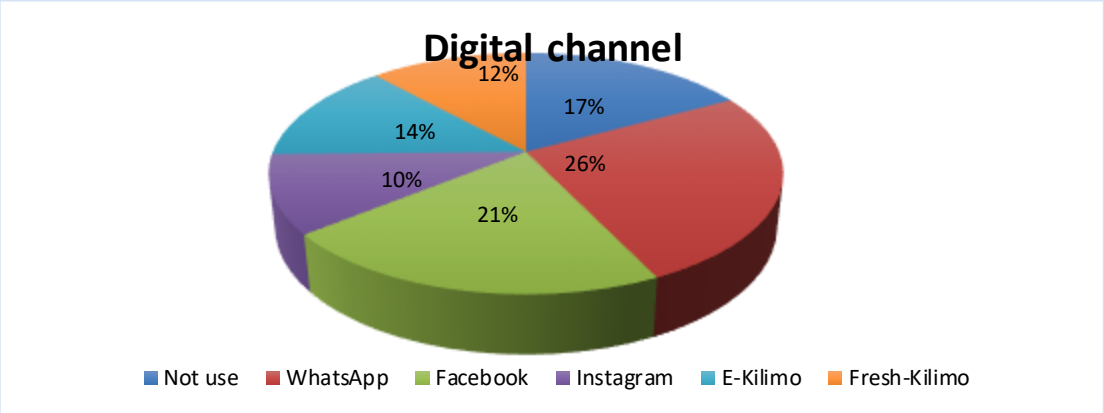

Table 3: Two-stage least square (2SLS) Model results for effects of digital platform usage on Return on investment among smallholder onion farmers

First-stage regressions				Second stage Instrumental variables 2SLS regression			
Digital Adoption	Coefficient	Std. err.	P>t	LNROI	Coefficient	Std. err.	P>z
Distance to Market	-0.118***	0.021	0.000	Digital Adoption	0.292**	0.137	0.033
Age	0.003**	0.002	0.043	Age	-0.002	0.001	0.236
Marital status	-0.204***	0.034	0.000	Marital status	0.052	0.041	0.201
Years of schooling	0.083***	0.018	0.000	Years of schooling	0.010	0.019	0.622
WhatsApp	0.018	0.044	0.677	WhatsApp	0.154***	0.035	0.000
Facebook	0.067	0.045	0.130	Facebook	0.170***	0.037	0.000
Instagram	0.009	0.055	0.862	Instagram	0.239***	0.043	0.000
E-Kilimo	0.042	0.056	0.443	E-Kilimo	0.229***	0.044	0.000
Fresh Kilimo	-0.008	0.064	0.890	Fresh Kilimo	0.188***	0.05	0.000
Sex	-0.244***	0.032	0.000	Sex	0.101**	0.044	0.023
Off farm Income	0.052*	0.029	0.080	Off farm Income	0.008	0.024	0.748
Smartphone Ownership	-0.013	0.028	0.622	Smartphone Ownership	0.013	0.022	0.560
Household size	-0.018	0.013	0.187	Household size	0.049***	0.012	0.000
Land ownership	-0.022	0.038	0.562	Land ownership	0.139***	0.029	0.000
Land size	-0.003	0.02	0.900	Land size	0.161***	0.015	0.000
Access of Electricity	0.014	0.036	0.701	Access of Electricity	-0.003	0.028	0.929
Digital training	0.038	0.029	0.192	Digital training	0.020	0.023	0.386
Extension services	-0.074**	0.033	0.025	Extension services	0.099***	0.024	0.000
Internet Access	0.001	0.001	0.106	Internet Access	0.0002	0.001	0.661
Lnincome	0.001	0.008	0.976	lnincome	-0.004	0.007	0.548
Access Credit	-0.047	0.029	0.107	Access Credit	0.084***	0.023	0.000
LNPRICE	0.113	0.04	0.005	LNPRICE	0.137***	0.034	0.000
Experience in Farming	0.001	0.005	0.916	Experience in Farming	-0.002	0.004	0.633
_cons	-0.238	0.403	0.556	_cons	9.787***	0.319	0.000
Mean dependent	74.643	SD dependent	7.95	Mean dependent	5.371	SD dependent	0.707

var		var		var		var	
R-squared	0.5867	Number of observations	399	R-squared		Number of observations	399
Chi-square	2642.936	Prob > chi2	0.000	Chi-square	14.114	Prob > chi2	0.000

Table 3 presents the second-stage results of the 2SLS regression model, estimating the impact of digital platform usage and other explanatory variables on the return on investment (ROI) for smallholder onion farmers. Digital adoption (platform usage) had a positive and statistically significant effect on ROI at the 5% level (coefficient = 0.292, p = 0.033). This implies that digital platforms improve ROI by reducing transaction costs through direct access to buyers, enhancing market efficiency. This is achieved by providing timely market information that allows farmers to make better pricing and sales decisions, thus maximizing returns.

The use of social media platforms WhatsApp, Facebook, and Instagram are significantly and positively associated with farmers' ROI, with all platforms showing statistical significance at the 1% level. Specifically, Instagram had the strongest impact with a positive coefficient 0.239, p = 0.000), followed by Facebook with a coefficient = 0.170, p = 0.000, and then WhatsApp with a coefficient of 0.154, p = 0.000) respectively. These results suggest that farmers are increasingly leveraging digital tools not just for social engagement but as strategic marketing and communication platforms. The consistent statistical significance across all platforms underscores the transformative potential of social media in improving agricultural marketing efficiency and profitability when appropriately utilization.

On the other hand, the use of E-Kilimo App was positively and significantly associated with ROI (coefficient = 0.229, p = 0.000), suggesting the Apps technical support and information services effectively contribute to farmer profitability. E-Kilimo likely provides weather updates, production advice, and market alerts tailored to local conditions. These services help farmers make well-informed agronomic and economic decisions, thereby minimizing production risks and maximizing revenues. The platform's structured and agricultural-specific content appears to be a valuable digital asset in improving return on investment among its users.

Fresh Kilimo usage was also significantly associated with higher ROI (coefficient = 0.188, p = 0.000). This implies that farmers accessing this platform benefit from enhanced traceability, quality control advice, and demand forecasting. Fresh Kilimo may also facilitate direct linkages with institutional buyers and exporters, allowing farmers to meet specific market requirements and reduce rejection rates.

Sex of the household head was positively associated with ROI at the 5% level (coefficient = 0.101, p = 0.023), indicating that male-headed households tend to achieve higher returns. This may reflect existing structural advantages such as better access to land, finance, extension services, or technology among male farmers. Cultural norms may also afford male-headed households greater decision-making authority, which could influence faster or more risk-tolerant marketing actions.

Farmers with large household size had a positive and statistically significant association with ROI (coefficient = 0.049, p = 0.000), which might initially appear counterintuitive but can be explained through labor dynamics. Larger households often have more family labor available for key farm activities, reducing the need to hire external workers and lowering operational costs.

Land ownership was significantly and positively associated with ROI (coefficient = 0.139, p = 0.000), supporting the notion that secure land tenure encourages long-term investment. Farmers who own their land may be more likely to invest in soil fertility, infrastructure, and digital technologies because they face lower risks of displacement or loss. Ownership also often improves access to credit, which can fund productivity-enhancing investments. This finding reinforces the importance of tenure security as a foundation for digital and financial transformation in smallholder farming.

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Similarly, Land size had a strong positive effect on ROI (coefficient = 0.161, p = 0.000), confirming that larger plots allow farmers to benefit from economies of scale. These farmers can better absorb fixed costs, optimize input usage, and diversify production or marketing channels. Larger landholdings also create opportunities for contract farming or bulk selling, which typically command better pricing. Thus, landholding capacity directly impacts profitability, especially when complemented by digital and institutional support.

Access to extension services was a significant positive predictor of ROI (coefficient = 0.099, p = 0.000), underscoring the role of advisory support in improving farm returns. Extension officers provide both technical and marketing guidance, which helps farmers adjust production plans, avoid mistakes, and take advantage of emerging market opportunities.

Smallholder onion farmers with access to credit had a positive and statistically significant effect (coefficient = 0.084, p = 0.000), indicating that farmers with credit access are more capable of making strategic investments. Credit may be used to purchase high-quality inputs, hire labor, or cover post-harvest costs actions that directly contribute to better yields and market readiness. Moreover, credit supports financial stability, allowing farmers to wait for favorable market conditions rather than selling out of urgency.

Market price (LNPRICE) was strongly associated with ROI, with a coefficient of 0.137 and p-value = 0.000. Farmers who access higher selling prices either due to quality, market timing, or digital connections naturally experience better returns. This reinforces the idea that price realization, influenced by access to information and buyer networks, is central to profitability.

Post Estimation Tests

Durbin-Wu-Hausman endogeneity test

Table 4 presents the diagnostic tests used to examine whether endogeneity exists in the relationship between digital platform usage and return on investment. The results show that the null hypothesis of exogeneity is rejected based on both the Durbin (score) chi-square test and the Wu-Hausman F test. The Durbin test statistic is $\chi^2(1) = 7.34$ with a p-value = 0.0067, while the Wu-Hausman test yields an $F(1,374) = 7.01$ with a p-value = 0.0084. These results are both statistically significant at the 1% level, indicating that digital platform usage is endogenous in the ROI model. Therefore, using ordinary least squares (OLS) would produce biased and inconsistent estimates, justifying the use of instrumental variable techniques, such as the 2SLS regression, to obtain reliable and consistent parameter estimates.

Table 4 Durbin-Wu-Hausman test

H0: Variables are exogenous	
Durbin (score) chi2(1)	7.34463 (p = 0.0067)
Wu-Hausman F (1,374)	7.01354 (p = 0.0084)

First-stage regression test

Table 5 presents the first-stage regression diagnostics of the 2SLS model, assessing the strength of the instrumental variable (distance to market). The instrument demonstrates strong relevance, as indicated by the F-statistic = 32.49, which exceeds the conventional threshold of 10, confirming it is not a weak instrument. The partial R-squared for digital adoption is 0.0797, while the adjusted and overall R-squared values are 0.5614 and 0.5867, respectively. The Minimum Eigen value Statistic is also 32.49, which exceeds critical values at all conventional significance levels (5%, 10%, 20%, and 30%) for both the 2SLS and LIML size tests. These diagnostics collectively validate the strength and appropriateness of the chosen instrument, affirming that the first-stage regression effectively explains variation in the endogenous regressor, thus supporting the reliability of the second-stage estimates for ROI.

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Table 5: First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq. 0.5614	Partial R-sq.	F (1,375)	Prob > F
Digital Adoption	0.5867		0.0797	32.4949	0
Minimum eigenvalue statistic = 32.4949					
Critical Values		# of endogenous regressors:	1		
H0: Instruments are weak		# of excluded instruments:	1		
		5%	10%	20%	30%
2SLS relative bias		(not available)			
		10%	15%	20%	25%
2SLS size of nominal 5% Wald test		16.38	8.96	6.66	5.53
LIML size of nominal 5% Wald test		16.38	8.96	6.66	5.53

Discussion

The study found that digital platform usage significantly increases ROI among smallholder onion farmers, suggesting that digital tools improve market access, reduce post-harvest losses, and minimize dependence on intermediaries—thus lowering transaction costs in marketing and logistics. These results are consistent with (Levi et al. 2020) who observed that online platforms in Ethiopia and India enhanced farm-gate prices by 3.6% and improved profit margins by up to 94%. Similar effects were reported by (Jung & Shegai, 2023) who found that digital marketing innovations expand market reach and efficiency. Ahmad et al. (2024) further demonstrated that data-driven campaigns with measurable metrics improve profitability, while Kaske et al. (2012) cautioned that user-focused design and continuous monitoring are essential for sustaining ROI gains.

Instagram exhibited the strongest positive relationship with ROI, as its visual interface enables farmers to showcase high-quality images that attract premium buyers and reduce information asymmetry, a major component of transaction costs. This finding aligns with (Ahmad et al. 2024), who emphasized that visual marketing enhances conversion and ROI when supported by analytic tools. However, Kanellos et al. (2024) warned that focusing solely on aesthetics without data-driven management can misallocate resources. In Igomelo, digitally literate youth leverage Instagram to engage niche markets such as restaurants and exporters, improving sales efficiency and brand differentiation while cutting negotiation costs.

On the other hand, Facebook also showed a significant positive effect on ROI by facilitating long-term buyer relationships, product updates, and collaborative marketing. Its interactive design supports transparent communication that reduces transaction frictions, aligning with (Rickard, 2021), who found that Facebook fosters trust and loyalty in digital markets. Kaske et al. (2012) noted that unstructured engagement could dilute marketing outcomes, emphasizing strategic use. In Igomelo, Facebook groups allow farmers to pre-negotiate terms and coordinate deliveries asynchronously, minimizing travel and search costs—thus increasing overall marketing efficiency.

similarly, WhatsApp demonstrated a strong positive influence on ROI due to its capacity for real-time coordination of market transactions. Farmers use it to compare prices, arrange transportation, and organize bulk sales, which lowers transaction costs related to information delays and logistics. This corresponds with (Rickard, 2021), who showed that two-way digital communication enhances market responsiveness. Nevertheless, Kanellos et al. (2024) cautioned that unfocused group discussions may reduce returns. In Igomelo, WhatsApp has become a low-cost coordination mechanism that fosters trust, timely feedback, and transparency—critical to sustaining profitable buyer–seller relationships.

The agricultural-specific platform E-Kilimo had a positive and significant association with ROI by offering localized agronomic guidance, pest alerts, and weather forecasts that improve decision-making and planning. These benefits, consistent with (Han & Id, 2023), lower production-

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related transaction costs by reducing uncertainty and improving input efficiency. However, Mendes et al. (2024) warned that outdated or generic information could diminish effectiveness. In Igomelo, E-Kilimo enables farmers to synchronize planting and harvesting with market signals, enhancing yield predictability and profit stability through timely digital advisories.

Fresh Kilimo also contributed positively to ROI through features that facilitate traceability, quality control, and formal buyer linkages. By reducing information and verification costs, it strengthens trust between producers and institutional markets. (Ahmad et al. 2024) noted that structured digital interventions increase ROI when addressing production-to-market inefficiencies, while (Kaske et al. 2012)emphasized the importance of maintaining relevance through system updates. In Igomelo, Fresh Kilimo users meet consistent buyer standards, reduce post-harvest losses, and gain stable incomes from long-term contracts.

Additionally, Household size was positively related to ROI, reflecting that larger families lower labor-related transaction costs by relying on internal labor for harvesting, packaging, and digital engagement. This aligns with (Maina et al. 2024) who reported that family labor efficiency enhances profitability when synchronized with market demands. Nonetheless, (Kaske et al. 2012) argued that poor coordination could negate this advantage. In Igomelo, households with efficient role specialization—such as youth handling social media marketing—achieved faster response times and improved ROI through coordinated digital participation.

Land ownership had a strong positive impact on ROI by encouraging long-term investment, access to credit, and stable engagement with digital markets—all factors that lower contractual and monitoring costs. Maina et al. (2024)found that tenure security motivates farmers to adopt and sustain technology use, while (Cimino et al. 2024) stressed the role of support systems in leveraging ownership benefits. In Igomelo, landowners more confidently registered on Fresh Kilimo and E-Kilimo, aligning production with buyer expectations and reducing negotiation uncertainties.

Moreover, land size also positively influenced ROI through economies of scale that distribute transaction and input costs over larger outputs. This corroborates (Nwangwu et al. 2024), who identified landholding as a key driver of digital commercialization. However, (Levi et al. 2020) noted that smallholders can still benefit collectively through digital cooperatives. In Igomelo, large-scale farmers leveraged digital networks for bulk delivery contracts, achieving higher price efficiency, while digital collaboration remains essential for smaller producers to minimize transaction burdens.

Lastly, extension services and credit access both enhanced ROI by lowering information and financing constraints that often drive transaction inefficiencies. Kiarie, (2020) and Jung & Shegai, (2023) observed that extension support improves digital tool utilization and market timing. Conversely, (Maina et al. 2024) noted that weak digital skills among agents may limit outreach effectiveness. Credit access, as confirmed by (Ahmad et al. 2024), provides liquidity for investing in productivity-enhancing technologies, though (Yogesh, 2023) warned against over-borrowing. In Igomelo, credit-enabled farmers were active on WhatsApp and Fresh Kilimo, coordinating group sales that reduced intermediary costs and maximized returns.

Conclusion

This study reaffirms that digital platforms substantially enhance smallholder farmers' return on investment (ROI) through improved access to market information, extension services, and financial inclusion. Digital adoption reduces transaction costs, minimizes post-harvest losses, and enhances decision-making efficiency. Consequently, farmers who integrate digital tools into production and marketing processes experience higher profitability and resource optimization. These findings are consistent with prior studies that underscore the transformative potential of digitalization in driving agricultural productivity and rural welfare.

The positive association between digital adoption and ROI highlights the crucial role of socio-economic and institutional factors, including education, access to finance, and government support. Digital platforms, when effectively utilized, not only improve cost-efficiency but also strengthen farmers' market position by bridging information asymmetries. Reducing transaction costs enables farmers to negotiate better prices and adopt timely market strategies, reinforcing the economic viability of digital investments in agriculture.

Digital platforms hold immense promise for transforming the agricultural marketing landscape and increasing ROI among smallholder farmers. However, their impact depends on complementary investments in rural connectivity, user-centered design, gender-responsive policies, and financial inclusion. Strengthening digital literacy, reducing data costs, and formalizing digital market systems will be vital to sustain long-term profitability. Bridging the digital divide through coordinated policy and institutional support will ensure that digital agriculture contributes meaningfully to inclusive economic growth and rural transformation in Tanzania and beyond.

References

Abate, G. T., Abay, K. A., Chamberlin, J., Kassim, Y., Spielman, D. J., & Paul Jr Tabe-Ojong, M. (2023). *Digital tools and agricultural market transformation in Africa: Why are they not at scale yet, and what will it take to get there? Food Policy*, 116(March 2022), 102439. https://doi.org/10.1016/j.foodpol.2023.102439

Abioye, D. O., Popoola, O., Akande, A., Fadare, D. A., Omitoyin, S. A., Yinusa, B., & Kolade, O. O. (2024). Farmers' willingness to adopt digital application tools in Ogun State, Nigeria. *Journal of Strategy and Management, 2000002865*. https://doi.org/10.1108/JSMA-06-2023-0135

Addison, M., Bonuedi, I., Arhin, A. A., Wadei, B., Owusu-addo, E., Antoh, E. F., & Mensah-odum, N. (2024). Heliyon Exploring the impact of agricultural digitalization on smallholder farmers' livelihoods in Ghana. *Heliyon*, 10(6), e27541. https://doi.org/10.1016/j.heliyon.2024.e27541

Ahmad, A. B., Frangieh, R. H., Abu-alsondos, I. A., & Nser, K. (2024). *Measuring the ROI of paid advertising campaigns in digital marketing and its effect on business profitability*. January. https://doi.org/10.5267/j.uscm.2023.11.009

Aker, J. C. (2011). Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger. *SSRN Electronic Journal*, 154. https://doi.org/10.2139/ssrn.1093374

Barzel, Y. (2016). Transaction Costs : Are They Just Costs ? Author (s): Yoram Barzel Source : Zeitschrift für die gesamte Staatswissenschaft / Journal of Institutional and Theoretical Economics , Bd . 141 , H . 1 ., *2nd Symposium on The New Institutional Economics Publis*. März 1985, 4–16.

Baumüller, H., Ikpi, U., Jumpah, E. T., Kamau, G., Kergna, A. O., Mose, L., Nientao, A., Omari, R., Phillip, D., & Salasya, B. (2023). Building digital bridges in African value chains: Exploring linkages between ICT use and social capital in agricultural marketing. *Journal of Rural Studies*, 100(April), 103002. https://doi.org/10.1016/j.jrurstud.2023.03.010

Cimino, A., Coniglio, I. M., Corvello, V., Longo, F., Sagawa, J. K., & Solina, V. (2024). Exploring small farmers behavioral intention to adopt digital platforms for sustainable and successful agricultural ecosystems. *Technological Forecasting and Social Change*, 204(May), 123436. https://doi.org/10.1016/j.techfore.2024.123436

FAO. (2002). Chapter 1 Agricultural And Food Marketing.

Fatih Atli, H. (2024). Digital marketing in the agricultural sector and digital transformation in agricultural marketing. *8th International Tokyo COnference on Innovative Studies of Contemporary Sciences*, February, 2–12. https://doi.org/10.13140/RG.2.2.17968.37122

Gizachew, F., Kuma, B., Tafesse, A., & Lambamo, A. (2024). *Digital tools and welfare : adoption determinants among ginger producers in Southern and Central Ethiopia.* November. https://doi.org/10.3389/fsufs.2024.1443775

Han, L., & Id, Z. Z. (2023). *Impact of digital finance on enterprise green innovation : From the perspective of information asymmetry , consumer demand and factor market distortions* (Issue September 2020). https://doi.org/10.1371/journal.pone.0295809

Jadhav, A., & Collins, K. (2023). *Digital Agriculture Ecosystem* (Issue September). https://doi.org/10.1007/978-3-031-67679-6_2

Jung, S., & Shegai, V. (2023). *The Impact of Digital Marketing Innovation on Firm Performance : Mediation by Marketing Capability and Moderation by Firm Size*.

Kanellos, N., Karountzos, P., Giannakopoulos, N. T., Terzi, M. C., & Sakas, D. P. (2024). Digital Marketing Strategies and Profitability in the Agri-Food Industry: Resource Efficiency and Value Chains. *Sustainability* (Switzerland), 16(14). https://doi.org/10.3390/su16145889

Kaske, F., Kügler, M., & Smolnik, S. (2012). Return on investment in social media - Does the hype pay off? Towards an assessment of the profitability of social media in organizations. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3898–3907. https://doi.org/10.1109/HICSS.2012.504

Kiarie, H. (2020). *Determinants of digital technologies adoption among small scale farmers in Kenya - a case of Embu and Kirinyaga Counties*. Strathmore University.

Kitole, F. A., Mkuna, E., & Sesabo, J. K. (2024). Smart Agricultural Technology Digitalization and agricultural transformation in developing countries : Empirical evidence from Tanzania agriculture sector. *Smart Agricultural Technology*, 7(December 2023), 100379. https://doi.org/10.1016/j.atech.2023.100379

Klerkx, L., Jakku, E., & Labarthe, P. (2019). A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. *NJAS - Wageningen Journal of Life Sciences*, 90–91, 100315. https://doi.org/10.1016/j.njas.2019.100315

Kos, D., & Kloppenburg, S. (2019). Digital technologies, hyper-transparency and smallholder farmer inclusion in global value chains. *Current Opinion in Environmental Sustainability*, 41, 56–63. https://doi.org/10.1016/j.cosust.2019.10.011

Levi, R., Rajan, M., Singhvi, S., & Zheng, Y. (2020). Improving Farmers' Income on Online Agri-platforms : Evidence from the Field. *Mondiale 2008*, 1–32.

Magesa, M. (2021). Agricultural market information in developing countries: A literature review. *Agricultural Economics (Czech Republic)*, 67(11), 468–477. https://doi.org/10.17221/129/2021-AGRICECON

Magesa, M. M., Michael, K., & Ko, J. (2020). Access and use of agricultural market information by smallholder farmers : *Measuring informational capabilities*. February, 1–21. https://doi.org/10.1002/isd2.12134

Magesa, M., Michael, K., & Ko, J. (2021). Agricultural market information in developing countries: *A literature review*. *Agricultural Economics (Czech Republic)*, 67(11), 468–477. https://doi.org/10.17221/129/2021-AGRICECON

Maina, F., Mburu, J., & Nyang, H. (2024). *Drivers of extent of commercialization of potato farming through digital marketing platforms in Nakuru County*, Kenya. February.

https://doi.org/10.3389/fsufs.2024.1307978

Mapiye, O., Makombe, G., Molotsi, A., Dzama, K., & Mapiye, C. (2023). Information and communication technologies (ICTs): The potential for enhancing the dissemination of agricultural information and services to smallholder farmers in sub-Saharan Africa. *Information Development*, 39(3), 638–658. https://doi.org/10.1177/02666669211064847

Mendes, J. de J., Carrer, M. J., Vinholis, M. de M. B., & Meirelles de Souza Filho, H. (2024). Adoption and impacts of messaging applications and participation in agricultural information-sharing groups: an empirical analysis with Brazilian farmers. *Journal of Agribusiness in Developing and Emerging Economies*, 14(4), 676–693. https://doi.org/10.1108/JADEE-09-2022-0194

Nagle, F., Seamans, R., & Tadelis, S. (2020). Transaction Cost Economics in the Digital Economy: A Research Agenda. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3661856

Nwangwu, K., Onyenekwe, C., Opata, P., Ume, C., & Ume, N. N. C. (2024). *Can digital technology promote market participation among smallholder farmers ?* 27(4), 706–728. https://doi.org/10.22434/IFAMR2023.0065

Rickard, M. (2021). *Values of social media within online Irish SMEs: Methodological approaches used to understand the return on investment (ROI) of social media* [Master's thesis, National College of Ireland]. NORMA Open Access Repository.

Shahab, S., & Lades, L. K. (2024). Sludge and transaction costs. *Behavioural Public Policy*, 8(2), 327–348. https://doi.org/10.1017/bpp.2021.12

Solekan, M., Soedirman, U. J., Faisal, H. N., Tulungagung, U., & Sriwijaya, P. N. (2024). Sustainability Innovation: *Digital Marketing of*. 2(6), 1624–1638.

Thakur, P., Mehta, P., Devi, C., Sharma, P., Singh, K. K., Yadav, S., Lal, P., Raghav, Y. S., Kapoor, P., & Mishra, P. (2023). Marketing performance and factors influencing farmers choice for agricultural output marketing channels: the case of garden pea (Pisum sativum) in India. *Frontiers in Sustainable Food Systems*, 7. https://doi.org/10.3389/fsufs.2023.1270121

Tollens, E. (2006). *Market Information Systems in sub-Sahara Africa Challenges and Opportunities Eric*. https://ideas.repec.org/p/ags/iaae06/25590.html

Uy, T. C., Limnirankul, B., Kramol, P., Sen, L. T. H., Hung, H. G., Kanjina, S., & Sirisunyaluck, R. (2024). Social Media adoption for agricultural development: Insights from smallholders in central Vietnam. *Information Development*. https://doi.org/10.1177/02666669241261355

Villar, P. F., Kozakiewicz, T., Bachina, V., Young, S., & Shisler, S. (2023). PROTOCOL: The effects of agricultural output market access interventions on agricultural, socio-economic and food and nutrition security outcomes in low- and middle-income countries: *A systematic review*. *Campbell Systematic Reviews*, 19(3). https://doi.org/10.1002/cl2.1348

Walelign, S. Z., & Kassie, W. A. (2024). *The effect of agricultural information provision on smallholders ' technology adoption and yield : experimental evidence from Ethiopia*. August, 1–19. https://doi.org/10.3389/fsufs.2024.1421442

Xu, D., Bian, Y., Rong, J., Wang, J., & Yin, B. (2019). Study on clustering of free-floating bike-sharing parking time series in Beijing subway stations. *Sustainability (Switzerland)*, 11(19), 1–20. https://doi.org/10.3390/su11195439

Yogesh, S. G. (2023). *Farmers ' Profitability through Online Sales of Organic Vegetables and Fruits during the COVID-19 Pandemic — An Empirical* Study.

Yousuf, A. (2017). Transaction Costs: A Conceptual Framework. *International Journal of Engineering and Management Sciences*, 2(3), 131–139. https://doi.org/10.21791/ijems.2017.3.13