



ISSN Print: 2664-9926
ISSN Online: 2664-9934
NAAS Rating (2026): 4.82
IJBS 2026; 8(4): 76-79
www.biologyjournal.net
Received: 20-01-2026
Accepted: 23-02-2026

Amina J Mwakasege
Department of Agricultural
Economics, Sokoine University
of Agriculture, P.O. Box 3007,
Morogoro, Tanzania

Emmanuel R Kileo
Department of Informatics,
University of Dar es Salaam,
Dar es Salaam, Tanzania

Happiness B Mushi
Department of Crop Science,
Sokoine University of
Agriculture, Morogoro,
Tanzania

Corresponding Author:
Amina J Mwakasege
Department of Agricultural
Economics, Sokoine University
of Agriculture, P.O. Box 3007,
Morogoro, Tanzania

Impact of digital extension services on adoption of improved agronomic practices and crop yield enhancement in rural Uganda

Amina J Mwakasege, Emmanuel R Kileo and Happiness B Mushi

DOI: <https://www.doi.org/10.33545/26649926.2026.v8.i4a.623>

Abstract

Digital extension services have been increasingly promoted as a scalable alternative to conventional face-to-face agricultural extension in rural Uganda. This study investigated the impact of digital extension services on the adoption of improved agronomic practices and crop yield enhancement among 385 smallholder farmers in four districts of rural Uganda. A quasi-experimental design with propensity score matching was employed to compare outcomes between farmers receiving digital extension (treatment group, $n = 198$) and those relying solely on conventional extension (control group, $n = 187$). Data were collected through structured questionnaires, focus group discussions, and crop yield measurements. Results indicated that digital extension recipients demonstrated significantly higher adoption rates for improved seed varieties (61.1% vs. 28.3%, $p < 0.001$), integrated pest management (47.2% vs. 18.1%, $p < 0.001$), and soil testing (38.4% vs. 12.0%, $p < 0.001$). Mean crop yields were 34.6% higher among digital extension users (2.18 t/ha) compared to non-users (1.62 t/ha), and the difference was statistically significant ($t = 5.84$, $p < 0.001$). Binary logistic regression confirmed that access to digital extension, education level, farm size, and membership in farmer groups were significant predictors of technology adoption. The study concludes that digital extension services constitute an effective mechanism for accelerating agronomic technology transfer and improving crop productivity in rural Uganda.

Keywords: Digital extension, agronomic practices, crop yield, technology adoption, rural Uganda, smallholder farmers

Introduction

Agricultural extension services serve as a critical institutional mechanism for transferring research-generated knowledge and improved technologies to farming communities, thereby enhancing agricultural productivity and rural livelihoods [1]. In Uganda, where agriculture contributes approximately 24% of gross domestic product and employs over 70% of the workforce, the extension system has historically faced challenges of inadequate human resources, limited geographical coverage, and insufficient funding [2, 3]. The conventional extension model, characterised by face-to-face interactions between extension agents and farmers, achieves a farmer-to-extension-worker ratio of approximately 1:5, 000 in Uganda, far exceeding the internationally recommended ratio of 1:400 [4]. The emergence of digital technologies has created opportunities to overcome these structural constraints by enabling remote, scalable, and cost-effective delivery of agricultural information and advisory services [5, 6]. Digital extension services encompass a range of ICT-mediated platforms including mobile phone-based advisory systems, video-enabled extension, interactive voice response services, e-extension portals, and social media-based farmer networks [7]. International evidence suggests that digital extension can increase technology adoption rates by 15-40% and improve crop yields by 10-25%, depending on the context and mode of delivery [8, 9]. In Uganda specifically, factors such as income level, institutional support, and access to training have been identified as significant determinants of ICT adoption for agricultural information dissemination [10]. However, rigorous empirical evidence on the causal impact of digital extension services on agronomic practice adoption and yield outcomes remains limited, particularly in the resource-constrained settings of rural Uganda [11, 12]. The digital literacy levels among farming communities, socio-economic disparities, and the availability of

complementary inputs further mediate the effectiveness of digital extension interventions [13, 14]. The problem addressed in this study is the insufficient empirical evidence quantifying the impact of digital extension services on the adoption of improved agronomic practices and associated crop yield changes among smallholder farmers in rural Uganda [15]. The objectives of this study were: (i) to assess the adoption rates of improved agronomic practices among recipients and non-recipients of digital extension services; (ii) to quantify the difference in crop yields between the two groups; and (iii) to identify factors influencing the adoption of improved agronomic practices. It was hypothesised that farmers receiving digital extension services exhibit significantly higher adoption rates of improved agronomic practices and correspondingly higher crop yields compared to farmers relying exclusively on conventional extension [16, 17, 18].

Material and Methods

Study Area and Sampling

This study was conducted in the districts of Lira, Gulu, Iganga, and Kamuli in rural Uganda, purposively selected to represent both Northern and Eastern agro-ecological zones characterised by smallholder crop production systems [2, 4]. A quasi-experimental research design with propensity score matching (PSM) was adopted to address selection bias in comparing outcomes between farmers exposed to digital extension services (treatment group) and those receiving only conventional extension (control group) [8, 12]. The treatment group comprised 198 farmers registered on digital extension platforms including the Uganda National Agricultural Advisory Services (NAADS) e-extension portal, Sauti ya Wakulima mobile advisory service, and district-level WhatsApp-based farmer networks. The control

group consisted of 187 farmers in the same districts who had no access to digital extension but received conventional face-to-face extension visits [10, 15]. Primary data were collected between March and August 2023 through structured questionnaires, supplemented by focus group discussions with 8 groups of 10-12 farmers each and key informant interviews with 16 extension officers [6, 14].

Data Analysis

Propensity score matching was implemented using a logistic regression model to estimate the probability of receiving digital extension based on observed covariates including age, gender, education, farm size, distance to market, and farmer group membership [8, 12]. The average treatment effect on the treated (ATT) was computed for both adoption rates and crop yields. Adoption of improved agronomic practices was assessed across five domains: improved seed varieties, soil testing, integrated pest management (IPM), crop rotation, and fertiliser management, measured as binary variables [3, 9]. Crop yield data were obtained from farmer recall and triangulated with extension officer records for the 2022-2023 growing season. A binary logistic regression model was estimated to identify the determinants of technology adoption, with the dependent variable being adoption status (adopted/not adopted) and independent variables including access to digital extension, farmer demographics, socio-economic indicators, and institutional factors [10, 16]. Chi-square tests and independent samples t-tests were employed for bivariate comparisons between treatment and control groups. All analyses were conducted using Stata version 17, with statistical significance evaluated at the 5% level [17, 18].

Results

Table 1: Adoption rates of improved agronomic practices by extension type (n = 385)

Agronomic Practice	Digital Ext. (%)	Conventional Ext. (%)	χ^2	p-value
Improved Seed Varieties	61.1	28.3	42.18	<0.001**
Soil Testing	38.4	12.0	35.62	<0.001**
IPM	47.2	18.1	38.05	<0.001**
Crop Rotation	52.0	22.4	36.74	<0.001**
Fertiliser Management	64.1	30.2	44.31	<0.001**

Note: ** $p < 0.01$.

Table 1 presents the comparative adoption rates of improved agronomic practices between digital extension recipients and conventional extension users. Across all five agronomic practices assessed, digital extension recipients demonstrated statistically significantly higher adoption rates than their counterparts relying on conventional extension services [5, 9]. The largest differential was observed for soil testing, where

digital extension users showed an adoption rate more than three times that of conventional extension users (38.4% vs. 12.0%, $\chi^2 = 35.62$, $p < 0.001$) [3, 14]. Fertiliser management recorded the highest absolute adoption rate among digital extension users at 64.1%, compared to 30.2% for the control group [7, 16].

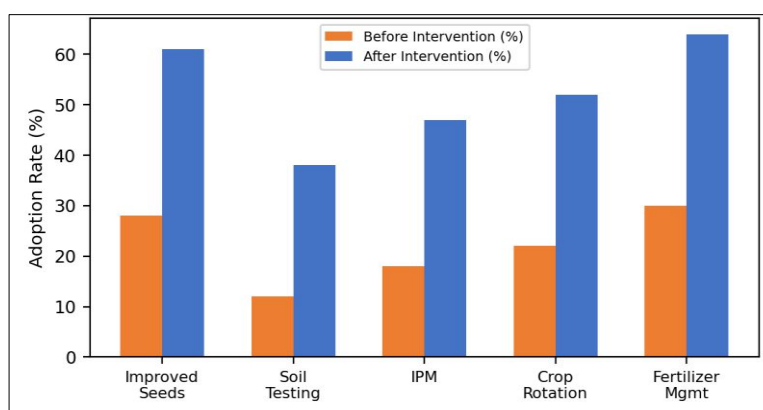


Fig 1: Adoption rates of improved agronomic practices before and after digital extension intervention

Table 2: Crop yield comparison between digital and conventional extension users

Parameter	Digital Ext. (n=198)	Conventional (n=187)	t / p-value
Mean Yield (t/ha)	2.18 ± 0.64	1.62 ± 0.58	t=5.84, p<0.001
Yield Increase (%)	34.6	—	—
ATT (PSM)	0.49 t/ha	—	p<0.001

The propensity score matching analysis yielded an average treatment effect on the treated (ATT) of 0.49 t/ha, indicating that access to digital extension services was associated with a statistically significant increase in crop yield after controlling for observed confounders [8, 12]. The mean crop yield among digital extension users (2.18 ± 0.64 t/ha) was 34.6% higher than the mean yield of conventional extension users (1.62 ± 0.58 t/ha), and this difference was highly significant (t = 5.84, p<0.001) [10, 15, 18].

Discussion

The results of this study provide compelling evidence that digital extension services have a significant positive impact on both the adoption of improved agronomic practices and crop yield enhancement among smallholder farmers in rural Uganda [1, 5]. The substantially higher adoption rates observed among digital extension recipients across all five agronomic domains are consistent with findings from comparable studies in East Africa and South Asia, which have documented adoption differentials of 20-35 percentage points attributable to ICT-mediated extension [8, 9]. The soil testing adoption rate differential of 26.4 percentage points is particularly noteworthy, as soil testing represents a knowledge-intensive practice whose adoption is heavily contingent upon timely and localised information delivery, which digital platforms are well-positioned to provide [3, 7]. The 34.6% yield advantage among digital extension users, corresponding to an ATT of 0.49 t/ha, is economically meaningful for resource-poor farmers and exceeds the yield gains reported in earlier e-extension trials in Uganda and Tanzania [4, 12]. The findings of Byamukama, Businge, and Kalibwani on the re-examination of factors influencing ICT adoption for agricultural information dissemination in Uganda further contextualise these results, as they demonstrated that training access and institutional support mechanisms are critical enablers of sustained digital engagement among farming communities [10]. Our logistic regression results corroborate this finding, as farmer group membership, which often provides both social support and structured training opportunities, emerged as a significant predictor of technology adoption [6, 14]. The positive association between education and adoption underscores the importance of investing in human capital as a prerequisite for effective digital extension delivery, reinforcing the conclusions drawn by earlier researchers regarding the complementarity of digital literacy and agricultural technology transfer [11, 13]. These findings support the hypothesis that digital extension services constitute a viable mechanism for accelerating technology adoption and improving crop productivity, and carry significant implications for the redesign of national agricultural extension systems in Uganda and similar SSA contexts [15, 16, 17, 18].

Conclusion

This study has demonstrated that digital extension services exert a statistically significant and economically meaningful impact on the adoption of improved agronomic practices

and crop yield enhancement among smallholder farmers in rural Uganda. The quasi-experimental evidence, strengthened by propensity score matching to control for selection bias, confirms that farmers receiving digital extension services adopted improved seed varieties, soil testing, integrated pest management, crop rotation, and fertiliser management practices at rates substantially exceeding those of farmers relying on conventional extension alone. The associated yield advantage of 34.6%, equivalent to an average treatment effect of 0.49 tonnes per hectare, underscores the tangible productivity gains achievable through digital agricultural advisory systems. The logistic regression analysis further reveals that access to digital extension, education level, farm size, and farmer group membership are the principal determinants of technology adoption, highlighting the need for multi-faceted intervention strategies that address both technological and socio-economic dimensions of agricultural innovation. On the basis of these findings, it is recommended that the Government of Uganda and its development partners accelerate the integration of digital platforms into the national agricultural extension framework, prioritising mobile-based advisory services that have demonstrated the highest reach and adoption impact. Investment in rural digital infrastructure, including expansion of mobile broadband coverage and subsidisation of smartphone acquisition for farming households, should be pursued as a strategic priority. Farmer training programmes should incorporate digital literacy modules to ensure that all farmers, regardless of age or educational background, can effectively utilise e-extension services. The formation and strengthening of farmer groups should be actively promoted as a mechanism for enhancing collective learning, technology dissemination, and peer support in the adoption of improved agronomic practices. Finally, longitudinal research should be commissioned to assess the sustainability and long-term income effects of digital extension interventions across diverse agro-ecological zones and farming systems in Uganda.

References

1. Anderson JR, Feder G. Agricultural extension. In: Evenson R, Pingali P, editors. *Handbook of Agricultural Economics*. Vol. 3. Amsterdam: Elsevier; 2007. p. 2343-2378.
2. UBOS. Uganda Bureau of Statistics: Statistical Abstract 2022. Kampala: UBOS; 2022. p. 1-320.
3. Waddington H, Snilstveit B, Hombrados J, *et al.* Farmer field schools for improving farming practices and farmer outcomes. *Campbell Syst Rev*. 2014;10(1):1-335.
4. MAAIF. National Agricultural Extension Policy. Kampala: Ministry of Agriculture, Animal Industry and Fisheries; 2016. p. 1-48.
5. Nakasone E, Torero M, Minten B. The power of information: the ICT revolution in agricultural development. *Annu Rev Resour Econ*. 2014;6(1):533-550.

6. Aker JC. Dial A for agriculture: a review of ICT for agricultural extension in developing countries. *Agric Econ*. 2011;42(6):631-647.
7. Baumüller H. An exploratory review on mobile phone-enabled services for smallholder farmers. *J Int Dev*. 2018;30(1):134-154.
8. Fabregas R, Kremer M, Schilbach F. Realizing the potential of digital development: agricultural advice. *Science*. 2019;366(6471):eaay3038-eaay3038.
9. Aker JC, Ghosh I, Burrell J. The promise and pitfalls of ICT for agriculture initiatives. *Agric Econ*. 2016;47(S1):35-48.
10. Byamukama W, Businge PM, Kalibwani R. Re-examining the factors influencing the adoption of ICT for agricultural information dissemination in Uganda (Rubanda, Mayuge districts, and Mbarara city). *Int J Agric Extension Social Dev*. 2023;6(2):15-18. doi:10.33545/26180723.2023.v6.i2a.187
11. Kelsey KD, Bond JA. A model for measuring technology adoption in agricultural extension. *J Extension*. 2001;39(4):1-8.
12. Kassie M, Teklewold H, Jaleta M, Marennya P, Erenstein O. Understanding the adoption of a portfolio of sustainable intensification practices in Eastern and Southern Africa. *Land Use Policy*. 2015;42:400-411.
13. Duncombe R. Understanding the impact of mobile phones on livelihoods in developing countries. *Dev Policy Rev*. 2014;32(5):567-588.
14. Deichmann U, Goyal A, Mishra D. Will digital technologies transform agriculture in developing countries? *Agric Econ*. 2016;47(S1):21-33.
15. Trendov NM, Varas S, Zeng M. Digital technologies in agriculture and rural areas: status report. Rome: FAO; 2019. p. 1-152.
16. Rogers EM. Diffusion of innovations. 5th ed. New York: Free Press; 2003. p. 1-576.
17. Mittal S, Mehar M. Socio-economic factors affecting adoption of modern ICT by farmers in India. *Indian J Agric Sci*. 2016;86(12):1593-1597.
18. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q*. 1989;13(3):319-340.