

Original Research Article

CODEN: PJZSAZ e-ISSN: 1331-7776

Institutional and socioeconomic factors influencing adoption of improved potato varieties in TanzaniaJohn K. Kigwinya^{1,2,*}, Charles Joseph Olambo² Athuman Mahinda³¹Tanzania Agricultural Research Institute (TARI HQ) Dodoma, Tanzania²The Department of Crop Sciences and Beekeeping Technology, University of Dar es Salaam, Dar es Salaam, Tanzania³Department of Agricultural Engineering University of Dar es Salaam, Dar es Salaam, Tanzania*Correspondence: John K. Kigwinya (kigwinyakalaye@gmail.com)**Article info:****Received:** 5 July 2026**Revised:** 1 October 2026**Accepted:** 1 October 2026**Available online:** 1 October 2026**Academic Editor:** Prof. Marina Piria, University of Zagreb Faculty of Agriculture, Croatia**How to Cite:**

Kigwinya J. K., Olambo C. J., Mahinda A. (2026). Institutional and socioeconomic factors influencing adoption of improved potato varieties in Tanzania. Agric Conspec Sci 91: e018.

This article is an accepted manuscript and an uncorrected proof that has not undergone copyediting, language editing, or technical checks. The final version of the record may differ from this version.

ABSTRACT

Despite the registration of 17 improved potato varieties in Tanzania, potato yields remain low (5–10 t ha⁻¹), partly due to limited adoption of improved varieties. This study examined the institutional and socioeconomic factors influencing the adoption of improved potato varieties among smallholder farmers in Mbeya and Rukwa regions. A cross-sectional survey of 240 randomly selected potato farmers was conducted and data were analysed using descriptive statistics and binary logistic regression. Only 12.9% of the surveyed farmers had adopted improved potato varieties. Access to agricultural training, farming experience and access to improved seed were positively and significantly associated with adoption. In contrast, potato price/bag and farmer group membership were negatively associated with adoption. These findings highlight the importance of strengthening farmer training, improving access to affordable certified seed and addressing price constraints to accelerate the uptake of improved varieties and enhance potato productivity in Tanzania.

Keywords: Technology uptake; Potato productivity; Agricultural training; certified seed; seed accessibility.

INTRODUCTION

Potato (*Solanum tuberosum* L.) has increasingly emerged as one of the most strategic food and cash crops in Tanzania because of its contributions to food security, employment, nutrition and household income (Laizer, 2025; Muthoni and Shimelis, 2023). Unlike many staple crops, potato has a short production cycle, high productivity per unit area and strong market demand making it one of the fastest income generating crops for farmers (Kwambai et al., 2023; Kyomugisha et al., 2018). The crop is widely consumed in both rural and urban areas in diverse processed forms such as chips, crisps, mashed potato and boiled products reflecting its expanding role in daily diets and agribusiness development (Beals, 2019;

Burgos et al., 2020). The crop is an important source of farm gate revenue in the major potato growing regions of Tanzania because of its high market value and continuous circulation in domestic markets (Parshotam & Revilla Diez, 2019).

Globally, potato has attracted significant attention because of its ability to produce more food within a shorter period under limited land resources compared to many cereal crops (Bajracharya and Sapkota, 2017; Levshin et al., 2020). Developed countries have substantially transformed their potato industries through the adoption of improved potato varieties characterized by high yield potential, early maturity, enhanced disease resistance, superior processing qualities and climate resilience (Ousmane & Nafiou, 2019; Tadele, 2017). Consequently, improved varieties is very important in boosting productivity, enhancing farmer profitability and stabilizing food systems (Kwambai et al., 2023; Merga and Dechassa, 2019; Prakash et al., 2023). Despite these proven advantages the adoption and utilization of improved potato varieties among smallholder farmers in developing countries including Tanzania remain considerably low and uneven (Ousmane and Nafiou, 2019).

Several studies conducted in Tanzania, East Africa and Sub-Saharan Africa have attempted to explain the persistently low adoption of improved potato varieties despite substantial investments made by Government, Research Institutions, NGOs and Development partners (Demo et al., 2015). Further studies across Africa have identified multiple factors influencing improved potato variety adoption, Socioeconomic determinants include education, age, household size and off-farm income (Dissanayake et al., 2022; Eliya, 2019). Institutional factors such as extension access, farmer training and credit availability consistently emerge as critical enablers of agricultural technology adoption (Gairhe et al., 2017; Nzenwa, 2024). Technological attributes including yield potential, disease resistance and compatibility with local preferences also shape adoption decisions (Andaregie & Astatkie, 2020; Zhang, 2025). Valuable evidence on the determinants of agricultural technology adoption has been documented

but most studies examine socioeconomic, institutional and technological factors independently with limited attention to their relative contribution to farmers' adoption decisions (Wordofa et al., 2021). Farmers may possess adequate financial or farm resources yet fail to adopt improved varieties because of limited access to quality seed, extension services, credit, information or reliable markets (Agussabti et al., 2022; Kumar et al., 2018). Conversely, institutional support may have limited effects where households lack the financial capacity, knowledge, or other socioeconomic resources required to utilize available opportunities (Katya Kule et al., 2025). These conditions suggest that adoption decisions are influenced by a combination of farmers' socioeconomic characteristics and the institutional environment in which they operate (Dissanayake et al., 2022).

This study addresses the adoption gap by examining socioeconomic and institutional factors influencing the adoption of improved potato varieties in Tanzania. This perspective provides an understanding of the socioeconomic characteristics, institutional support and market conditions associated with farmers' access to evaluation of adoption of improved potato varieties. Specifically, the study examines socioeconomic and institutional factors associated with adoption and assesses their individual contributions to farmers' adoption decisions, thereby providing evidence to guide policies and interventions for sustained adoption among smallholder farmers. Despite the recognized productivity potential of improved potato varieties, evidence on their adoption among smallholder farmers in the study area remains limited. In particular there is insufficient empirical evidence regarding the extent to which socioeconomic characteristics, institutional support, access to improved potato varieties, market conditions and farm-level factors influence farmers' decisions to adopt improved potato varieties. Understanding these factors is important because the continued dominance of local varieties may limit the realization of productivity gains associated with improved potato varieties.

MATERIALS AND METHODS

Description of the study area

The study was conducted in two purposively selected regions of Tanzania, namely Mbeya and Rukwa regions as illustrated in Figure 1. These regions were selected based on their strategic importance in potato production, their substantial contribution to national potato output and the presence of diverse agro-ecological conditions that support cultivation of the crop. Geographically, Mbeya region is located in the Southern Highlands of Tanzania between latitudes 7° and 9° South and longitudes 32° and 35° East. The region is characterized by high altitudes ranging from approximately 1,000 to 2,900 meters above sea level, moderate to high rainfall and relatively cool temperatures that provide favorable conditions for potato cultivation. Rukwa region is situated in the southwestern part of Tanzania between latitudes 6° and 9° South and longitudes 30° and 33° East. The region encompasses diverse topographical features, including plateaus and highland areas with suitable climatic conditions for agricultural production, particularly potato farming.

Within Mbeya Region, Mbeya district was purposively selected due to its prominence in potato cultivation and its extensive engagement in agricultural development initiatives. Two wards, Santliya and Hapoloto were included in the study, from which four villages Itizi, Hapoloto, Idimi and Iswago were selected as survey sites. In Rukwa region, Sumbawanga district was chosen as a representative potato producing district characterized by favorable production conditions and active farmer participation in potato value chain activities. The study covered two wards, Kipande and Sandulula, encompassing four villages: Nkundi, Sandulula, Msanda Muungano and Kipande. The selected districts, wards and villages were considered suitable for the study because of their established involvement in potato farming systems, relatively high levels of potato production and exposure to improved production technologies introduced

through governmental and development partner interventions. Data collection was carried out for ten days from 17th to 26th September 2024 which involved 6 enumerators.

Figure 1: Map of Tanzania showing the study area of the selected regions Mbeya, Rukwa and Districts (Mbeya DC, Sumbawanga DC) and sampled Villages.

Research design

The study adopted a cross-sectional research design, which involves the collection of data at a single point in time from a representative sample of the population (Arslan et al., 2022). This design is particularly suitable for studies aiming to establish relationships between variables and to assess the current status of technology adoption among farmers. It allows efficient data collection while capturing variations across different socio-economic and institutional settings (Card, 2022).

Sampling procedure

Five multistage sampling procedure was used to select respondents; the first step, Mbeya and Rukwa regions were purposively selected because of their substantial contribution to potato production in Tanzania and exposure to improved potato varieties and related agricultural interventions. Second, Mbeya and Sumbawanga Districts were purposively selected based on their prominence in potato production, favorable agro-ecological conditions and active participation in potato value chain activities. Third, two wards within each district were purposively selected, Santyla and Hapoloto at Mbeya District, Kipande and Sandulula at Sumbawanga district. Fourth, eight villages were selected, Itizi, Hapoloto, Idimi and Iswago in Mbeya district and Nkundi, Sandulula, Msanda Muungano and Kipande at Sumbawanga district. Simple random sampling was applied to minimize selection bias and provide eligible villages an equal chance of inclusion. Finally, lists of potato farming households were obtained with assistance from village leaders and agricultural extension officers, respondents were randomly

selected from these sampling frames, ensuring that each eligible household had an equal probability of being selected.

Sample size determination

The determination of the sample size was guided by the widely applied Yamane Formula of 1967 (Adam, 2020). The formula provides a simplified approach for calculating sample sizes from finite populations. The formula is expressed as:

$$n = \frac{N}{1+N(e^2)} \dots\dots\dots(i)$$

Where n represents sample size, N represents total house hold population of 600 farmers growing potato from four wards and e represents the level of precision, commonly set at 5% confidence level. Based on this formula, a total of 240 respondents were sampled sufficient to provide statistically reliable results. The required sample was allocated equally across the selected villages with 30 respondents selected from each village. This equal-allocation approach was adopted to ensure adequate representation of each selected village and to facilitate meaningful comparisons across study locations.

Figure 2: Sampling procedure and distribution of 240 respondents across the selected regions, districts, wards and villages in Tanzania.

Data collection methods

The study combined quantitative and qualitative data collection methods.

Structured questionnaire

A structured questionnaire was administered face to face of 240 sampled farmers, the questionnaire captured information on demographic characteristics, farming practices, access to extension services, awareness of improved potato varieties, sources of seed and constraints in adoption.

Secondary data collection:

Reports, agricultural databases and government publications supplemented and contextualized the primary data.

Data analysis techniques

Data were cleaned, coded and analyzed using SPSS and STATA. Frequencies, percentages, means and standard deviations summarized demographic characteristics and farming practices of respondents.

To examine factors influencing farmers adoption of improved potato varieties, a binary logistic regression model was employed because the dependent variable was dichotomous coded as 1 if a farmer adopted a variety and 0 otherwise. Let (Y_i) denote the binary response variable for the i^{th} farmer:

$Y_i = \{1, \text{ if the farmer adopts potato variety; } 0, \text{ if otherwise}\}$

The probability of adoption, conditional on explanatory variables, was specified as:

$$P_i = \Pr(Y_i = 1 | X_i) = \exp(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki}) / [1 + \exp(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki})] \dots \dots \dots (ii)$$

$$\text{Equivalently: } \ln [P_i / (1 - P_i)] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} \dots \dots \dots (iii)$$

where (P_i) is the probability of adoption, β_0 is the intercept, $\beta_1, \beta_2, \dots, \beta_k$ are estimated parameters and $X_{1i}, X_{2i}, \dots, X_{ki}$ are explanatory variables. These included socioeconomic, institutional, market-related and perceived varietal attributes. Coefficients were estimated using maximum likelihood estimation and their signs, statistical significance and odds ratios were used to assess their effects on acceptance. Statistical significance was assessed using the Wald test: $H_0: \beta_j = 0$, indicating that explanatory variable j has no statistically significant effect on potato variety adoption. $H_1: \beta_j \neq 0$, indicating that explanatory variable j has a statistically significant effect on potato variety adoption.

Description of variables used in logistic regression model

A multivariable binary logistic regression model was used to examine socioeconomic, institutional, market and farm-level factors associated with adoption of improved potato varieties. The 12 predictors were specified prior from the study objectives and conceptual framework (Yuniarsih et al., 2024). They represent distinct dimensions of farmers' adoption environment including household socioeconomic characteristics, institutional support, access to information and services, farm and market conditions. Retaining these theoretically relevant variables in a single model allowed their adjusted associations with adoption to be examined while controlling for the other factors. Although only 31 adoption events were observed, the predictors were retained based on their theoretical relevance and the exploratory objective of identifying potential determinants rather than developing an individual-level prediction model. The analysis therefore considered the broader influence of sample size, event prevalence, predictor distribution and effect sizes rather than relying solely on the conventional 10-events-per-variable rule (Feukeng, Otieno, Rajendran, Kapalasa, et al., 2024; Riaz et al., 2023). Odds ratios were interpreted as adjusted associations and with caution, particularly where confidence intervals were wide or statistical evidence was limited.

Table 1: Description of Logistic regression estimated model variables

RESULTS AND DISCUSSION

Demographic and institutional characteristics of respondents

The respondents were predominantly male operated mainly small-scale farms, however sex, age, education level and farm size were not significantly associated with adoption of improved potato varieties as indicated in Table 2. Most respondents operated small-scale farms, confirming the predominance of smallholder potato production in Tanzania (Mishra et al., 2020; Zossou et al., 2020). This suggests that demographic characteristics alone did not explain adoption behaviour in the study area. The similar evidence reported in Kenya indicate that gender should not be considered in isolation when explaining

potato varietal change because access to markets, inputs, labour and their characteristics valued by different market segments can be more decisive than gender itself (Friedmann et al., 2024; Hailemariam et al., 2024; Neway & Zegeye, 2022). The study found that, the rapid spread of local variety was linked strongly to the availability of planting, consumption material and to its short dormancy, illustrating how practical and market-related attributes can override simple demographic explanations. In contrast, farmer training and access to quality seed were significantly associated with adoption, underscoring its importance for technology adoption and productivity (Mastenbroek et al., 2021; Simtowe et al., 2019). This finding is consistent with recent evidence from Rwanda, where participation in a potato systems-improvement project increased adoption of improved seed and was accompanied by greater access to extension and other production support (Ainebyona et al., 2026; Becerra-Encinales et al., 2024; Mmapatla et al., 2021). It is also consistent with evidence from Malawi which showed that, confidence in extension services such as training access was important in explaining adoption of improved potato varieties (Fadeyi et al., 2022; Feukeng, Otieno, Rajendran, Demo, et al., 2024). The regional evidence documented that, adoption is more likely when farmers possess both knowledge to evaluate an innovation and the practical means to implement it as it enhances farmers skills and capacity to implement improved practices (Andaregie & Astatkie, 2020).

Table 2: demographic characteristics of the study area

Potato commercialization

The strong commercial orientation of potato production observed in this study indicated that, farmers make varietal and production decisions largely within a market context rather than primarily for household consumption as showed in Table 3. This finding has important implications for varietal adoption as farmers are unlikely to replace familiar varieties unless alternative varieties offer attributes that are valued by both traders and consumers, in addition of providing agronomic advantages. Thus, the marketability of

a variety alongside its agronomic performance is likely to play a critical role in shaping farmers varietal choices. Evidence from other sub-Saharan African countries reported the similar findings and supports this interpretation. Wakaba et al., (2022) reported that varietal turnover was strongly influenced by market conditions and product availability including characteristics affecting the availability of planting material and the timing of potato supply.

The economic benefits associated with improved varieties may further strengthen farmers incentives to adopt new varieties. The studies from Kenya and Ethiopia found that the adoption of improved potato varieties was associated with measurable productivity and economic benefits, suggesting that profitability can encourage farmers to shift from familiar varieties to improved alternatives (Abebe et al., 2013; Kimathi et al., 2021). In the present study however, the observed variability in potato prices/bag may create uncertainty regarding investment in improved seed particularly where the initial cost of quality planting material is relatively high. This concern is consistent with evidence from Uganda and Ethiopia reported that seed availability, affordability, technical knowledge, and market reliability remain important constraints to the uptake of agricultural technologies (Bararyenya et al., 2018; Das et al., 2026; Okello et al., 2019).

Table 3: Characterization of potato production and marketing

Level of adoption of improved potato varieties

The low level of adoption in this study as presented in Table 4 appears to reflect broader structural constraints affecting smallholder technology uptake rather than farmers' lack of interest in improved varieties. From the perspective of Rogers' Diffusion of Innovations Theory, the continued predominance of local varieties can be understood in terms of farmers' assessment of the relative advantages, compatibility, affordability and perceived risks associated with new technologies. Although improved varieties may offer higher yield potential, farmers are likely to favour varieties that are well adapted to their local production environments and that satisfy household and market requirements. Local varieties may therefore remain attractive where farmers perceive them as less risky, more readily available, affordable or better suited to existing production practices. Evidence from Malawi and Kenya similarly documented that farmer often retain local potato varieties because of their adaptability, desirable consumption characteristics and ability to perform under low-input production conditions (Kangogo et al., 2024; Kolech et al., 2017). The study further suggests that improving adoption requires simultaneous attention to both supply and demand-side constraints. On the supply side, inadequate availability and accessibility of quality seed, together with weaknesses in farmers capacity building and information delivery may limit farmers' ability to obtain and evaluate improved varieties. On the demand side, the cost of seed, farmers' resource constraints, accessibility and perceptions of the usefulness and suitability of improved varieties may reduce their willingness to adopt (Kaur Kapoor et al., 2014). These findings should however be interpreted in light of the relatively small number of adopters, the cross-sectional design and the study's restricted geographical coverage, which limit the extent to which the observed associations can be generalized beyond the study area or interpreted causally. In addition, the relatively small adopter group may reduce the precision and stability of the logistic regression estimates and the

identified relationships should therefore be interpreted as evidence of association rather than definitive causal effects.

Table 4: Farmer's adoption of improved potato varieties

Adoption of improved potato varieties by sex

The distribution of adoption by sex was interpreted using adoption rates within each sex category rather than the absolute number of adopters, given that males constituted 94.2% of the study sample compared with only 5.8% females as indicated in Table 5. Among male respondents 27 out of 226 farmers adopted improved potato varieties, representing an adoption rate of 11.9%, whereas 4 out of 14 female respondents adopted improved varieties corresponding to 28.6%. Thus, although the absolute number of male adopters was considerably higher 27 compared with 4, this largely reflects the much larger number of male respondents in the sample and should not be interpreted as evidence of greater male adoption. Nevertheless, the association between sex and adoption was not statistically significant indicating that sex was not a significant determinant of adoption in the study population. The observed differences in adoption rates may partly reflect broader gender-related differences in access to productive resources, credit and improved seed systems, which can influence farmers' capacity to adopt new technologies (Doss and Quisumbing, 2020; Tsige et al., 2020). However, the relatively small number of female respondents provide a caution when interpreting the higher female adoption rate as the estimate is based on only 14 women. More importantly, the non-significant statistical association indicates that the observed descriptive difference should not be interpreted as evidence of a systematic sex-based difference in adoption. Adoption decisions may instead have been influenced more strongly by socioeconomic and institutional conditions, including access to training, seed availability, prices and market opportunities (Binh, 2022; Mensah et al., 2021).

Factors related with adoption of improved potato varieties

The initial assessment of the study hypothesis, selected socioeconomic and institutional characteristics and examined in relation to adoption. The results showed that demographic characteristics including sex, age, education level and farm size, were not significantly associated with adoption. In contrast with institutional factors, particularly farmers training and access to quality seed showed significant associations with adoption. Among the institutional factors, training emerged as a key determinant of adoption. Most of all respondents 94.6% had received agricultural training and its association with adoption was highly significant. Training enhances farmers technical knowledge, awareness of innovation benefits and capacity to implement recommended practices, thereby facilitating technology uptake (Mgendi et al., 2022). Consistent with innovation diffusion theory, trained farmers are generally more likely to adopt improved technologies than untrained farmers (Liu et al., 2022).

Access to quality seed also exhibited a strong and significant association with adoption despite only 22.5% of respondents reporting access to quality seed. Seed availability is a fundamental prerequisite for the adoption of improved agricultural technologies because it directly influences farmers' ability to implement recommended production practices (Kwambai et al., 2024; Mastenbroek et al., 2021; Nzenwa, 2024; Simtowe et al., 2019).

In contrast, access to credit, participation in off-farm activities and extension services were not significantly associated with adoption ($p > 0.05$). The findings indicate that demographic characteristics were less influential in determining adoption behaviour, whereas institutional factors related to knowledge acquisition and access to critical production inputs, particularly training and quality seed, played a decisive role in shaping technology uptake among potato farmers. These bivariate results provide preliminary support for the study hypothesis by showing that adoption is more closely associated with institutional support and access to critical production resources than with demographic characteristics alone.

Determinants of improved potato varieties adoption

The binary logistic regression results showed that training, farming experience, seed access, price per bag and farmer-group membership significantly influenced the adoption of improved potato varieties, while education, sex, credit access, off-farm income, household size, quantity sold and land allocated to potato production were not statistically significant ($p > 0.05$) as indicated in Table 6. Farmer training was the strongest positive determinant of adoption with an odds ratio of 12.393, indicating that trained farmers were about 12 times more likely to adopt improved potato varieties than untrained farmers. This finding highlights the importance of capacity building and technical knowledge in enhancing farmers' awareness and confidence in improved technologies. Similar findings were reported by Gairhe et al., (2017); Kangogo et al., (2024). Farming experience also had a positive and significant effect on adoption, the odds ratio of 1.047 suggests that each additional year of farming experience increased the likelihood of adoption by about 4.7%, implying that experienced farmers are better able to evaluate and utilize improved varieties. The similar findings were reported by Ainembabazi and Mugisha, (2014); Sanogo et al., (2023).

Table 6: Logistic regression model on improved potato variety adoption decision

Access to seed was another important predictor of adoption, farmers with access to improved seed were about seven times more likely to adopt improved varieties than those without access. This result emphasizes the importance of efficient seed distribution systems and is consistent with findings described by Mwangi et al., (2026); Oli et al., (2025). who identified limited seed availability as a major constraint to potato improved varieties adoption, The most important and counter-intuitive finding was the negative effect of farmer group membership, farmers belong to organizations had approximately 97.7% lower odds of adopting improved potato varieties than non-members, after controlling other factors. Similar findings were noted by Selahkwe et al., (2021) who observed a negative and significant effect of membership on the adoption of potato technologies in Cameroon. This contrasts with findings reported by Wossen et al.,

(2019) and (Maina et al., 2024) where group membership and cooperatives positively influenced agricultural technology adoption through information sharing, collective action and improved access to inputs and extension services. The negative association in this study should not imply that farmer groups inherently discourage adoption. Instead, it may indicate that the organizations in the study area were not focused on potato production or seed dissemination, had weak links with extension agents and seed suppliers, or provided limited benefits related to improved seed. Therefore, the findings suggest that the functionality and purpose of farmer organizations are more important than membership alone.

Model adequacy and supporting diagnostics

The binary logistic regression model was statistically significant, revealing that the predictors jointly improved the prediction of the outcome variable as indicated in Table 7. The non-significant Hosmer–Lemeshow test confirmed an adequate model fit. The Cox and Snell, Nagelkerke R^2 , and pseudo- R^2 indicated that the model had moderate explanatory and predictive capacity.

Table 7: Binary logistic regression model summary and goodness of fit results

Multicollinearity diagnostics

The multicollinearity diagnostics in Table 8 showed that all explanatory variables had low VIF values, ranging from 1.03 to 3.02, with corresponding tolerance values well above the commonly accepted threshold of 0.10. These results indicate the absence of serious multicollinearity among the explanatory variables, confirming their suitability for inclusion in the binary logistic regression model.

Table 8: Multicollinearity diagnostics

CONCLUSIONS AND RECOMMENDATIONS

The study found that adoption of improved potato varieties was low (12.9%), adoption was significantly associated with training, farming experience, access to improved seed, potato price per bag and farmer group membership,

while demographic characteristics were not significant. Training, farming experience and access to improved seed were positively associated with adoption, whereas potato price per bag and farmer group membership showed negative associations.

The study recommends strengthening practical farmer training, improving the availability and affordability of quality improved seed and making farmer organizations more effective by linking members with technical information, seed suppliers and markets. Extension services can support delivery of these interventions, but should not be presented as a significant determinant based on the current analysis. Future studies should use longitudinal or experimental approaches to establish causal relationships.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Tanzania Agricultural Research Institute (TARI) for its institutional and technical support throughout the study. Appreciation is extended to all individuals who contributed to this study in all matters towards achievement of this output.

CRedit AUTHORSHIP CONTRIBUTION STATEMENT

All authors contributed substantially to the study, the first author led the conceptualization, questionnaire design, field data collection, data analysis, interpretation and manuscript drafting. The co-authors provided methodological guidance and research supervision, contributed to interpretation of the findings, critically revised the manuscript and approved the final version for publication.

DECLARATION OF COMPETING INTEREST

The authors declare no commercial, financial, or personal conflicts of interest. The study was conducted independently and the funding sources had no influence on its design, implementation, analysis, interpretation, manuscript preparation, or publication decision.

ETHICS AND PERMIT APPROVALS

Ethical approval for the study was obtained from the Institutional Research Ethics Committee (IREC), Directorate of Research University of Dar es Salaam, Tanzania dated 16 August 2024. The approval covered the study on institutional and socioeconomic factors influencing the adoption of improved potato varieties in Tanzania and authorized data collection involving adult participants, including farmers and other relevant stakeholders. Participation in the study was voluntary and written informed consent was obtained from all participants before data collection, in accordance with the conditions of the ethical approval. Participants were informed about the study and their participation, while privacy, confidentiality and anonymity were protected throughout the research process. The collected data were used exclusively for the approved research purposes.

DATA AVAILABILITY STATEMENT

All information including data analyzed and yielded this output are available from the corresponding author upon reasonable request.

FUNDING STATEMENT

This study was partially funded by the Ministry of Agriculture of the United Republic of Tanzania through the Tanzania Food Systems Resilience Program (TFSRP) while the remaining research costs were supported by the corresponding author's family.

AI USE STATEMENT

The authors declared on the use of generative AI (ChatGPT) solely for language editing and word refinement, all scientific content, interpretations and conclusions were developed, verified and approved by the authors.

REFERENCES

- Abebe, G. K., Bijman, J., Pascucci, S., Omta, O. (2013). Adoption of improved potato varieties in Ethiopia: The role of agricultural knowledge and innovation system and smallholder farmers' quality assessment. *Agric Syst* 122 22–32. <https://doi.org/10.1016/j.agry.2013.07.008>
- Adam, A. M. (2020). Sample Size Determination in Survey Research. *J Sci Res Rep* 90–97. <https://doi.org/10.9734/jsrr/2020/v26i530263>
- Agussabti, Rahmaddiansyah, Deli, A., Arida, A., Mahda, F. A. (2022). Factors affecting the decision of potato farmers in adopting superior seeds in Bener Meriah District. *IOP Conf Ser Earth Environ Sci* 951(1) 012016. <https://doi.org/10.1088/1755-1315/951/1/012016>
- Ainembabazi, J. H., Mugisha, J. (2014). The Role of Farming Experience on the Adoption of Agricultural Technologies: Evidence from Smallholder Farmers in Uganda. *J Dev Stud* 50(5) 666–679. <https://doi.org/10.1080/00220388.2013.874556>
- Andaregie, A., Astatkie, T. (2020). Determinants of technical efficiency of potato farmers and effects of constraints on potato production in Northern Ethiopia. *Exp Agric* 56(5) 699–709. <https://doi.org/10.1017/S0014479720000253>
- Arslan, A., Floress, K., Lamanna, C., Lipper, L., Rosenstock, T. S. (2022). A meta-analysis of the adoption of agricultural technology in Sub-Saharan Africa. *PLOS Sustain Transform* 1(7): e0000018. <https://doi.org/10.1371/journal.pstr.0000018>
- Bajracharya, M., Sapkota, M. (2017). Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal. *Agric Food Secur* 6(1) 47. <https://doi.org/10.1186/s40066-017-0125-5>
- Bararyenya, A., Nahayo, P.-C., Nduwimana, A., Niyonzima, P., Nyawakira, D., Sindihebura, J.-P., Vyizigiro, E., Ndayishimiye, V., Haverkort, A. J. (2018). Assessment of Opportunities for

- Burundian Small-Scale Potato Farmers to Increase Productivity and Income. *Potato Res* 61(1) 73–88. <https://doi.org/10.1007/s11540-018-9359-2>
- Beals, K. A. (2019). Potatoes, Nutrition and Health. *American Journal of. Potato Res* 96(2) 102–110. <https://doi.org/10.1007/s12230-018-09705-4>
- Becerra-Encinales, J. F., Bernal-Hernandez, P., Beltrán-Giraldo, J. A., Cooman, A. P., Reyes, L. H., Cruz, J. C. (2024). Agricultural Extension for Adopting Technological Practices in Developing Countries: A Scoping Review of Barriers and Dimensions. *Sustainability* 16(9) 3555. <https://doi.org/10.3390/su16093555>
- Binh, N. D. (2022). Factors affecting the application of high technology in agriculture production of farmers in Ho Chi Minh City, Vietnam. *Int J Health Sci* 6(S1) 52–63. <https://doi.org/10.53730/ijhs.v6nS1.4756>
- Burgos, G., Zum Felde, T., Andre, C., Kubow, S. (2020). The Potato and Its Contribution to the Human Diet and Health. In H. Campos & O. Ortiz (Eds.), *The Potato Crop* (pp. 37–74). Springer International Publishing. https://doi.org/10.1007/978-3-030-28683-5_2
- Das, R., Jha, K. K., Baveesh, P., Koul, B., Das, S. S. (2026). Evaluation of the Adoption of Potato Production Technology and Identification of Farmer Challenges in Northeast India for Enhancing Food Security. *Potato Res* 69(2) 34. <https://doi.org/10.1007/s11540-025-09958-7>
- Demo, P., Lemaga, B., Kakuhenzire, R., Schulz, S., Borus, D., Barker, I., Woldegiorgis, G., Parker, M. L., Schulte-Geldermann, E. (2015). Strategies to improve seed potato quality and supply in sub-Saharan Africa: Experience from interventions in five countries. In J. Low, M. Nyongesa, S. Quinn, & M. Parker (Eds.), *Potato and sweet potato in Africa: Transforming the value chains for*

food and nutrition security (1st ed., pp. 155–167). CABI.

<https://doi.org/10.1079/9781780644202.0155>

Dissanayake, C. A. K., Jayathilake, W., Wickramasuriya, H. V. A., Dissanayake, U., Wasala, W. M. C. B.

(2022). A Review on Factors Affecting Technology Adoption in Agricultural Sector. *J Agric Sci*

Sri Lanka 17(2) 280–296. <https://doi.org/10.4038/jas.v17i2.9743>

Doss, C., Quisumbing, A. R. (2020). Gender, household behavior, and rural development (0 ed.).

International Food Policy Research Institute. https://doi.org/10.2499/9780896293830_15

Eliya, K. (2019). Assessing Factors Influencing Farmers Adoption of Improved Potato Varieties in

Malawi. *Int J Econ Energy Environ* 4(1) 1. <https://doi.org/10.11648/j.ijee.20190401.11>

Fadeyi, O. A., Ariyawardana, A., Aziz, A. A. (2022). Factors influencing technology adoption among

smallholder farmers: A systematic review in Africa. [https://doi.org/10.17170/KOBRA-](https://doi.org/10.17170/KOBRA-202201195569)

202201195569

Feukeng, F. T., Otieno, D. J., Rajendran, S., Demo, P., Parker, M. (2024). Return on investment of the

International Potato Center–led seed system interventions in Malawi. *Crop Sci* 64(3) 1328–1339.

<https://doi.org/10.1002/csc2.21109>

Friedmann, M., Polar, V., Mendes, T. (2024). Gender analysis is not only about gender: Reshaping the

potato breeding priorities to increase varietal adoption in Kenya. *Front Sociol* 9 1446973.

<https://doi.org/10.3389/fsoc.2024.1446973>

Gairhe, S., Gauchan, D., Timsina, K. (2017). Adoption of Improved Potato Varieties in Nepal. *J Nepal*

Agric Res Counc 3 38–44. <https://doi.org/10.3126/jnarc.v3i1.17274>

Hailemariam, A., Kalsi, J., Mavisakalyan, A. (2024). Gender gaps in the adoption of climate-smart agricultural practices: Evidence from sub-Saharan Africa. *J Agric Econ* 75(2) 764–793.
<https://doi.org/10.1111/1477-9552.12583>

Kangogo, E., Otieno, D. J., Okello, J., Mwenye, O., Kapalasa, E. (2024). Effect of uptake of improved seed potato and donor-funded training on smallholder farmers' market participation. *Crop Sci* 64(3) 1432–1441. <https://doi.org/10.1002/csc2.21118>

Katya Kule, E., Agole, D., Obia, A., Okello, D. M., Odongo, W. (2025). Adoption of sustainable agricultural intensification practices: Assessing the role of institutional and socio-economic factors amongst smallholder farmers. *Cogent Soc Sci* 11(1) 2470373.
<https://doi.org/10.1080/23311886.2025.2470373>

Kimathi, S. M., Ayuya, O. I., Mutai, B. (2021). Adoption of climate-resilient potato varieties under partial population exposure and its determinants: Case of smallholder farmers in Meru County, Kenya. *Cogent Food Agric* 7(1) 1860185. <https://doi.org/10.1080/23311932.2020.1860185>

Kumar, G., Engle, C., Tucker, C. (2018). Factors Driving Aquaculture Technology Adoption. *J World Aquac Soc* 49(3) 447–476. <https://doi.org/10.1111/jwas.12514>

Kwambai, T. K., Griffin, D., Struik, P. C., Stack, L., Rono, S., Brophy, C., Nyongesa, M., Gorman, M. (2024). Seed Quality and Variety Preferences Amongst Potato Farmers in North-Western Kenya: Lessons for the Adoption of New Varieties. *Potato Res* 67(1) 185–208.
<https://doi.org/10.1007/s11540-023-09626-8>

Kwambai, T. K., Struik, P. C., Griffin, D., Stack, L., Rono, S., Nyongesa, M., Brophy, C., Gorman, M. (2023). Understanding Potato Production Practices in North-Western Kenya through Surveys: An

Important Key to Improving Production. *Potato Res* 66(3) 751–791.

<https://doi.org/10.1007/s11540-022-09599-0>

Kyomugisha, H., Sebatta, C., Mugisha, J. (2018). Potato market access, marketing efficiency and on-farm value addition in Uganda. *Sci Afr* 1: e00013. <https://doi.org/10.1016/j.sciaf.2018.e00013>

Laizer, H. C. (2025). Understanding farmer knowledge, practices and decision-making in pest and disease management: The case of Irish potato (*Solanum tuberosum*) cultivation in Mbeya, Tanzania. *Discov Agric* 3(1) 260. <https://doi.org/10.1007/s44279-025-00440-z>

Levshin, A., Ivashova, O., Gasparyan, I., Gasparyan, Sh., Deniskina, N. (2020). Competitiveness of Early Potato Production in Two-Crop Culture. *Proc Int Conf Policies Econ Measures Agric Dev (AgroDevEco 2020)*. International Conference on Policies and Economics Measures for Agricultural Development (AgroDevEco 2020). <https://doi.org/10.2991/aebmr.k.200729.040>

Liu, Y., Shi, R., Peng, Y., Wang, W., Fu, X. (2022). Impacts of Technology Training Provided by Agricultural Cooperatives on Farmers' Adoption of Biopesticides in China. *Agriculture* 12(3) 316. <https://doi.org/10.3390/agriculture12030316>

Maina, F., Mburu, J., Nyang'anga, H. (2024). Drivers of extent of commercialization of potato farming through digital marketing platforms in Nakuru County, Kenya. *Front Sustain Food Syst* 8 1307978. <https://doi.org/10.3389/fsufs.2024.1307978>

Mastenbroek, A., Sirutyte, I., Sparrow, R. (2021). Information Barriers to Adoption of Agricultural Technologies: Willingness to Pay for Certified Seed of an Open Pollinated Maize Variety in Northern Uganda. *J Agric Econ* 72(1) 180–201. <https://doi.org/10.1111/1477-9552.12395>

- Mensah, A., Asiamah, M., Wongnaa, C. A., Adams, F., Etuah, S., Gaveh, E., Appiah, P. (2021). Adoption impact of maize seed technology on farm profitability: Evidence from Ghana. *J Agribus Dev Emerg Econ* 11(5) 578–598. <https://doi.org/10.1108/JADEE-06-2020-0120>
- Merga, B., Dechassa, N. (2019). Growth and Productivity of Different Potato Cultivars. *J Agric Sci* 11(3) 528. <https://doi.org/10.5539/jas.v11n3p528>
- Mgendi, B. G., Mao, S., Qiao, F. (2022). Does agricultural training and demonstration matter in technology adoption? The empirical evidence from small rice farmers in Tanzania. *Technol Soc* 70 102024. <https://doi.org/10.1016/j.techsoc.2022.102024>
- Mishra, K., Sam, A. G., Diiro, G. M., Miranda, M. J. (2020). Gender and the dynamics of technology adoption: Empirical evidence from a household-level panel data. *Agric Econ* 51(6) 857–870. <https://doi.org/10.1111/agec.12596>
- Mmapatla, P. S., Thomas, B. L., Vincent, B., Onno, O., Gerben, V. D. V. (2021). Smallholder adoption of technology: Evidence from the context of climate smart agriculture in South Africa. *Journal of Development and. Agric Econ* 13(2) 156–173. <https://doi.org/10.5897/JDAE2020.1191>
- Muthoni, J., Shimelis, H. (2023). An overview of potato production in Africa. In *Potato Production Worldwide* (pp. 435–456). Elsevier. <https://doi.org/10.1016/B978-0-12-822925-5.00020-7>
- Mwakidoshi, E. R. (2021). Economic Importance, Ecological Requirements and Production Constraints of Potato (*Solanum tuberosum* L.) in Kenya. *Int J Bioresour Sci* 8(2). <https://doi.org/10.30954/2347-9655.02.2021.1>
- Mwangi, M. N., Nyarindo, W. N., Ngigi, M. W., Isaboke, H. N. (2026). Seeding food security: Overcoming barriers to quality potato seed adoption among smallholders in Kenya. *PLOS One* 21(5): e0346796. <https://doi.org/10.1371/journal.pone.0346796>

- Neway, M. M., Zegeye, M. B. (2022). Gender differences in the adoption of agricultural technology in North Shewa Zone, Amhara Regional State, Ethiopia. *Cogent Soc Sci* 8(1) 2069209. <https://doi.org/10.1080/23311886.2022.2069209>
- Nzenwa, T. N. (2024). A Value Chain Approach to Adoption of Improved Potato Varieties in Nigeria (p. 4.0 MB) [Pdf]. Unknown. <https://doi.org/10.22004/AG.ECON.349217>
- Okello, J., Zhou, Y., Barker, I., Schulte-Geldermann, E. (2019). Motivations and Mental Models Associated with Smallholder Farmers' Adoption of Improved Agricultural Technology: Evidence from Use of Quality Seed Potato in Kenya. *Eur J Dev Res* 31(2) 271–292. <https://doi.org/10.1057/s41287-018-0152-5>
- Oli, D., Gyawali, B., Acharya, S., Oshikoya, S. (2025). Factors influencing learning attitude of farmers regarding adoption of farming technologies in farms of Kentucky, USA. *Smart Agric Technol* 10 100801. <https://doi.org/10.1016/j.atech.2025.100801>
- Ousmane, D., Nafiou, M. M. (2019). Determinants of agricultural technology adoption: Farm households' evidence from Niger. *Journal of Development and Agric Econ* 11(1) 15–23. <https://doi.org/10.5897/JDAE2018.0998>
- Parshotam, A., Revilla Diez, J. (2019). Economic Growth Corridors Through a Value-Chain Lens: The Case of the Southern Agricultural Growth Corridor in Tanzania. In S. Scholvin, A. Black, J. Revilla Diez, & I. Turok (Eds.), *Value Chains in Sub-Saharan Africa* (pp. 61–77). Springer International Publishing. https://doi.org/10.1007/978-3-030-06206-4_5
- Prakash, D Jaganathan, Sheela Immanuel, R Muthuraj, P S Sivakumar. (2023). Socioeconomic impact of improved variety of Chinese potato in Tamil Nadu. *Indian J Hortic* 80(2) 177–183. <https://doi.org/10.58993/ijh/2023.80.2.8>

- Sanogo, K., Touré, I., Arinloye, D.-D. A. A., Dossou-Yovo, E. R., Bayala, J. (2023). Factors affecting the adoption of climate-smart agriculture technologies in rice farming systems in Mali, West Africa. *Smart Agric Technol* 5 100283. <https://doi.org/10.1016/j.atech.2023.100283>
- Selahnkwe, C., Nformi, M. I., Lengah, T. N., Nchanji, E. B., Fotang, C. (2021). Factors That Determine the Adoption of Improved Irish Potato Technologies by Farmers in the Western Region of Cameroon. *Agric Sci* 12(12) 1404–1413. <https://doi.org/10.4236/as.2021.1212089>
- Simtowe, F., Marenja, P., Amondo, E., Worku, M., Rahut, D. B., Erenstein, O. (2019). Heterogeneous seed access and information exposure: Implications for the adoption of drought-tolerant maize varieties in Uganda. *Agric Food Econ* 7(1) 15. <https://doi.org/10.1186/s40100-019-0135-7>
- Tadele, Z. (2017). Raising Crop Productivity in Africa through Intensification. *Agronomy* 7(1) 22. <https://doi.org/10.3390/agronomy7010022>
- Tsige, M., Synnevåg, G., Aune, J. B. (2020). Gendered constraints for adopting climate-smart agriculture amongst smallholder Ethiopian women farmers. *Sci Afr* 7: e00250. <https://doi.org/10.1016/j.sciaf.2019.e00250>
- Wordofa, M. G., Hassen, J. Y., Endris, G. S., Aweke, C. S., Moges, D. K., Rorisa, D. T. (2021). Adoption of improved agricultural technology and its impact on household income: A propensity score matching estimation in eastern Ethiopia. *Agric Food Secur* 10(1) 5. <https://doi.org/10.1186/s40066-020-00278-2>
- Wossen, T., Gatiso, T. T., Kassie, M. (2019). Estimating returns to fertilizer adoption with unobserved heterogeneity: Evidence from Ethiopia. *Food Energy Secur* 8(2): e00156. <https://doi.org/10.1002/fes3.156>

Zossou, E., Arouna, A., Diagne, A., Agboh-Noameshie, R. A. (2020). Learning agriculture in rural areas:

The drivers of knowledge acquisition and farming practices by rice farmers in West Africa. J

Agric Educ Ext 26(3) 291–306. <https://doi.org/10.1080/1389224X.2019.1702066>

Table 1: Description of Logistic regression estimated model variables

Variable	Description	Coding/measurement
Education level	Education level of the household head	1 = at least primary education; 0 = otherwise
Sex	Sex of the household head	1 = male; 0 = female
Credit access	Access to credit by the household	1 = yes; 0 = no
Off-farm income	Household has an off-farm income source	1 = yes; 0 = no
Training potato	Access to potato production training	1 = yes; 0 = no
Farming experience	Number of years involved in potato production	Continuous (years)
Household size	Number of members in the household	Continuous (count)
Price per bag	Price received per 100-kg bag of potato	Continuous (USD per 100-kg bag)
Farmer group	Household head belongs to a farmer group	1 = yes; 0 = no
Number of bags sold	Number of potato bags sold by the household	Continuous (count)
Land under potato	Area of land allocated to potato production	Continuous (ha)
Seed access	Access to improved potato seed	1 = yes; 0 = no

Note: Variables measured as categorical indicators were coded as 0/1, with the reference category coded as 0. Continuous variables were measured in their respective units as indicated. USD = United States dollars; ha = hectares and Kg=Kilogram.

Table 2: demographic characteristics of the study area

Variables	Category	Frequency	%	Chi-square	P-Value
sex	Male	226	94.2	3.239	0.072
	Female	14	5.8		
Age	15-24	14	5.8	3.515	0.476
	25-34	62	25.8		
	35-44	75	31.2		
	45-55	55	22.9		
	55+	34	14.2		
Education level	Primary	187	77.9	2.720	0.437
	Secondary	26	10.8		
	Tertiary	10	4.2		
	Informal	17	7.1		
Farm size	Small farmer	212	88.3	0.370	0.712
	Medium	28	11.7		
Training potato	Yes	227	94.6	13.499	0.001
	No	13	5.4		
Credit access	Yes	40	16.7	0.007	0.931
	No	200	83.3		
Seed access	Yes	54	22.5	21.350	0.001
	No	186	77.5		
Off farm Income	Yes	71	29.6	0.595	0.441
	No	169	70.4		
Extension					
Access	Yes	118	49.2	0.009	0.926
	No	122	50.8		

Table 3: Characterization of potato production and marketing

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Land share under potato	240	0.020	1	0.422	0.315
Consumption ratio	240	0	1	0.041	0.126
Sales ratio	240	0	1	0.919	0.168
Selling price/bag	240	8 USD	32USD	18.966	4.463

Table 4: Farmers' adoption on improved potato varieties

Seed type	Frequency	Percent	Valid Percent	Cumulative Percent
Local	209	87.1	87.1	87.1
Improved	31	12.9	12.9	100
Total	240	100	100	

Table 5: Adoption of Improved Potato Varieties by Sex

Sex	Improved variety		Local variety		Total	
	Frequency	%	Frequency	%	Frequency	%
Male	27	11.20	199	82.90	226	94.20
Female	4	1.70	10	4.20	14	5.80
Total	31	12.9	209	87.10	240	100

Note: Chi-Square=3.239 (0.072)

Table 6: Logistic regression model on improved potato varieties adoption decision

Predictor	B	SE	Wald	df	P- Value	OR	95% CI for OR	
							Lower	Upper
Education	0.841	1.043	0.651	1	0.420	2.318	0.300	17.889
Sex	-1.230	0.774	2.523	1	0.112	0.292	0.064	1.333
Credit Access	-0.956	0.851	1.262	1	0.261	0.384	0.072	2.039
Off-farm income	-0.055	0.531	0.011	1	0.918	0.947	0.334	2.682
Training potato	2.517	0.746	11.388	1	0.001	12.393	2.872	53.467
Farming experience	0.046	0.020	5.510	1	0.019	1.047	1.008	1.089
Household size	0.049	0.116	0.175	1	0.676	1.050	0.836	1.318
Price/bag (100)	-0.005	0.002	4.398	1	0.036	0.995	0.990	1.000
Farmer group	-3.757	1.305	8.290	1	0.004	0.023	0.002	0.301
Sold bags	0.002	0.003	0.597	1	0.440	1.002	0.997	1.008
Land under potato	-0.003	0.159	0.000	1	0.983	0.997	0.729	1.362
Seed access	2.010	0.481	17.438	1	0.001	7.464	2.906	19.175
Constant	4.898	2.654	3.406	1	0.065	133.998		

Note: B = regression coefficient; SE = standard error; OR = odds ratio; CI = confidence interval; df = degrees of freedom. *p*-values < 0.05 indicate statistical significance. The reference categories for categorical predictors are those specified in the regression model.

Table 7: Binary logistic regression model summary and goodness-of-fit results

Statistic	Value	Definition
–2 Log Likelihood	159.15	Model fit statistic; lower values generally indicate better fit relative to competing models.
Cox & Snell R ²	0.099	Pseudo-R ² based on the improvement in likelihood relative to the null model.
Nagelkerke R ²	0.185	Adjusted Cox & Snell pseudo-R ² scaled to a maximum of 1.
Model Chi-square	25.054 (p = 0.003)	Overall likelihood-ratio test comparing the fitted model with the null model.
Hosmer–Lemeshow Chi-square	8.290 (p = 0.406)	Goodness-of-fit test; the non-significant result indicates no evidence of lack of fit.
Pseudo-R ² (reported)	0.512	Pseudo-R ² value retained from the original statistical output; reported separately from Cox & Snell and Nagelkerke R ² .

Table 8: Multicollinearity diagnostics for variables included in the binary logistic regression model

Var	VIF	1/VIF(Tolerance)
Education	1.03	0.97
Sex	1.05	0.95
Credit	1.12	0.89
Off farm income	1.08	0.93
Training potato	1.33	0.75
Farming Experience	1.04	0.96
House hold size	1.25	0.8
Price	1.07	0.93
Farmer group	2.15	0.46
Sold bags	1.09	0.92
Land under potato	1.10	0.91
Seed access	3.02	0.33
Mean VIF	1.36	

FIGURES

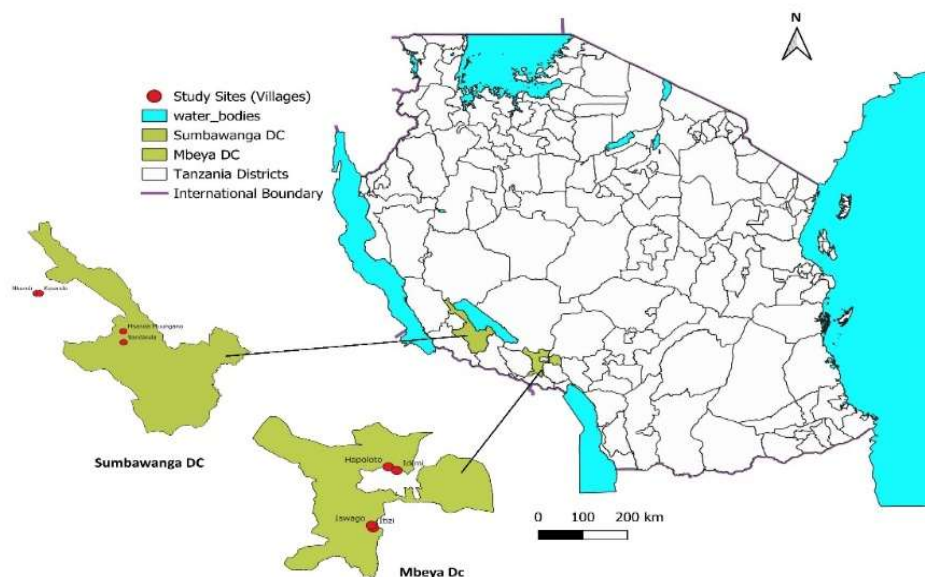


Figure 1: Map of Tanzania showing the study area, including the selected regions Mbeya and Rukwa, Districts (Mbeya DC, Sumbawanga DC) and sampled Villages.

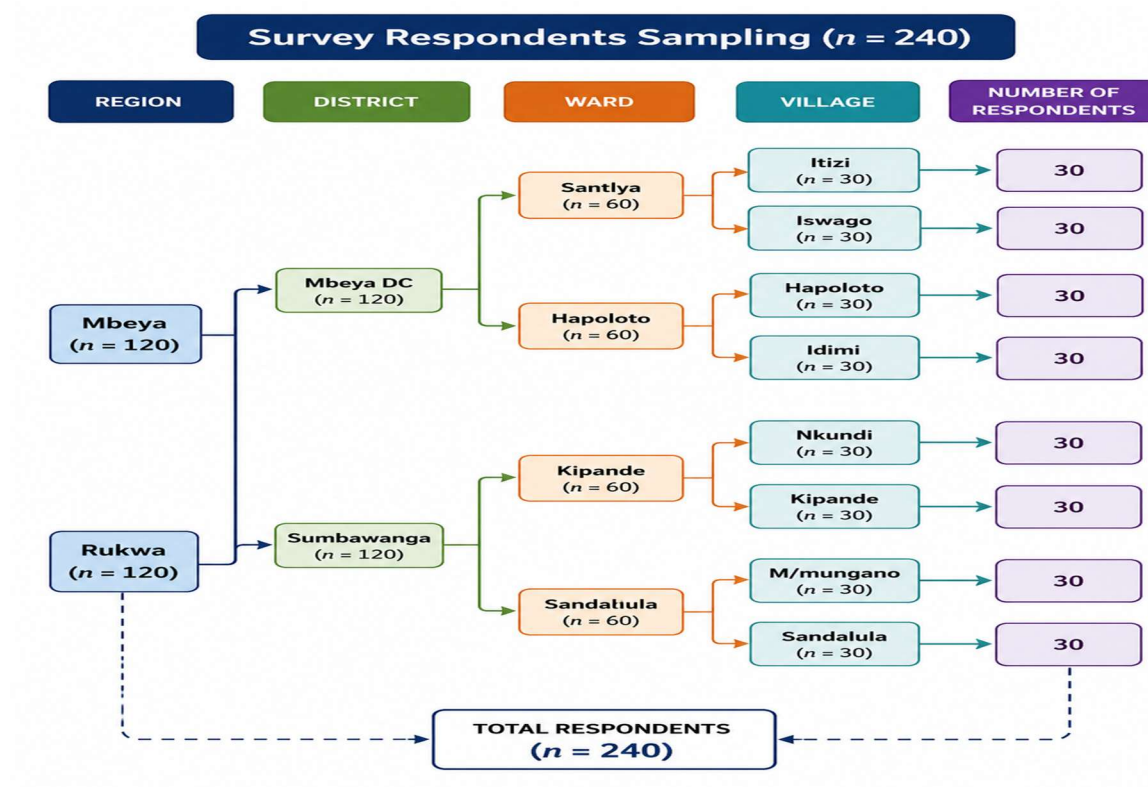


Figure 2: Sampling procedure and distribution of 240 respondents across the selected regions, districts, wards, and villages in Tanzania.