

The Influence of Access to Training Services on the Performance of Small-Scale Horticultural Farmers: A Participatory Approach

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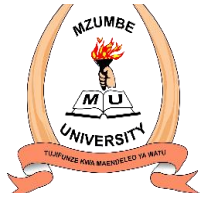
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Abstract

This study examines the influence of access to training services on the performance of small-scale horticultural farmers (SSHFs) in Tanzania, specifically assessing outcomes when a participatory approach is used to deliver training. Guided by Indigenous Knowledge Theory, data were collected from 397 SSHFs through a cross-sectional survey and analysed using descriptive statistics and partial least squares path modelling with SPSS and Smart PLS.

4.0. The findings confirm a significant positive relationship between access to farmer-specific training and performance, particularly when training is designed through participatory methods. Unlike findings from other scholars who propose a top-down approach to the provision of farmers' training services, the findings underscore the value of inclusive, locally informed training methods in improving agricultural outcomes. Theoretically, it makes a novel contribution to Indigenous Theory by empirically validating the impact of participatory training and reinforcing Indigenous Theory by illustrating how culturally embedded practices shape farmers' responses to interventions. In practice, the study urges SSHFs to engage in training initiatives actively and highlights the need for policymakers and stakeholders to consider local contexts when designing effective training programs. By presenting an empirically grounded model, the study contributes new insights into the interplay between access to training and indigenous knowledge in improving farmer performance.¹

Keywords: Access to Training Services, Small-scale Horticultural farmers, Seasonal

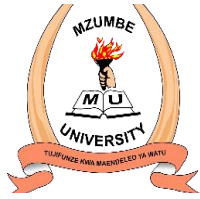


1. Introduction

The performance of small-scale horticulture farmers has been widely acknowledged as contributing significantly to sector performance and, consequently, to the economic growth of most countries (Kasimba et al., 2022). Beyond increasing the sustainable income of individual farmers, small-scale horticulture plays a key role in enhancing food and nutritional security, especially in low- and middle-income countries where access to diverse, fresh produce remains a challenge (Ahmed et al., 2024; Bakshi et al., 2022; Masele, 2023). Remarkably, the small-scale horticulture sub-sector is a significant source of employment, supporting an estimated 600 million individuals globally as of 2024, especially in economies where agriculture constitutes the primary livelihood base (Makule et al., 2024). Enhanced performance in this segment has been consistently associated with increased agricultural productivity, improved resilience to market and environmental shocks, and enhanced competitiveness of smallholder farmers (Hlatshwayo et al., 2023). As such, the performance of small-scale horticulture farmers transcends personal or household-level welfare; it represents a strategic component of national food systems, employment generation, and long-term economic transformation.

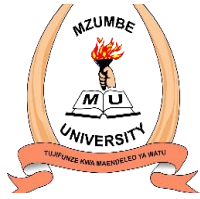
In several sub-Saharan African nations, including Tanzania, Kenya, and Ethiopia, the horticulture sector plays an important role in economic development, contributing substantially to gross domestic product (GDP), foreign exchange earnings, and rural transformation (Ng'atigwa et al., 2020). In Tanzania, the performance of small-scale horticultural farmers (SSHFs) is particularly central to this sector, accounting for nearly 90% of national agricultural output (George, 2022). The sector is estimated to support the livelihoods of approximately 2.5 million individuals and has been closely linked to poverty alleviation through increased household incomes and employment opportunities. In particular, the horticultural subsector recorded a growth rate of 11% in 2022, surpassing the broader agricultural sector's growth of 4%, highlighting the significance of smallholder productivity as a driver of sectoral progress (Kirui et al., 2023). Consequently, improving the performance and efficiency of SSHFs is not only essential for sustaining the momentum of horticultural expansion but also for achieving broader goals of national economic development and rural socio-economic resilience.

Despite the recognized importance of performance among SSHFs, the key determinants underpinning their productivity in Tanzania remain insufficiently examined.



Among the limited body of evidence, farmer-specific training has emerged as a particularly influential factor in enhancing performance outcomes. Luo et al. (2022) demonstrated that farmers who received targeted training achieved significantly higher yields compared to their untrained counterparts. Similarly, Bai-Sesay (2024) associated training with improved conservation practices, driven by better utilisation of agronomic information. In a related study, Pandey et al. (2024) emphasized that sustained exposure to specialised training not only improves the effectiveness of agricultural programs but also facilitates the broader adoption of sustainable farming practices. Consistent with these findings, Kirui et al. (2025) and Mgendi et al. (2021) reported a strong positive relationship between training and enhanced vegetable yields. Research conducted in Rwanda by Habiyaambere and Njenga (2022), further confirmed the pivotal role of training in improving smallholder performance. While scholarly consensus underscores the value of targeted farmer training, there remains debate over the most effective modalities for delivering these interventions. Some researchers advocate for top-down, expert-led approaches that ensure consistency and structure, whereas others promote participatory models that engage farmers as active collaborators in the learning process.

Building on the preceding discussion, a substantial body of literature supports the efficacy of top-down (or hierarchical) training models in enhancing farmer performance across varied agricultural contexts. For instance, Maertens et al. (2021) reported that structured, centrally coordinated training programs in Malawi significantly improved both training adoption and agricultural productivity. Similarly, Jordan and Guerzoni (2022) found that formal support interventions in Ethiopia increased the uptake of agricultural inputs, while earlier work by the same authors Jordan & Guerzoni, 2020 demonstrated that centralised fertiliser advisory services influenced adoption even among initially reluctant farmers. In South Africa, Maake and Antwi (2022) and Rakoena et al. (2022) noted the effectiveness and trustworthiness of public extension agents, despite minimal farmer participation in program design. Rakoena et al. (2022) further emphasised that centrally delivered training programs significantly accelerated technology adoption and income generation, offering high returns on public investment. Turyasingura and Chavula (2022) also underscored the scalability and cost-effectiveness of ICT-based, top-down training models in Uganda. Complementarily, Mwinkom et al. (2021) argued for the critical role of public agents in ensuring standardised dissemination of innovations, such as Push-Pull Technology and climate-smart agricultural practices.

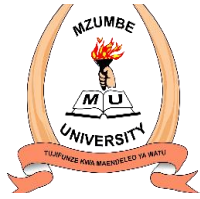


Nevertheless, a parallel line of scholarship highlights the limitations of hierarchical approaches and advocates for participatory training models that prioritise farmer engagement in program design and implementation. Van den Berg et al. (2021) found that the success of training interventions often hinged on involving farmers in the planning process. Similarly, Mariyono et al. (2022) observed that Indonesia's Farmer Field Schools improved farmers' knowledge and environmental sustainability, although the impacts on yield and long-term adoption were

variable. In support of grassroots-centred models, Wijeratne and De Silva (2024) recommended Participatory Rural Appraisal techniques that empower local farmers to contribute to the development and implementation of training programs actively. Osumba et al. (2021) strongly advocated for participatory approaches, contending that they yield the most contextually relevant and sustainable outcomes.

Collectively, these studies illustrate a fundamental tension in extension service design: while top-down approaches offer efficiency, scalability, and consistency, participatory models provide localised insights, foster ownership, and enhance long-term sustainability. As such, no single training modality appears universally superior; rather, their effectiveness depends on contextual factors, including institutional capacity, farmer demographics, and the nature of the agricultural innovations being promoted.

This study addresses a notable gap in the literature by empirically evaluating the effectiveness of a participatory training delivery model for small-scale horticultural farmers in Tanzania. Specifically, it examines the outcomes of farmer-specific training implemented through a participatory approach by the Tanzania Horticultural Association (TAHA). The core objective is to assess whether participatory training methods lead to the intended improvements in farmer performance and in the adoption of practices among smallholder horticulturalists. Grounded in the Tanzanian context, the study provides context-specific insights to inform the design and implementation of more effective agricultural training programs.



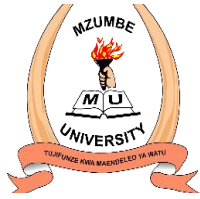
Theoretically, the research is underpinned by Indigenous Knowledge Theory, which emphasises the importance of incorporating local knowledge systems in shaping farmers' receptiveness to training and their willingness to adopt innovative practices. By integrating this perspective, the study contributes to a deeper understanding of how contextually relevant learning approaches can enhance the effectiveness of agricultural extension services.

The article is organised as follows: Section Two presents the theoretical perspective. Section Three reviews the empirical literature and develops the research hypothesis and conceptual framework. Section Four outlines the research methodology. Section Five reports the empirical results. Section Six discusses the findings and concludes with implications and recommendations.

2.1 Theoretical Perspective

This study is anchored in Indigenous Knowledge Theory, as articulated by Hountondji (1997) which underlines the significance of localised, culturally embedded knowledge systems in addressing real-world challenges. The theory posits that traditional knowledge accumulated and transmitted across generations within specific socio-cultural and ecological contexts offers practical and contextually relevant solutions to pressing issues, including those in agriculture. In this regard, Indigenous Knowledge Theory emphasises the value of community-based understandings and experiential learning in shaping sustainable agricultural practices and improving farmers' decision-making processes (Nyakaisiki et al., 2019). By leveraging these localised knowledge systems, the theory provides a lens through which farmer training programs, such as those examined in this study, can be tailored to align with the lived experiences and existing knowledge frameworks of small-scale horticultural farmers.

Indigenous knowledge has been broadly conceptualized as a dynamic and cumulative body of practices, beliefs, and experiences that evolves through adaptive processes and is transmitted across generations through cultural traditions. Kom et al. (2023) describe it as encompassing the relational understanding that local communities have with each other and with their surrounding environment. In the context of this study, indigenous

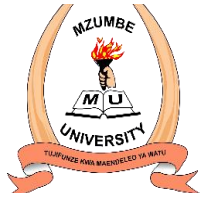


knowledge systems (IKS) refer to a repository of culturally embedded know-how, beliefs, local customs, and experiential strategies for managing natural resources, all of which have been preserved and refined over time through intergenerational transmission. These systems are often identified in scholarly discourse by various terms, including traditional ecological knowledge, local knowledge, farmers' knowledge, or Indigenous peoples' knowledge.

IKS represents more than just a set of technical practices; it is part of a broader cultural complex that includes language, classification systems, resource-use norms, social institutions, ritual practices, and spiritual beliefs. This form of knowledge is inherently situated, shaped by and responsive to the specific environmental, cultural, and socio-economic conditions of the communities in which it develops. As Baye and Teshome (2020) emphasise, indigenous knowledge is uniquely adapted to the geographical and cultural contexts of the societies that generate and sustain it, making it an invaluable resource for locally grounded development interventions, including those in agriculture.

In this study, Indigenous Knowledge Theory serves as a central conceptual framework for examining how small-scale horticultural farmers engage with externally delivered training interventions. The theory foregrounds the significance of culturally embedded knowledge systems, traditional practices, and lived experiences as valid and functional epistemologies. When applied in a comparative framework, specifically assessing the effectiveness of top-down versus participatory training models, Indigenous Knowledge Theory suggests that training content is more likely to be internalised, adapted, and applied when it aligns with or respects local knowledge traditions. From this perspective, participatory approaches are hypothesised to generate more effective outcomes, by fostering mutual learning, contextual relevance, and inclusive decision-making. In contrast, top-down approaches may risk marginalizing indigenous practices, potentially resulting in resistance, limited adoption, or disconnects between training content and the practical realities of smallholder farmers.

However, the application of Indigenous Knowledge Theory is not without limitations. One particular challenge is its reliance on oral transmission and informal learning channels, which often lack systematic documentation, thereby constraining the accessibility and scalability of indigenous knowledge among smallholder farming communities. Furthermore, the theory is inherently context-specific knowledge systems that prove effective in one cultural or ecological setting may not translate easily to another. Given the



heterogeneity of smallholder farmers' needs and challenges, sole reliance on indigenous knowledge may not provide comprehensive or universally applicable solutions (Sandy et al., 2024).

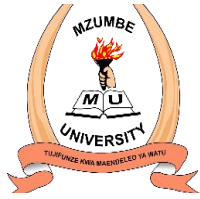
Despite these limitations, the adoption of Indigenous Knowledge Theory in this study is justified by its capacity to indicate how farmer-centered information exchange can facilitate the adoption of improved agricultural practices. The theory provides a valuable lens through which to understand the interplay between training modalities and the epistemic frameworks of smallholder farmers, particularly when those farmers are given the agency to adapt training content to their existing horticultural practices and socio-cultural contexts.

2.2 Empirical Literature Review and Hypotheses Development

Although the determinants of performance among small-scale horticultural farmers are contextually varied and not universally agreed upon, a substantial body of empirical literature emphasizes the importance of targeted agricultural training in enhancing productivity and sustainability. Numerous studies have consistently identified training as a key enabler of improved agronomic practices, and hence performance.

For instance, Habiyambere and Njenga (2022) documented that agricultural training in Rwanda contributed to improved harvest quality, increased sales volumes, enhanced profitability, better product storability, and stronger market positioning. Mwangi (2020), studying horticultural projects in Kenya, found training to be a more influential determinant of sustainability than infrastructural or financial support. Similarly, Zhou et al. (2020) reported that Tanzanian smallholders who received structured training outperformed their untrained counterparts in terms of yield and profitability.

Additional evidence by Luo et al. (2022) and Pandey et al. (2024) supports the conclusion that trained farmers exhibit significantly better performance metrics, including higher yields and improved adoption of agronomic innovations. Bai-Sesay (2024) further linked agricultural training with enhanced conservation practices, largely due to improved farmer understanding and application of ecological knowledge. Pandey et al. (2024) also emphasized the importance of sustained exposure to training, arguing that repeated engagement enhances program effectiveness and promotes the widespread adoption of sustainable practices. This is corroborated by Kirui et al. (2025) and Mgendi et al. (2021),



who demonstrated that targeted training positively affects vegetable productivity and quality.

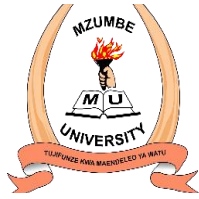
Fikadu and Gebre (2021) emphasised the practical skills imparted through training, including optimal plant spacing, timely irrigation, integrated pest management, and crop rotation. Their study also noted improvements in farm management through enhanced record-keeping, allowing farmers to track inputs and outputs and respond more effectively to market demands in terms of product quality, appearance, and shelf life.

Despite these converging findings, the delivery mode of training specifically the efficacy of participatory versus top-down approaches remains contested. While most studies agree on the value of training, a critical gap persists regarding the optimal model for delivering such services, especially within the Tanzanian context, where empirical studies remain limited.

A number of scholars advocate for top-down training approaches, highlighting their scalability and uniformity. For example, Maertens et al. (2021) found that structured, centrally delivered training in Malawi led to higher technology adoption and productivity. Jordan and Guerzoni (2022) showed that formal government-led programs in Ethiopia enhanced the uptake of agricultural inputs, while Rakoena et al. (2022) emphasised that public extension agents in South Africa remained trusted sources of knowledge despite limited farmer involvement. Similarly, Mwinkom et al. (2021) argued that public agents are pivotal for disseminating standardised agricultural innovations, such as climate-smart practices and Push-Pull Technology

. Top-down approaches have also proven effective in influencing resistant or less proactive farmers. For instance, Jordan and Guerzoni (2020) found that fertiliser advice delivered through centralised channels influenced even reluctant Ethiopian farmers, while Turyasingura and Chavula (2022) demonstrated the scalability and effectiveness of ICT-based training in Uganda.

Conversely, proponents of participatory training models argue that meaningful farmer involvement in planning, design, and implementation fosters greater ownership, relevance, and contextual adaptation of training content. Van den Berg et al. (2021) noted that



participatory engagement is critical for ensuring the effectiveness of interventions. Mariyono et al. (2022), studying Farmer Field Schools in Indonesia, observed gains in farmer knowledge and ecological awareness, although improvements in yield and adoption consistency were mixed. Similarly, Wijeratne and De Silva (2024) advocated for the use of Participatory Rural Appraisal methods to improve training outcomes by integrating grassroots insights. Osumba et al. (2021) also emphasised the participatory model as the most effective for achieving sustainable impact, arguing that co-designed interventions better align with farmers lived realities.

In Tanzania, Mdemu et al. (2023) found that participatory approaches yielded better performance outcomes for small-scale farmers than traditional extension models. These

findings suggest that context-specific participatory training may offer greater long-term benefits, especially when tailored to local knowledge systems and ecological conditions.

Adding to this complexity is the emerging literature on integrating Indigenous Knowledge

Systems (IKS) into training interventions. Sospeter et al. (2025) highlighted the role of Indigenous knowledge in climate adaptation practices among Tanzanian smallholders. Transmitted through community networks and intergenerational teaching, this knowledge system includes traditional water conservation techniques, diversified cropping, cultural rituals, and organic pest management. Sospeter recommended greater empirical documentation and integration of IKS into formal training mechanisms to enhance their cultural resonance and effectiveness.

Taken together, the reviewed studies reflect a consensus on the importance of training for improving small-scale horticultural performance. However, contradictions remain concerning the comparative effectiveness of top-down versus participatory training approaches. While the former is praised for efficiency and scalability, the latter is often lauded for its contextual relevance and farmer empowerment. In Tanzania, this dichotomy remains underexplored, especially within horticultural sub-sectors, presenting an important empirical gap.

In light of the preceding discussion and acknowledging the empirical ambiguities surrounding training delivery models, this study posits the following hypothesis for empirical testing:

H1: Access to training services significantly influences the performance of small-scale horticultural farmers when delivered through a participatory approach.

Research Model

Drawing on Ingenuous Theory and empirical literature review, and the formulated hypotheses, Figure 1 substantiates the research framework underpinning this study



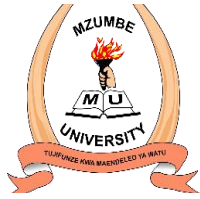
Figure 1: Conceptual Framework

Source: Developed from Literature Review

3. Methodology

This study was anchored in a positivist research philosophy, which posits that social phenomena can be objectively observed, measured, and analysed through empirical methods. This ontological and epistemological stance facilitated the development and testing of hypotheses using a structured, quantifiable approach, thereby enabling the establishment of causal relationships between variables. Consistent with positivist assumptions, a deductive reasoning approach was employed. Existing theoretical frameworks guided the formulation of testable hypotheses, which were subsequently validated through empirical data. The adoption of a deductive strategy reinforced the study's objective: to empirically test theoretical constructs related to training delivery models and smallholder horticultural performance.

An explanatory research design was selected to investigate causal relationships among the study's key constructs. This design was deemed appropriate given the study's objective to identify the direction and strength of associations between access to participatory training services and farmer performance outcomes. To operationalise this design, a quantitative survey strategy was implemented. This method was selected for its efficiency in collecting



standardised data from a large, geographically dispersed population and its compatibility with the study's deductive orientation.

Study Area and Contextual Justification

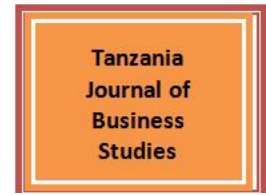
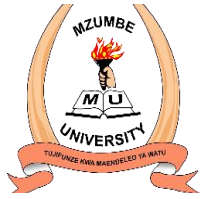
The research was conducted in Arusha, Njombe, and Unguja, purposively selected for their strategic significance in Tanzania's horticultural economy and for their active engagement with the Tanzania Horticultural Association (TAHA)'s training programs. These regions collectively represent approximately 65% of the 46,500 small-scale horticultural farmers currently registered with TAHA. According to historical data as per Irwin, 2018, TAHA had approximately 42,000 members in 2018, a figure that has since risen, underscoring the organisation's growing outreach and relevance. Arusha, in particular, hosts the largest cluster of registered horticultural farmers to its favorable agro-ecological conditions and relatively advanced infrastructure (Mwandima, 2015).

Established in 2004, TAHA operates as an apex, member-based private-sector organisation tasked with fostering inclusive growth in Tanzania's horticulture sector. Its functions include policy advocacy, extension service provision, capacity building, and value chain facilitation. In collaboration with the Government of Tanzania, TAHA implements key interventions, especially in the delivery of training and technical support services (Ng'atigwa et al., 2020).

Sampling Design and Data Collection

The study employed a probability-based random sampling technique, ensuring representativeness and reducing selection bias. The sampling frame consisted of 30,000 small-scale horticultural farmers across the three target regions. The required sample size was calculated using Cochran's formula, yielding an initial estimate of 381 respondents. In line with recommendations by Miroro et al. (2023), the sample size was increased by 20% to 457 respondents to mitigate the risk of non-responses.

Data collection resulted in 432 completed responses, of which 397 were deemed valid for statistical analysis after data cleaning and screening. The unit of analysis was the individual smallholder farmer, defined as both the recipient and implementer of the training services provided under TAHA's programs. The survey instruments were administered using a structured questionnaire composed of closed-ended items designed to measure latent constructs aligned with the study's conceptual model.



Instrument Validation and Data Quality Assurance

To ensure the validity and reliability of the data collection instrument, the study employed both pre-validated and adapted measurement scales from extant literature. Content and construct validity were assessed through expert review and pilot testing. Internal consistency was evaluated using Cronbach’s alpha and composite reliability (CR) measures, while convergent and discriminant validity were assessed through Average Variance Extracted (AVE) and the Fornell–Larcker criterion, respectively.

Analytical Procedure

For data analysis, the study utilized Partial Least Squares Structural Equation Modelling (PLS- SEM), implemented via SmartPLS software. PLS-SEM was selected in handling complex models with latent constructs and moderating effects, and for its suitability for exploratory and theory-testing studies with relatively small to medium sample sizes. The approach also accommodates non-normal data distributions and supports the simultaneous evaluation of measurement and structural models.

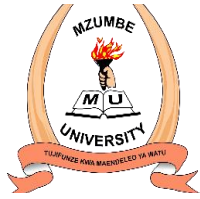
Prior to model estimation, a rigorous data preprocessing protocol was implemented. This included handling missing values, identifying outliers, verifying linearity assumptions, and ensuring response consistency. These steps were essential in preserving the integrity of the dataset and enhancing the credibility of the findings.

Operationalization of Variables

Operationalization of the Variables: Predictor Access to Training Services was conceptualised by six items as indicated below.

Table 1: Operationalization of Variable Access specific farmers' trainings

Indicators	Indicative measures elaborations	Source
Involvement in Planning Initiatives	I'm always involved in planning the training programes	(Mdemu et al., 2023)
Accommodating local knowledge in training initiatives	The training initiatives from external actors take into consideration existing local knowledge(e.g., indigenous planting techniques, soil conservation practices, and seasonal cropping patterns).	(Sospeter, Mtega, & Malekani, 2025)



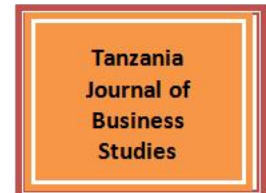
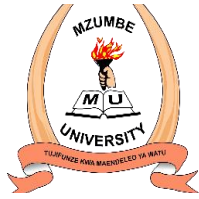
Farming skills	The training has equipped me with practical and efficient agricultural skills (For example, appropriate plant spacing, timely irrigation, effective pest management, and the implementation of crop rotation practices.	(Fikadu & Gebre, 2021)
Farm record-keeping	Through farm record-keeping, I have improved my farm accounting skills (For example, in tracking production inputs and outputs)	(Fikadu & Gebre, 2021)
Product Quality	After the training, my horticultural produce now better meets consumers' expectations in terms of shape, taste, shelf life, variety, and colour.	(Fikadu & Gebre, 2021)
Post-Harvest Loss Reduction	My post-harvest produce loss has consistently gone down after attending the training.	(Chegere, Eggert, & Söderbom, 2022)

The instrument used in this study asked respondents to rate the items on a Likert scale ranging from 1 to 7, allowing them to express their perceptions (Axelin, Raiskila, & Lehtonen, 2020). The scale was structured as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neither Agree nor Disagree, 5 = Somewhat Agree, 6 = Agree, and 7 = Strongly Agree. This approach is supported by Kusmaryono, Wijayanti, and Maharani (2022), who assert that a rating scale with an odd number of responses (more than five points, especially on a seven-point scale) is the most appropriate Likert Measurement Scale in the social sciences, as it increases reliability.

4. Results

The study revealed that small-scale horticulture farming in Tanzania is predominantly male-driven (61%), with the majority of participants aged 25–54 (69%), indicating that agriculture is mainly undertaken by mature adults capable of handling labour-intensive tasks. Most respondents (54%) have 2–5 years of farming experience, with 78% having 2–10 years overall, suggesting a relatively youthful farming population that needs youth-focused interventions. Academically, 91% had primary or secondary education, suggesting limited formal education but sufficient literacy to engage in farming activities.

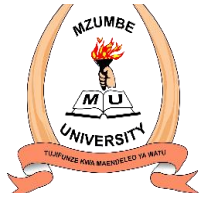
Economically, 46% rely solely on farming, emphasising the sector's role in livelihood. Farm



sizes are small, with 94% owning less than 5 acres, underlining the need for support tailored to very small-scale operations. Additionally, 82% of respondents are members of farm groups, affirming the study’s focus on a demographic likely to benefit from collective access to services and innovations.

Table 2: PLS Model Quality Criteria Access to Training Services

Indicator	Variables	Loadings	Cronbach's alpha	CR (rho_a)	CR (rho_c)	AVE
AT1	I am always involved in planning the training program	0.821	0.840	0.869	0.882	0.600
AT2	The training initiatives from external actors take into consideration existing local knowledge (e.g, indigenous planting techniques, soil conservation practices, and seasonal cropping patterns)	0.784				
AT3	I can carry out horticultural farming practices effectively, which enables me to apply efficient skills (e.g, proper spacing, timely irrigation, pest management, and crop rotation)	0.744				
AT4	Farm accounting skills, in terms of the practice of keeping documents on production inputs and outputs in horticultural farming, have improved. Following the training.	0.715				
AT5	After the training, my horticultural produce now better meets consumers' expectations in terms of shape, taste, shelf life, variety, and colour.	0.806				
HP1	My crop production has increased.	0.765				



HP2	I have employed some more staff.	0.781	0.768	0.770	0.852	0.590
HP3	My income has increased.	0.720				
HP4	I have expanded my farms.	0.803				

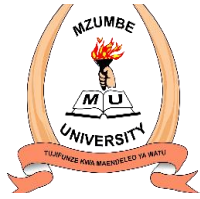
Note: AVE = Average Variance Extracted, CR = Composite Reliability

Measurement Models

To evaluate the reliability and validity of the latent constructs, the study employed Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS. Following the guidelines of Hair Jr. et al. (2021), the measurement model was assessed by examining indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. All standardised outer loadings for reflective indicators exceeded the recommended threshold of 0.70 and were statistically significant at the 0.05 level, indicating strong indicator reliability. As shown in the Table2, the Average Variance Extracted (AVE) values for all constructs surpassed the 0.50 minimum threshold (Purwanto & Sudargini, 2021), confirming adequate convergent validity. Internal consistency reliability was evaluated using Composite Reliability (CR) and Cronbach's Alpha (α). All latent constructs reported CR and α values above the 0.70 benchmark, which supports the internal consistency and measurement reliability of the constructs (Hair Jr. et al., 2021). Therefore, the reflective measurement model demonstrated satisfactory psychometric properties across all evaluated criteria.

Common Method Bias

Common Method Bias (CMB) refers to variance attributable to the measurement method rather than to the constructs being measured, and it poses a risk in cross-sectional survey designs in which both predictor and outcome variables are collected from the same respondents (Kock et al., 2021). Sources of CMB typically include item similarity, everyday measurement context, and respondent tendencies. To mitigate CMB, this study incorporated both procedural (ex-ante) and statistical (ex post) remedies. Procedurally, a pilot test was conducted to refine and validate the clarity, neutrality, and structure of measurement items. The instrument provided explicit instructions, ensured respondent anonymity, and emphasised confidentiality to reduce evaluation apprehension and social desirability bias.



Statistically, the study utilised complete collinearity assessment as recommended by Kock et al. (2021). Variance Inflation Factors (VIFs) were computed for each latent construct. As presented in Table 3, all VIF values were well below the conservative threshold of 3.3, indicating the absence of multicollinearity and no evidence of common method bias in the dataset. Together, these steps ensured that the measurement model's integrity was maintained and that observed relationships among constructs were not artefacts of the data-collection method.

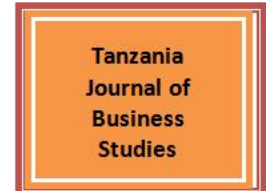
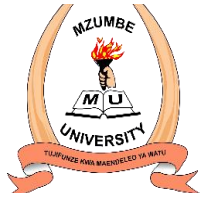


Table 3: Full Collinearity VIFs

Indicator	VIF
AT1	1.698
AT2	1.727
AT3	2.465
AT4	2.372
AT5	1.741
HP1	1.584
HP2	1.612
HP3	1.441
HP4	1.729

Structural Model

The model was initially examined for multicollinearity using the Variance Inflation Factor (VIF) Values. Teunis, Jayakumar, and Ring (2021) suggest that a measurement model is free from collinearity problems when the Variance Inflation Factor (VIF) of outer coefficients is below 3.0. In our study, the VIF values for the outer coefficients were all below this threshold, indicating that collinearity is not an issue in the measurement model.

The explanatory power and predictive importance of exogenous factors were evaluated using the coefficient of determination (R-squared), a requirement for evaluating the structural model. As indicated in Table 4, the R-Square value for the direct relationship between small-scale horticultural farming performance and performance is 0.187. Therefore, access to and use of specific farmers' Training services can contribute as much as 18.7% to the sector's performance. In this study, the f^2 values for the variables access to training services was 0.119. This value exceeds the threshold for a minimal effect of 0.02, placing them in the category of small and medium influence, which aligns with the notion that the influence of access to training services on the performance of the small-scale horticulture farming sector is not negligible (Cohen, 1988). Predictive relevance (Q2) of 0.05, which is greater than zero, confirms that access to specific farmers' training services influences the performance of small-scale horticultural farmers, with predictive power over access to training services as highlighted below.

Table 4: Explanatory Power and Predictive Relevance

Relationship Type	R ²	F ² -Effect size	Predictive relevance (Q ²)
Direct Relationship	0.187	0.119	0.05

Results of Hypotheses Testing

After the two-step analysis to verify the reliability and validity of the measures, the path relationships are presented in the structural model. Findings indicate that Access to Trainings Services in is positively associated with performance of small-scale horticulture farmers. The results show these Access to Training Services explains almost 18.7 per cent of the variation in small-scale horticulture farmers' performance. The major goal of the study was to examine how access to training services influences the performance of small-scale horticulture in Tanzania. The results in Table 5 indicate that access to specific small-scale horticultural farmers' training services significantly influences small-scale

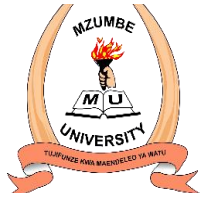
horticulture performance ($\beta = 0.432$, $t = 9.871$, $p < 0.00$). As a result, the findings supported the hypothesis that access to training positively influenced the performance of small-scale horticulture farmers.

Table 5: Results of Hypotheses Testing c

Hypothesis	Original sample (O)	Sample mean (M)	Standard deviation	T statistics	P values	Remarks
AT -> HP	0.432	0.438	0.044	9.871	0.000	Accept the Hypothesis

Discussion of Findings and Theoretical Implications

This study examined the influence of access to specific training services on the performance of small-scale horticultural farmers in Tanzania, particularly within the context of participatory training delivery models. The empirical results, presented in Table 5, indicate that access to training services (AT) has a positive, statistically significant effect on horticultural performance (HP) among small-scale farmers ($\beta = 0.432$, $p < 0.05$; $t > 1.65$, one-tailed test). This finding affirms the hypothesised relationship and is consistent with a substantial body of empirical literature.



Prior studies have similarly documented the performance-enhancing impact of targeted training among smallholder farmers (Bai-Sesay, 2024; Fikadu & Gebre, 2021; Habiya mbere & Njenga, 2022; Kansanga et al., 2021; Kirui et al., 2025; Mgendi et al., 2021; Mwangi et al., 2023; Pandey et al., 2024; Zhou et al., 2020). These studies collectively emphasise the role of agricultural training in improving agronomic practices, market access, and overall productivity.

Furthermore, the findings underscore the effectiveness of participatory training approaches in enhancing farmer performance. This aligns with existing scholarship advocating participatory methodologies for the provision of agricultural extension services (Mariyono et al., 2022; Osumba et al., 2021; van den Berg et al., 2021; Wijeratne & De Silva, 2024). These studies argue that participatory models improve knowledge retention, contextual adaptation, and farmer empowerment, key factors in ensuring the long-term success of capacity-building interventions.

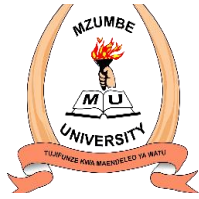
The results also resonate with the perspective advanced by Sospeter et al. (2025), who highlighted the value of Indigenous Knowledge Systems (IKS) in training smallholder farmers in Tanzania. Their study emphasised that locally embedded knowledge, passed through generations and grounded in community experience, plays a pivotal role in addressing context-specific environmental and agronomic challenges.

Theoretical Implications

The findings offer important theoretical contributions, particularly in validating the relevance of Indigenous Knowledge Theory as a conceptual lens in the study of smallholder agricultural development. This theory asserts that local knowledge systems, cultural practices, and lived experiences are not only legitimate but functionally effective in shaping farmer behaviour and response to externally introduced interventions.

In this study, Indigenous Knowledge Theory provided a framework for understanding how farmers engage with training initiatives, particularly when these are designed and implemented using participatory approaches that respect and integrate local epistemologies. The empirical support for this framework reinforces its theoretical utility in agricultural and rural development contexts, especially in sub-Saharan Africa.

While the model confirms the significant role of training access, it explains approximately 19% of the variance in farmer performance, leaving 81% unexplained. This suggests the



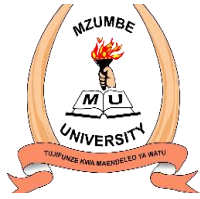
presence of other critical variables not captured within the current model. Factors such as access to credit, the quality of extension services, market linkages, irrigation infrastructure, and land tenure security are likely to significantly influence farmer outcomes. For instance, access to credit has been associated with yield improvements of up to 30% among Tanzanian smallholders (Rasheed et al., 2024; Winter-Nelson & Temu, 2005). Similarly, contract farming schemes underpinned by reliable extension systems have been shown to enhance productivity and reduce market risk (Abdulla et al., 2023). These findings suggest fruitful directions for future inquiry to construct a more comprehensive explanatory model of small-scale horticultural performance.

Study Practical Implications

The findings of this study offer significant policy guidance for institutions involved in the training and development of small-scale horticultural farmers in Tanzania, including the

Ministry of Agriculture, the Tanzania Horticultural Association (TAHA), and international development partners. The evidence emphasises the value of training models that actively involve farmers in both the design and delivery of learning initiatives. Such participatory approaches align with contemporary scholarship and are grounded in theoretical frameworks such as Indigenous Knowledge Theory, which affirms the relevance of culturally embedded, context-specific knowledge systems.

Policymakers are thus encouraged to shift from conventional, top-down dissemination strategies towards more inclusive frameworks that incorporate local knowledge, farmer-led innovations, and community-based decision-making. This not only enhances the adoption of new agricultural practices but also ensures that the content of training interventions is culturally resonant and contextually appropriate. Moreover, given that approximately 81% of the variation in farmer performance remains unexplained by training alone, it is imperative that policy strategies also address structural enablers, such as access to affordable credit, reliable infrastructure, and quality extension services, which are known to impact smallholder productivity. A multisectoral policy framework that embeds participatory training within a broader ecosystem of support is essential to achieving long-term improvements in horticultural performance among small-scale farmers.



Theoretical Contributions

This study contributes to the theoretical advancement of Indigenous Knowledge Theory by providing empirical support for its application in the context of small-scale horticultural farming in Tanzania. The results reveal that participatory training models significantly enhance farmer performance, thereby affirming the theory's central premise: that culturally grounded knowledge systems, local traditions, and experiential learning are valid and powerful drivers of behaviour and innovation in rural agricultural settings.

The research highlights the integrative potential of participatory training approaches in bridging indigenous epistemologies with formal agricultural extension systems. This convergence strengthens both the credibility and effectiveness of training interventions, offering a nuanced understanding of how indigenous and scientific knowledge can coexist to produce measurable outcomes. These findings enrich the theoretical discourse by illustrating how bottom-up knowledge systems can be operationalised within formalised training structures to facilitate sustainable development.

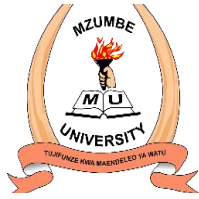
Study Limitations

Despite its contributions, this study is subject to several limitations. Chief among them is its reliance on a cross-sectional design, which captures data at a single point in time and limits the ability to infer causal relationships among variables. Additionally, the use of self-reported data introduces the potential for response bias, particularly for attitudes and behaviour that are socially or culturally sensitive, such as the use of indigenous knowledge

The limited scope of survey instruments may also constrain the study's ability to capture the full complexity of farmer experiences and knowledge systems. To address these limitations, future research could employ longitudinal designs to track changes over time and integrate qualitative methods better to capture the depth and nuance of indigenous knowledge practices. Nonetheless, the current study provides a solid empirical foundation and opens meaningful pathways for future research and policy development in smallholder agriculture.

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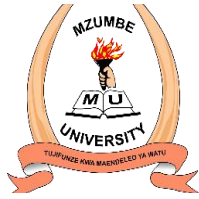


Conflict of Interest Statement

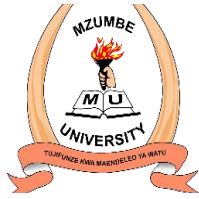
The author declares no conflict of interest, financial, institutional, or personal that could have influenced the development or outcomes of this research.

Reference

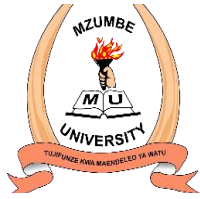
- Abdulla, N., Vasylieva, N., & Volovyk, I. (2022). Production optimization for sustainable agriculture and efficient contract farming in the Republic of Maldives. *Bulgarian Journal of Agricultural Science*, 28(4).
- Ahmed, M., Babayola, M., & Bake, I. (2024). Role of Horticultural Crops in Food and Nutritional Security: A Review. *J. Nutrition and Food Processing*, 7(8).
- Axelin, A., Raiskila, S., & Lehtonen, L. (2020). The Development of Data Collection Tools to Measure Parent-Infant Closeness and Family-Centred Care in NICUs. *Worldviews on Evidence-Based Nursing*, 17(6), 448-456.
- Bai-Sesay, G. (2024). *Assessment of cooperative interventions on beekeeping, household incomes and forest conservation: A case of Kamaki farmers' cooperative society in Kitui County, Kenya*
- Bakshi, P., Singh, M., Kour, K., Iqbal, M., Kumar, R., & Sarita. (2022). Horticulture: A key for Sustainable development. In *Innovative approaches for sustainable development: Theories and practices in agriculture* (pp. 169-190). Springer.
- Baye, B., & Teshome, W. (2020). The role of indigenous knowledge in agricultural farming practices: the case of Gonder and Gojam areas, Amhara Regional State, Ethiopia. *International journal of advanced research in biological sciences*, 7(12), 106-112.
- Chegere, M. J., Eggert, H., & Söderbom, M. (2022). The effects of storage technology and training on postharvest losses, practices, and sales: evidence from small-scale farms in Tanzania. *Economic Development and Cultural Change*, 70(2), 729-761.
- Cohen, J. (1988). Set correlation and contingency tables. *Applied psychological measurement*, 12(4), 425-434.
- Fikadu, A. A., & Gebre, G. G. (2021). Evidence from Fogera district in Ethiopia on the configuration of farmers' information literacy conditions that better explain the productivity performance of horticultural crops. *Agriculture & Food Security*, 10(1), 24.



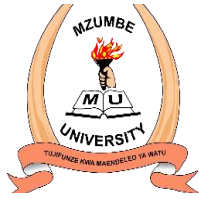
- George, W. (2022). Export performance of the horticultural sub-sector in Tanzania. In *Trade and Investment in East Africa: Prospects, Challenges and Pathways to Sustainability* (pp. 293–313). Springer.
- Habiyambere, M., & Njenga (2022). Influence of smallholder farmers training on project performance: A case of smallholder horticulture farmers under the PRICE project, Rwanda.
- Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modelling (PLS-SEM) using R: A workbook*. Springer Nature.
- Hlatshwayo, S. I., Slotow, R., & Ngidi, M. S. C. (2023). The role of smallholder farming on rural household dietary diversity. *Agriculture, 13*(3), 595.
- Hountondji, P. J. (1997). Endogenous knowledge: Research trails.
- Irwin, D. (2018). Influencing public policy in Tanzania: Trials and tribulations of the Tanzania Horticultural Association. *Pan-African Journal of Business Management, 2*(1), 35-54.
- Jordan, A., & Guerzoni, M. (2020). The pain of a new idea: Do Late Bloomers response to Extension Service in Rural Ethiopia? *arXiv preprint arXiv:2006.02846*.
- Jordan, A., & Guerzoni, M. (2022). Extension services in Ethiopia: First adoption of chemical fertilizers in rural villages. *African Journal of Science, Technology, Innovation and Development, 14*(5), 1240-1252.
- Kansanga, M. M., Kerr, R. B., Lupafya, E., Dakishoni, L., & Luginaah, I. (2021). Does participatory farmer-to-farmer training improve the adoption of sustainable land management practices? *Land use policy, 108*, 105477.
- Kasimba, S., Covic, N., Motswagole, B., Cockeran, M., & Claasen, N. (2022). Street vending of traditional and indigenous food and the potential contribution to household income, food security and dietary diversity: the case of Gaborone, Botswana. *Agroecology and Sustainable Food Systems, 46*(2), 181-199.
- Kirui, E. C., Kidoido, M. M., Akutse, K. S., Wanyama, R., Boni, S. B., Dubois, T., Dinssa, F. F., & Mutyambai, D. M. (2025). Factors Influencing the Adoption of Agroecological Vegetable Cropping Systems by Smallholder Farmers in Tanzania. *Sustainability (2071-1050), 17*(3).
- Kirui, E. C., Kidoido, M. M., Mutyambai, D. M., Okello, D. O., & Akutse, K. S. (2023). Farmers' knowledge, attitude, and practices regarding the use of agroecological-based pest management practices in crucifers and traditional african vegetable (TAV) production in Kenya and Tanzania. *Sustainability, 15*(23), 16491.
- Kock, F., Berbekova, A., & Assaf, A. G. (2021). Understanding and managing the threat of common method bias: Detection, prevention and control. *Tourism management, 86*, 104330.
- Kom, Z., Nethengwe, N. S., Mpandeli, S., & Chikoore, H. (2023). Indigenous knowledge indicators employed by farmers for adaptation to climate change in rural South Africa. *Journal of Environmental Planning and Management, 66*(13), 2778-2793.



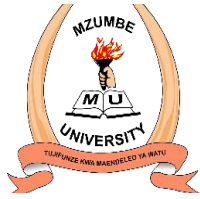
- Kusmaryono, I., Wijayanti, D., & Maharani, H. R. (2022). Number of Response Options, Reliability, Validity, and Potential Bias in the Use of the Likert Scale Education and Social Science Research: A Literature Review. *International Journal of Educational Methodology*, 8(4), 625-637.
- Luo, L., Qiao, D., Tang, J., Wan, A., Qiu, L., Liu, X., Liu, Y., & Fu, X. (2022). Training of farmers' cooperatives, value perception and members' willingness of green production. *Agriculture*, 12(8), 1145.
- Maake, M. M. S., & Antwi, M. A. (2022). Farmer's perceptions of effectiveness of public agricultural extension services in South Africa: an exploratory analysis of associated factors. *Agriculture & Food Security*, 11(1), 34.
- Maertens, A., Michelson, H., & Nourani, V. (2021). How do farmers learn from extension services? Evidence from Malawi. *American Journal of Agricultural Economics*, 103(2), 569-595.
- Makule, E., Dimoso, N., & Tassou, S. (2024). Production, Postharvest Practice, Marketing and Challenges of Smallholder Vegetable Producers in Tanzania.
- Mariyono, J., Dewi, H. A., Daroini, P. B., Latifah, E., Hakim, A. L., & Luther, G. C. (2022). Farmer field schools for improving economic sustainability performance of Indonesian vegetable production. *International Journal of Productivity and Performance Management*, 71(4), 1188-1211.
- Masele, J. J. (2023). Information needs and sources used by small-scale horticulture farmers in Morogoro urban, Tanzania. *University of Dar Es Salaam Library Journal*, 18(2).
- Mdemu, M. V., Kimaro, E. G., Tafula, M., de Sousa, W., Moyo, M., Parry, K., Bjornlund, H., Mukwakwami, N., & Ramshaw, P. (2023). Participatory mapping of irrigation schemes in Tanzania, Mozambique and Zimbabwe and their value for multi-level learning. *Agricultural Water Management*, 290, 108591.
- Mgendi, G., Mao, S., & Qiao, F. (2021). Is a training program sufficient to improve the smallholder farmers' productivity in Africa? Empirical evidence from a Chinese agricultural technology
- Miroro, O. O., Anyona, D. N., Nyamongo, I., Bukachi, S. A., Chemuliti, J., Waweru, K., & Kiganane, L. (2023). Determinants of smallholder farmers' membership in co-operative societies: evidence from rural Kenya. *International Journal of Social Economics*, 50(2), 165-179.
- Mwandima, I. H. (2015). *Towards unlocking the hidden potential of Horticulture in Arusha Tanzania*
- Mwangi, J., Chitere, P., & Kariuki, J. (2023). Determinants of Smallholder Farmers' Access to Agricultural Extension Channels and their Effects on Awareness and Compliance with Good Agricultural Practices in Kenya. *International Journal of Agricultural Management and Development*, 13(4), 273-288.
- Mwangi, R. W. (2020). Credit, entrepreneurship training, and performance of micro and small enterprises in Nakuru County, Kenya. *Nairobi: Kenyatta University*.



Mwinkom, F. X., Damnyag, L., Abugre, S., & Alhassan, S. I. (2021). Factors influencing climate change adaptation strategies in North-Western Ghana: evidence of farmers in the Black Volta Basin in Upper West region. *SN Applied Sciences*, 3(5), 548.



- Ng'atigwa, A. A., Hepelwa, A., Yami, M., & Manyong, V. (2020). Assessment of factors influencing youth involvement in horticulture agribusiness in Tanzania: A case study of Njombe Region. *Agriculture*, 10(7), 287.
- Nyakaisiki, K., Mugume, I., Ngailo, T., & Nakabugo, R. (2019). The use of indigenous knowledge in predicting changes in seasonal rainfall by smallholder farmers of ruteete subcounty, Kabarole District. *Journal of Geoscience and Environment Protection*, 7(1), 13-22.
- Osumba, J. J., Recha, J. W., & Oroma, G. W. (2021). Transforming agricultural extension service delivery through innovative bottom-up climate-resilient agribusiness farmer field schools. *Sustainability*, 13(7), 3938.
- Pandey, S. C., Modi, P., Pereira, V., & Fosso Wamba, S. (2024). Empowering small farmers for sustainable agriculture: a human resource approach to SDG-driven training and innovation. *International Journal of Manpower*.
- Purwanto, A., & Sudargini, Y. (2021). Partial least squares structural equation modeling (PLS-SEM) analysis for social and management research: a literature review. *Journal of Industrial Engineering & Management Research*, 2(4), 114-123.
- Rakoena, V. M., Maake, M. M. S., & Antwi, M. A. (2022). The impact of the recapitalisation and development programme on agricultural productivity in South Africa. *Journal of Agribusiness and Rural Development*, 64(2), 169-176.
- Rasheed, S., Tabasam, N., Anwar, J., & Jabeen, S. (2024). Impact of credit on agriculture production in Pakistan: A review. *European Journal of Ecology, Biology and Agriculture*, 1(1), 3-13.
- Sandy, N., Salehe, F., & Magesa, M. (2024). Sources and knowledge of smallholder farmers in agricultural information in Mvomero district, Tanzania: Where does misinformation originate? *Tanzania Journal of Agricultural Sciences*, 23(1), 19-32.
- Sospeter, M. E., Mtega, W. P., & Malekani, A. (2025). Indigenous knowledge for climate change adaptation among Tanzanian smallholder farmers: A systematic review. *IFLA Journal*, 03400352251317997.
- Teunis, T., Jayakumar, P., & Ring, D. (2021). The problem of collinearity in mental health and patient-reported outcome research. *Journal of Hand Surgery*, 46(2), e1-e2.
- Turyasingura, B., & Chavula, P. (2022). Climate-smart agricultural extension service innovation approaches in Uganda. *International Journal of Food Science and Agriculture*, 6(1).
- van den Berg, H., Phillips, S., Poisot, A.-S., Dicke, M., & Fredrix, M. (2021). Leading issues in implementation of farmer field schools: a global survey. *The Journal of Agricultural Education and Extension*, 27(3), 341-353.
- Wijeratne, M., & De Silva, W. (2024). The paradigm shift of agricultural extension from technology transfer towards participatory approaches. *Journal of Agricultural Sciences–Sri Lanka*, 19(1).



- Winter-Nelson, A., & Temu, A. A. (2005). Liquidity constraints, access to credit and pro-poor growth in rural Tanzania. *Journal of International Development*, 17(7), 867-882.
- Zhou, L., Zhang, F., Zhou, S., & Turvey, C. G. (2020). The peer effect of training on farmers' pesticide application: a spatial econometric approach. *China Agricultural Economic Review*, 12(3), 481- 505.