OPEN ACCESS

Int. J. Agr. Ext. 13 (02) 2025. 175-188

DOI:-10.33687/ijae.013.02.5866

Check for updates

Available Online at EScience Press

International Journal of Agricultural Extension

ISSN: 2311-6110 (Online), 2311-8547 (Print)

https://esciencepress.net/journals/IJAE

CHALLENGES TO EFFECTIVE IMPLEMENTATION OF HANNS R. NEUMANN STIFTUNG INTERVENTIONS AMONG SMALLHOLDER COFFEE FARMERS IN RUNGWE AND MBEYA DISTRICTS, TANZANIA

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ARTICLE INFO

Article History

Received: April 04, 2025

Revised: July 28, 2025

Accepted: August 08, 2025

Keywords

Coffee

Farmers

HRNS interventions

NGO

Smallholder

ABSTRACT

This study examined the challenges hindering the effective implementation of improved coffee production interventions by Hanns R. Neumann Stiftung (HRNS) in Rungwe and Mbeya Districts, Tanzania. A cross-sectional research design was adopted, employing multiple data collection methods. Data were collected from 52 randomly selected respondents in the smallholder coffee-growing areas of Mbeya. The respondents were members of Umalila and Tutafika Agricultural Marketing Cooperatives (AMCOS) in Isuto Ward, as well as Ikuti AMCOS in Ikuti Ward, using a structured questionnaire, focus group discussions, and key informant interviews. The study employed the Likert scale to examine perceptions of the challenges hindering effective implementation of HRNS interventions among smallholder coffee farmers in Rungwe and Mbeya Districts. Results revealed that 92.3% of respondents perceived the cost of implementing HRNS farming techniques as too high, 84.6% were unable to secure financial loans to support implementation, and 78.8% reported inadequate support from extension officers. Conversely, 61.5% disagreed with the statement that HRNS techniques had not been tested on a small scale prior to adoption. It is recommended that HRNS strengthen access to financial resources by facilitating credit schemes tailored to smallholder farmers. Improving connections to international markets, strengthening farmer organizations to enhance collective bargaining, and ensuring access to necessary resources are also recommended. Additionally, providing more consistent and accessible agricultural extension services to minimize pest and disease outbreaks is essential. HRNS should further expand targeted training for smallholder coffee farmers.

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INTRODUCTION

The global coffee industry is not only a vital component of international trade but also a significant source of livelihood for millions of people worldwide, particularly in coffee-growing regions of the Global South (Bager and Lambin, 2020). Coffee cultivation spans diverse landscapes, from the highlands of Ethiopia to the lush plantations of Brazil, encompassing a complex network of smallholder farmers, multinational corporations, and local cooperatives. However, this global industry is not without its challenges, as fluctuating market prices, climate change impacts, and socio-economic disparities continue to pose obstacles to the sustainability and prosperity of coffee-producing communities (Bianco, 2020).

To address these challenges, a range of global initiatives have emerged. Programmes such as Fair Trade and

Rainforest Alliance aim to create more equitable and sustainable coffee production by offering certification standards that ensure fair wages and environmentally responsible practices (Lemeilleur et al., 2020). The Sustainable Coffee Challenge and the Global Coffee Platform foster collaborative efforts between private companies, non-government organizations, and governments to promote long-term sustainability goals, such as climate resilience and improved livelihoods for farmers (Barreto Peixoto et al., 2023). Meanwhile, research-driven initiatives such as World Coffee Research focus on developing disease-resistant coffee varieties. At the same time, Volcafe and Starbucks Company support smallholder farmers through training in coffee production, processing, and access to better markets (Dietz et al., 2020). Together, these efforts reflect a growing recognition of the need for comprehensive, multi-stakeholder approaches to ensure the future sustainability of the global coffee industry.

Transitioning to the African continent, Tanzania stands out as a key player in the global coffee market, renowned for its high-quality Arabica beans cultivated in regions such as Ruvuma, Kilimanjaro, Arusha, Mbeya, and Mara (Makangila and Ahmad, 2023). Smallholder farmers are the backbone of Tanzania's coffee sector, contributing approximately 80per cent of the country's total coffee production (Tanzania Coffee Board, 2017). Despite its significant potential for driving economic growth and alleviating poverty, the Tanzanian coffee industry faces numerous challenges (Kessy, 2020). These challenges include limited market access, inadequate infrastructure, widespread coffee diseases, ageing coffee tree populations, poor adoption of recommended agronomic practices, and heightened vulnerability to climate change (Otieno et al., 2019).

The effects of these challenges on Tanzania's coffee sector are far-reaching and significantly impact both productivity and profitability (Kiwelu et al., 2021). Limited access to markets restricts smallholder farmers from obtaining fair prices for their coffee, often forcing them to sell their produce to middlemen at lower rates, which reduces their income by around 35% and discourages investment in improved farming practices (Kangile et al., 2021). Inadequate infrastructure, such as poor road networks and limited access to storage facilities, further compounds this problem by increasing the cost and difficulty of transporting coffee to markets (Kimaro and Nnko, 2024). The prevalence of coffee diseases, such as coffee leaf rust and coffee berry disease, alongside the ageing populations of coffee trees, has diminished 25% of the yields over the last decade, compromising bean quality and threatening the global competitiveness of Tanzanian coffee (Jawo, 2023).

Moreover, the slow adoption of modern agronomic practices, driven by limited access to knowledge and resources, hinders the efforts of improving productivity and farm sustainability (Snyder et al., 2020). Climate change adds another layer of complexity, as unpredictable weather patterns and extreme conditions, such as droughts and floods, increasingly affect coffee yields and quality (Tilumanywa, 2021). With the current production averaging 150-200 kg per hectare, which is far below the global recommended level of 1.5 metric tons per hectare, these challenges exacerbate the gap between Tanzanian coffee production and global standards (Lemma and Megersa, 2021). Addressing these issues is critical to unlocking the full potential of Tanzania's coffee sector and improving the livelihoods of smallholder farmers (Sambuo et al., 2017).

The Hanns R. Neumann Stiftung (HRNS) is a global organization dedicated to improving the livelihoods of smallholder farmers, particularly in coffee-growing regions of developing countries (Wagner et al., 2021). In Tanzania, HRNS has implemented a range of targeted interventions in Rungwe and Mbeya Districts to address the challenges faced by these farmers. According to HRNS Reports (2021), key interventions include capacity building on modern agronomic practices to enable farmers to improve production and productivity. HRNS also facilitates access to high-quality inputs such as improved seedlings and fertilizers, invests in better storage facilities to reduce post-harvest losses, and improves market connectivity. To improve collective action, HRNS supports the formation and strengthening of farmer primary cooperative societies, enabling better resource pooling and market negotiation.

Other interventions outlined by Lecoutere and Chu (2024) include promotion of climate-smart agricultural practices to help farmers adapt to changing weather patterns and manage environmental impacts. Pest and disease management is another critical area of focus, with HRNS providing resources and strategies to combat coffee diseases and pests. Efforts of enhancing market access include connecting farmers with buyers and developing value chains that add value to coffee through processing and branding. Financial support, including connecting

farmers with microfinance institutions, is provided to help farmers access loans, invest in their operations, and manage risks. Community engagement and capacity building are central to HRNS's approach, involving local stakeholders through on-farm training, workshops, and partnerships. Furthermore, HRNS supports research and development by working with Tanzania Coffee Research Institute to drive innovation and address emerging challenges in coffee cultivation (Ngango and Kim, 2019). Despite these comprehensive efforts, effective implementation of these interventions faces several challenges that impede their overall success, highlighting the need for undertaking this study.

The interventions by HRNS Tanzania have significantly transformed smallholder coffee farming, processing, and marketing. A key initiative has been the collaboration with the Tanzania Coffee Research Institute to implement improved coffee replanting programmes, revitalizing production with disease-resistant and high-yielding seedlings. Additionally, HRNS has provided extensive training in good agricultural practices (GAP), including pruning, pest management, and post-harvest handling, which has led to substantial increases in yield and quality. By connecting farmers directly to global markets, HRNS has enabled them to bypass middlemen, resulting in higher export prices and increased household income, further strengthening the sustainability and profitability of Tanzania's coffee sector.

Research on Tanzania's coffee landscape is gradually expanding, focusing on different dimensions, including stakeholders' efforts to address coffee sustainability challenges. Notable studies include Nsabimana and Tirkaso (2020), who analysed coffee export performance, finding that Tanzania's coffee exports are heavily influenced by exchange rates, global market prices, and productivity levels, with the country underperforming compared to its regional counterparts. Makangila and Ahmad (2023) and Kangile et al. (2021) both evaluated the implementation of coffee certification schemes, highlighting that certification has improved the quality and marketability of Tanzanian coffee while also providing environmental and social benefits. Kimaro et al. (2024) examined coffee marketing channels, revealing inefficiencies within the supply chain, where most farmers rely on intermediaries, resulting in lower prices and limited market access. Finally, Mapunda et al. (2020) analysed the determinants of smallholder farmers' participation in the warehouse receipt system, identifying factors such as price incentives, access to storage facilities, and cooperative membership as key drivers for increased participation, which in turn enhances income stability and reduces post-harvest losses. These studies collectively highlight the importance of addressing sustainability challenges in Tanzania's coffee sector, offering critical insights for enhancing productivity, improving market access, and fostering the long-term growth of the industry.

Despite this growing body of literature, a gap remains in research specifically addressing the challenges associated with implementing interventions aimed at enhancing coffee production and productivity among smallholder farmers across various coffee-growing areas in Tanzania. This gap represents both a knowledge and a theoretical shortfall. Knowledge-wise, the existing studies focused on isolated aspects of the coffee supply chain or specific interventions, neglecting a comprehensive analysis of the multifaceted challenges faced by farmers in varying contexts. This lack of detailed, context-specific research limits our understanding of how socio-economic, environmental, and cultural factors interact to influence the effectiveness of these interventions.

To address this gap, the current study examined the challenges encountered by smallholder coffee farmers in implementing HRNS interventions in the coffee-growing districts of Mbeya Region. Practically, the study provides valuable insights that can help stakeholders, including HRNS, the Tanzania Coffee Board, Local Government Authorities, and farmers, enhance the effectiveness and sustainability of coffee development initiatives in the region. Theoretically, this study contributes to the literature by highlighting context-specific challenges in the implementation of agricultural interventions. It fills a critical gap in the existing research by providing a detailed analysis of the barriers to effective intervention in a specific geographical area, thus offering a nuanced understanding of how local conditions and challenges affect the success of development programmes. This theoretical contribution enhances the broader discourse on agricultural development and intervention effectiveness, adding depth to our understanding of how tailored strategies can be designed to overcome unique regional obstacles.

Theoretical literature review

Two theories guided the study: Rogers' (1962) diffusion of innovations Theory and institutional Theory. Rogers'

(1962) diffusion of innovations Theory was selected to guide this study due to its focus on the process of how new ideas, practices, and technologies spread within a community. This Theory is particularly relevant to the HRNS interventions, which aim to introduce new agricultural practices, technologies, and market access strategies to smallholder coffee farmers in Rungwe and Mbeya Districts.

The Theory helps to explain the aspects that influence the adoption or rejection of these innovations, such as perceived benefits, compatibility with existing practices, and ease of use. In synthesis, the integration of these two theories offers a comprehensive framework for understanding the multifaceted challenges to effective implementation of Hanns R. Neumann Stiftung interventions among smallholder coffee farmers in Rungwe and Mbeya Districts.

In addition to Rogers (1962) diffusion of innovations Theory, Institutional Theory was also selected to guide this study. This Theory provides a framework for understanding how formal and informal institutions, such as cultural norms, social practices, and socio-economic conditions, influence the implementation of HRNS interventions. This Theory posits that the behaviour of individuals and organizations is heavily influenced by the formal and informal structures, norms, and rules within a society (Jepperson and Meyer, 2021). In the context of HRNS interventions, institutional Theory helps to explain how cultural norms, traditional practices, and socio-economic conditions, such as access to resources, education, and institutional support, can either facilitate or hinder the adoption of new farming techniques and innovations. It highlights the role of local institutions, governance structures, and social networks in shaping how interventions are perceived and implemented, making it a strong framework for understanding the socio-economic and cultural challenges in the effective implementation of HRNS interventions.

Rogers' diffusion of innovations Theory and Institutional Theory complement each other by offering a holistic framework for understanding how innovations are adopted and institutionalized within social systems. While Rogers' Theory focuses on the individual and organizational processes of innovation adoption, highlighting factors such as perceived attributes of the innovation, Institutional Theory examines the broader social and cultural contexts that influence these processes, emphasizing the role of norms, structures, and legitimacy. In the context of this study, this interplay provides a valuable lens for investigating the challenges that limit the acceptance and effective implementation of HRNS interventions among smallholder farmers, allowing for a comprehensive analysis of both interventions' attributes, individual behaviours, and the institutional barriers that may hinder successful adoption.

The conceptual framework

The conceptual framework for this study, guided by Rogers' Diffusion of Innovations Theory, examines challenges to the effective implementation of Hanns R. Neumann Stiftung (HRNS) interventions in Rungwe and Mbeya Districts. The dependent variable, Challenges to Effective Implementation of HRNS Interventions, is shaped by several innovation attributes. Relative advantage reflects the extent to which HRNS interventions, such as improved farming techniques and market access strategies, are perceived as superior to existing practices; a greater advantage reduces barriers. Compatibility refers to the degree to which interventions align with farmers' values, prior experiences, and needs, with higher compatibility fostering greater adoption. Complexity captures the perceived difficulty of understanding and applying interventions, where higher complexity intensifies challenges. Trialability refers to the ability of farmers to test interventions before full adoption, with limited opportunities heightening uncertainty.

Lastly, observability denotes the visibility of intervention outcomes, where more observable benefits encourage smoother and more widespread implementation among farmers. In addition to these innovation attributes, socio-economic and cultural barriers serve as the independent variables. Socio-economic barriers, such as access to financial resources, infrastructure, famers' understanding of the interventions, and technical support, significantly influence the adoption process, with limited resources creating major obstacles. Cultural barriers, including traditional practices, social norms, and resistance to change, can also impede the adoption and integration of new practices. Together, these factors determine the extent of challenges encountered in implementing HRNS interventions among smallholder coffee farmers, shaping the overall effectiveness and sustainability of these initiatives.

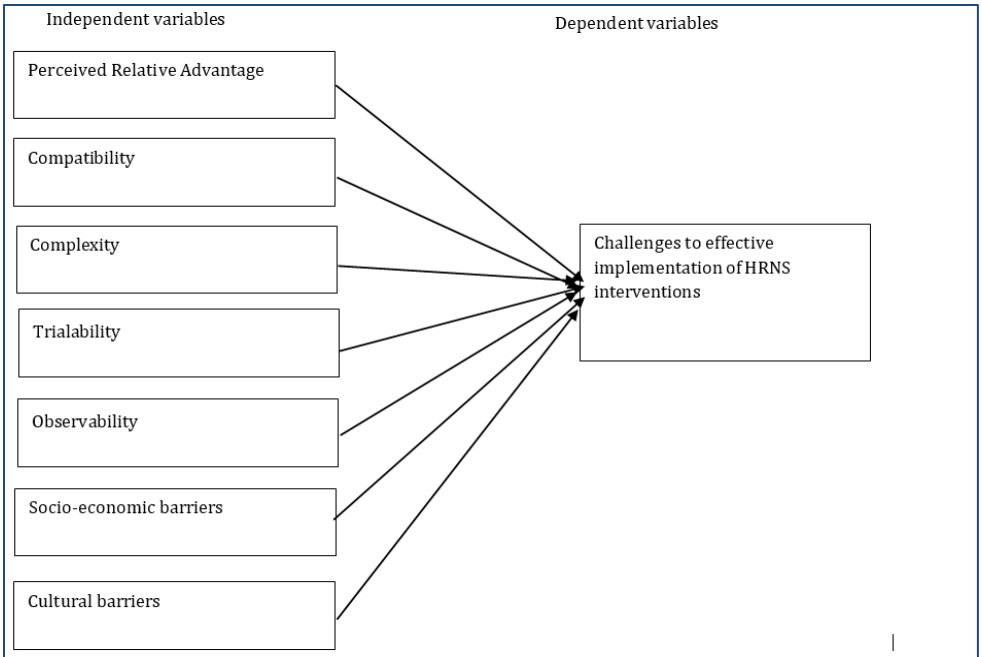

Figure 1. Conceptual framework of the study. Source: Synthesized from theoretical literature review (2024)

Description of the study area

This study was conducted in Mbeya and Rungwe Districts in Tanzania. These districts were selected because they are the leading producers of Arabica coffee and have participated in the implementation of HRNS interventions since 2006. Mbeya District lies between latitudes 7 ° and 9 South of the Equator and between longitudes 33 ° and 35 East of Greenwich. Rungwe District lies between latitudes 8° 30' East at 9° 30' south of the Equator and Longitudes 33' and 34' east of the Greenwich Meridian. Mbeya District is bordered by Rungwe and Ileje districts to the South, Mbozi District to the West, Chunya District to the Northwest, and Iringa Region to the East. On the other hand, Rungwe District is bordered by Kyela District to the East, Ileje District to the West, and Kyela District to the South. The annual average temperature in these districts ranges between 12 and 30 degrees Celsius. Therefore, Mbeya and Rungwe Districts share a border with an average yearly temperature ranging between 12°C and 30°C, a climate conducive to Arabica coffee cultivation. This spatial and climatic positioning is crucial to understanding the dynamics of coffee production within the study area.

Research design

The study employs a cross-sectional design to examine the challenges to effective implementation of HRNS interventions in Rungwe and Mbeya Districts.

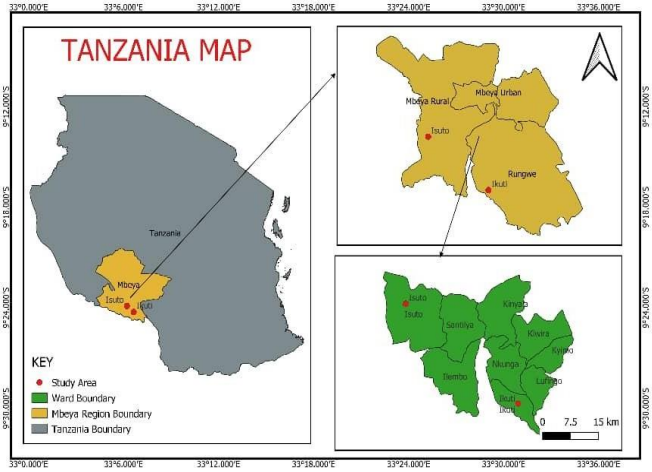

Figure 2. Study area map: (a) Tanzania boundary (grey), (b) sampling sites (red dots). Ikuti Ward, Rungwe: 9°19′S, 33°32′E; Isuto Ward, Mbeya Rural: 9°05′30″S, 33°16′53″E

This design was selected for its cost-effectiveness and efficiency, as it enables the collection of data at a single point in time, thereby reducing the need for long-term tracking and follow-up, which is a resource-intensive process (Butler et al., 2022). Cross-sectional studies are particularly suitable for capturing a snapshot of current challenges and conditions, providing valuable insights into the immediate factors affecting intervention success. This approach aligns with Wang and Cheng (2020), who highlighted the design's advantages in managing

participant and researcher time while delivering timely and relevant data for decision-making and policy development. The cross-sectional design thus facilitates a comprehensive examination of the current barriers to intervention implementation, offering practical recommendations for stakeholders.

Study population

The study population consisted of smallholder coffee farmers who are actively engaged in implementing HRNS interventions, reflecting a targeted focus on individuals directly impacted by these initiatives. These farmers are located across ten villages in Isuto and Ikuti wards of Mbeya and Rungwe Districts, respectively. Each ward encompassed a cluster of five villages, with Isuto ward comprising Idiwili, Shitete, Mlowo, Isuto, and Shisonta, and Ikuti ward encompassing Lyenje, Kyobo juu, Kyobo, Lumbe, and Ikuti. This deliberate selection ensured representation from diverse geographic areas within the districts, enriching the study's scope and depth. Therefore, the selection of wards and villages ensured comprehensive representation of varied geographical, environmental, and socio-economic contexts necessary for capturing the challenges limiting the effective implementation of HRNS interventions.

Unit of analysis

The unit of inquiry of this study was the HRNS interventions in the Mbeya and Rungwe Districts of Tanzania. This focus is justified because examining the interventions themselves allows for a comprehensive assessment of their design, implementation, and impact on smallholder farmers. By focusing on the interventions, the study identified specific challenges related to their implementation, including the effectiveness of the strategies employed, resource allocation, and alignment with local needs. Understanding these factors is critical for evaluating the overall success and sustainability of the HRNS programmes. This approach provides insights into the intervention mechanisms and highlights areas for improvement, ultimately informing better practices and strategies for future agricultural development initiatives.

Unit of inquiry

The unit of inquiry in this study is smallholder farmers participating in HRNS interventions in Mbeya and Rungwe Districts of Tanzania. This focus is justified because these farmers are the primary recipients of the interventions; thus, their experiences, perceptions, and challenges are central to understanding the effectiveness of HRNS programmes. By examining farmers' perspectives, the study directly addresses the core issues affecting the implementation of the interventions, including adoption barriers, resource constraints, and socio-cultural factors. Additionally, smallholder farmers are a critical stakeholder group whose feedback can provide actionable insights for improving the design and execution of HRNS initiatives, ultimately enhancing their impact on agricultural productivity and sustainability in the region. Thus, focusing on this unit of inquiry ensures that the study's findings are relevant and practical for addressing the challenges faced in the field.

Sampling frame

The sampling frame for this study consisted of a list of smallholder farmers who participated in the implementation of HRNS interventions in Mbeya and Rungwe Districts of Tanzania. This list was sourced from the HRNS office, which maintains detailed records of the farmers involved in its programmes. Using this list ensured the study targeted individuals directly engaged in the interventions, providing relevant and accurate data on the challenges they face. The HRNS office's records provide a comprehensive, up-to-date list of smallholder farmers across two districts. Therefore, focusing on those with firsthand experience with the HRNS initiatives ensured accurate data collection that reflects the implementation issues.

Sampling procedure and Sample size

The respondents were drawn from HRNS beneficiaries who were members of Umalila, Kyobo, Tutafika, and Ikuti Agricultural Marketing Cooperatives (AMCOS) located in Mbeya and Rungwe Districts. Two wards, Isuto and Ikuti, were purposively selected from the 18 wards in the study area, as they represented key intervention zones. Within these wards, 10 villages were selected from a total of 28, based on the presence of HRNS beneficiaries. To ensure representativeness, cluster sampling was first applied by grouping farmers according to their geographical locations (AMCOS and villages). From these clusters, systematic sampling was then used to select individual respondents from the lists of HRNS beneficiaries. Approximately six respondents were selected from each of eight villages, while two respondents were taken from each of the remaining two villages, resulting in a total of 52 respondents. The

respondents were drawn from HRNS beneficiaries who were members of Umalila, the sample size was determined using Kothari's (2004) formula for finite populations. This combined approach, purposive selection of wards, cluster grouping of farmers, and systematic sampling within clusters, was adopted to minimize bias and enhance the representativeness of smallholder farmers involved in HRNS interventions. The sample size was determined using the formula proposed by Kothari (2004), which is expressed as:

$$n = \frac{Z^2.p.q.n}{e^2(N-1) + Z^2.p.q} \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where:

- n is the sample size,
- Z is the standard value at a given confidence level (e.g., 1.96 for a 95% confidence level),
- p is the sample proportion,
- q is equal to 1−p,
- N is the size of the population or sampling frame, e is the sampling acceptable error, i.e., 0.05

Thus, n=0.052·(83−1)+1.962·0.5·0.51.962·0.5·0.5·83= 52

This formula enabled the selection of 52 participants from a population of 83 smallholder coffee farmers, taking into account the level of confidence and an acceptable marginal error. The sample size for each village was determined proportionally using the formula proposed by Kothari (2004), as presented in Table 1.

Table 1. Sampling Matrix (Source: Mbeya and Rungwe 2022).

District	Ward	Village	Sample for With HRNS Interventions
Mbeya	Isuto	Isuto	7
		Mlowo	6
		Idiwili	5
		Shisonta	3
		Shitete	5
Rungwe	Ikuti	Ikuti	7
		Kyobo juu	5
		Kyobo	4
		Lyenje	5
		Lumbe	5
		Total	52

Data collection instruments

Primary data for the study were collected through a combination of tools, including a structured questionnaire, focus group discussions (FGDs), and key informant interviews (KIIs). Quantitative data were collected using a structured questionnaire comprising statements designed to assess perceived challenges in implementing HRNS interventions. A three-level Likert scale was used, allowing respondents to indicate their level of agreement or disagreement with each statement, typically ranging from "Agree," "Neutral," to "Disagree." Qualitative data were collected through focus group discussions (FGDs) and key informant interviews. Four FGDs, two from each district, involved smallholder coffee farmers, were conducted to explore cultural, social, and economic barriers, with each group consisting of 8 participants. Additionally, key informant interviews with 6 Ward Agricultural Extension Officers, and two coffee inspectors, each from the district agricultural office, provided expert perspectives on the implementation challenges and potential solutions.

Data Analysis

Data analysis employed both quantitative and qualitative methods to provide an inclusive understanding of the challenges to the effective implementation of HRNS interventions. Quantitative data, gathered through a structured questionnaire, were analyzed using descriptive statistics, including frequencies, percentages, and means, to summarize the responses. For qualitative data collected through Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs), thematic analysis was employed to identify, code, and report key themes and patterns as the study's findings. Together, these methods ensured a robust analysis and reporting of the challenges experienced by smallholder coffee farmers in implementing HRNS interventions.

Validity and reliability

Validity was ensured through content and construct validation methods. For content validity, experts in agricultural extension and development studies were consulted to review the questionnaire, focus group discussion (FGD) guides, and key informant interview (KII) protocols. Their feedback was carefully integrated into the refinement of the tools by identifying ambiguities, improving clarity, and ensuring that the questions aligned with the study objectives.

Revisions were made to enhance the relevance and comprehensiveness of the tools, ensuring they accurately capture the challenges faced by smallholder coffee farmers in implementing HRNS interventions. This iterative process strengthened the overall validity and reliability of the research instruments. Construct validity was achieved by aligning the statements with the theoretical framework that guided the study (diffusion of innovation Theory and institutional Theory) to ensure that the data collected accurately reflected the constructs being studied, such as perceived benefits and compatibility of the interventions. This process ensured that the tools adequately covered all relevant dimensions of the challenges faced by smallholder farmers in implementing HRNS interventions.

Reliability was ensured by pre-testing (pilot testing) the tools with a small sample of 10 respondents similar to those in the actual study. This allowed the researcher to refine questions for clarity and eliminate any ambiguity. The use of a standardized checklist with a Likert scale for quantitative data collection also contributed to reliability, as it ensured consistency in responses across participants. Additionally, inter-rater reliability was maintained during FGDs and KIIs by employing multiple trained facilitators and interviewers who adhered to a uniform protocol, ensuring consistent data collection across all respondents. Overall, these measures not only enhanced the reliability of the research instruments but also strengthened the integrity of the study's findings.

Table 2. Score for the challenges to the effective implementation of HRNS Interventions.

Sr.	Statement	Agree (Freq/%)	Neutral (Freq / %)	Mean	SD
1	HRNS market strategies have not improved access to good international markets.	39 (75%)	3 (5.8%)	13.33	19.09
2	The cost of implementing HRNS farming techniques is too high for smallholder farmers like me.	48 (92.3%)	0 (0%)	17.35	26.63
3	Have been unable to secure financial loans from financial institutions to implement HRNS interventions.	44 (84.6%)	0 (0%)	23.53	23.44
4	Inadequate support from extension officers limits the implementation of HRNS interventions.	41 (78.8%)	0 (0%)	17.33	21.22
5	Farming techniques introduced by HRNS are too complicated for me to understand and apply.	20 (38.5%)	0 (0%)	18.22	16.17
6	Inadequate observed tangible results from HRNS interventions limit its implementation.	38 (73.1%)	4 (7.7%)	16.02	18.15
7	The HRNS farming techniques have not been tested on a small scale before adopting them.	32 (61.5%)	4 (7.7%)	18	14
8	Farmers' organizations are ineffective in promoting the implementation of HRNS interventions.	37 (71.2%)	2 (3.8%)	14.06	17.90
9	A moderate understanding of HRNS interventions hinders its implementation.	34 (65.4%)	1 (1.9%)	17.03	16.50
10	Regular occurrences of coffee pests and diseases prevail despite implementing HRNS interventions	35 (67.3%)	3 (5.8%)	16.33	16.26

Challenges limiting the effective Implementation of HRNS Interventions

Financial Challenges

High Cost of Implementation

One of the challenges reported is the high cost associated with implementing HRNS techniques. A substantial 92.3% of the respondents admitted that the cost is prohibitively high for smallholder farmers. This financial burden restricts farmers' ability to adopt new technologies and methods, particularly for those operating with limited resources. The expense of implementing HRNS techniques, coupled with the inability to afford necessary tools and inputs, highlights a critical barrier to adoption. Without adequate financial

resources, farmers struggle to invest in the essential inputs, thereby limiting the implementation of HRNS interventions. During focus group discussions conducted at Isuto Ward on 27 March 2023, participants remarked,

> *"The prohibitive cost of HRNS techniques and their inability to afford essential tools and inputs are the major obstacles to the adoption."*

The findings align with Aboye et al. (2024), who reported that the high cost of innovation and technology adoption is a significant obstacle preventing farmers from investing in new methods and practices. To reduce the cost of implementing HRNS interventions, it is recommended to explore cost-sharing models, optimize resource use through strategic partnerships, and provide financial support or subsidies to offset initial expenses for farmers.

Financial constraints

The inability to secure financial loans, reported by 84.6% of the respondents, further exacerbates farmers' struggle to find the capital needed for investing in the interventions. Lack of access to financing limits farmers' ability to purchase essential inputs such as pruning tools, fertilizers, and personal protective gear required for the successful adoption of HRNS interventions, ultimately hindering production and long-term growth. This was evident during focus group discussions held at Ikuti Ward in March 2023, when participants often pointed out that the Lack of financial loans prevents them from affording essential inputs such as pruning tools and fertilizers needed for HRNS interventions." The findings of the current study align with those of a study by Al-Najjar et al. (2023), who report that coffee growers in Yemen face challenges in accessing inputs due to financial constraints, despite implementing various initiatives aimed at improving coffee production. In addition, this finding aligns with the findings of Zerssa et al. (2021), who noted that limited access to credit is a critical barrier to the adoption of new agricultural technologies among smallholder farmers in Ethiopia. To overcome this challenge, it is essential to develop cost-effective solutions and provide financial support mechanisms or subsidies to make these interventions more accessible to smallholder farmers.

Constrain in Market Access

Regarding market access, 75% of the respondents agreed that HRNS market strategies have not improved access to good international markets. This lack of perceived improvement in market opportunities can be a significant deterrent for farmers. Without clear market benefits that add to the farm gate price, farmers are less likely to see value in adopting new practices that require significant time and financial investment. This was evident during the focus group discussion at Isuto Ward on 27 March 2023, where coffee farmers remarked,

> *"The HRNS market strategies have not significantly improved access to international markets, making it difficult to justify the time and financial investment required to adopt new practices".*

Tadesse et al. (2020) also revealed that ineffective market strategies can hinder farmers' access to international markets, leading to diminished incentives for adopting new practices and technologies. Thus, the current study recommends that the HRNS market strategies be improved by implementing targeted market access initiatives, providing better support for navigating international trade regulations, and creating clear economic incentives, so that farmers are more motivated to adopt and invest in HRNS interventions.

Technical Challenges

Perceived Complexity of Techniques

The complexity of HRNS techniques is also a significant barrier. Notably, 61.5 percent of the respondents find the techniques too complicated to understand and apply. This complexity discouraged farmers from adopting new methods, as they felt overwhelmed by the technical requirements. The challenge is to simplify HRNS techniques and make them more user-friendly. During a focus group discussion conducted at Isuto Ward on 27 March 2023, participants remarked;

> *"The complexity of HRNS techniques overwhelmed us and discouraged adoption, highlighting the need for simpler, more user-friendly methods".*

The study findings align with those of Rizzo et al. (2024), who confirm that complexity hinders the adoption of new technologies. However, hands-on demonstrations are important for learning and adoption. Therefore, the current study suggests providing clear, step-by-step guidance and hands-on training to reduce the perceived complexity and facilitate easier adoption among farmers.

Unsatisfactory Observable Benefits

A large percentage (73.1%) of the respondents have not observed tangible results from HRNS interventions, such as increased productivity or income. The inadequacy of visible benefits leads to skepticism and reluctance among farmers to adopt new practices. Farmers are more likely to embrace

new techniques if they can see clear, measurable improvements. During a focus group discussion conducted at Ikuti Ward on 28 March 2023, participants opined;

> *"Unsatisfactory visible results from HRNS interventions, such as increased productivity or income, beget skepticism and reluctance, emphasizing the need for clear, measurable improvements to encourage the adoption."*

Hermans et al. (2021) also revealed that the lack of observable benefits from agricultural innovations necessitates a rethinking of the adoption strategies, emphasizing the need for more explicit demonstration of tangible results to foster greater acceptance among farmers. This study recommends demonstrating the effectiveness of HRNS interventions through successful case studies, pilot programmes, and evidence-based results to build trust and encourage adoption.

Inadequate Testing Opportunities

The inability to test HRNS techniques on a small scale before full adoption is another significant challenge. With 61.5 percent of the respondents reporting that they were unable to trial these methods, concerns centered on the risks involved in adopting unproven techniques. Allowing farmers to test HRNS interventions on a smaller scale can reduce perceived risks and increase their willingness to adopt new methods. During a focus group discussion at Ikuti Ward on 27 March 2023, farmers noted;

> *"The inability to trial HRNS techniques on a small scale increases our reluctance to adopt new methods due to the perceived risks of implementing untested interventions".*

The current study's findings align with those of a study by Suri and Udry (2022), who found that inadequate testing of agricultural innovations significantly hampers farmers' willingness to adopt new techniques, as the lack of trial opportunities heightens uncertainty and increases the perceived risks associated with unproven methods. Therefore, this study recommends the introduction of small-scale trials to provide valuable insights and build confidence in the effectiveness of HRNS techniques.

Occurrences of Coffee Pests and Diseases

The finding reveals that 67.3 per cent of the respondents experience regular occurrences of coffee pests and diseases despite implementing HRNS interventions, implying a significant challenge to its adoption. Persistent pest and disease issues undermine the perceived benefits of the HRNS interventions, as farmers may not see the anticipated improvements in productivity or quality. This ongoing problem led to frustration and skepticism among farmers regarding the efficacy of the new methods, which could potentially further discourage their adoption and full implementation. During the key informant interview with coffee experts on 16 April 2023, at Rungwe, they remarked;

> *"The ongoing prevalence of coffee pests and diseases despite HRNS interventions significantly hampers the effectiveness and perceived value of these methods".*

A study by Acosta-Alba et al. (2020) also revealed inadequate adoption of new agricultural practices due to persistent challenges, including ongoing pest issues and insufficient farmer support. The authors advocate for the adoption of integrated farming systems, which have been shown to enhance farm resilience and productivity significantly. Similarly, the current study suggests that HRNS experts and other stakeholders should address persistent pest issues by exploring alternative mechanisms, such as developing and promoting resistant crop varieties and providing financial incentives for pest control measures. Additionally, improving access to timely pest diagnosis and treatment resources can further enhance the adoption and effectiveness of the interventions.

Institutional Challenges

Inadequate Support from Agricultural Extension Officers

Another major challenge is the perceived lack of support from Local Agricultural Extension Officers. An overwhelming 78.8 per cent of the respondents reported that there was insufficient assistance from these officers. Extension services play a crucial role in bridging the gap between research and practical application on the ground. However, inadequate cooperation between HRNS farmer trainers and Government Extension Officers further complicates the implementation of interventions, as it limits effective sharing of knowledge and resources necessary for supporting farmers in adopting new practices. Therefore, inadequate support hinders the effective dissemination and adoption of HRNS interventions, which was revealed during focus group discussion conducted at Ikuti Ward on 28 March 2023, where farmers commented that;

> *"Insufficient support from local agricultural extension officers severely impedes their ability to*

understand, implement, and benefit from HRNS interventions".

The study findings are consistent with those of another study by Steinke et al. (2021), which revealed that current agricultural extension services have limited capacity, suggesting the need to harness the full potential of the digital revolution to support and improve outcomes for farmers. Smallholder coffee farmers also recommended strengthening extension services by increasing funding for training, equipping Extension Officers with the latest tools and technology, thus enhancing their knowledge about HRNS interventions to ensure that they too can effectively support farmers in the successful implementation of these practices.

Weak Farmers Organizations

The effectiveness of farmers' organizations in promoting HRNS interventions appears limited, with 71.2% of respondents rating them as ineffective. This weak organizational support may lead to uncoordinated efforts and poor information dissemination, leaving individual farmers to navigate the challenges of adopting HRNS interventions independently. Without a strong network or support system, farmers may struggle to implement new techniques or capitalize on market opportunities. During the Key Informant Interviews on 16 April 2023 at Rugwe, coffee experts emphasized, "The weakness of farmers' organizations severely hampers the collective adoption of HRNS interventions, leaving individual farmers without the necessary support, coordination, and resources to benefit from these innovations fully". In line with the current study's findings, Bizikova et al. (2020) revealed that weak farmers' organizations lead to limited knowledge transfer, poor resource mobilization, and fragmented efforts, which significantly hinder farmers' ability to adopt innovative agricultural practices and capitalize on market opportunities. This study concludes that strong farmers' organizations are essential for providing support, facilitating knowledge sharing, and advocating for resources. Their weakness can impede the successful implementation of new techniques.

Moderate Level of Understanding of HRNS Interventions

The finding indicates that 65.4% of the respondents agree that a moderate understanding of HRNS interventions during and after training sessions hinders their implementation. When the majority of farmers have only moderate knowledge, their ability to implement complex farming techniques, market strategies, and other interventions is limited. With insufficient knowledge and skills, these farmers are less likely to implement interventions effectively, resulting in suboptimal outcomes or resistance to change. The complexity of the interventions may overwhelm farmers with limited formal education, making it crucial to provide additional training and support tailored to their learning capacities. Key informant interviews with coffee experts on 15 April 2023 at Mbeya, highlighted,

"*The majority of farmers, having only a primary education, face significant difficulties in comprehending and applying the advanced techniques introduced by HRNS, which experts identified as a major barrier to the effective implementation of these interventions".*

CONCLUSION AND RECOMMENDATIONS

The findings of this study highlight the numerous challenges impeding the effective implementation of Hanns R. Neumann Stiftung (HRNS) interventions in Rungwe and Mbeya Districts, Tanzania, ranging from attributes of the interventions themselves to various socio-economic barriers. These include the complexity of HRNS techniques, insufficient support from local extension officers, inadequate testing opportunities, and the lack of tangible results demonstrating the interventions' benefits. Others include financial constraints, limited access to international markets, weak farmers' organizations, a regular incidence of coffee pests and diseases, and low educational levels. These challenges have constrained the successful adoption of HRNS interventions. However, cultural barriers appear to have a negligible impact on the implementation process. When viewed through the lens of Rogers' Diffusion of Innovation Theory, these challenges align with critical factors influencing the rate of adoption, including complexity, trialability, and observability. The perceived complexity of HRNS techniques discourages farmers from adopting the interventions, as they find them challenging to understand and implement. Similarly, inadequate testing opportunities (low trialability) heighten farmers' perceived risk of adoption, as they lack the opportunity to experiment with new methods on a small scale. Furthermore, the absence of observable benefits, such as increased productivity or income, reduces farmers' motivation to invest time and resources in the interventions. According to Rogers' Theory, for innovations to be widely adopted, they must be perceived

as relatively simple, testable, and capable of yielding visible benefits in areas in which HRNS interventions currently face challenges. Moreover, Institutional Theory offers further insights into the implementation challenges. Weak cooperation between HRNS trainers, local Agricultural Extension Officers, and farmers' organizations reflects a lack of strong institutional frameworks to support the diffusion of new practices. The absence of cohesive, well-supported institutions hinders farmers' ability to navigate the complexities of international markets, access necessary financial resources, and receive the training they require. Institutional Theory emphasizes that well-established norms, rules, and structures are critical for the effective dissemination and adoption of innovations. Without these in place, as demonstrated by the weak farmers' organizations and inconsistent support from Extension Officers, the implementation process is severely undermined.

Based on these findings, it is recommended that HRNS efforts be adopted to simplify their interventions, enhance support from local extension officers, provide opportunities for small-scale testing, and clearly demonstrate the tangible benefits of the interventions to facilitate more effective adoption and implementation in Rungwe and Mbeya Districts. Other recommendations include improving access to international markets, reducing the cost of implementing interventions, improving farmers' access to financial credits, strengthening farmers' organizations, and providing regular training on the coffee value chain.

Limitations of the study

While the findings of this study offer valuable insights into the challenges affecting the effective implementation of HRNS interventions among coffee farmers, several limitations should be acknowledged. Firstly, the data presented may lack generalizability, as they are specific to the study area's context and may not apply to other regions with different socio-economic and cultural attributes. Secondly, the study relies on self-reported data, which may be subject to recall bias or social desirability bias, potentially affecting the accuracy of the results. Therefore, while the findings of this study offer valuable insights, these limitations highlight the need for further research and a better understanding of the adoption process of HRNS interventions among coffee farmers.

Areas for further research

Further research in this field could explore several areas to deepen our understanding of the adoption of HRNS among coffee farmers. Firstly, investigating the effectiveness of specific interventions tailored to address the identified barriers, such as educational programmes, financial support mechanisms, and organizational capacity-building initiatives, would provide valuable insights into their impact on the adoption rates. Additionally, exploring the interactions between different factors influencing the adoption, such as the interplay between socio-economic characteristics, climatic conditions, and farm-level constraints, could offer a more nuanced understanding of the adoption process. Furthermore, longitudinal studies tracking the adoption trajectories of coffee farmers over time would help identify long-term trends and dynamics, providing insights into the sustainability of the adoption efforts. Moreover, conducting comparative studies across different regions or countries with varying socio-economic and environmental contexts would enable a more comprehensive analysis of the factors influencing the adoption and the generalizability of the findings. Finally, exploring innovative approaches, such as digital technologies or participatory approaches, in promoting HRNS adoption could offer novel insights into practical strategies for fostering agricultural innovation in the coffee sector.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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