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Barriers and enablers to women smallholder farmers' adoption of agricultural innovations in Rwanda

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Introduction

Women play a central role in agricultural production and household food security in Sub-Saharan Africa, contributing substantially to the agricultural workforce (Bigler et al., 2017; Njobe and Kaaria, 2015). However, their contribution does not necessarily translate into equal access to agricultural resources or influence over innovation processes. Gender inequalities in access to land, credit, training and technology, together with socio-cultural norms affecting decision-making and mobility, continue to constrain women's participation in agricultural innovation (Clay and Yurco, 2024; World Economic Forum, 2024).
These challenges are particularly relevant in Rwanda, where agriculture remains central to economic and social development, while the modernisation of the sector does not always adequately address the different needs and constraints of women and men farmers (MacNairn and Davis, 2018; Yongabo and Göktepe-Hultén, 2021). Understanding these dynamics is essential to ensure that agricultural innovations are accessible, relevant and beneficial to women smallholder farmers. Against this background, this study examines women's engagement with three agricultural innovations in Rwanda: small-scale irrigation, composting and Juncao technology for mushroom production. Specifically, it investigates the socio-economic, cultural and institutional barriers affecting their adoption, as well as the support mechanisms that could improve women's access to and uptake of these innovations.

Material and Methods

The study was conducted in five agroecological zones of Rwanda, selected based on irrigation suitability according to the Irrigation Master Plan (RAB, 2020) and the agroecological classification developed by MINAGRI (Ministry of Agriculture and Animal Resources) in 1980 (FAO, 2010; Kabirigi et al., 2024). Within these zones, six districts with poverty rates above 20% were selected based on the *Seventh Integrated Household Living Conditions Survey Report* (NISR, 2025): Kayonza, Ngoma, Bugesera, Musanze, Huye, and Nyanza.
Agricultural innovations relevant to women smallholder farmers were identified through a preliminary review and assessed using the Relevance, Opportunity, and Feasibility (ROF) framework. Eight agricultural experts rated the innovations against these criteria on a scale of 1–10. The eight highest-rated innovations were then assessed by nine women farmers, whose rankings and qualitative feedback informed the final selection of three innovations: small-scale irrigation, composting, and Juncao technology for mushroom production.
Data were collected through structured interviews with 37 farmers (28 women and 9 men), six focus group discussions (FGDs; 35 participants, 27 women and 8 men), and 11 semi-structured

key informant interviews (KIIs) with researchers, private-sector representatives, NGO staff, and a MINAGRI representative. Farmer questionnaires were developed using the Pro-WEAI framework (IFPRI, 2025) and USAID's toolkit on agricultural technologies, gender dynamics, and food security (Manfre et al., 2017), and pilot-tested with two mushroom farmers in Kigali. Farmers were selected through Swisscontact's CASA and AgroInnovation project networks, while key informants were selected through snowball sampling. Data were collected using KoboToolbox, with interviews and FGDs conducted in Kinyarwanda with translation support. Informed consent was obtained from all participants.
Qualitative data from FGDs and KIIs were analysed thematically, combining semantic and latent approaches (Braun and Clarke, 2006), while quantitative interview data were analysed using descriptive statistics. Gender-disaggregated analyses were used to compare experiences and perspectives.

Results and Discussion

The study involved 37 smallholder farmers, of whom 24 (18 women and 6 men) were exclusively engaged in agricultural production. The remaining participants were involved in mushroom production, either exclusively (5 women and 2 men) or alongside other agricultural activities (5 women and 1 man). This paper focuses on overall findings and, where relevant, on farmers engaged exclusively in agriculture.
At the overall level, women reported a broader range of barriers to innovation adoption than men. Among women, lack of information represented the largest share of reported barriers (29.5% of mentions), followed by lack of skills and high costs (23% each), and limited training opportunities (13.3%). Among men, high costs accounted for the largest share of mentions (47%), followed by lack of information (27%). Thus, while affordability is a concern for both genders, women face additional constraints related to knowledge and capacity, consistent with evidence on gender inequalities in access to resources, information and training (FAO, 2019; Hidrobo et al., 2024).
Radio, agricultural extension agents and cooperatives emerged as important information sources. Among women's mentions, radio accounted for 19.6%, while extension agents and cooperatives each represented 17.4%. Men most frequently mentioned social media and YouTube (26.7%), followed by radio and other sources (20% each). However, within the group exclusively engaged in agriculture, social media and YouTube accounted for only 11.1% of men's information-source mentions and were not mentioned by women. At the overall sample level, regarding information about training opportunities, extension agents accounted for the largest share of women's mentions (19.6%), followed by radio and cooperatives (17.4% each), while men most frequently mentioned radio and extension agents (16.7% each). Furthermore, 15.2% of the women interviewed reported having no access to information about training opportunities. This highlights the continued importance of traditional information channels for smallholders.
Financial and social resources also shape farmers' opportunities to adopt innovations. Saving groups were the most common form of group membership among both women and men, providing an important source of informal credit. Borrowing was common among respondents, with women relying mainly on these groups to meet their financial needs. Qualitative findings nevertheless reveal that women face specific barriers to accessing formal credit, particularly the lack of collateral. Women also reported that husbands may oppose loan applications or refuse to sign the required documents, especially when family land is needed as collateral. Key informants confirmed that men often retain the final say over household borrowing decisions. Fear of indebtedness, limited awareness of available financial products and mistrust of financial institutions further discourage women from approaching banks and formal credit providers.
Household decision-making and mobility further influence women's participation. Among women exclusively engaged in agriculture, 76.9% reported making decisions about innovation

adoption jointly with their husbands. In contrast, 66.7% of men in the same group identified the husband as the main decision-maker. Qualitative evidence suggests that men often retain greater authority over investment decisions and the use of agricultural products, indicating that joint decision-making does not necessarily imply equal influence over final decisions. Mobility restrictions reinforce these inequalities: among the 19 married women interviewed, only 16% reported being able to move freely without asking for permission, while 89% needed permission to visit an urban centre and 74% to visit a neighbouring village. Among married women exclusively engaged in agriculture, these figures rose to 92% and 77%, respectively. Household expectations and norms positioning men as primary decision-makers may therefore limit women's access to information, training and other opportunities, as well as their control over agricultural resources. These findings are consistent with research on the influence of gender norms, household relations and mobility constraints on women's agricultural participation (Bigler et al., 2017; Rietveld and Farnworth, 2018).

The findings also identify several conditions that could support women's adoption. Across the three innovations, training and access to information were the most frequently mentioned requirements by both women and men. Training accounted for 32.5% of women's mentions and 28.6% of men's, while information represented 29.9% and 33.3%, respectively. Credit was another important enabling factor. Women additionally highlighted access to the internet and smartphones, cooperative membership, childcare support and the involvement of men in awareness-raising activities. These needs were particularly evident among women exclusively engaged in agriculture: 94.1% identified training as important, 76.5% mentioned access to credit and 47.1% highlighted childcare support. Involving men in awareness sessions was also emphasised by 52.9%, underlining the relevance of household dynamics alongside individual access to resources. Access to training itself was linked to practical conditions such as cooperative membership, free transport, internet access and childcare.

Qualitative findings further stress the value of practical and participatory approaches. Demonstrations and visible evidence of benefits, together with peer learning, particularly opportunities for women to learn from successful female adopters, were considered important for encouraging adoption. Cooperatives can support access to training, information and credit, while facilitating the exchange of knowledge and experiences among farmers. Key informants also emphasised gender-responsive training, affordable and locally relevant technologies, stronger extension services and women's involvement in the design and adaptation of innovations. Engaging couples and households was considered important to prevent potential opposition from men and promote more sustainable adoption. Government initiatives were also identified as an important source of encouragement by both genders.

Conclusions and Outlook

The findings show that women's adoption of agricultural innovations is shaped by the interaction of informational, economic, institutional and socio-cultural constraints. Limited access to information and training, difficulties in accessing finance, restricted control over resources, and gender norms affecting mobility and decision-making can reinforce one another, making it more difficult for women to engage with and benefit from agricultural innovations.

At the same time, the study highlights several mechanisms that can help address these barriers. Training, reliable information and accessible credit emerged as key enabling conditions, alongside cooperative membership, peer learning, demonstration activities and improved access to digital tools. The findings also underline the importance of addressing women's everyday constraints, particularly their domestic workload and limited mobility, and of involving men and households in the adoption process. Overall, promoting women's engagement requires more than simply providing technologies: it means creating the conditions for women to access, use and benefit from innovations. Adoption therefore depends not only on the availability of technologies,

but also on whether women have the necessary resources, opportunities and agency to make use of them.

The study contributes context-specific evidence on women's engagement with agricultural innovations in Rwanda. Its findings can inform the design of more inclusive agricultural interventions and support the development of gender-responsive approaches that address both the practical and structural constraints faced by women farmers.

Future research should build on these findings through larger and more representative samples, while examining in greater depth how access to information, finance and training translates into sustained adoption and changes in women's decision-making power. Further attention should also be given to household dynamics and men's roles in innovation processes. Understanding these dimensions will be essential to developing interventions that not only increase technology uptake but also strengthen women's agency and participation in agricultural development.

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