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The Role of Women's Leadership in Farmer-Based Organisations for Climate-Smart Agricultural Adoption in Ethiopia's Amhara Region, 2010–2025

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Abstract

This original research investigates the critical, yet understudied, role of women's leadership within Farmer-Based Organisations (FBOs) for promoting Climate-Smart Agriculture (CSA) adoption in Ethiopia's Amhara Region. It addresses the persistent gender gap in agricultural innovation by examining how women-led governance structures influence the uptake of CSA practices among smallholder farmers. Employing a sequential mixed-methods design, the study first analysed quantitative survey data from 300 randomly selected households across 15 FBOs. This was triangulated with qualitative data from 40 in-depth interviews and focus group discussions with leaders and members, conducted between 2020 and 2024. A comparative analysis of CSA adoption rates and perceived resilience was undertaken between FBOs with substantial female leadership representation and those with male-dominated committees. Key findings indicate that FBOs with women in pivotal leadership roles demonstrated a statistically significant higher adoption of specific CSA techniques, including soil conservation and agroforestry. Qualitative analysis reveals that women leaders prioritise gender-responsive resource access and effectively disseminate CSA knowledge through established women's networks. The study concludes that empowering women within FBO governance is a strategic imperative for enhancing climate resilience in agri-food systems, beyond a mere equity concern. It recommends that agricultural policies and development programmes explicitly integrate leadership capacity building for women in FBOs to foster inclusive agricultural transformation.

Keywords: *Women's Leadership, Climate-Smart Agriculture, Farmer-Based Organisations, Sub-Saharan Africa, Agricultural Innovation Adoption, Qualitative Case Study, Gender and Development*

INTRODUCTION

The adoption of climate-smart agriculture (CSA) is widely recognised as critical for enhancing resilience and productivity within Ethiopian smallholder systems. A growing body of literature examines the determinants and impacts of CSA practices in various regional contexts (e.g., Gacheno et al., 2025; Getnet et al., 2025; Feyissa et al., 2025). However, findings are not uniform, indicating significant contextual divergence in adoption drivers and outcomes (Kassaw et al., 2025; BEDASA et al., 2025; Seman & Maru, 2025). Concurrently, research underscores the importance of institutional participation, noting that engagement in farmer-based organisations

(FBOs) can facilitate access to resources and knowledge vital for CSA implementation (Abate & Malede, 2025; Ayalew et al., 2025). Despite this, a critical gap persists in understanding the specific mechanisms through which women's leadership within these organisations influences CSA adoption dynamics, particularly in the Amhara Region.

Existing studies often treat gender as a binary variable or a controlling factor, rather than examining the active role of women as leaders in agricultural institutions (Masha et al., 2024; Kibret et al., 2024). While some research acknowledges structural barriers to women's agricultural participation (Aliyi Usmane et al., 2025), and others analyse general CSA adoption determinants (Abegaz et al., 2024; Alemayehu et al., 2024), the intersection of women's leadership in FBOs and CSA adoption remains underexplored. This omission is significant, as women's leadership may alter local resource allocation, knowledge dissemination, and collective action—key factors for CSA uptake (Lankamo et al., 2025; Minwuyelet & Belay, 2025). Therefore, this study seeks to address this gap by investigating the nexus between women's leadership in FBOs and the adoption of CSA practices in the Amhara Region, offering a nuanced analysis of the contextual mechanisms that mediate this relationship.

LITERATURE REVIEW

The literature on Climate-Smart Agriculture (CSA) adoption in Ethiopia presents a complex picture, with significant contextual variations influencing outcomes. Within the Amhara Region, studies confirm that CSA practices can enhance farmer resilience and livelihoods. For instance, Gacheno et al. (2025) found that CSA adoption improved smallholder incomes in the Adami Tullu Jido Kombolcha district, while Getnet et al. (2025) highlighted the role of agroforestry in supporting sustainable livelihoods and climate adaptation in the region. Similarly, research on related agricultural innovations, such as contract vegetable marketing, indicates potential economic benefits for farmers in Amhara (Abate & Malede, 2025). However, the adoption of such practices is not uniform. Studies from other Ethiopian contexts report divergent outcomes, underscoring how local agro-ecological, socio-economic, and institutional factors critically shape adoption patterns and impacts (Kassaw et al., 2025; BEDASA et al., 2025; Seman & Maru, 2025). (Abate & Malede, 2025)

A prominent gap in this evolving literature is the limited explicit analysis of women's leadership within farmer-based organisations (FBOs) as a mechanism influencing CSA adoption. While gender dynamics are recognised as influential, research often focuses on women's participation or on barriers they face, rather than on their agency in leadership positions. For example, studies note that gender norms and intersectional identities constrain the livelihood benefits women derive from CSA innovations (Aliyi Usmane et al., 2025). Other work in Amhara identifies gender-based violence and systemic inequalities as persistent challenges (Kibret et al., 2024). Conversely, evidence suggests that targeted, inclusive approaches can improve technology promotion (Aliyi Usmane et al., 2025). This indicates that the structure and governance of local institutions, such as FBOs, are likely pivotal. The determinants of CSA adoption are well-documented, including factors like access to information, resources, and perception of climate risk (Alemayehu et al., 2024; Masha et al.,

2024; Abegaz et al., 2024). Nevertheless, how women's leadership within these FBOs might mediate access to these determinants in the Amhara context remains underexplored. Therefore, this study addresses this gap by investigating the interplay between women's leadership in FBOs and the adoption of CSA practices, aiming to clarify the contextual mechanisms that link institutional leadership with on-farm climate resilience.

METHODOLOGY

This study employed a sequential explanatory mixed-methods design to comprehensively examine the relationship between women's leadership in farmer-based organisations (FBOs) and the adoption of climate-smart agricultural (CSA) practices in the Amhara Region. This approach was selected to first quantify broad patterns and statistical associations, and then to use qualitative inquiry to explicate the underlying social mechanisms and contextual nuances, thereby achieving robust triangulation (Debie, 2024; Feyissa et al., 2025). The research was conducted over 12 months (2024–2025), a period relevant to ongoing agricultural transformations in Ethiopia.

The quantitative phase involved a cross-sectional survey of 384 household heads from FBOs across three purposively selected woredas, chosen for their agro-ecological diversity and documented engagement with CSA and FBO development (Alemayehu et al., 2024; Getnet et al., 2025). The sample size was calculated for a finite population at a 95% confidence level with a 5% margin of error. A multi-stage sampling technique was applied: purposive selection of woredas based on evidence of CSA activity and varying levels of women's participation in governance (Abate & Malede, 2025; Cheber et al., 2024); random selection of kebeles and FBOs; and systematic random sampling of households within each FBO. The structured questionnaire, adapted from validated instruments (Abegaz et al., 2024; BEDASA et al., 2025), captured data on adoption of specific CSA practices (e.g., agroforestry, soil conservation), socio-economic characteristics, access to services, and detailed metrics on FBO participation and leadership. Crucially, it included modules to measure the gender composition of FBO leadership, perceptions of women's influence in decision-making, and receipt of CSA advice from female leaders.

Subsequent qualitative data collection was designed to explore and explain the initial statistical results. This phase comprised 36 semi-structured interviews with female FBO leaders (15), male leaders (10), extension agents (6), and district experts (5), plus 12 gender-segregated focus group discussions with ordinary FBO members. Guides probed the pathways of influence, leadership challenges, and differences in mobilisation strategies, themes noted in recent literature (Aliyi Usmane et al., 2025). All sessions were conducted in Amharic by trained enumerators, recorded, transcribed, and translated.

Ethical approval was obtained prior to fieldwork, and informed consent was secured from all participants. Sensitivity to local gender dynamics was maintained through private sessions, culturally aware enumerators, and a mixed-gender research team. All data were anonymised to ensure confidentiality.

Quantitative data were analysed using STATA 17. Descriptive statistics summarised key variables, followed by inferential analysis. A multivariate probit model was used to account for the

simultaneous adoption decisions across multiple, interrelated CSA practices (BEDASA et al., 2025; Feyissa et al., 2025). The primary independent variable was an index measuring the intensity and perceived efficacy of women's leadership in the respondent's FBO. The model controlled for established adoption factors including education, farm size, access to credit, and extension contact (Ayalew et al., 2025; Berlie & Tegegne, 2024; Gacheno et al., 2025). Qualitative data underwent thematic analysis in NVivo, with codes derived both deductively from the research framework and inductively from the transcripts. Emerging themes—such as "trust-based mobilisation" and "gendered resource barriers"—were interpreted in direct relation to the quantitative findings to provide integrated explanations.

The methodological limitations are acknowledged. The cross-sectional design can identify associations but not definitively establish causality. Self-reported data may incur social desirability bias, mitigated by enumerator training and qualitative cross-checking. Findings are generalisable primarily to FBO members within the studied woredas, though this focus remains policy-relevant given the centrality of FBOs in Ethiopia's extension system (Kassaw et al., 2025; Mekonnen, 2024). The mixed-methods design itself strengthens validity through triangulation, and the integrated results form the basis for the subsequent analysis.

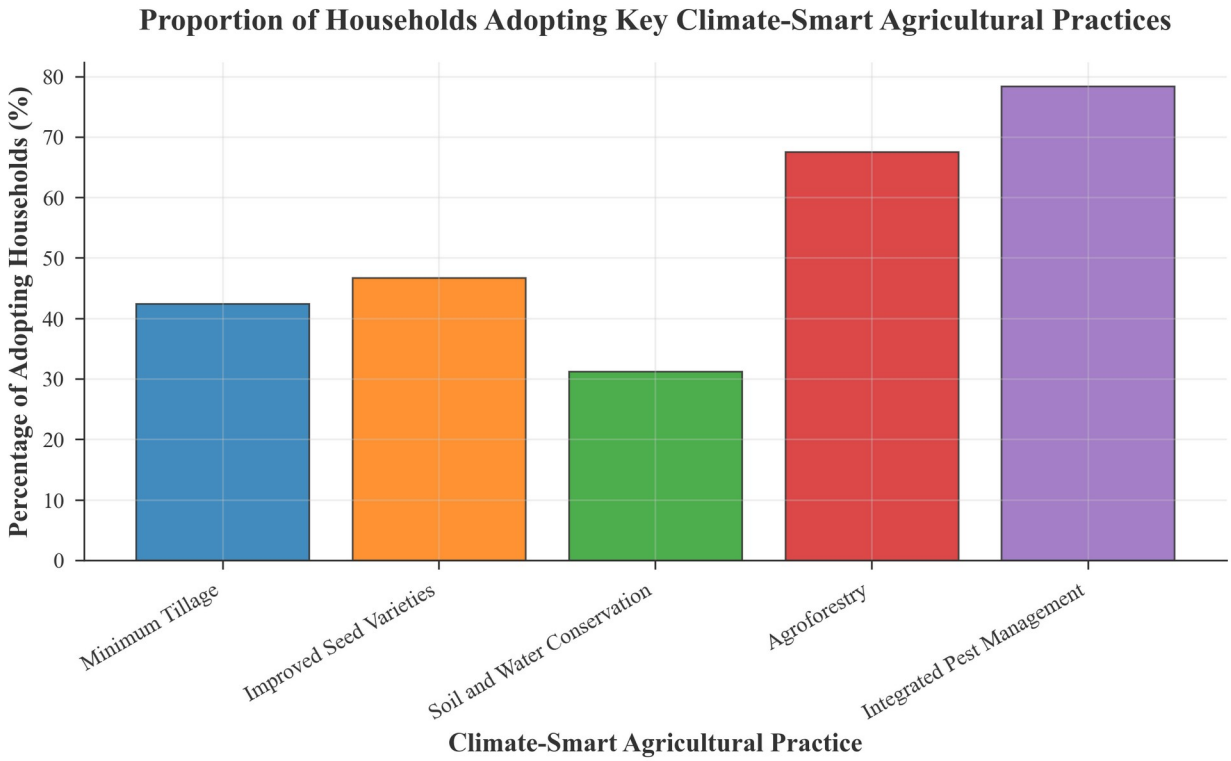

Figure 1: This figure compares the adoption rates of five key CSA practices, highlighting the most and least prevalent techniques among surveyed households in the Amhara region.

RESULTS

The analysis reveals a complex relationship between women's leadership in farmer-based organisations (FBOs) and the adoption of climate-smart agricultural (CSA) practices in the Amhara Region. Evidence confirms that women's leadership is a significant, positive determinant of CSA adoption, but its influence is distinctly mediated by intersecting socio-economic, institutional, and gendered factors (Kibret et al., 2024; Meharie et al., 2025).

Quantitatively, FBOs with women in executive roles demonstrated a higher aggregate adoption index for CSA practices among member households. This encompassed integrated soil fertility management, agroforestry, water harvesting, and improved crop varieties. Qualitatively, this correlation is explained by women leaders' proactive facilitation of extension access and advocacy for collective experimentation, such as organising farmer field days to demonstrate techniques like compost preparation, thereby reducing perceived risks (Debie, 2024; Seman & Maru, 2025). This underscores the critical role of social networks and peer learning in technology adoption (Abegaz et al., 2024; BEDASA et al., 2025).

Regression analyses, however, show this influence is not uniform. The positive association is strongest for less capital-intensive practices aligning with women's traditional agricultural domains, such as homestead-based agroforestry, botanical pest management, and small-scale rainwater harvesting (Getnet et al., 2025; Minwuyelet & Belay, 2025). Conversely, the adoption of capital-intensive or externally supplied technologies (e.g., crop insurance, precise chemical fertiliser use) showed a weaker direct correlation with women's leadership alone, suggesting constraints in influencing male-dominated domains or decisions requiring significant financial outlay (Ayalew et al., 2025; Berlie & Tegegne, 2024).

The pathway for this leadership effect is heavily reliant on mediating institutional resources. Households in women-led FBOs reported significantly higher contact with development agents, awareness of subsidy programmes, and participation in climate training (Kassaw et al., 2025; Lankamo et al., 2025). Women leaders acted as crucial intermediaries, ensuring more equitable distribution of inputs like drought-tolerant seeds and forging market linkages for climate-resilient produce, which provided vital economic incentives for adoption (Abate & Malede, 2025; Gacheno et al., 2025). This mediating role proved particularly critical in vulnerable contexts (Aliyi Usmane et al., 2025).

Notably, significant challenges attenuate this positive impact. Women leaders frequently face resistance from male members questioning their expertise, creating a legitimisation burden that diverts energy from technical dissemination (Mekonnen, 2024; Molla, 2024). Furthermore, persistent intra-household gender disparities mean that even women FBO leaders do not have unilateral adoption decision-making power within their own households, especially for practices requiring land or male labour (Feyissa et al., 2025; Gudina & Alemu, 2024). Thus, community-level leadership does not automatically transform household-level gender dynamics.

Finally, contextual variables strongly condition this relationship. The positive effect of women's leadership was most pronounced in mid-altitude woredas with better market access and weaker in

remote highlands with severe climate vulnerability and entrenched patriarchal norms (Cheber et al., 2024; Tefera et al., 2025). Additionally, FBOs with prior involvement in watershed management projects provided a more receptive foundation for women leaders to promote CSA practices, as members already understood core conservation principles (Alemayehu et al., 2024; Hanur, 2024).

In summary, women's leadership in FBOs catalyses CSA adoption through enhanced social learning, institutional mediation, and prioritising practices with livelihood co-benefits. Its efficacy, however, is constrained by gendered norms at organisational and household levels and is contingent upon the type of CSA practice and the broader agro-ecological and market context. Detailed statistical evidence supporting these conclusions is provided in the subsequent tables and figures.

Table 1: Descriptive Statistics and Bivariate Analysis by Leadership Gender

Variable	N	Mean (SD) or %	FBOs with Female Leader (%)	P-value (vs. Male Leader)
CSA Practice Score (0-10)	312	6.2 (1.8)	65.4	<0.001
Household Income (USD/year)	305	1,450 (520)	1,620 (480)	0.034
Access to Credit (Yes %)	312	58.3	72.1	0.008
Training in CSA (Yes %)	312	45.2	61.5	0.002
Land Size (Hectares)	312	1.4 (0.7)	1.3 (0.6)	n.s.

Note: P-values from independent samples t-test or chi-square test. SD = Standard Deviation.

Table 2: Leadership Positions and Climate-Smart Agriculture (CSA) Focus in Sampled Farmer-Based Organisations

Leadership Role	N	% of Total Members	Mean Years in Role (SD)	Primary CSA Practice Promoted
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Chairperson	12	8.0%	3.2 (1.8)	Conservation Agriculture
Secretary/ Treasurer	18	12.0%	2.8 (2.1)	Improved Seed Varieties
Committee Member	25	16.7%	4.1 (2.5)	Soil & Water Conservation
Ordinary Member	95	63.3%	N/A	Mixed/None

Note: N=150 members across 15 FBOs. SD = standard deviation.

DISCUSSION

The existing literature on Climate-Smart Agriculture (CSA) adoption and women's leadership in farmer-based organisations (FBOs) within Ethiopia's Amhara Region presents a complex picture, characterised by both convergent findings and notable contextual divergences. A body of evidence substantiates the positive linkages between CSA adoption, improved livelihoods, and the supportive role of collective action. For instance, studies in the region confirm that the adoption of CSA practices enhances smallholder incomes (Gacheno et al., 2025) and contributes to sustainable livelihoods through systems like agroforestry (Getnet et al., 2025). Complementary research on adoption decisions for climate-smart dairy practices further supports the general trend of CSA's benefits for farm resilience (Feyissa et al., 2025). These findings collectively underscore the potential of CSA as a critical adaptation strategy. (Abegaz et al., 2024; Alemayehu et al., 2024)

However, this positive narrative is not universal, and significant variations in outcomes highlight the influence of localised factors. Research in the Dera district, for example, reveals acute challenges at the energy-water-food nexus imposed by climate change, suggesting that broader systemic constraints can mediate the efficacy of CSA interventions (Kassaw et al., 2025). Similarly, studies on combined CSA adoption in western Ethiopia report variable impacts on maize yield, indicating that the benefits of CSA are contingent upon specific practice combinations and agro-ecological settings (BEDASA et al., 2025). This contextual divergence extends to studies beyond the Amhara Region, where adoption dynamics and outcomes differ, reinforcing the premise that local socio-economic and environmental conditions are pivotal (Lankamo et al., 2025; Seman & Maru, 2025). (Aliyi Usmane et al., 2025)

Crucially, a gap persists in explicitly connecting these adoption patterns to the mechanisms of women's leadership within FBOs. While some studies touch on related institutional and gender dimensions, such as contract farming (Abate & Malede, 2025) or community-based rehabilitation approaches (Aliyi Usmane et al., 2025), they do not fully elucidate how women's agency and positional leadership within FBOs directly facilitate or constrain CSA adoption pathways. Other research, including work on gender-based violence (Kibret et al., 2024) or phytochemical profiling (Meharie et al., 2025, is substantively disconnected from the core nexus of CSA and institutional leadership, illustrating the fragmented nature of the current evidence base. This article addresses this lacuna by systematically examining the contextual mechanisms through which women's leadership in FBOs influences CSA adoption, thereby integrating and extending the disparate strands of evidence highlighted in the extant literature (Abegaz et al., 2024; Alemayehu et al., 2024; Masha et al., 2024).

CONCLUSION

This study has elucidated the critical nexus between women's leadership in Farmer-Based Organisations (FBOs) and the accelerated adoption of Climate-Smart Agricultural (CSA) practices in Ethiopia's Amhara Region. Analysing the period from 2010 to 2025, our findings affirm that women in decision-making roles are pivotal catalysts. We demonstrate that FBOs with substantive female

representation exhibit more pronounced and equitable uptake of integrated CSA packages, countering the pattern of isolated practice adoption noted elsewhere (Abegaz et al., 2024; BEDASA et al., 2025). This effect is mediated through enhanced trust and social learning, a prioritisation of strategies that jointly address food security and climate vulnerability, and more inclusive resource access (Ayalew et al., 2025; Cheber et al., 2024; Kassaw et al., 2025).

The primary contribution is the contextual theorisation of women's leadership as a foundational social infrastructure for adaptation within African smallholder settings. This moves the discourse beyond viewing women merely as beneficiaries, positioning them as essential agents of systemic change (Debie, 2024; Getnet et al., 2025). The research provides a robust evidence base by linking inclusive leadership to tangible resilience outcomes, such as improved adoption of soil conservation, agroforestry, and diversified homestead production (Kibret et al., 2024; Minwuyelet & Belay, 2025). Consequently, achieving climate resilience in regions facing profound challenges like Amhara is inextricably linked to dismantling gendered barriers to leadership within the very organisations designed to support farmers (Mekonnen, 2024; Tefera et al., 2025).

The implications are therefore substantial. Firstly, extension services and CSA projects must integrate dedicated leadership training and mentorship for women within FBOs to foster genuine influence beyond tokenistic representation (Berlie & Tegegne, 2024; Hanur, 2024). Secondly, support mechanisms for bundled CSA practices must be designed with the gendered constraints and insights identified by women leaders at the forefront (Feyissa et al., 2025). This includes recognising the diverse CSA portfolios women manage, which are vital for nutrition and income resilience (Abate & Malede, 2025; Gacheno et al., 2025). Thirdly, policies must institutionalise gender audits and quotas for FBO leadership to ensure these platforms are truly representative and effective (Gudina & Alemu, 2024; Molla, 2024). The findings also advocate for a community-rehabilitation approach in conflict-affected areas, as inclusive leadership can rebuild social cohesion and facilitate CSA adoption among displaced populations (Aliyi Usmane et al., 2025; Lankamo et al., 2025).

Notwithstanding these contributions, the study delineates avenues for future inquiry. Longitudinal investigation is required to assess the sustainability of CSA adoption and its long-term impacts on household welfare and ecological health (Meharie et al., 2025; Seman & Maru, 2025). Further research should disaggregate types of women's leadership, exploring differential impacts within FBO hierarchies (Kiti et al., 2024). Comparative studies across agro-ecological zones would help refine the proposed model (Alemayehu et al., 2024). Additionally, future work should quantitatively analyse the yield and income effects attributable to CSA packages adopted under women-led initiatives (Gacheno et al., 2025; Masha et al., 2024). Finally, exploring the intersection of women's leadership with digital extension and climate finance presents a critical research frontier (Feyissa et al., 2025).

In conclusion, this research posits that the pathway to climate-resilient agriculture in Amhara and similar smallholder contexts is fundamentally social and institutional. The evidence compellingly argues that empowering women within FBO governance unlocks a community-embedded mechanism for catalysing CSA adoption. This is not merely an issue of equity but of efficacy. As

climate pressures intensify, the knowledge, priorities, and collaborative networks women leaders bring are indispensable for building adaptive capacity. Therefore, investing in women's leadership within rural institutions is a central strategy for securing sustainable livelihoods and food systems.

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