Innovations

Innovations of Climate Smart Agricultural Practices Friendliness' for Female- Headed Households in West Belesa District, North Western Ethiopia

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Abstract:

Climate change poses a significant threat to disadvantaged female-headed households (FHHs), particularly in their ability to access agricultural inputs and services. To address this vulnerability and enhance resilience, there is a critical need to promote gender-sensitive Climate-Smart Agricultural (CSA) practices among these smallholder farmers. This study analyzed the prioritization and selection of specific, gender-friendly CSA practices by FHHs. Data were collected from 200 smallholder female-headed farm households across six kebeles (villages) in the West Belesa district. A structured survey questionnaire was used to gather quantitative primary data, which was complemented and triangulated by focus group discussions and key informant interviews. Descriptive statistics (mean, standard deviation, and frequencies) were calculated using SPSS (version 25). The analysis revealed that the most preferred CSA practices among FHH farmers were: crop rotation (85.5%), construction of terraces (83.5%), use of organic fertilizer (83%), alley cropping (70.5%), poultry farming (69%), and use of improved crop varieties (58%). The findings underscore that development policies and program interventions aimed at boosting agricultural productivity for FHHs must prioritize activities that are already familiar and preferred by the women themselves. To effectively support income generation and improve access to savings and loans, institutions engaged in climate change adaptation and mitigation must focus their efforts on the specific CSA needs of female-headed farm households. Further research is essential to fully understand how traditional gender roles influence the differential engagement of men and women with CSA practices.

Key words: *Climate smart agriculture (CSA), Female- Headed Households, Friendliness, Innovations, Prioritization.*

1.Introduction

Climate change presents a severe global challenge, with impacts that are profoundly differentiated by gender. Women are disproportionately vulnerable to the effects of climate change due to their distinct roles, responsibilities, and the underlying inequitable power dynamics that exist at household and community levels (Nellemann, Verma, and Hislop, 2011; Liru, 2020). The impacts and related adaptive strategies are inherently not gender neutral, as vulnerability is shaped by socio-economic factors, access to knowledge, information, services, and support—all of which vary significantly along gender lines. Case studies have shown that environmental stress often leads to the intensification of women's workloads and a decrease in the assets of poor households, even as both men and women adopt new practices to enhance resilience (World Bank, FAO and IFAD, 2015).

Agriculture is a cornerstone of the economy in many developing countries, particularly in Sub-Saharan Africa, where it employs approximately 70% of the population and contributes about 14% to GDP. However, this critical sector is highly vulnerable to climate change, which directly threatens productivity, employment, food security, and the wider economy (FAO, 2021; Tilahun et al., 2023). In many developing contexts, a clear gender gap exists in agricultural activities, visible in men's and women's responsibilities, priorities, and access to resources and services (Khatri-chhetri et al., 2020).

Ethiopia, characterized by a high population growth rate, heavy reliance on subsistence rain-fed agriculture, and frequent droughts, is particularly exposed to climate change (Ayal et al., 2021; Kifle et al., 2022). The national economy is heavily dependent on agriculture, which contributes 52% to GDP and provides a livelihood for 80% of the total population (Tilahun et al., 2023). Despite its importance, the sector is marked by low productivity due to small-scale and fragmented production systems (Mustefa et al., 2024). Achieving food security and mitigating greenhouse gas emissions necessitates a transformation of traditional production systems, primarily through the scaling up and adoption of Climate-Smart Agriculture (CSA) practices (FAO, 2021).

Climate-Smart Agriculture is a comprehensive strategy integrating crops, livestock, forests, and fisheries to simultaneously address the interconnected challenges of food security and climate change (Mustefa et al., 2024). CSA integrates the three dimensions of sustainable development (economic, social, and environmental) through its three core pillars: (1) sustainably increasingagricultural productivity and incomes; (2) adapting and building resilience to climate change; and (3) reducing and/or removing greenhouse gas emissions, where feasible (Barasa et al., 2021).

Crucially, the existing gender gap in accessing technologies and practices means that climate change disproportionately worsens the disadvantages faced by female-headed household (FHH) farmers in accessing inputs and agricultural services (Khatri- Chhetri et al., 2017). Promoting gender-sensitive CSA practices is therefore essential for increasing the resilience of smallholder FHHs, as closing this gender gap is key to reducing both gender inequality and poverty (UN-Women, 2022).

This paper aims to address this critical knowledge gap by identifying and analyzing the specific Climate-Smart Agricultural practices that are most used, chosen, and considered gender-friendly by female-headed households in their local contexts. The study utilized a household survey as the main data source, corroborated with in-depth interviews with experts and farmers. To propose appropriate CSA practices for specific localities, it is essential to understand the preference of FHHs across various categories, including crop management, field management, climate change mitigation, farm risk mitigation, supplementary income generation, and soil and water conservation practices, as local choice is a prerequisite for successful adoption and dissemination.

2. Materials and Methods

The study was conducted in the West Belesa district, located in the Central Gondar Zone of the Amhara Region, Northwest Ethiopia. This district was specifically chosen due to its diverse agro-ecological areas, which are deemed appropriate for climate change studies (Sisay et al., 2018).

West Belesa is geographically positioned at a latitude of $12^{0}20'0"$ N and a longitude of 37^{0} 40' 0" E (Figure I). The district is bordered by Wogera to the North, LiboKemkem to the South, Gondar Zuria to the West, and East Belesa to the East.

The area's climate is characterized by high rainfall registered predominantly from June to August, although this period is marked by intermittent occurrences of both rainfall shortage and heavy rain. The mean monthly temperature is recorded at 33.5^{0} C. Based on the agroecology classification used for this study (West Belesa BOF and E, 2021), the district contains three main climatic zones: the hot zones (kola) cover 60% of the area, the cold zones (dega) cover 35%, and the moderate zones (weynädega) constitute the remaining 5%.

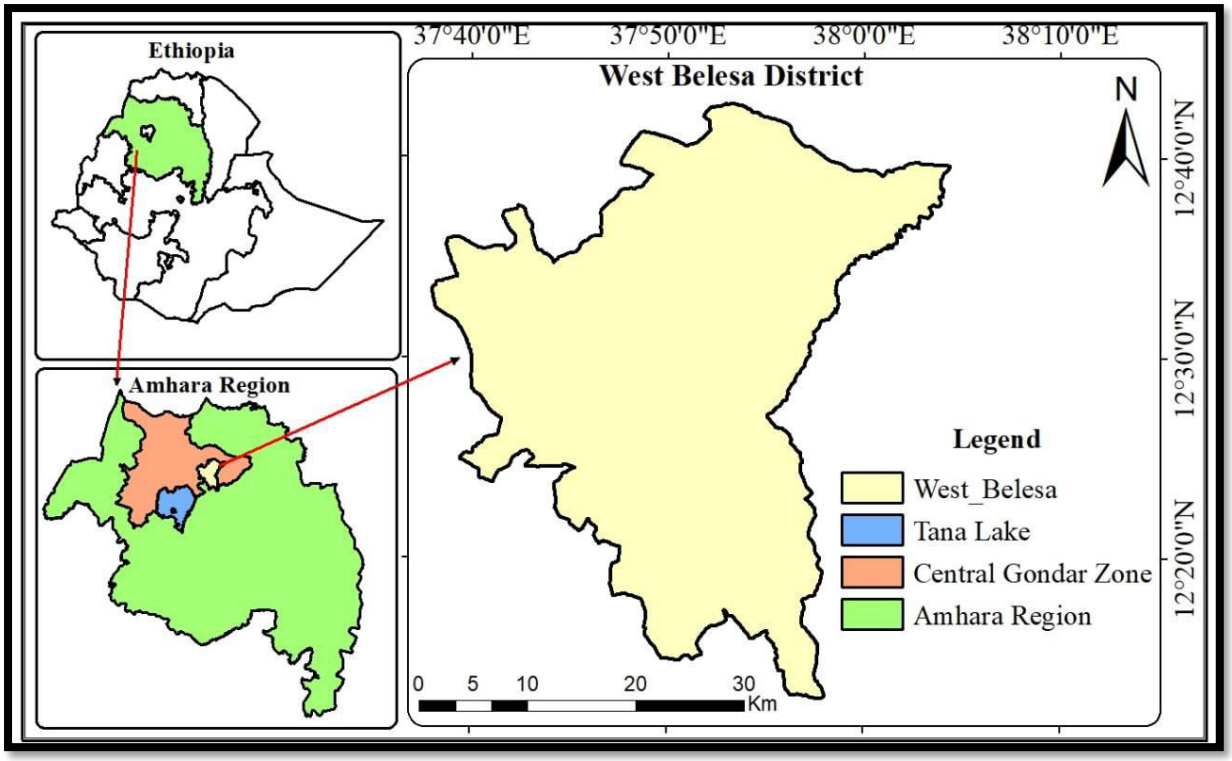

Figure 1: Map of the Study area [Own construction by using Arc GIS 10.2 (2024)]

2.2. Sampling Procedures and Sample Size Determination

In this study, a multi-stage sampling procedure was systematically employed to identify the potential respondents for the survey. The process began with the purposive selection of the Central Gondar Zone, based on its established appropriateness for a Climate-Smart Agriculture (CSA) study. Subsequently, the West Belesa district within this zone was also purposively selected. This second-stage decision was justified by the district's diverse agroecological zones, significant climatic and land degradation challenges, and the persistent problems faced by its rural population, such as continuous food shortages stemming from decreasing land holding sizes, erratic rainfall, and increasing population pressure(Sisay et al., 2018).

The West Belesa district was then stratified based on its three distinct agro-ecological zones: *Dega* (with 2 Kebeles, or KAs), *Woynadega* (with 14 KAs), and *Kola* (with 16 KAs). The third phase involved selecting two Kebeles, the lowest administrative tiers of Ethiopia, from each of these three strata to ensure proper representation of the wider area. This resulted in a total of six Kebeles being selected randomly from the identified strata within the district.

The overall technique used to select the Kebele Administrations was stratified systematic random sampling. This method was utilized to minimize heterogeneities across the agroecological zones and reduce potential sampling error. The sample populations were then drawn at the household level. The final

sample size was set at 200 female-headed households (FHHs), a determination made based on basic determinants such as ensuring adequate representation, the availability of funding, the need to reduce sample error, and the imperative to avoid systematic sample biases (Kothari, 2004). Given the study's specific focus on the exposure and preferences of female-headed households towards different CSA practices, Kebeles with a higher concentration of female-headed farmers were prioritized in the selection process. The unit of analysis for this research was strictly the household level within the study area.

2.3.Data Sources and Data Collection Tools

2.3.1. Data Sources and Methods of Data Collection

The primary quantitative data for this study were collected using a pre-tested, structured interview schedule administered directly to the selected female-headed households (FHHs). The questionnaire was meticulously designed to include a combination of closed-ended questions to facilitate systematic analysis, alongside supportive open-ended questions which allowed respondents to fully articulate their impressions and provide essential qualitative context to the issues at hand.

To ensure the highest possible quality and reliability of the data, the process involved rigorous steps concerning personnel and instrument assurance. Enumerators were carefully recruited based on their qualifications—typically a background in agriculture or rural development, fluency in the local language (Amharic), and familiarity with the cultural setting. Before beginning fieldwork, these enumerators and their supervisors underwent an intensive training workshop. This training covered a detailed review of the questionnaire's intent, effective interviewing techniques (such as maintaining neutrality and proficient probing), and strict data recording protocols.

Validity and reliability were further secured through essential quality control measures. First, the questionnaire underwent a crucial pre-testing phase on a small sample of FHHs in a location outside the final study area. This process allowed the researchers to identify and refine any ambiguous questions, ensuring the final instrument had a clear logical flow. Furthermore, the instrument was drafted in English, translated into Amharic, and then back-translated by an independent party to confirm the semantic equivalence of all questions. Throughout the fieldwork, a field supervisor maintained oversight, conducting spot-checks on interviews in progress and performing back-checks on completed questionnaires to verify data accuracy and consistency. Finally, enumerators participated in daily review and debriefing sessions with the supervisor to discuss and immediately resolve any inconsistencies or fieldwork challenges encountered, ensuring the generation of robust data that accurately reflects FHHs' preferences and experiences with CSA practices.

2.3.2. Qualitative Data Collection

Qualitative data was systematically gathered through Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). These methods were critical for triangulating the findings derived from the quantitative survey, providing essential in-depth context, exploring the underlying reasons for observed practice preferences, and validating the overall results.

FGDs were strategically implemented to foster group interaction, enabling participants to collaboratively discuss diverse perspectives on CSA practices and deliberate on the specific gender-specific barriers and opportunities related to adopting various innovations. Following established research standards (Hancock et al., 2009), each focus group was designed to comprise approximately eight participants. This size was considered optimal for facilitating a rich and deep discussion while ensuring effective management and broad input. The selection of FGD participants prioritized female-headed households from the study Kebeles, ensuring that representation was secured across the different agro-ecological zones. These discussions were guided by a semi-structured protocol, which systematically addressed core themes such as perceived climate change impacts, the rationale behind prioritizing certain CSA practices, existing constraints in accessing crucial inputs and services, and the perceived degree of gender-friendliness of specific agricultural innovations.

In parallel, KIIs were conducted to capture specialized, expert-level information and professional opinions from individuals holding unique knowledge relevant to gender, agriculture, and climate change within the district. These interviews employed a prepared open-ended questionnaire that was carefully tailored to the distinct expertise of each informant. Key informants included a selection of experienced female-headed households, who provided rich case studies and detailed life histories; district-level officers from the Women, Youth, and Children Affairs Office, offering vital perspectives on policy and social and gender-role constraints; and district-level agriculture officers, who contributed technical knowledge on recommended CSA practices, the performance of local extension services, and agricultural trends. To maintain the rigorous quality of this qualitative data, separate, semi-structured protocols were developed for both the FGDs and KIIs. Furthermore, all discussions were conducted in the local language,and then subsequently transcribed word-for-word and translated to English for rigorous thematic analysis, ensuring the fidelity of the participants' unique insights.

2.4. Methods of Data Analysis

This study utilized a dual approach to data analysis, employing both quantitative and qualitative techniques to thoroughly address the research objectives.

For the quantitative analysis, both descriptive and econometric analytical techniques were employed, as dictated by the specific demands of the research objectives. Descriptive statistics, such as frequencies, means, and standard deviations, were used to summarize the characteristics of the sample and the prevalence of specific CSA practices. The quantitative data, which were collected primarily through the structured survey, were organized and analyzed using the Statistical Package for the Social Sciences (SPSS version 25), complemented by Excel tools for data cleaning and preliminary calculations.

For the qualitative analysis, a content analysis approach was used to triangulate and enrich the findings from the quantitative survey. The data collected through the Focus Group Discussions, Key Informant Interviews, and the open-ended sections of the survey questionnaire were first transcribed from the local language. Subsequently, these textual data were carefully arranged and systematically synthesized based on the similarities of their content, allowing researchers to identify recurring themes, patterns, and in-depth explanations regarding the female-headed households' preferences, challenges, and experiences with Climate-Smart Agricultural practices.

3. Result and Discussion

3.1.Female-Headed Households' Friendliness to CSA Crop Management Practices

This section presents the findings regarding the preferences of female-headed households (FHHs) for various Climate-Smart Agricultural (CSA) crop management practices. Based on existing literature, the commonly known and implemented CSA crop management practices include: the efficient use of inorganic fertilizers (optimizing time, method, and amount), adjusting planting dates, intercropping cereals with legumes, practicing crop rotation, utilizing organic fertilizers, implementing compost and manure management (including green manuring), and employing reduced tillage techniques (Jirata et al; 2016, ICCAS, 2018; Simane et al; 2012 and Abiyot et al., 2023). Following the established methodology, FHHs were interviewed about these practices, and the results of their preferences, which indicate the perceived friendliness and suitability of these innovations, are presented in the forthcoming Table 1 for detailed discussion.

Table 1.FHH'sFriendlinessCropManagementCSA Practices (N=200)

CSA Crop Management Practices	Yes	No	Percent (%)	Level
Crop rotation	171	29	85.5	1
Use of organic fertilizer (compost)	166	34	83	2

Intercropping	163	36	81.9	3
Changing planting dates	145	55	72.5	4
Use of efficient inorganic fertilizers	141	59	70.5	5
Reduced tillage	131	69	65.5	6

Source: Own computation (2023).

The survey results presented in Table 1 clearly demonstrate the preferences of female-headed households (FHHs) for various Climate-Smart Agricultural (CSA) crop management practices. A high majority of the surveyed FHHs indicated a strong preference for practices that are generally familiar and have a long history of use in the area, and which are also considered gender-friendly in terms of time and labor requirements.

Specifically, the data shows that 85.5% of the FHHs prefer crop rotation, followed closely by 83% who prefer the use of organic fertilizers like compost, and 81.9% who favor intercropping. These high rates of preference suggest that FHHs generally perceive practices that are effective at increasing productivity while also being manageable within their existing workload and resource constraints as being gender-friendly. This finding aligns with the results of previous studies concerning CSA adoption and gender preferences (Abiyot et al., 2023; Tsigie et al., 2020).

3.2. FHH's Friendliness to CSA Field Management and Climate Change Mitigation Practices

This section analyzes the preferences of female-headed households (FHHs) regarding Climate-Smart Agricultural (CSA) Field Management and Climate Change Mitigation Practices. Field management practices are crucial for climate change mitigation as they work to reduce greenhouse gas emissions and enhance carbon sequestration in soils (Feliciano et al., 2022).

Based on existing literature and information (Jirata et al; 2016, ICCAS, 2018; Simane et al; 2012 and Abiyot et al; 2023), the appropriate CSA Field Management and Climate Change Mitigation Practices identified for review included: the use of cover crops, alley cropping, tree planting for windbreaks and shelter, the use of mulching for seedlings, tree-based conservation agriculture, and the usage of alternative energy sources like biogas.

The study interviewed female-headed households on their exposure to and actual implementation of these specific practices. The results of this analysis, which

reflect the FHHs' perceived friendliness and adoption of these field management and mitigation strategies, are presented in the forthcoming Table 2.

Table 2. Field Management and Climate Change Mitigation CSA Practices**(N=200)**

CSA Field management and climate change mitigation practices	**Yes**	**No**	**Percent (%)**	**Level**
Alley cropping	141	59	70.5	1
Tree planting for wind break and shelter	115	85	57.5	2
Alternative energy fuel efficient source (bio-gas)	87	113	43.5	3
Use of mulching	85	115	42.5	4
Use of cover crops	84	116	42	5
Tree based conservation agriculture	82	118	41	6

Source: Own computation (2023).

The survey results detailed in Table 2 provide insights into the adoption and preference of Climate-Smart Agricultural (CSA) Field Management and Climate Change Mitigation Practices among female-headed households (FHHs). It is evident from the findings that the preferences of the FHHs are strongly influenced by their exposure and awareness of the activities already being implemented in their localities.

The most preferred practice among the respondents is alley cropping, favored by approximately 70.5% of the FHHs. Following this, tree planting for windbreak and shelter use is preferred by over 57% of the respondents. Additionally, 43.5% of the FHHs expressed a preference for the use of alternative energy sources, such as biogas, indicating a growing interest in mitigation practices that extend beyond direct field crop management. These preferences highlight the FHHs' pragmatic selection of practices that they perceive as manageable and beneficial within their local context.

3.3. FHH's Friendliness of CSA Farm risk reduction practices

This section examines the preferences of female-headed households (FHHs) for Climate-Smart Agricultural (CSA) Farm Risk Reduction Practices. These practices are fundamentally implemented to enhance productivity and mitigate the critical risks often faced by farmers, particularly the threat of food shortage.

The primary practices considered for farm risk reduction in this context include the use of improved crop varieties, the implementation of small-scale irrigation, and general field improvement techniques. Crucially, the use of improved crop varieties specifically refers to the adoption of high-yielding varieties that possess desirable traits such as drought tolerance, short maturity periods, and enhanced

resistance to diseases and pests. The effectiveness and perceived friendliness of these practices by FHHs will be detailed in the subsequent table and discussion.

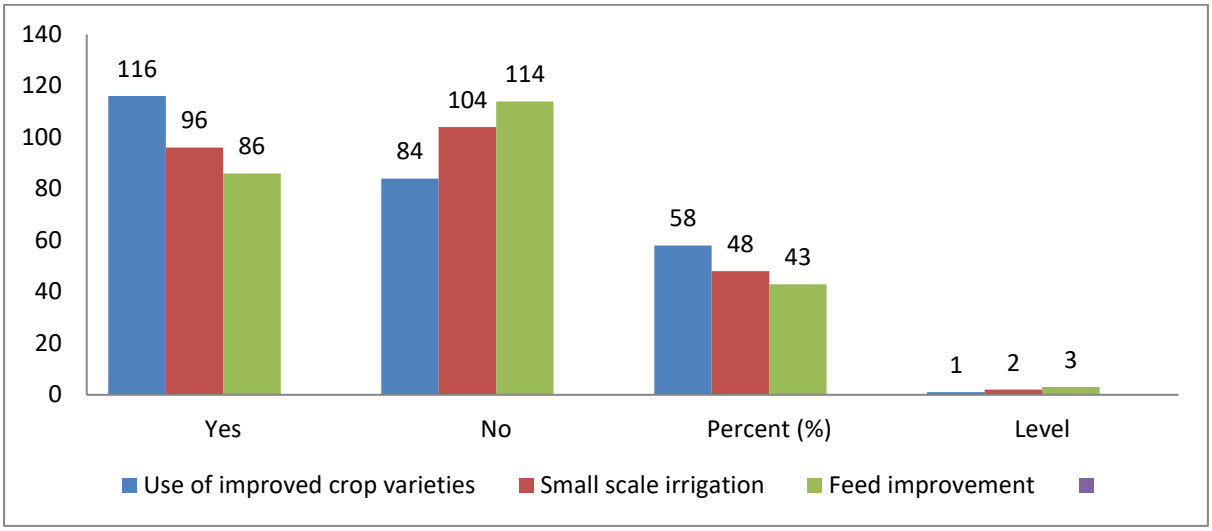

Figure 2. FHH's Friendliness of Farm risk reduction CSA practices (N=200)

Figure 2 illustrates the assessment of female-headed households' (FHHs) friendliness toward various Climate-Smart Agricultural (CSA) farm risk reduction practices. The data clearly show that the most preferred risk reduction strategy among the surveyed FHHs is the use of improved crop varieties, favored by 58% of the respondents. These varieties include those that are drought-tolerant, short-maturing, and resistant to disease and pests. Following this, small-scale irrigation is preferred by 48% of the FHHs, demonstrating a significant interest in strategies that secure water access. Finally, feed improvement practices are preferred by 43% of the FHHs. These figures indicate that FHHs prioritize easily accessible, high-impact strategies, particularly those related to crop genetics and water management, to minimize farm risks and mitigate the threat of food shortage.

3.4. FHH's Friendliness of Supplementary income generation CSA practices

This section focuses on the preferences of female-headed households (FHHs) for Climate-Smart Agricultural (CSA) Supplementary Income Generation Practices. In agriculture, supplementary income generation involves expanding revenue streams beyond traditional crop and livestock production. Diversifying income through methods like agroforestry, off-farm pursuits, and agricultural product processing is crucial for improving food security, boosting farmers' overall livelihoods, and increasing their resilience to climate change impacts (GIZ, 2024).

The study assessed FHHs' interest in several of the most identified and utilized CSA supplementary income practices: poultry farming, improved animal husbandry practices (including specialized housing, feeding, and animal health improvements), and apiculture (beekeeping). The results of the FHHs'

preferences for these income-boosting activities will be presented and discussed below.

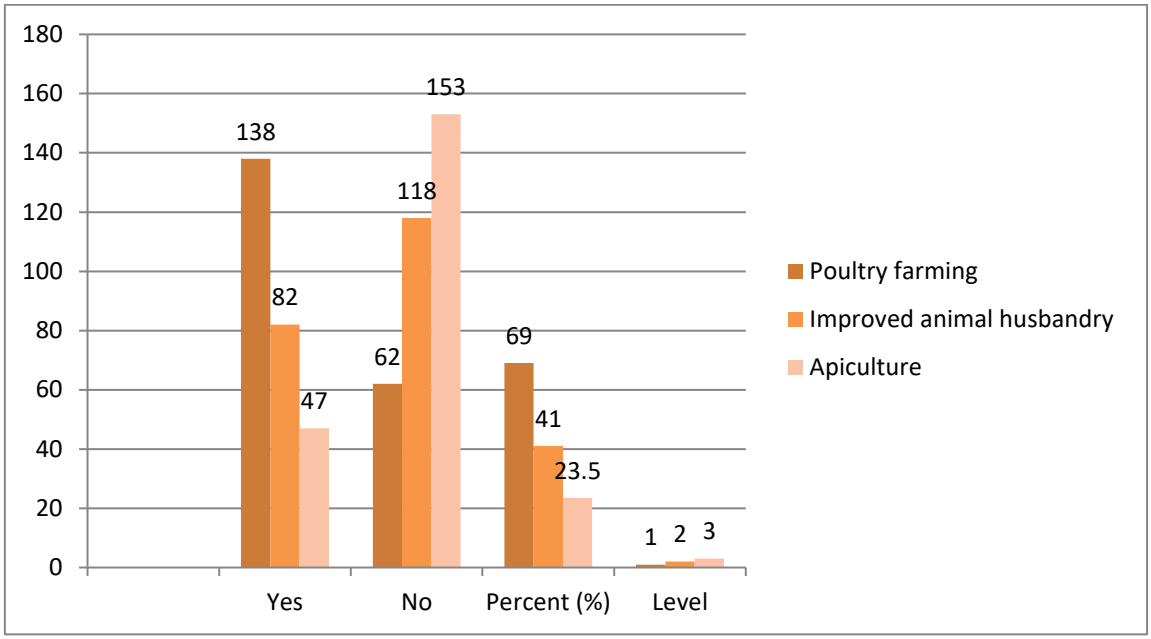

Figure 3. FHH's Friendliness of Supplementary income generation practices

Figure 3 clearly illustrates the survey results regarding female-headed households' (FHHs) friendliness toward Supplementary Income Generation Practices within the context of Climate-Smart Agriculture (CSA). The findings indicate that women farmers largely favor activities that require less labor, are easily accessible, and are affordable to implement.

Specifically, the study reveals that 69% of the surveyed FHHs demonstrate a preference for poultry farming, making it the most popular supplementary activity. This high preference is likely due to its low initial investment and manageable labor demands. Following this, improved animal husbandry practices are preferred by 41% of the FHHs. In contrast, apiculture (beekeeping) shows the lowest preference, favored by only 23.5% of the respondents. These results strongly align with previous studies which suggest that the accessibility and affordability of technologies significantly enhance the uptake by women farmers (Khatri-chhetri et al., 2017).

3.5. FHH's Friendliness of Soil and Water Conservation CSA Practices

This section analyzes the preferences of female-headed households (FHHs) for various Climate-Smart Agricultural (CSA) Soil and Water Conservation (SWC) Practices. SWC activities are recognized as vital for sustainable farming, primarily by mitigating soil erosion and significantly improving soil fertility, thereby strengthening climate resilience. The specific SWC activities assessed in the study included the construction of terraces, which can be either stone or soil bunds designed to reduce erosion; water conservation or water harvesting

activities, involving the collection and storage of water mainly during the Ethiopian *kiremt* (rainy season); and the use of grass strips, such as Vetiver grass, which function as biological barriers to reduce soil erosion. The subsequent analysis will detail the FHHs' perceived friendliness and reported preference levels for these crucial soil and water conservation practices.

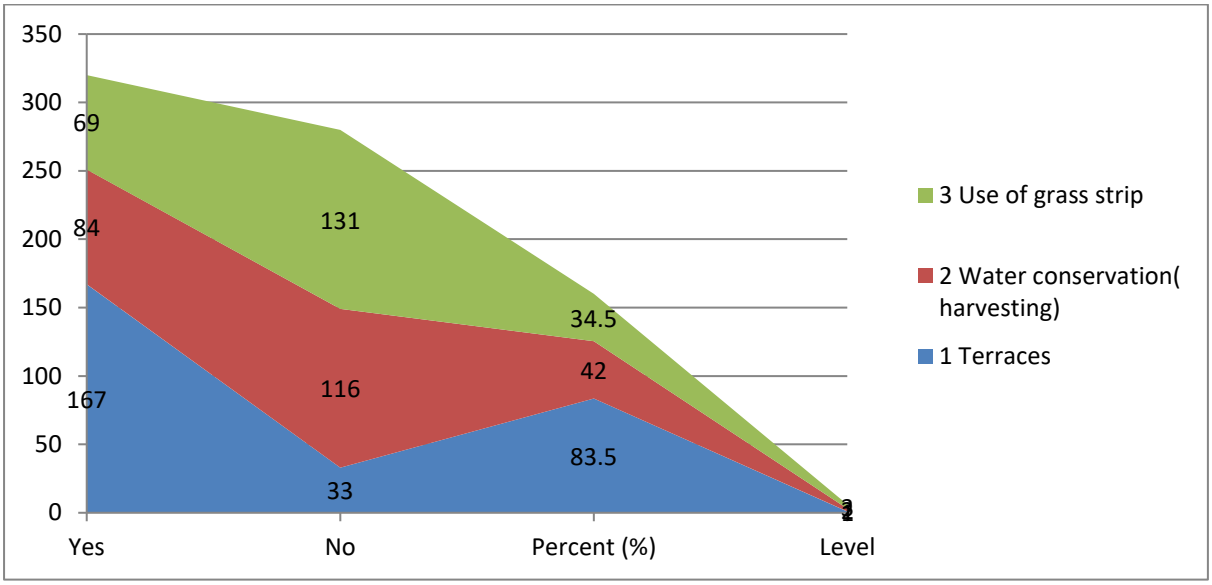

Figure 4. FHH's friendliness of soil and water conservation practices (N=200)

Figure 4 presents the survey results detailing the preferences of female-headed households (FHHs) for various Soil and Water Conservation (SWC) practices. The results show that a significant majority, 83.5%, of the respondents prefer the construction of terraces. This is followed by water conservation practices, preferred by 42%, and the use of grass strips, favored by 34.5%. The strong preference for terracing suggests that farmers who perceive that this practice will improve soil fertility are more likely to adopt it over other SWC methods. This finding contrasts with a previous study by Simeneh and Getachew (2016), which stated that some farmers were reluctant to use SWC innovations due to concerns that they could decrease crop yields by attracting pests, impeding tillage, and reducing the effective farm size.

During the assessment of the most preferred CSA practices, crop management practices consistently ranked first among the various innovative agricultural techniques chosen by FHHs. Separate FGDs were conducted in the selected *kebeles* to understand FHHs' knowledge and preference for CSA practices in their locality. The female participants strongly affirmed their familiarity with crop management practices, particularly crop rotation, intercropping, and preparing compost (use of organic fertilizers) for their backyards.

Crop rotation was identified as the first and most widely used practice by FHHs. They recognized it as a normal farming routine, and even when male hired laborers prepared and planted the farmlands, the FHHs retained the right to choose the crops to be sown and decide on the rotation practice. Another familiar practice highlighted was intercropping maize with beans. The participants explained that maize leaves provide protection for beans during periods of high sunlight exposure, while the beans, through their roots, help improve soil fertility for the maize. They also noted that intercropping helps prevent the farmland from remaining idle, as one crop is harvested early while the other remains, and when combined with the construction of SWC practices like soil and stone bunds, the farmland is protected from soil erosion.

Regarding agroforestry practices, such as planting trees on farmlands, the FGD participants mentioned that they plant various tree species primarily when the land has suffered reduced productivity or become bare due to overgrazing, using this practice to restore the land. This practice is recognized for its ability to increase soil fertility and contribute to climate change mitigation. Finally, the use of compost was highly preferred by FHHs because it serves as an affordable alternative, allowing them to improve soil health without incurring the cost of buying inorganic fertilizers.

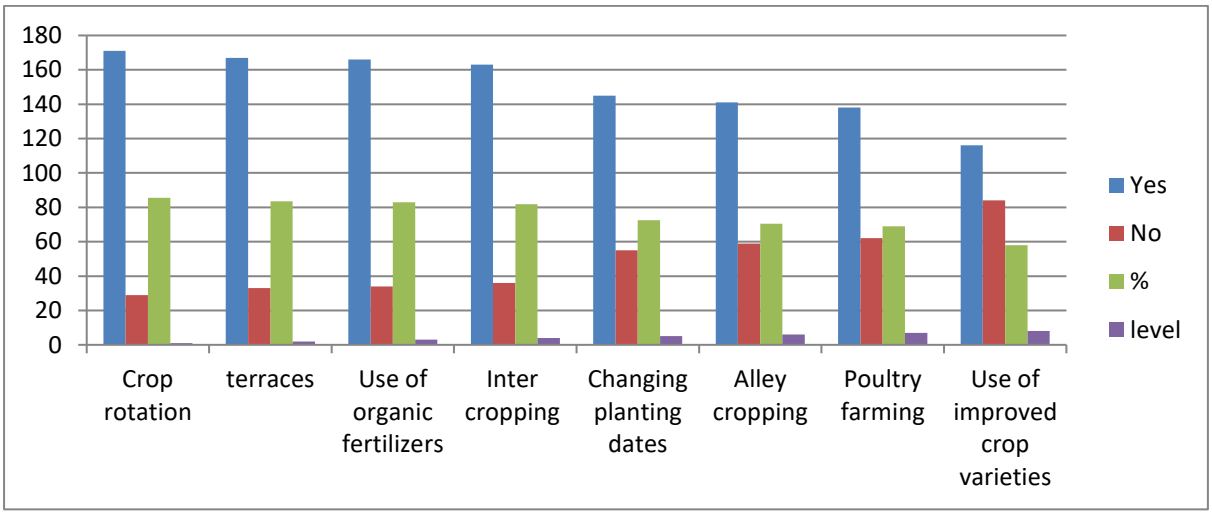

Figure 5: Female headed households' friendliness to CSA practices

Figure 5 summarizes the overall survey results regarding female-headed households' (FHHs) friendliness and preference for the various categories of Climate-Smart Agricultural (CSA) practices. The data clearly indicates that the most highly practiced and chosen CSA innovations fall under two categories: Crop Management practices, preferred by 85.5% of the FHHs, and Soil and Water Conservation practices (specifically the construction of terraces), preferred by **83.5%**. These high preference rates suggest that FHHs favor practices that directly enhance soil health and crop productivity, likely due to their long-term familiarity, affordability, and manageable labor requirements.

With respect to Field Management practices, alley cropping was the most preferred activity, regarded as gender-friendly by 70.5% of the respondents. Finally, in the category of supplementary income generation, poultry farming was overwhelmingly selected as the preferred practice by female-headed households to boost household revenue.

4. Conclusion and Recommendations

This empirical study, based on a comprehensive analysis of 200 female-headed households (FHHs) using both quantitative and qualitative methods, critically examined the preferences and friendliness of previously implemented Climate-Smart Agricultural (CSA) practices in the study area. The findings fundamentally underscore that successful CSA adoption among FHHs relies heavily on incorporating activities that align with their existing knowledge, resource capacity, and labor constraints, rather than introducing entirely new and unfamiliar technologies.

The study concludes that FHHs demonstrate a strong, pragmatic preference for agricultural practices that, while now framed within the modern CSA approach, were already known or utilized as traditional farming methods, thus qualifying them as gender-friendly. Specifically, crop rotation, the use of organic fertilizer (such as compost), and intercropping were the most dominantly practiced and preferred crop management activities, given their low-input nature and high familiarity. The reason is that these practices are favored because they can be easily integrated into the FHHs' routine without relying heavily on expensive external inputs or hired male labor. Furthermore, alley cropping emerged as a favorable field management practice because the resulting tree products provide crucial energy sources and materials, directly aligning with household needs. The use of improved crop varieties that are drought-resistant and early-maturing is regarded as a vital, gender-friendly strategy for reducing farm risks, while poultry farming is overwhelmingly preferred for supplementary income generation due to its affordability, low labor requirement, and easy management within the courtyard. Finally, the acceptance of soil and water conservation (SWC) practices like the construction of terraces is driven by the perceived benefit of improved soil fertility and the historical context of government introduction in a food-insecure region, making the practice socially accepted and necessary for resilience.

Based on these findings, development policies and program interventions designed to enhance agricultural productivity for female-headed households must critically consider the familiarity of the activities mainly preferred by women themselves. In the study area, there is a clear need to account for the previous known friendliness and ease of use of CSA practices for FHHs.

Consequently, the Ethiopian Ministry of Agriculture must implement a new agricultural extension system that gives primary focus to the needs and preferences of FHHs, strengthening their capacity in already familiar practices through continuous awareness creation and targeted training. This effort should be complemented by the Ministry of Children and Women Affairs Office actively

facilitating credit access for FHHs, specifically to purchase improved inputs and to strengthen poultry production activities. Policy makers must also prioritize creating a gender-responsive agriculture management strategy to increase the use of these gender-friendly CSA practices. Furthermore, to support comprehensive livelihood improvement, policy must give attention to the formation of smaller, village-level groups primarily consisting of FHHs for activities like poultry production, simultaneously working to secure reliable market opportunities for their products. In a broader sense, institutions engaged in climate change adaptation and mitigation are urged to collaborate with women's community-based organizations to leverage women's potential as successful innovators and to improve access to essential services like savings, loans, and health care. Ultimately, the researchers' judgement is that for interventions to be truly successful and scalable, they must be tailored to the lived realities of FHHs, and additional research is still required to fully understand how gender roles influence the differential interaction of men and women with CSA initiatives.

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Declaration of competing interest:

The authors declare that they have **no competing interests** or personal relationships that could have appeared to influence the work reported in this paper.

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