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Full Length Research Paper

Research Title: Coping Strategies of Rural Households to Environmental Constraints in Home Gardening in Jabi Tehnan District, Ethiopia

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Abstract

Home gardening is an important activity for rural livelihoods, food security, and sustainability, although it is increasingly threatened by environmental issues. This study investigated the coping and adaptive practices used by rural households in response to the limiting effects of the environment on home gardening in Jabi Tehnan, Ethiopia. The study employed a research design comprising a combination of survey techniques involving 333 rural households, in addition to Focus Group Discussions and Key Informant Interviews. Data analysis techniques involved the use of descriptive statistics for quantitative data, while analysis for the latter employed Thematic Content Analysis assisted by triangulation for reinforcement. The analysis is framed by ecofeminism and sustainability theory to explain gendered adaptive responses. The study findings show that rural households have mainly employed cost-effective, indigenous, and knowledge-intensive techniques in the form of organic fertilizer, soil conservation, weeding, and climate dependent serve as both short-term coping and long-term adaptive strategies. Water and economic adaptations were less effective because of infrastructural and institutional limitations, while in-situ adaptations were preferred over migration as adaptation strategies among rural households. The concluding findings not only justify policies addressing water, extension services, and institutional limitations but also encourage further longitudinal research and advocate for research exploring similar dynamics. This study calls for integrated, gender responsive, and sustainability-oriented policies to strengthen rural adaptive capacity.

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1. Introduction

Home gardening has been recognized as one of the longest living agricultural systems, dating back to human efforts to domesticate valuable plant species around settlements for food, medicinal and securing livelihood purposes (Hutterer, 1984; Niñez, 1987). In rural areas,

home gardens are an integrated food production system that addresses security, livelihood diversification, biodiversity conservation, and the provision of various ecological services, such as soil fertility support and microclimate regulation (Kumar, 2006; Malte Reimers & Stephan Klasen, 2013). In line with the increased variability in climate conditions and environmental degradation, home gardening has emerged as an effective approach for rural households to manage environmental constraints to secure their livelihood. In Africa, home gardens have been recognized to make significant contributions to improving self-reliability for food security, food diversification, and improving home gardening resilience to climatic shocks such as irregular rainfall, drought, and soil fertility reduction in Africa (ATCD, 2018; FAO, 2018). In rural areas, farmers have adopted various coping strategies to counter environmental stress and enhance home gardening productivity, such as crop diversification, preservation of indica seeds, rainwater harvesting, and soil conservation techniques (Altieri et al., 2015; Kumar, 2006).

Empirical evidence from smallholder agro ecological systems further supports that soil and crop based methods are the most popular forms of adaptation to climatic conditions because of their low cost and manageability, which improve the long-term resilience of such ecosystems (Adger, 2006; Altieri et al., 2015). Nonetheless, the availability of water infrastructure and technology is still disproportionate in rural Africa, as it often hinders household adaptation efforts in favor of manual or low-tech adaptation methods (FAO, 2018). Among household-level adaptation and mitigation practices, women are most central to household gardens where they utilize local knowledge in the identification of plant species (Anderson, 2003; FAO, 2009). However, such efforts are hampered by socio-cultural factors and unequal access to resources (Anderson, 2003; FAO, 2009). Home gardening is an integral part of livelihood diversification in rural communities in Ethiopia, especially in regions that rely on rain-fed sources and where irrigation in farmland is still done in an infrastructurally underdeveloped manner. In this respect, home gardens are essential in supplementing the production of staple foods, increasing dietary diversification, and earning supplemental income for rural families (Feleke, 2011; Zemede, 2011).

In contrast, despite their significance, there are also rising levels of environmental limitations in home gardens, including land degradation, reduced soil quality, fluctuating rainfall, and water shortages (FDRE, 2012; Fransen & Kuschminder, 2009). At the national level, there are also findings suggesting an environment shaping aspect for the extent of adaptation in smallholder systems in Ethiopia, where, in addition to environmental exposure, there are institutional and infrastructural limitations, especially irrigation service coverage and gender dimensions (FAO, 2009; FDRE, 2012). Socio-ecological relations of power qualify these adjustments in response to environmental limitations (Warren, 2000). The structure tends to reproduce lack of access to land, capital, and decision-making in women despite being principal actors in home gardens, as forwarded by Eco patriarchal frameworks informing on non-equitable gender relations where women's access is systematically impeded (Gaard & Gruen, 1993; Shiva, 1991; Warren, 2000)

Although men increasingly play dominant roles in commercial farming, the subsistence-based coping methods practiced by women in home gardening are less acknowledged in policy and scientific research (Bunderson et al., 1990; FAO, 2009). Empirical research on home garden farming in Ethiopia has centered almost exclusively on crop diversification, agro biodiversity, and health-related research, specifically targeting the southern parts of the country (Hailu & Asfaw, 2011; Semu, 2018; Zemede, 2011). In contrast, however, the relatively less attended parts of Ethiopia to these studies are the northern parts, specifically the Jabi Tehnan District, where, in particular, environmentally limiting factors play key roles, and where rural living practices depend almost entirely on home garden farming systems. The contribution of the literature actually appears to

underrepresent the magnitudes of the methods and measures by which rural households cope within environmentally stressful settings (Abay & Melese, 2019; Kebede, 2009; Mengistu & Fitamo, 2015).

In the context of the multiple challenges facing small landholdings, soil degradation, erratic rainfall, and limited irrigation infrastructure, poor rural households in the Jabi Tehnan District have to adopt coping responses from short to longer term adaptive strategies in home gardening. While such responses are crucial for household resilience and environmental sustainability, there is limited systematic evidence regarding the nature and contribution of coping and adaptive strategies for sustainable home gardening in the study area. Therefore, this study was conducted to identify the coping strategies employed by rural households in the context of environmental stressors, explore the adaptive strategies used in response to these constraints, and determine their contribution to sustainable home gardening livelihoods and environmental management in Jabi Tehnan District, Ethiopia. To better interpret these gendered and ecological dynamics, this study is grounded in eco-feminism, liberal feminism, and sustainability theory.

2. Theoretical Lane

2.1. Liberal and Eco-feminism theory

Ecofeminism thought provides a critical perspective for examining the connection between gender relations and resource management. Eco feminist thought suggests that the patriarchal mechanisms of domination over human beings are inextricably connected to the domination of nature and that both women and nature are subordinated in socio-ecological relations (Gaard & Gruen, 1993; Hunnicutt, 2021; Warren, 2000). In the context of rural agricultural settings, eco feminist thought can help elucidate why the role of women in home gardening and their ecological knowledge in this respect are often overlooked and obscured as they are of fundamental importance for maintaining household food and biodiversity security (Salleh, 2003; Shiva, 1991). In this research, ecofeminism thought will be employed to analyze how resource use and the ability to make decisions for coping strategy implementation are affected by eco patriarchal conditions.

As Beauvoir (1949) argues, “Otherness” has been the historical state of women, which to this day marginalizes women’s decision-making role in livelihood systems like home gardening. In particular, within the context of home gardening, liberal feminism suggests the relevance of equality of opportunity, formal rights, and resource differences for the empowerment of women (Okin, 1989; Tong & Botts, 2009). In applying its principles to home gardening in rural areas, this school of feminism underscores how home gardening projects with imbalances in access to land, credit, agricultural extension, and decision-making are limited in building households’ coping capacities, particularly for women. By identifying institutionalized obstacles, how home gardening can better develop decision-making roles for women in home gardening through an interventionist approach underpinned by the principles of liberal feminism can thus be informed (Moghadam, 2005). In this research, for instance, liberal feminism can provide a good counterbalance to ecofeminism in underlining solutions.

2.2. Sustainable Development Theory

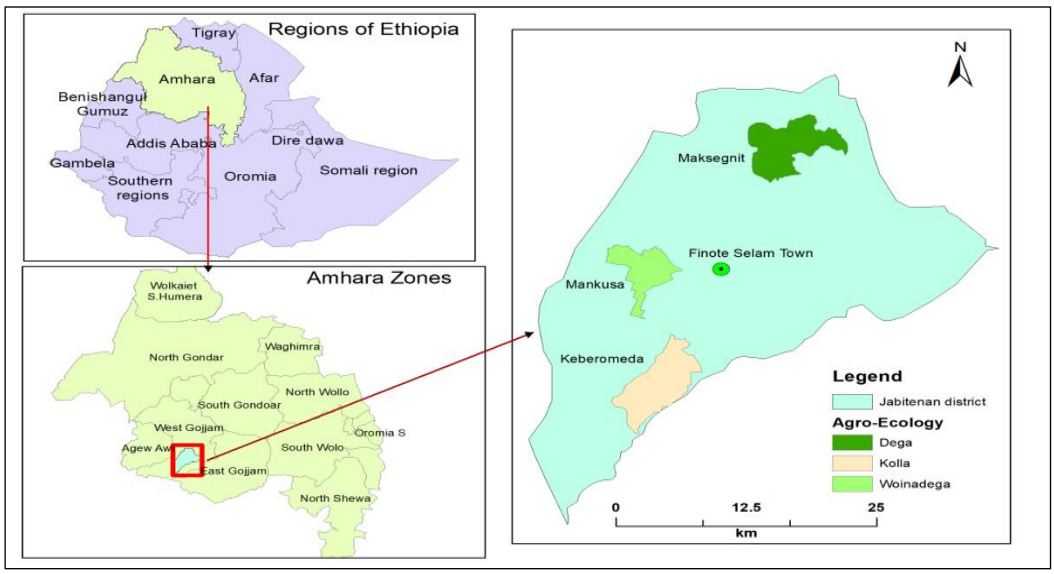
As suggested by the Brundtland Commission, cited by Borowy (2013), the concept of sustainable development states that current demands should be considered without reducing the ability of the future generations to address their demands. This definition identifies t methods as adaptive, in terms of adaptation and resilience, if they enhance the ability of socio-ecological systems to bear environmental stress while sustaining system functions (Adger, 2006; Smit & Wandel, 2006). Sustainability theory, in relation to home gardening practices, identifies household adaptation methods such as crop diversification, natural seed preservation, soil and water conservation practices, and low input gardening practices as practices that aim for household and environmental sustainability and

conservation concurrently (Kumar, 2006; Malte Reimers & Stephan Klasen, 2013). By applying sustainability theory and ecological and liberal feminist ideas, this research approachs the concept of home gardening as an environmental system that enhances resilience, equity, and sustainable development in the Jabi Tehnan District through household adaptation practices.

3. Method and Materials

2.1 Study area description

Jabi Tehnan District, West Gojjam Zone, Amhara Regional State, northwest Ethiopia, is where this study was carried out. The district has an area of around 1,180 square kilometers and is located between latitudes 10°56′ and 11°25′N and longitudes 37°17′ and 37°53′E.The three main agro ecological zones Dega (Highland), Woina-Dega (Midland), and Kolla (Lowland) are covered by the elevation, which varies between 1,500 and 2,500 m. above sea level (Jabi, 2020). Variations in height and rainfall patterns are the main characteristics that distinguished locations. Jabi Tehnan District's variation in altitude has produced a range of microclimatic and edaphic conditions conducive to a range of cultivated and wild plant species. Highlands (dega) are favorable for temperate vegetables and citrus fruits, midlands (woina-dega) are favorable for a combination of fruit and vegetable crops, and lowlands (kolla) are favorable for tropical fruit crops such as mango, papaya, and banana (Abebe & Asfaw, 2023; Tafere & Woreta). Ecological differentiation is the reason for the total agro biodiversity of the region and is a platform for the diversity of home garden species reported in this study paper. Jabi (2020) report that the area has a total 103,000 hectares of arable land and 12,000 hectares of forest cover as well as an approximate livestock population of 173,000 cattle, 65,000 small ruminants, and 29,000 poultry. The study area is presented below:



(Source: Adopted from Amhara National Regional State Plan Bauru, 2023)

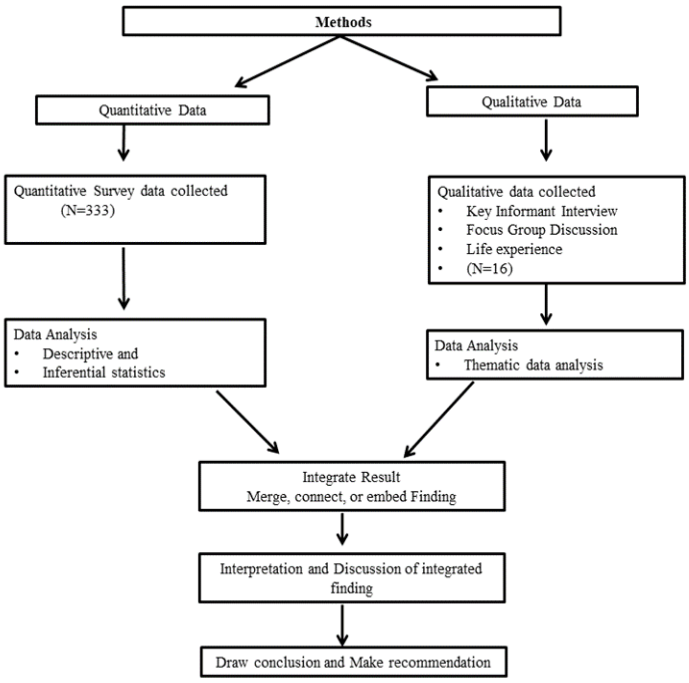
Figure 1. Administrative Map of Amhara region and the study district

Agro ecological heterogeneity and drought as well as land degradation susceptibility make Jabi Tehnan District an ideal location for carrying out research on perceived advantages of home gardening in environmental conservation. Zonal rainfall variation can be estimated as an average annual rainfall in Dega of 1,200 mm, in Woina-Dega of 1,000 mm, and in Kolla as 800 mm. These environmental conditions are highly suitable for the generalizability of findings in similar rural settings. Taking into account the life support system characteristics, it is known that the livelihood of the population is based on agriculture. The study location is characterized by maize, teff, and barley, wheat, and red paper, potato, bean, maize, pea, cabbage, onion, potato,

and tomato cultivation, as well as livestock rearing (Jabi, 2020). A map of the study location has been presented (Figure 1), where the zones, districts, and kebeles are appropriately labeled in order to ensure geographic consistency. The use of 'agro ecology' in this study only refers to climatic and physical geographical characteristics of ecological zones for farming and excludes the broader socio-political and ecological definition by (FAO, 2009). Figure 1 is the map of the study location showing the selected kebeles and agro ecological zones.

3.2. Research Design and Approach

The study employed a concurrent mixed-methods approach, specifically the convergent parallel model by (Creswell et al., 2011). This is when both quantitative and qualitative data are gathered at the same moment but separately analyzed. The design served to allow for in-depth investigation of factors that determines gender equality access to and control over rural household home garden resources, Quantitative data were collected through a systematic survey, while qualitative data were collected through semi-structured interviews, focus group discussions (FGDs), key informant interviews (KIIs), and observation. Each dataset was separately analyzed before being put together at the stage of interpretation. This allowed the strengths of quantitative and also qualitative data counter their respective weaknesses, facilitated triangulation, and richened the overall insight of the research problem. For the sake of conciseness, the researchers have utilized this concurrent (mixed methods research design) flowchart, adapted and visualized according to (Creswell et al., 2011). The study employed a concurrent mixed-methods research design, as shown in (Figure 2).



Source: Creswell et al. (2011)

Figure 2. Conceptualized Mixed (Concurrent) method research design flow chart

3.3. Sampling Design and Techniques

The district was purposively selected because it spans diversified agro-ecological zones. As the district comprises kebeles covering diverse agro-ecologies, a stratified sampling technique was applied for purposes of covering such variations. As such, the district was first divided into three broad agro-ecological zones Dega (highland), Woina-Dega (midland), and Kolla (lowland), and a single kebele was randomly selected from each stratum, resulting in three representative kebeles

from the seventeen existing in the district. Following that, the sample houses for each chosen kebele were determined using a proportional stratified random sampling technique. This method reduced sample bias and improved uniformity by ensuring that households chosen in each kebele were proportionate to their population size. The final household respondents were chosen systematically using household lists provided by the kebele administrations. To this effect, the sample size was determined using the sample size determination formula,

The formula is $n = \frac{z^2 .p .q .N}{e^2 (N-1) + z^2 .p .q}$,

Where n = the required numbers of sample size, z = the value of the standard variety at a given confidence level and to be worked out from table showing area under normal curve, p = the estimated proportion based on past experience (pilot survey), q = 1 – p, N = size of population, and e = maximum allowable error (the precision). Since the study population was relatively large, a sufficient sample size was required to accurately analyze proportions. In accordance with this, the total sample household heads were 333, and the sample was proportionally allocated among the respective selected kebele administrations based on population size (Table 1).

Table 1. Distribution of the sample of HH by agro-ecology, kebele administrative and sample of total

Rural kebele administrations	Agro-ecology	Total households	Sample households	Questionnaires not returned for analysis
Arbowash-Maksegnit	Dega (Highland)	869	117	0
Ergib-Kebero Meda	Kolla (lowland)	515	69	0
Mankusa/Abdegoma	Woina-Dega (Mid land)	1094	147	0
	Total	2,478	333	0

In the case of qualitative data, purposive sampling method was employed to select information-rich participants. For every kebele, only one FGD of ten participants from male and female headed households was conducted. The participants were selected with the assistance of development agents and local leaders by sampling communities based on their experience and involvement in community gardening practices. Furthermore, three KIIs involving agricultural experts in a ratio of one per agro ecological zone were carried out. These respondents were selected based on their technical competence and expertise in home gardening and environmental protection in their locations. Three household heads (one from each zone), selected for their extensive experience in home gardening, were interviewed through interviews. The utilization of local language (Amharic) and familiarity of the researcher with the local geography and culture allowed for effective communication, contextual understanding, and inexpensive data collection.

3.4. Data Collection Methods

Quantitative data was generated with the help of the structured questionnaire in determining the coping Strategies of Rural Households to Environmental Constraints in Home Gardening. On the other hand qualitative data was produced with the help of FGDs, Key Interviews, as well as observations. Further, semi-structured guides were used in the generation of the data. Data was collected in the local language of the respondents and recorded through audio and note-taking. Field notes were also taken to provide contextual data that would not emerge from interviews. Ethical practices of informed consent and confidentiality were strictly followed throughout the process.

3.5. Data Analysis Techniques

The study employed descriptive statistical analysis to examine quantitative data collected from 333 households, using frequencies and percentages to summarize multiple-response coping and adaptive strategies, disaggregated by agro-ecological zone and sex of household head. Percentages were computed using the formula (Triola et al., 2006);

$$P = \frac{n_i}{N} \times 100$$

Where:

P=Percentage of household
ni= Number of households reporting
N= total number of sampled households
100=constant used to convert the proportion into percent

Qualitative data from observation, focus group discussions, and key informant interviews were analyzed using thematic content analysis, which included transcription, coding, categorization, and theme development to identify recurring patterns related to environmental constraints, gendered resource access, and adaptation practices. Integration of qualitative and quantitative findings was realized through triangulation, allowing qualitative narratives to contextualize and explain the statistical patterns observed in the results from the survey. The frequencies and percentages are appropriate for summarizing survey responses, while thematic analysis allows identifying recurring patterns and meanings in qualitative data, and triangulation enhances the credibility of findings (Creswell, 2012). During the analysis, the household practices reported in the questionnaire were analytically distinguished into two categories of coping and adaptive strategies. Practices that could represent long-term sustainability and had a potential to reduce future vulnerability were classified as adaptive strategies, whereas short term, crisis driven, or asset depleting responses were retained as coping strategies.

3.6. Integration and Triangulation

The triangulation protocol informed the combination of the qualitative and quantitative findings. After independent analyses, both data sets were compared to identify areas of convergence, divergence, and complementarity. For instance, quantitative findings on coping and adoptive strategy household using in home gardening during environmental constraints were supported by qualitative evidence, highlighting household strategies. This approach maximized both findings' validity and interpretive density simultaneously and guided policy-relevant conclusions on the basis of both statistical trends and ordinary life.

3.7. Reliability and Trustworthiness

The dependability of the quantitative tool was verified through pretesting, which produced a Cronbach's alpha coefficient of 0.8105, suggesting high internal consistency (Cronbach, 1951) The value of Cronbach's alpha ranges from 0 to 1, where values ≥ 0.9 indicate excellent reliability, values between 0.8 and 0.9 indicate good reliability, values between 0.7 and 0.8 indicate acceptable reliability, and values below 0.7 suggest that the measurement scale may require improvement. Formula:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum S_i^2}{S_t^2}\right)$$

Where:

- α = Cronbach's alpha coefficient
- k = Number of items in the scale
- $\sum S_i^2$ = Sum of item variances
- S_t^2 = Total variance of the test score

Validity was also guaranteed by having the tool reviewed by experts. Trustworthiness in the qualitative data was realized through utilization of Guba and Lincoln (1994) four standards: credibility, transferability, dependability, and conformability. Credibility was established through member checking and prolonged involvement transferability was maintained by reporting thorough contextual detail, dependability was established through transparent documentation of procedures, and conformability was enabled through triangulation and reflexive measures. Researchers were also thoughtful in pre-empting biases, particularly on issues of gender dynamics during FGDs, and steps were taken to establish participatory equity on gender grounds.

3.8. Conceptual clarification of key terms

Households deploy coping strategies as short-term reactions that offset sudden stress or shocks. Those reactions secure temporary survival and

stabilize the situation (Devereux, 2001). Adaptive strategies differ because they rest on long term structural changes that strengthen resilience plus shrink exposure to repeated environmental, economic, or social pressures (Adger, 2006). Sustainability denotes the ability to preserve ecological integrity, social equity, and economic viability across time, leaving future generations equipped to satisfy their own needs, as stated in the World Commission on Environment besides Development report (Burton, 1987).

4. Results

4.1. Respondents' demographic

Respondents originated from three main agro-ecological zones, predominantly Woina-Dega as indicated in Table 2. Just over half were men, and the majority were married. Most relied on farming as their primary occupation. The education levels were generally poor, and the majority of the respondents could not read and write, and only a few had secondary education or above.

Table 2. Respondents' agro-ecology, sex, education, marital status, and employment

Demographic characterist8ics	Categories	Frequency (N)	Percentage
Agro-ecologies	Dega	117	35
	Woina-Dega	147	44
	Kolla	69	21
Sex of the respondents	Male	177	53.2
	Female	156	46.8
Educational status of the respondents	Unable to read and write	184	55.3
	Non formal education	85	25.5
	Primary (1-8)	39	11.7
	Secondary (9-12)	19	5.7
	Certificate	3	0.9
	Diploma	1	0.3
	First degree	1	0.3
	2nd degree & above	1	0.3
Marital status of the respondents	Single	12	3.6
	Currently married	265	79.6
	Widowed/widower	10	3.0
	Divorced	29	8.7
	Separated	17	5.1
Main employment type/income source	On-farm	299	89.8
	Off-farm	22	6.6
	Non-farm	12	3.6
Housing status	Privately owned	229	68.8
	Private rented house	72	21.6
	Kebele rented house	26	7.8
	Private without rented house	6	1.8

(Source: Field survey, 2024)

Table 3, shows that the typical family size consisted of about five people, and the average age of the household heads was about 42. This implies that middle-aged family heads with moderately large households are mostly in charge of home gardening.

Table 3. Average scores of respondents' ages and family sizes

Respondents agro-ecology		Age of respondents	Respondents' family sizes
Dega	Mean	42.67	4.64

	N	117	117
	Std. Deviation	7.312	1.539
	Minimum	25	1
	Maximum	63	9
	Mean	41.61	4.60
	N	147	147
Woina-Dega	Std. Deviation	6.327	1.511
	Minimum	32	1
	Maximum	65	9
	Mean	42.99	4.65
	N	69	69
Kolla	Std. Deviation	7.399	1.270
	Minimum	25	2
	Maximum	58	8
	Mean	42.26	4.62
	N	333	333
Total	Std. Deviation	6.918	1.471
	Minimum	25	1
	Maximum	65	9

(Source: Field survey, 2024)

As indicated in Figure 3, a number of respondents had period of home gardening practice between six and ten years. Both men and women had about two-fifths of their length of professional experience at five years or less. Longer experience was also prevalent, with a significant portion of the respondents having over fifteen years in home gardening. Generally, it was the case that male representation was slightly greater at most levels of experience. Variations in family size and age composition (Table 3) imply the availability of household labor and participation of household members in home gardening activities. Larger families may provide greater labor potential, enabling more intensive management of garden plots delivering environmental services such as soil fertility enhancement, crop diversity, and waste recycling.

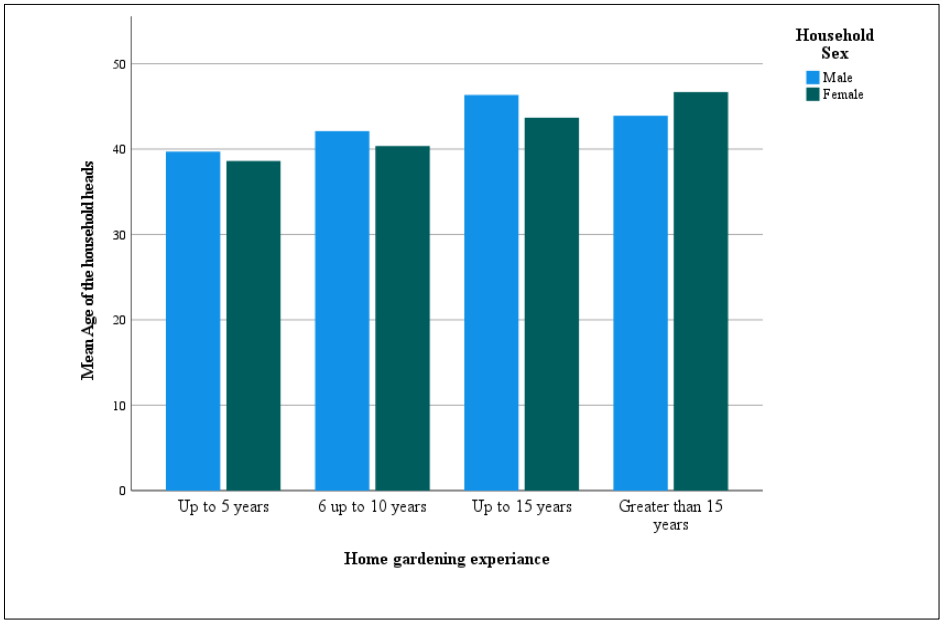


Figure 1. Mean age of household heads by home gardening experience and sex

4.2. Household coping strategies

Table 4. Coping Strategies Adopted by Rural Households to Environmental Constraints in Home Gardening (n = 333)

Coping strategy	n	% of households
Apply manure/compost/household waste	333	100
Use terracing or soil bunds	333	100
Timely weeding	333	100
Select climate-suitable crop varieties	333	100
Plant trees/shrubs around garden	313	94
Use pump/donkeys to fetch water	224	67.3
Sell minor livestock/diversify income	224	67.3
Practice environmental stewardship	203	61
Use public/community irrigation	124	37.2
Collect and store rainwater	60	18
Use a household hand-dug water source	43	12.9
Displacement/migration	35	10.5

Percentages exceed 100% due to multiple responses.

The different coping strategies adopted by rural households in response to environmental constraints affecting home gardening in Jabi Tehnan District. The results (Table 4) show that agronomic and soil management practices constitute a significant foundation upon which coping mechanisms are built. Organic fertilizer application, terracing or soil bunds, timely weeding, and choice of crop varieties compatible with local climatic and soil conditions were reported by all households. In addition, the vast majority of the households (94.0%) reported using trees or shrubs planted around home gardens for protection, revealing the widespread use of low-cost and knowledge-based adaptation measures. Coping strategies related to water use were highly variable. Whereas about two-thirds of the households reported using generator pumps or donkeys that fetched water from a distant source, the proportion of households adopting

Other water-enhancing coping strategies, such as rainwater harvesting and use of household-owned hand-dug water sources was much lower, at 18.0 and 12.9%, respectively.

About 37.2% of the households reported access to irrigation systems either f public or community, indicating binding constraints in irrigation infrastructure availability. The next category of widely used coping strategies is livelihood-based. Selling minor livestock or diversification of income sources to support gardening inputs were reported by about two-thirds of the households (67.3%), while environmental stewardship in home garden management was reported by 61.0% of the households. On the other hand, displacement or migration was less common, reported by fewer than one in ten households, implying that relocating was an option for relatively fewer households compared with staying in their locations and adapting to environmental stressors. The qualitative results further validate the quantitative data shown in Table 4 and suggest that rural farming households mainly adopt agronomic and soil management techniques as a means of adapting to environmental constraints when gardening at home. The respondents uniformly mentioned that the application of farm manure or compost, soil bunds or terraces, effective weeding, and selection of varieties tolerant of climatic conditions were normal or essential activities for maintaining the fertility of the gardens and adapting to environmental variations. As a participant at one of the focus-group discussions pointed out;

"If we do not apply manure, construct bunds, and weed on time, the garden would not survive the dry season; it is because of it that we have lived as every other person here" (Woina Dega, FGD participant).

Several of the households also reported the practice of establishing trees or shrub plantations around home gardens as a means of preventing crop damage by wind, warmth, and poor soil quality. Access to water could be obtained through the use of water pumps or donkeys to transport water from water sources located away from the home gardens. This would mean less usage of rainwater collection. One key informant explained,

"Most of the families use either donkeys or small pumps in drawing faraway water as storage for rainwater, and irrigation facilities are highly inadequate." (Key Informant Interview of Kolla)

Field observations also confirmed that's in line with findings from FGDs and interviews, those livelihood-based coping strategies such as selling minor livestock or diversifying income sources, were commonly used to support gardening inputs. In contrast, displacement or migration was rarely mentioned, reflecting a strong reliance on in-situ coping strategies.

4.3. Coping strategies by agro-ecological zone

Table 5. Rural household coping strategies by agro ecological zone (% of respondents)

Coping / Management Strategy	Dega (Highland)	Woina-Dega (Midland)	Kolla (Lowland)	Total
Water management strategies				
Collect and store rainwater	0	14.3	56.5	18
Use pump/donkeys to fetch water	64.1	68	71	67.3
Use household hand-dug water source	13.7	18.4	0	12.9
Use public/community irrigation	0	63.9	43.5	37.2
Soil and land management strategies				
Apply manure/compost/household waste	100	100	100	100
Use terracing or soil bunds	100	100	100	100
Plant trees/shrubs around garden	100	86.4	100	94
Crop management strategies				
Timely weeding	100	100	100	100
Select climate-suitable crop varieties	100	100	100	100
Livelihood and economic coping strategies				
Sell minor livestock/diversify income	64.1	67.3	72.5	67.3
Environmental and social strategies				
Practice environmental stewardship	59	61.9	62.3	61
Displacement/migration	3.4	5.4	33.3	10.5

Note: Values represent percentages of households within each agro ecological zone reporting use of the respective coping or management strategy, Woina-Dega (Midland); Dega (Highland); Kolla (Lowland)

Table 5 highlights rural household home gardening practices that can be employed to adapt to and mitigate these environmental limitations and factors in the Jabi Tehnan District. Practices related to production were widely employed, in which all rural households in Dega, Woina-Dega, and Kolla (100%) employed manure/compost, terracing/soil bunds, appropriate timing in weeding, and cultivating varieties that can cope with local climatic and soil conditions. Trees or shrubs around the home gardening structure were employed by (94.0%) of rural households. The water-related strategies employed were highly

variable and differed based on demographics. Rainwater harvesting is greatly targeted in the Kolla where 56.5% of rural households employed this technique, with no rural households in Dega using this technique. Rural households in Woina-Dega employed public or communally managed irrigation at a higher percentage (63.9%), in contrast to (43.5%) in Kolla, with a (0%) usage in Dega. Among all rural households representing most demographically diverse zones, (67.3%) employed pumps or donkeys to access water from distant sources, indicating a widespread scarcity of water in these zones.

Livelihood strategies were also significantly employed in which (67.3%) of rural households sold minor livestock or made income adjustments or supplements in a bid to sustain home gardening despite adverse effects from the environment. Stewarding the environment were (61.0%) of these rural households. Displacement or migration was relatively low and stood at (10.5%). Higher displacements or migration rates were however noted in Kolla at (33.3%), higher compared to (5.4%) in Woina Dega and (3.4%) in Dega. To attain this, the research reflects that core home gardening practice is applied in all demographically diverse zones, with variable adaptability based upon availability of water and related livelihood strategies. Evidence from qualitative studies also verifies the agro-ecological variation in coping strategies (Table 5), especially with regard to water sources and management. Focus group discussions in the Dega zone of the highland rainforest zone highlighted the reliance of home gardening on soil and crop management, in the absence of irrigation systems, in addition to annual rain being felt to be adequate for seasonal growth. According to one of the participants in one of the FGDs,

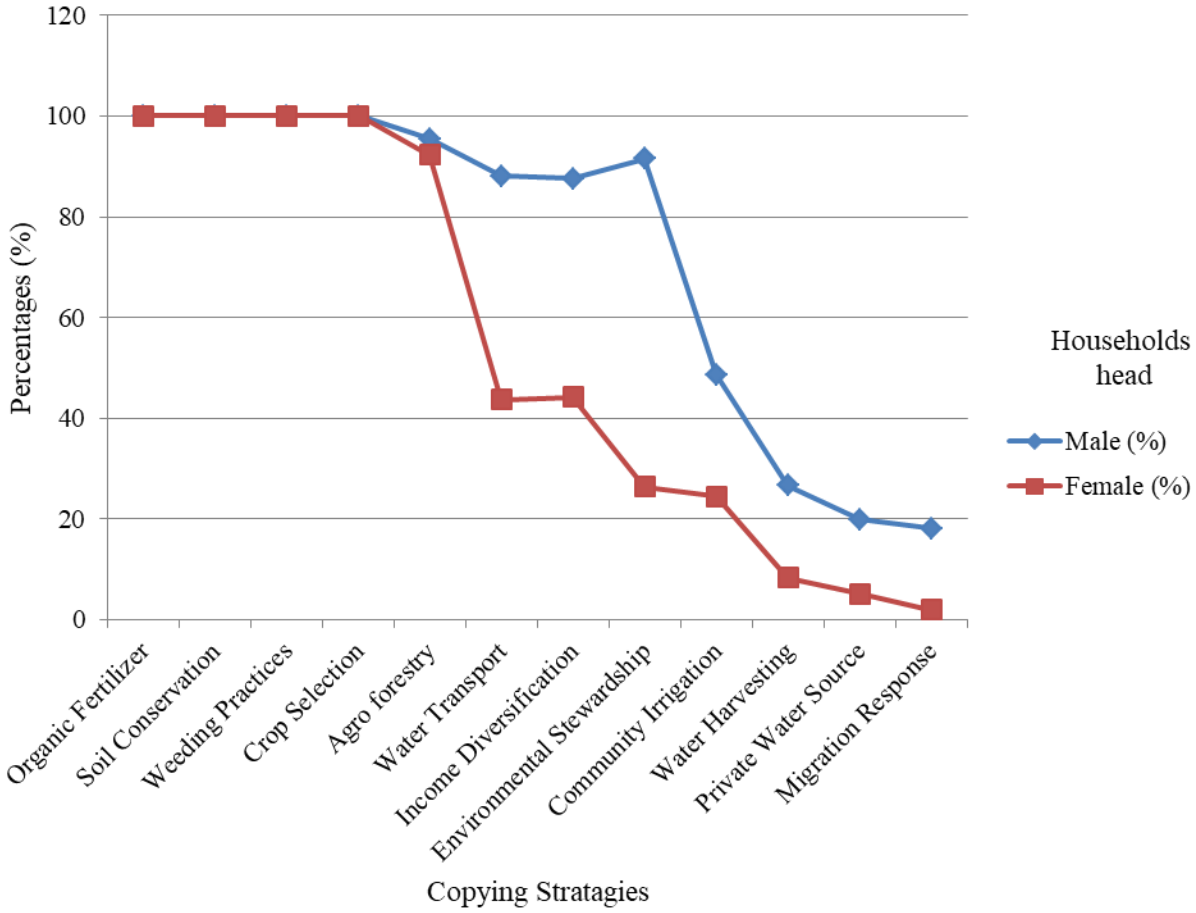
> *"In this upland area, manure conservation, contour ridges, and such crops as Irish potatoes are preferred; we don't harvest rainwater or irrigate because there are no arrangements for such here" (FGD, Dega)*

On the other hand, key-informant interviews in the Woina-Dega zone identified a greater reliance on water sources, with respondents in this zone indicating that point sources of community irrigation are available in the zone to facilitate continued gardening during the dry season. According to one of the respondents,

> *"In the midland zone, households use community irrigation or where rain is not adequate, use pumps to seek water in sufficient quantities to continue gardening" (Key informant, Woina-Dega)*

Utmost households in agro ecological zones indicated using asset based options, such as the sale of small animals, for meeting home gardening needs, whereas moving away from the location was a less frequently mentioned strategy, which suggests there was continued localized adaptation.

4.4. Coping strategies by sex of household head



Note. Percentages are calculated within households' sex

Figure 2. Rural household home garden coping strategies by gender (N=333)

As pointed out in figure (4), the results indicate significant differences between genders regarding rural household responses to home gardening activities within environmental constraints (N=333; Male=177, Female=156). Water harvesting activities, for example, demonstrated the greatest difference, where rainwater harvesting was employed by 26.6% of male-headed versus 8.3% female headed households, while the use of water pumps or donkeys to fetch water was employed by 88.1% of male-headed vs. 43.6% female-headed rural households. Also, income generation activities were more sought by 87.6% of male-headed versus 44.2% female-headed rural households, where selling small livestock or diversified income was compared. Practices of environmental stewardship, for example, were also more followed by 61.0% of male-headed versus 26.3% female-headed rural households. However, practices like applying manure (organic fertilizer), environmental terracing (soil conservation), weeding on time, and planting climates suitable crop varieties tended to be universal practices followed by both male (100%) and female (100%) rural-headed households. On the other hand, displacement was relatively low (10.5%), where 18.1% displaced activities were done by male-headed versus 1.9% female headed rural households. Collectively, these results highlight how gendered access to resources, labor, and mobility shapes household responses to environmental stress in home gardening systems. Findings from qualitative responses demonstrate gender disparities in coping mechanisms related to garden cultivation during environmentally challenging conditions, especially concerning water resource access,

economic opportunities, and movement. Male respondents from the lowland Kolla region reported higher engagement in water resource and economic support-related activities, indicating higher engagement with resource-intensive coping mechanisms. One male respondent remarked,

> *"If water is scarce, you can rely on my donkey to fetch water from long places and sell my goat occasionally to sustain garden growth" (Male Participant, Kolla)*

Conversely, female respondents from the Woina-Dega region reported dependency on garden maintenance activities while constrained from accessing water and economic resources. One female respondent said,

> *"As a garden maintainer, managing it with dung, weeding, and accurate positioning is easier; however, accessing pumps or selling my animals is not possible for me" (Female participant, Woina-Dega)*

Among both groups, garden conservation activities like compost addition, soil protection, weeding at appropriate times, and crop choices suited for favorable climatic conditions, while migration was rarely brought up, indicating that garden-related coping is still in-situ and gender-based.

5.5. Adaptive strategies for sustainable home gardening

Although the above coping strategies exemplify immediate household reactions to environmental constraints, certain strategies can also be seen as longterm adaptation practices to improve home garden system sustainability and resilience. Thus, an exploration of home garden system adaptation with regard to specific coping measures is being undertaken below.

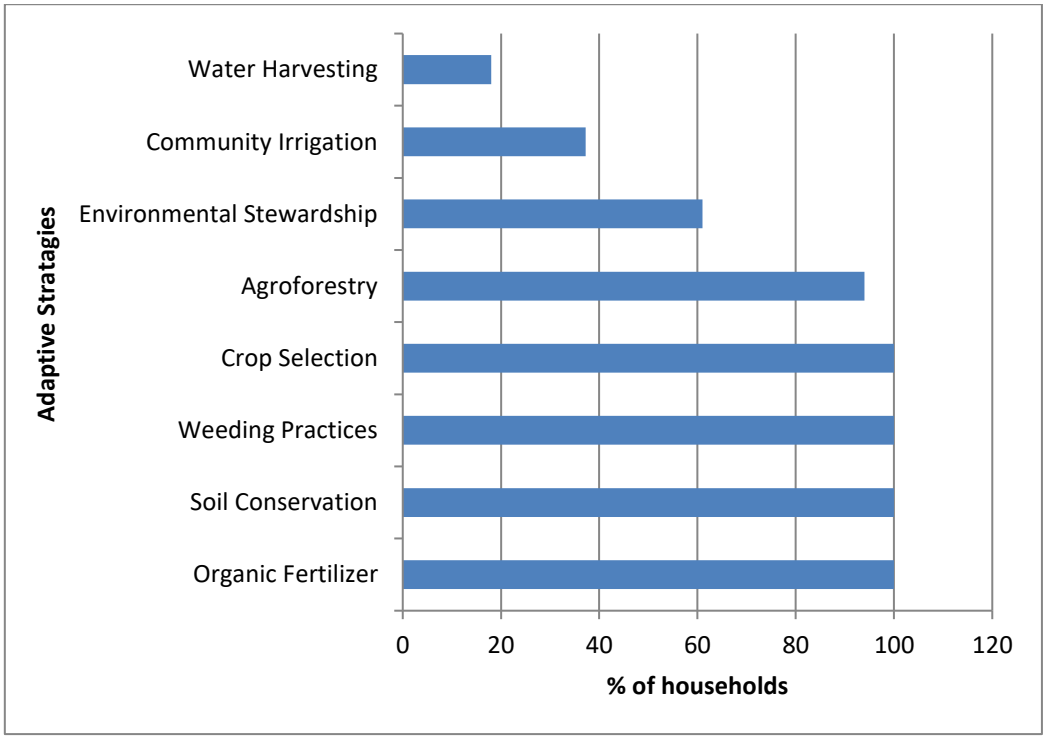


Figure 3. Adaptive strategies revealed by rural households for sustainable home gardening

As illustrated in figure (4), 333 percentages of rural households practiced some adaptive measures to maintain home garden cultivation in environmentally challenged conditions in the Jabi Tehnan District. Agronomic practices and soil management practices reported complete

adaptation, where all households practiced the use of organic fertilizers such as, manure or compost, terracing or soil bunds, weeding at the right time, and choosing varieties tolerant to climate and soil conditions. Based on these practices, a large percentage of reported members planted trees or shrubs around home gardens (94.0%), while a significantly large percentage demonstrated environmental stewardship (61.0%), denoting the use of locally accessible, knowledge-based adaptation practices. In contrast, water management practices were not significantly adopted, as only 37.2% of the members utilized public or community irrigation systems, and 18.0% of the members utilized rainwater storage..

Qualitative evidence from focus group discussions across the study area suggests that several of the routinely practiced measures are considered long-term adaptations rather than short term response to environmental stress. The participants highlighted that measures such as maintaining soil quality, garden plot protection, and including perennial vegetation contribute to stabilizing production over time and reducing vulnerability to rainfall variability. Such measures were referred to as reliable because they depend on locally available resources and accumulated experience, while water-related adaptations were referred to as being constrained by limited infrastructure and unequal access. As one of the participants in the focus group discussions explained;

> *"We are utilizing the manure season after season, ensuring that the bunds are strong and trees are grown around the garden because they protect the soil for a long time. If it rains and it gets a little delayed, it actually helps the garden because the trees protect the soil. Irrigation will help the garden but it will not be possible for all of us. What we do by our own hands is what makes the garden strong." (FGD participant, Woina-Dega)*

5. Discussion

5.1. Households Coping Strategies to Environmental Constraints

Rural households in the Jabi Tehnan District were found to mainly use agronomic and soil-related garden coping strategies (Table 4). All rural households (100%) surveyed practicing manure and compost use, terracing and construction of soil bunds, effective weeding, and use of climate-financial suitable varieties appropriate for the climate conditions. This high level of reliance on low-cost and highly knowledge intensive home garden practices instead of capital intensive practices reflects the logical long term home garden sustainable strategy based on indigenous knowledge and continuous labor investment during stressed environmental conditions described ((Altieri et al., 2015; Kumar, 2006). Evidence documented through household qualitative observations strongly suggests that such garden practices are part and parcel of daily household decision making processes, with participants clarifying during focus group discussions that not doing so would mean garden death during dry season months (Semu, 2018). A framework analysis on ecofeminism theories with respect to household garden practices on the other hand suggests that garden practices at the household level tend to continue with equitable and undervalued levels of household labor and home experiential knowledge practices, specifically during eco-patriarchal conditions with limited access expenditures on financial and technological resource expenditures Shiva (1991) described by Warren (2000). Conversely, water based coping methods showed lower adoption, where only 37.2% practiced irrigation from public or community water sources and 18.0% from rainwater harvesting methods (Table 4). The structural and institutional limitations rather than lack of intention to adapt, which continues to be evident in rural Ethiopia and Africa at large (FAO, 2018; FDRE, 2012).

5.1.1. Agro Ecological Variation in Coping Strategies

Home garden coping strategies were marked differences in agro-ecologies within the Jabi Tehnan District, but differences were most apparent for water coping strategies, whereas soil and crop management strategies were universal in application (Table 3). Quantitative analysis reveals that rainwater harvesting is predominant in lowland Kolla agro ecology (56.5%), whereas irrigation from public or communal water is most practiced in midland Woina-Dega agro-ecology (63.9%) and nonexistent altogether in highland Dega agro ecology, signifying disparities in water supply distribution and infrastructural facilities within agro ecologies (Table 3). This is in line with agro ecological adaptation theories, where theory contemplates that household level coping strategies are informed by locally specific climate factors, endowments, and institutional arrangements rather than by behavioral rules and policies applied uniformly by all individuals and/or households (Malte Reimers & Stephan Klasen, 2013; Smit & Wandel, 2006). The qualitative descriptions from highland agro ecologies tend to conform to this line of thought as all study participants rated highly for dependence on rain and soil, signifying another lack of economic incentives and opportunities for cost effective water storage and irrigation schemes and practices (Kebede, 2009).

Contrary the lowland regions of Ethiopia, Home gardens are differently utilized for water harvesting and irrigation scheme practices traditionally. Home garden systems in Ethiopia and elsewhere require no economic incentives or relevant institutional frameworks for capital and infrastructure investments and feasibility for lowland regions of Ethiopia and elsewhere to sustain and operate successfully (Zemede, 2011). In contrast, key informants from Woina-Dega highlighted the use of communal irrigation to buffer seasonal rainfall variability, while lowland households described rainwater harvesting as an essential coping response to chronic water scarcity and climatic exposure, consistent with empirical evidence from semi-arid and lowland areas of Ethiopia (FDRE, 2012; FAO, 2017). Although displacement was more frequently reported in the Kolla zone (33.3%) than in Woina-Dega (5.4%) and Dega (3.4%), it remained a secondary response complete (10.5%), reinforcing evidence that households prioritize agro-ecology-specific, in-situ coping strategies to manage environmental stress in home gardening systems (Fransen & Kuschminder, 2009).

5.1.2. Gendered Dimensions of Coping Strategies

The results indicate marked gender differences in coping strategies for home gardening under environmental constraints, particularly in accessing access to resource intensive responses (Figure 3). Quantitative evidence shows that male-headed households were substantially more likely than female-headed households to use pumps or donkeys for water fetching, sell minor livestock or diversify income, practice environmental stewardship, and engage in migration, whereas low-input and labor routine practices such as compost application, soil conservation, timely weeding, and climate appropriate crop selection were universally adopted across genders (Tong & Botts, 2009). This pattern aligns with ecofeminism perspectives, which emphasize that patriarchal power relations shape both environmental management and access to productive resources, rendering women's ecological labor central yet structurally, constrained within household systems (Gaard & Gruen, 1993; Shiva, 1991; Warren, 2000).

Findings from female respondents' qualitative data also underscore the fact that inequalities in control over livestock, transport, and economic resources, rather than a deficiency in knowledge or intention, perpetuate the eco-patriarchal character of resource access institutionalized in the household and community context. From a liberal feminism perspective, the gender gap identified in water resource access and income-generating plans indicates institutional disparities in property rights, mobility, and decision-making

power that firmly affect their adaptive capacity despite mutual knowledge in agronomy (Moghadam, 2005; Okin, 1989). Aligning with previous empirical findings in Ethiopia, the current study is points towards the undervalued role of women in agricultural productivity, despite their higher adaptive burdens in their day-to-day environmental stewardship efforts (FAO, 2009).

5.2. Adaptive Strategies of Environmental constraints

The designation of some coping practices as adaptive strategies means that many household practices in the Jabi Tehnan District are used as methods of long-term resilience enhancement and vulnerability reduction in home gardening systems (Fig. 4). The popularity of many soil and crop centered practices like the use of organic fertilizers, terracing, and tree planting demonstrates adaptations processes whose objectives are improved soil stability, water retention, and micro climatic regulation, which are generally known to be the fundamental principles of sustainable smallholder systems (Altieri et al., 2015; Kumar, 2006; Malte Reimers & Stephan Klasen, 2013). There is an impression from the qualitative findings of the research that households in the studied area are able to make discerning distinctions between short-term coping and longer-term adaptive practices, where it is believed that practices like soil protection and perennial vegetation possess accumulating benefits across seasons. Such distinctions are based on the concept of adaptive strategy, whose more general definition states it is the process of reducing the sensitivity of systems to environmental change, as opposed to shock-absorbing practices through immediate interventions (Adger, 2006; Smit & Wandel, 2006).The persistence of these practices is closely linked to women's experiential knowledge and continuous labor inputs, reinforcing ecofeminism arguments that women's ecological work underpins household adaptation despite structural constraints on access to capital and water technologies (Beauvoir, 1949).

5.3. Sustainability of Home Gardening

The issue of household gardening as a sustenance strategy for households residing in Jabi Tehnan District is anchored on household-level, contextually rooted, and biologically attuned gardening practices, especially addressing soil fertility and crop variety, which are core constructs for household sustenance strategy, but are constrained by low adaptability concerning water. The paper asserts that low input, knowledge intensive approaches are core constructs for small farm sustenance under stress conditions and that these are highly constrained as a sustenance strategy for households by deep rooted eco-patriarchal frameworks that inhibit women's access to productive resources, decision-making, and institution building, leaving less scope for expansion from an adaptive strategy (Moghadam, 2005). From an ecofeminism framework, gender inequality, as highlighted in this paper, is more than a social problem; it is an ecological problem as women's oppression results in unsustainable resource management, which is fundamental as it causes ecological degradation and suppresses women's autonomy, freedom, and creativity as producers, and is expressed as a problem concerning gender inequality, justice, freedom, and empowerment, as expressed by (Salleh, 2003; Shiva, 1991). As Beauvoir (1949) has famously asserted, "One is not born, but rather becomes, a woman," pointing out the ways that social conditions impact the position and ability of women with regard to their interaction with nature, or rather, the protection of the natural world as related to gardening. Additional support for the idea that the lack of control that women have over land, water, and extension services negatively impacts the household level of sustainability (Borowy, 2013), despite their integral level of involvement with gardening, it is derived from further examination of the focus group discussions and Key informant interviews confirmed the same. The inequality between men and women must be remedied regarding irrigation, credit, or access to extension services by Brundtland Commission, cited (Borowy, 2013; FAO, 2009; Okin, 1989).

6. Limitation of the study

There are a number of limitations in the current study that must be acknowledged. The study relies on a cross-sectional database collected in March and April of the year 2024, but the respondent's strategy of adaption was assessed on the basis of the past years' experience, regardless of the season. This implies that data on the household's strategy of adaption is a snapshot in time and does not necessarily represent the dynamic nature of home garden adaption. Moreover, the current study's scope is limited to the Jabi Tehnan District, which can limit the generalizability of the findings to other settings. Future studies should focus on the dynamic nature of home garden adaption and should be conducted on a comparative database of a number of districts.

7. Policy Implication

A result of this research was to suggest that an emphasis in any policy developments should place a priority on promoting low cost, but locally based and knowledge driven methods of home gardening as coping mechanisms and as part of long term adaptation to climate change. District agriculture offices should develop outreach programs for local farmers to improve soil conservation methods; promote the use of organic fertilizers; and introduce new crops suited to the various climatic conditions within their jurisdictions. Since water related strategies are still not fully utilized due to lack of infrastructure, joint efforts of local government institutions and other development actors, such as NGOs and community-based organizations, are required to develop small scale irrigation systems, water harvesting, and community-based water management systems. Overcoming water limitations is important to enhance household adaptive capacity. In addition, removing institutional and financial constraints through better access to rural credit, agricultural inputs, and capacity-building programs can help households diversify livelihoods and promote sustainable home gardening practices. Better cooperation between local government institutions, development actors, and rural communities will be vital for developing resilient and environmentally sustainable livelihood systems in Jabi Tehnan District, Ethiopia. Finally, this study recommended that future interventions should take an integrated and participatory approach to ensure alignment of technical assistance, water infrastructure development, and institutional strengthening for inclusive and sustained adaptation outcomes.

8. Conclusion

This paper explored the issue of coping and adaptation strategies in gardening during environmental stress in the Jabi Tehnan District in an integrated agro ecological and gender sensitive theoretical framework. The result reveals that adaptation and coping measures in soil and crop approaches, such as using organic fertilizer, terrace gardens, and plantations, operate in the short term and long term as adaptation measures that improve the ecological resilience of the soil. These methods can be localized, less costly, and more knowledge-intensive, meaning that they highly correlate with the constraints that exist in the environment. Nevertheless, in terms of its capacity in agro-ecological zones and according to gender, water measures remain an obstacle in progress. The labor and knowledge of women play a critical role in the maintenance of home gardening practices but are hampered in adapting due to a lack of access to water technologies, capital, and decision making power.

Data Availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Conflicts of Interest

We declare that we do not have any known competing financial interests or personal relationships that could appear to have influenced the work reported in this study.

Copyright

The authors confirm that the manuscript is original, not submitted elsewhere, and that copyright will be transferred to the publisher upon acceptance.

Ethics

The authors confirm that the research was conducted ethically and in accordance with national and international standards.

Authors' Contributions

SM contributed in the conceptualization, formal analysis, investigation, and writing-original draft. SA and MD contributed in the methodology and writing review and editing.

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