

Research Article

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Women's role in agroforestry, food security, and livelihood: land ownership, decision-making power, and indigenous knowledge resilience

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Abstract: The practice of agroforestry is a fundamental element of sustainable land management, providing nature-based solutions (NBSs) to address environmental degradation, food insecurity, livelihood, and climate change resilience

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globally. While women are said to contribute substantially to agroforestry, they continue to face challenges due to social and cultural norms and economic constraints in Uganda. Therefore, this study investigated women's involvement in Ugandan agroforestry practices to understand their roles and challenges, and to examine their impact on achieving SDGs related to poverty reduction and food security, gender equality, and environmental resilience. The study employed Focus Group Discussions (FGDs) to explore women's roles and perceptions of their involvement in agroforestry systems in Uganda. The research indicated that women play an essential role in agroforestry and sustainable land management, and possess the necessary indigenous knowledge in the sector; yet, they continue to face restricted decision-making authority. We noted that the success of enhanced agroforestry and equitable development requires addressing structural barriers through gender-sensitive, gender-centered policies, such as providing women and other vulnerable groups with access to resources and opportunities that enhance their decision-making capacity. The integration of gender considerations into agroforestry programs remains essential for Uganda and the world to achieve developmental goals.

Keywords: agroforestry; food security; cultural and social norms; decision-making power; gender equity; traditional knowledge

Highlights

- (1) Women actively participate in agroforestry and agriculture activities in Uganda.
- (2) Knowledge and Expertise: women conserve traditional knowledge about cultural practices necessary for agroforestry success
- (3) Women significantly contribute to food security and livelihoods, and sustainable environmental and economic advancement in many tribes and societies in Uganda.

- (4) Majority Ugandan women have limited decision-making power and land rights, which are often supported by cultural and social norms.
- (5) Policy and gender inclusion, as well as broader community support, are needed to harness the potential for resilience and capacity.

1 Introduction

Agroforestry is a vital farming method that integrates trees and shrubs with agricultural and livestock operations to enhance sustainable land management, biodiversity conservation, and improve rural community living standards [1–4]. Moreover, agroforestry is cherished for its contribution to ecological, social and economic contrition globally [3, 4].

It is noted that women actively participate in agroforestry success through their knowledge and traditional practices, as well as through their physical work, which contributes significantly to these practices [5–7]. Full involvement and participation of women in agroforestry initiatives and programs has remained limited due to many obstacles, including restricted decision-making authority, limited access to resources and land ownership, and various socio-cultural barriers in many parts of the world, especially Africa [6–9].

The success of agroforestry practices is suggested to depend heavily on women, who are said to contribute through their traditional knowledge, labor, and expert management. Women who act as traditional ecological knowledge holders lead the planting and preservation of trees and crops that strengthen food security, environmental health, and rural livelihoods [3, 6, 10, 11]. Through their active involvement in agroforestry, women and the youth can contribute to sustainable land management, which may support development targets, especially the Sustainable Development Goals (SDGs), including SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land).

Women in Uganda are said to make essential contributions to agroforestry systems but face various social, cultural, and economic barriers that limit their full engagement and decision-making authority. Understanding the dynamics of women's participation, their decision-making abilities, and the challenges they encounter enables the creation of gender-centered interventions/planning that focus on and promote equal access to sustainable development [12–16]. It is therefore paramount to explore the systemic barriers (social, cultural, and economic) that limit women's full participation and decision-making power in agroforestry practices in Uganda, despite possessing valuable traditional knowledge and skills

in agriculture and agroforestry more broadly, and how these barriers can be addressed to enhance sustainable development outcomes.

This study identified the roles and contributions of women in agroforestry practices in Uganda. Also, we analysed key social, cultural, and economic barriers that hinder women's decision-making power and their full participation in agroforestry. Moreover, we propose gender-sensitive interventions based on the results of focused group discussions on these women-led roles, indigenous knowledge, and the obstacles they face, to enhance women's empowerment in agroforestry and their contributions to specific SDGs. Our research demonstrated that women's empowerment can enhance environmental sustainability and household and community well-being (including income and food security), supporting broader development and resilience objectives in Uganda.

2 Theoretical framework: women's participation in agroforestry, sustainable development goals, and barriers to participation

2.1 Feminist political ecology and women's participation in agroforestry

This study is grounded in the Feminist Political Ecology [15, 16]. The theory assesses the intersections of gender, power dynamics, and natural resource management. Feminist Political Ecology integrates gendered knowledge of ecological systems, environmental rights regarding resource access, and participation in grassroots activism to reveal how socially constructed gender roles create diverse relationships between men and women in land and natural resource management [16–18]. Several similar studies have applied the framework to investigate gender-based land access restrictions in Ethiopia [19] and household gender dynamics influencing land restoration in Kenya [20]. Approximately, women make up 50 % of Sub-Saharan Africa's agricultural labour force and play significant roles in agroforestry, thereby managing over 80 % of fodder shrubs in Kenya and Uganda [12, 21]. However, women's participation remains concentrated in labor-intensive, low-commercial-value activities, with female-headed households planting only half as many trees as male-headed households due to constrained access to resources [21]. A recent study in Uganda's Mount Elgon region confirms that meaningful participation depends on addressing access to resources, extension services,

and decision-making authority [22]. Various factors influence women's participation in agroforestry and tree projects, and these must be taken seriously from a policy perspective to achieve the various nexus benefits [23–27]. Moreover, in many parts of the world, women face more challenges than support in the social, economic, and political spheres [28–32].

2.2 Decision-making power, land rights, and indigenous knowledge

Land ownership determines women's participation in agroforestry, yet critical disparities persist. Women account for the majority of African family farming labour but continue to have less access to agricultural land and to services such as credit and capacity-building for extension. Moreover, while the majority of continental wealth is derived from land, less of it is women-owned [33–36]. Women are suggested to constitute 76 % of the agricultural workforce and still face significant inequalities in control over resources, with male household heads monopolizing decision-making in Uganda [37]. Cultural norms reinforce these disparities. For instance, inheritance systems usually exclude women, and customary practices across multiple African countries deny women property rights despite legal frameworks [12, 21]. Studies show that intra-household agroforestry decision-making is heavily gendered, with women's authority limited to subsistence crops and low-value products [38–42]. Simultaneously, women serve as the primary custodians of traditional agroecological/environmental knowledge (TAeK), encompassing the identification of medicinal plants, seed selection and storage, and sustainable agricultural techniques such as mulching and crop rotation, among others [43–45]. A study in Benin indicated that incorporating gendered indigenous knowledge may improve agroforestry outcomes [46], yet mainstream policies often marginalize women's knowledge systems [47].

2.3 Sustainable development goals and barriers to participation

Agroforestry has the potential to contribute to SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 5 (Gender Equality), SDG 13 (Climate Action), and SDG 15 (Life on Land) significantly (Table 1), with climate-smart systems promoting crop resilience while contributing approximately 200 million tonnes of carbon annually to agricultural lands [24, 48–50]. The participation of women strengthens the achievement of these outcomes: when they are engaged in agricultural

decision-making, households and communities attain better food security and produce more nutritious crops [50, 51]. Nevertheless, multiple structural barriers hinder women's full active participation. Investigations identified tenure insecurity, limited access to credit and extension services, cultural restrictions, and market exclusion as persistent challenges that limit women's potential in agriculture [52, 53]. In Ghana, socioeconomic and cultural factors constrain women's involvement [42], while climate-smart agriculture programs exhibit gender disparities in knowledge acquisition [41]. Social and cultural norms in Vietnam limit women to subordinate roles [54], and studies from Ethiopia confirm gendered skepticism regarding women's technical capabilities [53]. These research findings call for gender-sensitive policies that address structural barriers while recognizing women's contributions to indigenous knowledge.

3 Methodology

The research study employed a qualitative method. A Focus Group Discussion (FGD) method was used to examine the role of women in agroforestry in Uganda. The FGDs are a qualitative research technique used across various fields, particularly for collecting economic data. Data collection is a demanding task that requires thorough planning, hard work, patience, determination, and more to be completed successfully. One of the easiest and cost-efficient [55, 56] instruments for collecting primary data is the focus group discussion. Focus Group Discussions (FGDs) were initially adopted in marketing during the mid-20th century. FGDs have since gained traction in the social and health sciences because of their ability to elicit rich, interactive data [57]. It is recommended that an experienced research leader guide group discussions to examine attitudes, beliefs, experiences, and motivations related to the study topic [58]. The research organization commences with identifying the target population of participants of interest to the study. The recruitment process depends on the sampling approach, e.g., purposive, snowball, or convenience sampling. They were chosen to assemble a relatively homogeneous group that reflects the study's focus (e.g., similar age, gender, or cultural background) [59]. This was because the study focused on capturing a national situation in its findings, which can be generalized to all aspects related to the study.

Recruitment was facilitated by community networks and community leaders in the study areas [60]. It is usually conducted within each group, consisting of six to 10 participants, a size that is sufficient for interaction yet manageable for moderation, allowing participants greater control over the issues raised in the discussion [58, 59, 61]. Sessions last

Table 1: Key concepts and their definitions.

Key concepts and themes	Definitions
Decision-making power	Refers to an individual's perceived or actual capacity to influence or make choices regarding agroforestry practices and related resources within their household or community
Control over land and resources	The ability to make independent decisions about land use, tree planting, harvesting, and sale of agroforestry products
Participation in planning and management	Involvement in household and community-level planning meetings for agroforestry initiatives, including input on strategies and implementation
Access to financial resources	The capacity to obtain loans or control income generated from agroforestry activities, which enables further investment or independent action
Autonomy in initiating projects	The ability to independently start or implement agroforestry projects without requiring explicit permission or dominant oversight from others
Indigenous knowledge	Refers to the localized, traditional, and often intergenerationally transmitted understanding, practices, and beliefs concerning ecological systems, natural resources, and socio-cultural norms relevant to agroforestry
Knowledge of specific plant species	Identifying and utilizing medicinal plants, food crops, and trees for various purposes (e.g., healing, nutrition, soil improvement)
Traditional farming techniques	Specific practices such as mulching, seed selection, soil conservation methods, water management, and pest control passed down through generations
Cultural practices	Norms and traditions influencing the cultivation, harvesting, preservation, and use of agroforestry products that reflect a deep connection to the local environment
Intergenerational transfer	The perceived role of women in preserving and transmitting this knowledge to younger generations
Agroforestry participation	Refers to women's direct involvement in various activities associated with the establishment, maintenance, and harvesting within agroforestry systems
Physical labor	Activities including land preparation (e.g., weeding), planting, pruning, and harvesting crops and tree products
Management activities	Nursery bed management (including watering), selection of appropriate plant species for integration, and general crop/tree care
Application of knowledge	Utilizing traditional knowledge in practices like mulching, identifying beneficial plant combinations, or performing specific tasks to enhance system productivity and health
Resource allocation	Contributions to the management and utilization of resources within the agroforestry system
Sustainable development outcomes	Refer to the perceived positive impacts of women's involvement in agroforestry practices on community well-being, economic stability, and environmental health, contributing towards broader Sustainable Development Goals
Food security	Improved access to and availability of diverse food sources for households, contributing to SDG 2 (Zero Hunger)
Poverty reduction/Livelihood improvement	Increased household income, diversified economic activities, and enhanced living standards stemming from agroforestry, contributing to SDG 1 (No Poverty)
Environmental sustainability	Practices contributing to soil conservation, biodiversity preservation, climate change adaptation/mitigation (e.g., carbon sequestration), and efficient resource management, contributing to SDG 13 (Climate Action) and SDG 15 (Life on Land)
Gender equity	Enhanced women's empowerment, recognition, and capacity within the community through their agroforestry roles, indirectly supporting SDG 5 (Gender Equality)

approximately 1–1.5 h and are structured using a discussion guide that includes open-ended questions and probes designed to stimulate conversation and participation [59].

Discussion guides are informed by prior literature and refined in pilot testing [60]. The study leader introduces the goal of the study and gives the basic guidelines. More so, the leader asks and confirms informed consent of the group members (study participants) for audio recording. Research approaches, e.g., participant-generated cards or visual stimuli, may be integrated to enhance engagement [60]. During the sessions, maintaining confidentiality and protecting participants' anonymity are critical. Because group dynamics can compromise internal anonymity, researchers

carefully designed ground rules and reported quotations in pseudonymised or categorical form (e.g., "Female, age 25"). Researchers addressed deductive disclosure risks, where individuals may be indirectly identifiable through contextual details, and managed over-disclosure sensitively [62].

All sessions were transcribed verbatim, and supplemented by detailed field notes and observational records of non-verbal behavior (posture, silences, tone) [63]. FGD data analysis consists of thematic and/or content analysis, including identifying patterns, developing themes, and iteratively refining interpretations until saturation is reached [59]. FGD involved study introduction, member checking, and control, as well as clear audit trails, which collectively

promote the trustworthiness of the research [55]. Thereafter, the results are reported with representative quotations to illustrate major themes, preserve participants' voices, and maintain anonymity [63]. However, the method has limitations which include managing group dynamics (such as dominance and conformity) and challenges in distinguishing between individual and group-level data [63]. Additionally, follow-up probing is limited, as further clarification once the group ends requires a separate interview [56].

3.1 Focus group discussion data collection

The focus group discussions were conducted in two districts of Uganda (Kampala and Wakiso). The FGDs were carried out at the beginning of June 2025. The two districts were chosen because they have a majority of youth in the country and also have the majority of women participating in various socioeconomic activities, including agroforestry and agriculture. Moreover, in the studied districts, people from different tribes/cultures and regions reside, allowing for diverse cultures and indigenous views to be captured, particularly in the context of land ownership versus women's participation.

The study utilized the local networks and leadership to identify participants. Gender and other representative characteristics, such as region or tribe, were factored into the selection criteria to ensure quality, diversity, and representativeness. The composition of discussion teams included professionals such as teachers, agriculturalists, administrators, and economists, among others, to mitigate bias.

English was used as the medium of communication throughout the process, since everyone was comfortable with it. Moreover, everyone agreed, and given the multiple tribes' participation, it was the most appropriate language to use. There were no issues or communication problems due to a language barrier.

The study comprised eight groups (A-H), primarily composed of individuals aged 18–35 (Table 2). This was because the study focused on young people's perceptions of women's and youth's participation in agroforestry in Uganda. The sampling was very purposive, given that the study focused on the youth. The youth constitute the majority of the Ugandan population, making them viable stakeholders whose views and opinions are very important in the pursuit of agroforestry.

The youth, though, had the same chances of being selected and participating in the discussion. The groups had a recommendable number of participants, ranging from 6 to 10 people (Table 1). More so, the time requirement of at least 60 min was observed.

Potential influences were identified in the groups, which were carefully guided not only to keep track of the discussion but also to shape it, given the diverse backgrounds in the FGD teams. More so, emerging themes, challenging interpretations, and seeking alternative explanations for participant narratives to mitigate individual biases were taken seriously, guided, and discussed.

To alleviate dominance and gendered power dynamics throughout mixed-gender FGDs, skillful and experienced moderators set ground rules such as equal chances and confidentiality. We used targeted stimuli to motivate lower or softer members. The study leader, importantly, separated sensitive probes and guided the FGDs.

Pre-set structured questions were introduced to the groups. Moreover, the study leader introduced the study and guided the participants on the expectations and the importance of the discussion.

The study used pre-designed, open-ended discussion questions (as stated in the methodology), which helped ensure a consistent approach to data collection across all FGDs and minimized the imposition of the researcher's viewpoints during interactions.

Study Questions;

- (1) What role do women play in the success of agroforestry practices in your community?
- (2) Do women have sufficient decision-making power regarding agroforestry activities in your community?
- (3) Involving women in agroforestry is essential for sustainable environmental and economic development.
- (4) Women face more obstacles than men when participating in agroforestry projects.
- (5) Women's knowledge and traditional practices are valuable assets for successful agroforestry initiatives.
- (6) What are the main limitations preventing women from fully participating in agroforestry activities?
- (7) What are the main limitations preventing youth from fully participating in agroforestry activities?

Table 2: Details of the composition of the FGDS.

Group	Females	Males	Total
A	5	2	7
B	4	3	7
C	4	2	6
D	4	3	7
E	5	3	8
F	4	4	8
G	4	3	7
H	5	3	8

3.2 Informed consent

All study participants in the FGDs were given informed consent prior to participation. The study aims, processes, and the voluntary nature of participation were explained. Participants agreed to audio recording and to the anonymised use of quotes/extracts. Consent to participate in the study was obtained before each FGD. Moreover, the participants were informed they could withdraw their consent at any time without consequence.

The study leader asked the group members in this study for their consent to participate in the study. They all agreed to the survey. Moreover, they were assured that their personal details would be kept private and that their responses would remain anonymous, in line with institutional and international research standards.

3.3 Ethics approval

The study was deemed exempt from formal ethics approval by the institutional review board because it involved no human participants in a clinical setting, no identifiable personal data, and relied on aggregate group perceptions that could not be linked back to individuals.

However, all our research activities adhered to the ethical principles of informed consent, confidentiality, and anonymity, as outlined by Mendel University in Brno and relevant international research guidelines.

3.4 Detailed data analysis: deductive and inductive techniques

Transcription methods and procedures, such as inductive and deductive techniques, familiarisation, consensus meetings, refinement of themes, member checking, audit trail, and quotations/extracts selection [55, 58–60, 63]. We used mixed methods, starting with familiarising or sensitising thoughts on literature (deductive), while remaining open to new themes that emerged from the FGD participants (inductive). The combination of techniques helped the study balance prior knowledge with findings [55, 58–60].

The rationale for using a deductive methodology included testing specific hypotheses or assessing existing theories, whereas inductive methodology explored under-researched topics and/or issues, generating new concepts and, moreover, centering participants' perspectives. Using a hybrid linked empirical findings to existing theory and concepts while incorporating unexpected study findings. We used a predominantly inductive thematic methodology, drawing on

sensitising thoughts from Feminist Political Ecology. FGD records were first studied openly to categorize frequent ideas and patterns from the study participants. The patterns were then clustered into higher-order themes and compared against FPE concepts such as access, control, knowledge, and power to enhance interpretation. Originally, two investigators independently reviewed the transcripts, resolved differences through discussion, maintained an audit trail through member scrutiny, and used descriptive quotes to sustain trustworthiness and reliability [55, 59, 63]. The study's deductive mapping to theory safeguarded the study's findings, keeping them grounded in participants' viewpoints while positioning results within a recognized theoretical framework [55, 58–60].

FGD discussion controls for reliability were observed for reliability [55, 59, 60];

- (1) Triangulation: We used multiple groups and researchers to verify findings. The study gathered data from different groups using both qualitative methods.
- (2) Deliberate effort was made during analysis to prioritize and directly quote participant statements, ensuring that the findings remained grounded in their expressed perceptions and experiences.
- (3) Member Checking: The findings were discussed and interpreted with participants to obtain their feedback and confirm the accuracy of the data collected. This helps ensure that the results genuinely reflect participants' perspectives.
- (4) Thick Description: The study provided rich, detailed descriptions of the context, participants, and findings. This will allow readers to understand the study's character and enhance the reliability of the investigation.
- (5) Audit Trail/process: Maintain detailed documentation of the research process, including decisions made during data collection and analysis. This transparency allows others to follow and verify your research steps.

4 Results and discussion

4.1 Women's critical role in agroforestry

Participants in the focused group discussions on women's roles in agroforestry success agreed that women play essential multiple roles in this context. All groups confirmed that women participate in all aspects of agroforestry as much as in general agriculture, from preparing the land to planting and caring for the trees until they are ready for harvesting. Weeding, tree pruning, and care duties are the responsibility of women because they play the most important role in maintaining healthy, productive agroforestry systems (Table 3).

Table 3: Women play a critical role in the success of agroforestry practices.

Groups	Response	Justification
A	Yes	<i>Women participate in land preparation both manually and somehow mechanically. They participate in planting and selecting the plant species to blend on the farm. They participate in management operations such as weeding, pruning and so on. They participate in harvesting to provide food to families, and some for sale and the improvement of livelihood.</i>
B	Yes	<i>Women possess knowledge about various types of tree species and their purposes. Various women are herbalists, meaning they possess knowledge of medicinal plants, which enables them to integrate specific trees of importance, such as Aloe vera, for the treatment of various diseases.</i>
C	Yes	<i>Because women are heavily involved in planting, nurturing and maintaining agroforestry trees.</i>
D	Yes	<i>We agree, due to division of labor in the pre- and post-agricultural activities within the farmyards, like pruning and sowing.</i>
E	Yes	<i>Because women act as additional labour in agroforestry practices, which increases food security in the community. For example, in Northern Uganda, men plough the garden while women do weeding, sowing, and harvesting.</i>
F	Yes	<i>This is because they are involved in many activities, such as Tree planting, Nursery bed management (including watering), Weddings, Harvesting, and others.</i>
G	Yes	<i>This is because women have their activities assigned to do, like weeding, harvesting and leave heavy duties for men, like digging the land."</i>
H	Yes	<i>The women are involved in all the activities on the plantations. They start clearing of land, planting, weeding, harvesting, drying and storage. All the agroforestry processes have a woman participating. We see it in all the regions in our country.</i>

Moreover, the men in all the groups unanimously asserted that women are critical actors in the success of agroforestry in Ugandan society. They argued that women are involved in all processes of the agroforestry system, from land preparation and seedling production to planting, garden care (such as weeding, pruning, and harvesting), and post-harvest care (such as drying and storage). On occasion, some men help out with activities that are very difficult for women, though in some situations, women still do such work because they have no men's assistance at all. The men too reiterated that indeed women play a central part in the success of sustainable agriculture through various on-farm and off-farm activities (Table 3).

Group G demonstrated that women typically perform most of the agricultural management work and labour, while men handle the physically demanding gardening activities. Overall, all the groups agreed that Ugandan women perform essential agricultural work, but their roles remain defined by traditional gender expectations (Tables 3 and 4). More so, women were said to be involved in harvesting and production activities, which directly boost food security and community income. Group E reported that women's work primarily ensures food security in Northern Uganda and other similar regions.

Group B members stressed that women possess distinct Expertise, including the ability to recognize valuable plant species and medicinal herbs. Also, the group noted that women's traditional experiential knowledge supports more effective, sustainable agroforestry practices. They asserted that women demonstrate additional capabilities beyond farming, serving as herbal experts who maintain knowledge of medicinal plants to meet their communities' health needs.

The research findings demonstrated that women are essential to the success of agroforestry because they bring different skills and knowledge and perform various tasks. Women's participation strengthens the technical aspects of agroforestry practice and preserves the wealth and societal resilience of local communities. Furthermore, similar studies noted that women's empowerment and recognition of the roles they play enhanced agroforestry outcomes, led to more substantial gender equality, and increased community resilience [4, 38–40].

Additionally, our study's findings illustrated that gender-centered mechanisms must be included in agroforestry initiatives and programs to build women's potential and decision-making power, leading to better sustainable land management and food security outcomes [4, 12, 38, 39]. The findings strongly observed and confirmed that women are heavily invested in agroforestry and agricultural processes and activities, thereby aligning with the Feminist Political Ecology theory [15, 16, 19, 20].

5 Decision-making power and land rights system

The discussions about women's decision-making power in agroforestry activities showed a negative trend, with the majority of groups stating that women have little or no decision-making authority in Ugandan society across most regions (Table 4). Even though discussions showed that, in some cultures, women participate in decision-making, the general view remains negative.

Table 4: Summary of the responses to the FGD questions.

Question	A	B	C	D	E	F	G	H
Women play a critical role in the success of agroforestry practices	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Women have sufficient decision-making power regarding agroforestry activities	Yes/No	Yes/No	Yes/No	No	No	No	No	No
Involving women in agroforestry is essential for sustainable environmental and economic development	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Women face more obstacles/limitations than their men when participating in agroforestry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Women's knowledge and traditional practices are valuable assets for successful agroforestry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The current women's decision-making situation in Uganda depends on the nature of family dynamics, such as level of education, marital status, and or the presence of the male partner at home, and or household bargaining on such matters. At the community level, in various areas, most women have no access to planning or even have no time to be involved. At the institutional level, the decision-making platform is only available to women across Uganda, especially regarding access to financial and extension services, and other formal policy tools such as land governance, which is reportedly weak and unable to facilitate the needs of women in agriculture and agroforestry regarding land-related decisions and planning [8, 9, 14, 29, 38, 64, 66].

Most groups, including C, E, F, G, and H, agreed that women face structural barriers in decision-making because they cannot own land, follow cultural traditions, or access resources in Uganda. Women face barriers to making decisions about agroforestry because they lack inheritance rights (Group E) and do not control land ownership (Groups F, and G). Social and cultural norms in groups D, F, G, and H maintained the notion that women face and suffer discrimination due to societal norms of their inferior and subordinate status, which prevents them from participating in community planning and meetings and obtaining financial resources, including loans. These social norms continue to perpetuate gender-based inequities within decision-making systems in Ugandan societies.

Group A expressed a dual perspective on decision-making authority for Ugandan women, suggesting that they should have such power through their husbands, who are often not interested or absent from agricultural activities. However, findings from Group B demonstrated that women's involvement in agricultural activities, e.g., agroforestry and resource-use management roles, enhances their decision-making capacity. They (women) are enabled to take on resource-control positions and make decisions in certain situations.

"Group A and B

Yes and No: Some women have full decision-making power regarding agroforestry and other agricultural activities when their

husbands are not interested in agriculture, whereas in other families, men hold the dominant role.

Group D

Yes: we partly agree, in some cases, women are taken to be inferior where there is a man, and the decision-making is masked.

Group B, C, D, E, F, G, and H

No: Because most of them (women) have no control over land ownership, the social and cultural norms, among others. They do not even have access to loans, which also limits their decision-making power.

Most women in Uganda are not allowed to inherit resources like land, where they could exercise their decisions regarding agroforestry activities.

Remarkably, men in all groups asserted that women do not have decision-making power, especially on farm management decisions, even if they are the majority users of such land or farm. They blame the culture for this situation. Moreover, the men faulted the government for not supporting women directly, especially with loans rather than requiring land as collateral, yet the majority of women do not own or have power over the land and farms they use for agriculture and agroforestry.

The majority of evidence suggests that women have limited decision-making authority; however, groups A, B, and D emphasized that women who control resources or serve as knowledge custodians can shape decisions and promote sustainable development and economic growth.

The discussions indicated that women in Ugandan communities face multiple barriers to decision-making regarding agroforestry, mainly due to deeply rooted social norms and cultural expectations, as well as economic constraints [8, 9, 14, 38–40]. The restrictions on their land ownership rights, together with their exclusion from community decision-making forums, reduce their ability to make decisions [8, 9, 14, 29, 38, 64].

Other studies also agree that the decision-making power of women and other vulnerable groups can increase when

they are involved in planning activities and have equal control over the resources necessary to society [65, 66]. Moreover, they noted that the presence of gender equity and improved land rights, along with inclusive community involvement, would enable women to take more active roles in agroforestry decisions, leading to sustainable resource management with equal benefits [39, 40, 66]. The study demonstrates that targeted programs are needed to overcome structural barriers and build women's capabilities for full participation in agroforestry decision-making processes.

5.1 Women in agroforestry and sustainable development

The groups' discussions on women's participation in agroforestry reached a universal agreement that female inclusion is necessary to achieve sustainable environmental and economic advancement (Table 4). Participants identified that women's empowerment in the agroforestry sector delivers numerous advantages.

Groups A, D, and G emphasized that women are committed to farming activities and that their involvement contributes to sustainability, supports household income, and promotes economic growth. People consider female participation essential because women demonstrate strong commitment, planning abilities, and a fundamental role in family farming.

Several groups (E, G, and H) stated that teaching women agroforestry skills would enable them to start their own businesses and earn money, thereby improving their economic situation. Economic development at the household and community levels could benefit from direct support for females in agroforestry and agriculture.

The discussion in groups B and C indicated that women and young people face economic and social marginalization because traditional cultural norms restrict their access to land inheritance rights. Agroforestry initiatives often face obstacles in benefiting women and youth because they lack access to financial resources and decision-making authority.

Group C asserted that women's participation in agroforestry programs leads to increased support from their families and communities, proving their essential role in resilience and sustainable development in Ugandan society.

Group H asserted that women conserve and protect traditional knowledge of cultural methods necessary for sustainable agriculture and agroforestry, e.g., mulching, weeding, and harvesting, which can be integrated into agroforestry systems. Their continued involvement of women showcases their vital role in maintaining agricultural practices.

Group A

Yes, this is because women are more passionate about agriculture and providing for their families, ensuring sustainability, and improving livelihoods.

Group B

Yes, women have the capacity to operate as single parents in many households. They (women) are either sole providers or play a leading role in food security and farm management. Women can do what men can do.

Group C, D, E, E, and G

Yes: we agree, women are committed, good at planning, and easily mobilized to participate in agroforestry and related activities. The outcomes of their involvement help in many ways, such as food security, firewood energy, incomes, and environmental protection, including soil and water services.

Involving women in agroforestry can improve household welfare by enhancing overall well-being and reducing poverty. Increases in the hands-on skills and knowledge on how to grow and the market updates for the products produced.

Women need more knowledge of agroforestry to be able to employ themselves and improve their livelihoods and household income, thereby contributing to economic growth.

Group H

YES: Women are mostly involved in family practices and roles, such as weeding, planting, and harvesting, which are integrated into agroforestry and benefit families and society.

Most women preserve the history of agricultural cultural practices, such as mulching.

Most women's profits in agriculture are reinvested back in it.

All groups agreed that women are involved in agroforestry because it leads to sustainable environmental management and economic advancement. Our findings are in line with previous studies; moreover, from various regions of the world that emphasized the role of women in sustainable agriculture and ecological and sustainable development [4, 19, 21, 23, 27, 38, 65, 67–69]. The findings are supported by the theory of Feminist Political Ecology, which emphasizes the full participation of women in environmental initiatives and conservation [19–21, 23].

The discussions reveal ongoing obstacles, including cultural practices, land ownership rules, and financial inequalities, which prevent women from reaching their full potential. To achieve sustainable agroforestry and development goals, it is necessary to promote gender equity, accompanied by capacity building and access to land and

resources, to enable women to reach their full potential in supporting the achievement of sustainable development goals, especially Zero Hunger, reduce poverty, and improve the lives of land [24, 30, 32, 38–40, 49, 50, 68, 69].

Empowering women in agroforestry and other agricultural practices directly could lead to sustainable development and enhanced household well-being, thereby creating resilient, economically and environmentally sustainable communities [38–40].

5.2 Community and institutional limitations: women face more obstacles than men

Agroforestry project participation creates additional difficulties for women, according to the focus group discussions, compared to those encountered by men. Social, economic, cultural, and physical obstacles combined act as barriers to women's full engagement in agroforestry initiatives (Table 4).

Groups A, B, D, G, and H demonstrated that women experience inferior status to men, which diminishes their ability to make decisions and affects their social standing. They also stated that women typically lack access to land ownership rights and face restrictions on essential agroforestry and agricultural activities due to cultural norms.

Groups A, C, E, and H agreed that women lack land ownership rights, which prevents them from fully participating in agroforestry activities. Most women lack the autonomy to make independent decisions or initiate projects that require land ownership because they lack land rights.

The discussions in B, E, and H groups demonstrate that women encounter financial challenges because they lack access to credit facilities and necessary project resources. Moreover, the combination of household responsibilities takes away women's time and physical capability to participate in agroforestry activities.

Group G stated that certain activities require significant physical effort, which acts as a barrier for women because they face societal beliefs about their physical abilities. Women encounter difficulties when using heavy machinery because they have limited access to it and may struggle to operate it. Additionally, women's decision-making authority and domestic work responsibilities, combined with their exclusion from extension services targeted to men, limit their participation in agroforestry projects, according to Groups F and H. Women face barriers that limit their participation by reducing their ability to express themselves and make decisions. On the other hand, Group B recognized the strong resilience and independent project management abilities of women in agroforestry and agriculture, despite

their challenges, which demonstrates potential paths for empowerment.

Groups A, B, C, D, E, F, G, and H

Yes: In our local communities, women are taken to be inferior to men in most families.

Physically, women are said to be too weak to perform certain activities, such as pruning a tall tree.

Women and youth are financially disadvantaged.

Women are constrained by various cultural norms, such as the prohibition on inheriting land.

Women struggle to get loans because they don't have collateral, such as land or livestock.

A lot of domestic work at home leaves less time for them to attend meetings and participate in capacity-building initiatives.

Extension services often target male farmers more than females.

The study found that women face challenges beyond those faced by men in agroforestry projects, mainly due to cultural restrictions and structural and economic barriers. The results are in tandem/agreement with various studies from various regions around the world, especially in Africa and South Asia [20–22, 33, 40–43]. Finding solutions to these obstacles and problems requires comprehensive, systematic approaches that grant women land ownership rights while enhancing their access to funding and extension services, and that dismantle cultural norms that block women's involvement [22, 45, 54].

To strengthen agroforestry participation in gender-sensitive policy development and legislation, accompanied by resource enhancement and capacity building on the essential role of women in these initiatives [20, 21, 36]. The removal of obstacles will both establish gender equality and utilise women's capabilities to manage the environment while developing their communities sustainably, given their contribution to food security, household incomes, and land management through sustainable agricultural practices [22, 33, 41, 45].

5.3 Women's indigenous knowledge and traditional practices

Participants in the focus group discussions consistently stated that women's knowledge, alongside their traditional practices, holds essential value for achieving successful agroforestry (Table 4). The group participants recognized

that women's indigenous knowledge and cultural practices, along with their experience, are fundamental to establishing productive and sustainable agroforestry systems.

Some selected examples of traditional knowledge in agriculture and agroforestry reported by FGDs participants included: seed selection and storage techniques; mulching and composting blends (e.g., banana leaves and ash) to maintain soil moisture; and use of specific medicinal or species combinations such as *Aloe vera* and Moringa, other leguminous plants, and trees for household remedies and soil improvement. Moreover, practices like mixing trees with other crops are a generational norm, as stated, for example, in mixing leguminous tree species with other crops on most farms, such as banana and/or coffee for nitrogen fixation, shade, and wind protection.

Groups C, F, and H recognized that women possess extensive knowledge about medicinal plants, food crops, and sustainable land-use and soil-conservation practices such as mulching and mixed farming. This specialized knowledge is a fundamental requirement for creating successful agroforestry approaches that promote sustainability.

Group B noted that women have successfully transmitted knowledge across generations, enabling essential agricultural and land management practices to thrive. More so, Group E noted that women's cultural involvement in agriculture enhances the depth of agroforestry methods. Also, Group D identified women as creative agents who bring their innovative knowledge and practical experience to the success of agroforestry initiatives.

A, G, and E groups observed that cultural traditions assign women a central role in protecting traditional practices, which could lead to better performance of agroforestry initiatives and broader participation. Moreover, Group H emphasized that women play a crucial role in protecting traditional knowledge and historical practices, which provide opportunities to develop sustainable and innovative agroforestry methods.

Group A

Yes: It promotes inclusivity and increases productivity in agroforestry initiatives, as women are often more passionate and experienced in local agriculture.

Group B

Yes, because of women's ability to transfer knowledge to the next generation.

Group C

Yes: Because they possess deep knowledge of medicinal plants, food crops and sustainable land use practices.

Group D

Yes, we agree; women are indeed creative.

Group E

YES: Since most African cultures involve women in agriculture, they bring their experiences with them into agroforestry, which will make it successful.

Group F

Yes: Women's knowledge and traditional practices are valuable assets because they provide practical guidance on management practices, seed selection, and soil conservation, as well as ideas.

Group G

Yes: This is because some cultures tend to view women as important participants in agriculture, thereby making agroforestry successful.

Group H

Yes:

Women preserve the history of cultural practices that could later be valuable for the success of agroforestry, such as which plant species to have on the farm or mix with other crops.

Most women in Uganda are experienced with agricultural knowledge, which adds to the success of agroforestry.

The collective responses demonstrated that women's knowledge is rooted in cultural traditions and is vital to the success of agroforestry and forestry. Our study is in tandem with previous studies that cultural and traditional knowledge, and skills such as mulching, pruning, medicinal plants and land management such as land fallowing, crop rotation, mixed farming held by women is essential to boosts productivity and sustainability hence helping with communities' resilience against various challenges such as food insecurity, climate change, and crop diseases [70–74].

The integration of indigenous/traditional knowledge and practices by women in agroforestry projects and programs creates more suitable and successful interventions [45, 75]. Knowledge transition from one generation or group to another supports both the preservation of cultural traditions and the adoption of sustainable agroforestry practices as evidenced in previous studies [75–78]. Women must be empowered to sustain traditional ecological knowledge guardians and transmitters, as this path leads to greater sustainability in agroforestry and development goals [24, 45, 49, 50].

Moreover, given the role and expertise of women in the entire food value chain including agroforestry products,

livelihood, ecological sustainability and resilience, it is paramount to promote policies and support them with necessary resources, legislation, and capacity building at all levels of society [77–80].

Limitations of the study

- (1) Study's focus on youth (18–35 years) regarding women's roles possesses age restriction. However, not so many studies have focused on these specific stakeholders in society hence giving this study rather a unique perspective on the role of women in agroforestry and food security in Uganda and the region.
- (2) Single time-point data collection without longitudinal perspective. We note that perceptions and challenges can evolve. We suggest longitudinal studies as valuable future research direction.

6 Conclusion and recommendations

This study examined women's involvement in Ugandan agroforestry practices to understand their challenges and opportunities while assessing their impact on achieving SDGs related to poverty reduction and food security, gender equality and environmental management. The theoretical outcomes from inductive analysis of Feminist Political Ecology demonstrated women's involvement in agroforestry in Uganda. However, limitations such as access to resources, power and decision making, and control dominate and underestimate their contribution to agroforestry and agriculture as a whole in Uganda.

Our study demonstrated that although underrated, women play an important part in the success of agroforestry, as they contribute their diverse skills, knowledge, and labour to these practices. Their active involvement not only enhances technical outcomes but also fortifies the socio-economic fabric of their communities.

The majority of women in Uganda face significant social, cultural, and economic barriers in their communities that limit their full involvement, including access to land, inheritance rights, and decision-making power, which restrict their full potential to contribute to agroforestry.

The full utilisation of women's contributions and efforts in sustainable land management through agroforestry, among other agricultural activities, requires specific gender-sensitive interventions to overcome existing obstacles in Uganda and globally.

Community and stakeholder engagement: Specific strategies should be planned and implemented to promote and support stakeholders in enabling women's involvement in

enhancing agroforestry outcomes and fostering sustainable, resilient communities aligned with development objectives.

Reforming land rights and tenure systems: Policies should be implemented to protect women's rights to inherit and own land. The legal and land tenure system should establish women as fundamental decision-makers for land and resource management, enabling sustainable land management and agroforestry, including reforming inheritance laws to protect and foster women's land ownership rights.

Enhance access to credit resources and extension services: The availability of credit, extension services, and training programs for women in agroforestry practices should be increased. Gender-sensitive programs must focus on women's economic and social empowerment, hence boosting their capacities in various ways. Women should be actively involved in decision-making forums and community planning processes for sustainable planning and implementation of intended developments.

Integrate women's indigenous knowledge: Formal and current agroforestry programs should incorporate traditional practices into their frameworks. Cultural heritage preservation and sustainability depend on supporting intergenerational knowledge transfer in agroforestry activities and initiatives.

Capacity building and awareness for women: Women and men should receive leadership training together with skills development opportunities. Moreover, the community needs to be educated on why gender equality matters for agroforestry and sustainable development in general, therefore, facilitating their progress rather than limiting their capabilities.

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