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The impact of community-led conservation models on women's nature-based livelihood outcomes in semi-arid Northern Ghana

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Abstract
With increasing human-induced environmental degradation, women's nature-based livelihood activities are threatened. In semi-arid northern Ghana, shea processing (i.e., shea butter, a derivative of shea nut from the shea tree), a vital women-dominated economic activity, is at risk as naturally occurring shea trees continue to decline in numbers and productivity. The decline of the shea tree's number and productivity and the ensuing biodiversity loss have sparked conservation efforts by governments and local communities. This includes community-led conservation models, which have recently gained traction in the Global South. Ghana implemented the Community Resource Management Areas (CREMA)—a community-led conservation model to improve biodiversity and ecosystem services, including shea trees conservation in response to climate change. Research has not explored the impacts of community-led conservation efforts on women's nature-based livelihoods in Ghana. Using a mixed-methods approach involving surveys ($n=517$) and focus group discussions ($n=8$), this study explored shea productivity outcomes under CREMAs. Findings show that women residing in CREMAs had significantly better shea harvesting outcomes than those outside CREMAs ($\alpha=-53.725$; $P<0.01$). These findings demonstrate the potential for targeted conservation initiatives that are community-led, such as the CREMAs, to improve the conservation of economically significant naturally occurring trees like Shea. With the increasing impacts of climate change and environmental degradation, such models would be instrumental in achieving sustainable development goals like SDG5-gender equality, SDG10-reduced inequalities, SDG13-Climate action, SDG14-life below water, and SDG14-life on land.

Keywords Community-led conservation · Feminist Political Ecology · Nature-based livelihoods · Access to credit · Shea trees · Ghana

1 Introduction

Historically, natural resource management has followed a top-down approach, with government or international organizations leading initiatives [1, 2]. Some scholars described it as the "fortress conservation" paradigm, which usually preserves biodiversity by excluding people [2, 3]. While the top-down approaches have had some positive outcomes, they have often marginalized communities, treating them as outsiders rather than critical stakeholders in conservation efforts [3]. However, in the early 1970s, this approach was challenged by the Community-Based Natural Resources Management (CBNRM) initiative [4, 5]. The CBNRM era emerged in modern conservation discourse due to the growing global awareness

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of positive outcomes of community-based stewardship of natural resources and, hence, demand for increased involvement of local communities in managing and sustaining natural resources [6, 7]. For example, the biocultural heritage territory model in the potato park of Cusco, Peru, has successfully promoted sustainability while preserving biodiversity and improving community adaptation to climate change [8]. The model emphasizes integrating indigenous knowledge, cultural values, and sustainable practices in conservation and development strategies, providing a comprehensive approach to addressing climate change and biodiversity loss challenges. Several scholars believe that CBNRM, which places people and their communities at the center of resource management decision-making, is sustainable [9]. Like in Zimbabwe, Murphree documented the Communal Areas Management Programme (CMAP) success for indigenous resources in promoting African nature conservation [10]. In Kanya, Wekesa et al. found that indigenous biocultural heritage values support sustainable natural resource management, preserve traditional knowledge and practices, and foster social cohesion through the Rabai Cultural Landscape [8]. On the other hand, CBNRM has gained criticism for being unrealistic and ironically recreating a "tragedy of the commons" [11–13].

Ghana's Community Resource Management Area (CREMA) initiative exemplifies this evolution from fortress conservation to CBNRM [14]. CREMAs were designed as a structured, democratic, and legally supported approach to conservation that prioritizes community-led strategies [14]. The foundation of CREMAs rests on the belief that local communities, due to their interactions and standing relationship (indigenous and cultural ecological) with their environment, possess invaluable insights into sustainable resource management [14, 15]. CREMAs strive to align conservation goals with local/traditional and modern knowledge and well-being by empowering communities with tools, authority, and understanding [16–18].

Ghana's Upper West Region (UWR) exemplifies the relationship between the community and the environment surrounding the shea tree (Vitellaria paradoxa). Shea trees symbolize the savannah ecosystems in West Africa [15, 19]. These trees play a role beyond being plants; they are essential connectors linking ecological vitality with socioeconomic well-being [20]. At the heart of this relationship are women who primarily rely on the product of Shea trees, such as shea nut and butter, for their livelihoods [15, 21, 22]. As global demand for shea continues to grow and community dynamics come into play, prioritizing conservation practices for this vital resource becomes increasingly essential [9, 15, 23]. Given the interconnectedness between human communities and the ecosystems, shea trees comprise [24, 25]. In this context, women's livelihoods are closely intertwined with the local environment, creating an intricate tapestry. Despite the dimensional economic, cultural, and environmental importance of shea trees and the effects on local conservation, including biodiversity [26–28], it remains unclear how CREMAs affect shea conservation and their influence on women's livelihoods. Against this backdrop, the study investigates the question: does implementing community-led conservation models like CREMA result in a higher shea yield for women compared to non-CREMA communities?

1.1 Literature review

Community-led conservation initiatives are essential to sustainable natural resource management and biodiversity conservation. In Sub-Saharan Africa (SSA), specifically Ghana, these initiatives primarily occur through Community Resource Management Areas (CREMAs), vital in involving local communities in conservation activities to achieve conservation goals and enhance livelihoods. CREMAs provide a platform for community members to demarcate traditional boundaries for the resource management area, including core and development zones [14, 29]. They establish committees such as the CREMA Executive Committee (CEC) and Community Resource Management Committee (CRMC) to oversee resource management. The government officially recognizes CREMAs by awarding them a certificate of devolution, granting communities legally binding authority over their resources. Together, these committees develop a comprehensive resource management plan that includes rules and regulations, monitoring activities, and enforcement [14]. Within CREMAs, various activities occur, including ecosystem restoration and rehabilitation efforts, environmental awareness campaigns, and regulating bushfires, hunting, and logging practices. CREMAs also facilitate connections between producers such as farmers and Shea collectors and businesses that promote community initiatives while ensuring the procurement of high-quality products at fair prices. Conservation agreements may also be established where organizations or companies contribute to a conservation fund to support conservation activities.

Studies have reported CREMA's benefits, including the potential to reduce emissions from deforestation and forest degradation (REDD+) [16, 30] and support ecotourism activities [31, 32]. They promote income diversity, which boosts local economies and further increases accountability and democratization at the grassroots level [33]. Communities in the CREMAs are reported to have access to natural resource goods as a source of food, fuel, medicine, flora, and fauna [29], 34. In the CREMAs, 7.5 million natural resource products (22% of all trees) can be used commercially. The most found are shea (5.4 million), followed by (902,000 trees), mango (403,000 trees), moringa (280,000 trees), and dawadawa (216,000 trees). Shea, dawadawa, baobab, and tamarind are the natural resource products that CREMA smallholders exploit the most for livelihoods [35]. CREMAs have also increased community and landowner rights to manage natural resources usually controlled by the government [35]. However, despite its potential, the CREMA initiative has been criticized [36]. Some argue that this policy and legal framework is state-centered and fails to fully consider the local community's holistic needs regarding sustainable and effective forest and animal resource management [36]. Also, Pienaah et al. found that the CREMAs lack the financial support to operate their conservation funds system. They recommended establishing credit systems for women in CREMAs and non-CREMAs to support conservation efforts [15]. Despite recognizing the importance of natural resources in CREMAs, there is little information available on the impact of CREMAs on the host communities.

Furthermore, women's involvement in CREMAs is increasingly recognized as vital due to their direct involvement in resource management and utilization for household and community well-being. However, women often face significant socio-economic barriers that limit their participation and benefits from such conservation initiatives. Studies have shown mixed impacts of CREMAs on women's livelihoods, with some regions reporting positive outcomes such as improved access to natural resources and increased income generation opportunities [15]. However, other studies highlight the challenges of shifting traditional gender roles and enhancing women's decision-making power within these conservation frameworks. Despite the potential benefits, the effectiveness of CREMAs in supporting women's nature-based livelihoods, like Shea's productivity (yield), is still under-explored. To fill this gap, this paper compares shea yield harvested by women in CREMA and non-CREMA locations in UWR, Ghana.

1.2 Theoretical context

This study is situated within a theoretical framework of feminist political ecologies (FPE). Feminist Political Ecology provides an approach to understanding the complex relationship between gender, environment, and political economy [37]. Building on the work of Rocheleau, FPE is insightful in uncovering power dynamics and knowledge systems within governance and resource management [38, 39]. Its fundamental belief is that marginalized women and communities often face barriers that limit their access to and control over natural resources. This perspective becomes crucial in analyzing the aspects and consequences of initiatives. Elmhirst emphasizes that the FPE examination of power relations goes beyond concepts—it recognizes these dynamics' impacts on accessing, controlling, and distributing resources [37]. FPE shapes the narratives, policies, and actions related to governance, ultimately determining who benefits from them and bears the burden. This is particularly important in areas such as the UWR of Ghana, whereby women in male-dominated environments are often overlooked in traditional conservation efforts and prioritizing ecological benefits. Van Aelst and Holvoet emphasized the need to consider how environmental impacts vary intersectionally based on gender, class, age, or ethnicity and the impact of different forms of masculinity [40]. FPE recognizes that experiences with nature are complex beyond gender [41, 42]. By understanding these power dynamics through the FPE lens, we can critically evaluate how community-led natural resource conservation initiatives impact marginalized groups— women—in real-world scenarios [43].

Furthermore, a crucial element in FPE conception revolves around livelihood strategies and gender-specific knowledge systems [44]. Based on their interactions with the environment, often shaped by gendered historical and current socioeconomic inequalities (income and resources, for example), women often develop a closer connection and understanding of nature than men. Ingram et al. and Agarwal argued that women's connection with their environment may also be more closely tied than men to how they sustain their livelihoods [43, 44]. Therefore, conservation or resource management efforts should incorporate gender knowledge. Ghana's CREMA initiative in the semi-arid UWR provides a context for understanding women's livelihoods within the climate-induced decline of shea trees. As decentralized governance mechanisms, CREMAs promote resource conservation and utilization while supporting livelihoods [15, 16]. Despite patriarchal structures that often minimize or undervalue women's roles in the broader climate and conservation discourse, it is essential to consider the impact of community-led conservation on women's nature-based livelihoods. By examining the social, cultural, and political factors that influence livelihood outcomes, we can better understand CREMA-based governance on CBNRM beyond simply measuring their "success" or "failure" in decontextualized ways. This approach allows us to identify structural obstacles and propose ideas for making community-led conservation initiatives fair and more inclusive.

1.3 Study context

The UWR of Ghana has 11 municipalities and districts with a population of 901,502 [45] people (Fig. 1). It borders Burkina Faso, Upper East, and Savannah Regions. The region covers 18,476 square kilometers, or 7.8% of Ghana's total landmass [45]. UWRs lie between 9.8° and 11.0° N and 1.6° and 3.0° W [45]. The UWR in Ghana is the country's poorest region, with 90% of residents living on less than 1.0 USD daily [46]. The poverty rates as of 2015 are highest in Wa West 92.4%, Wa East 83.8%, and Nadowli-Kaleo 68.5% districts, according to the Ghana Statistical Poverty Mapping Report [15]. The UWR has a semi-arid landscape with scattered trees and diverse plant species, including the vital shea trees, *Adansonia digitata* (Baobab), *Faidherbia albida* (Acacia albida), *Mangifera indica* (Mango), *Blighia sapida* (Ackee), and *Parkia biglobosa* (Dawadawa) [15]. The Shea tree is crucial to the economy of the UWR, with Shea butter processing as the primary livelihood activity for women [15, 47, 48]. Shea nuts harvest is a deeply rooted cultural activity in the region, reflecting its social fabric. The shea tree also contributes to biodiversity conservation in the region [15, 49, 50]. Shea trees are a significant nectar source for honey production in the UWR [48]. The UWR is also a landmark for quality honey production but has relatively recorded low production due to a lack of technology and the prevailing environmental conditions [51].

The UWR has natural resource challenges, including food insecurity, extreme weather events, and land degradation [52, 53]. Sanitation is also a challenge in the region [54]. The UWR's shea landscape ownership and utilization dynamics are deeply rooted in its complex traditional setup. Unlike regions where traditional chieftaincy institutions have significant authority over land allocations, as reported by Biiri and Nara, the situation in UWR is characterized by unique distinctions [55]. At the heart of land custodianship in the UWR is "Tendamba" (Land priests). Symbolically regarded as custodians of

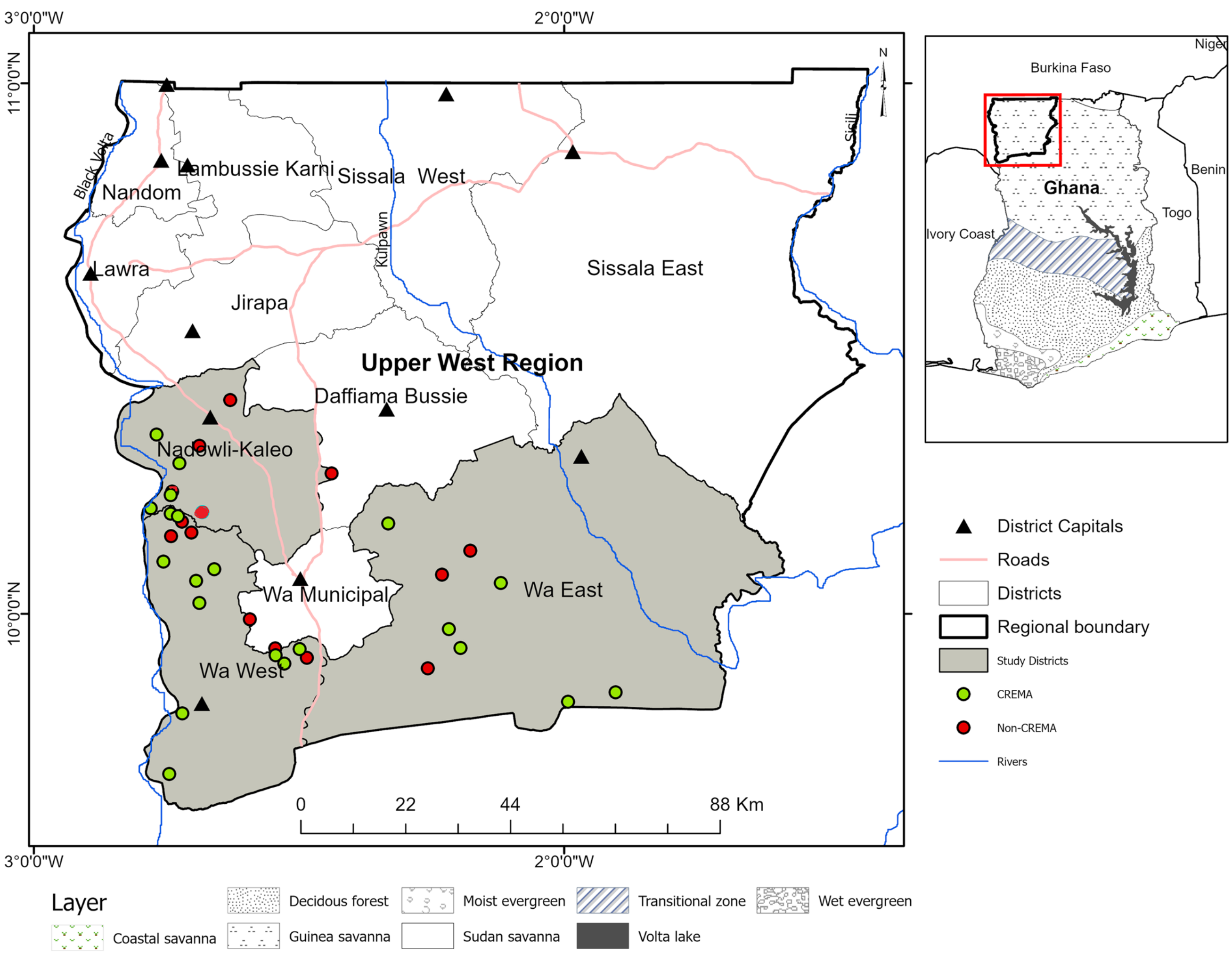

Fig. 1 Map of UWR showing study area (prepared by authors using ArcGIS Desktop 10.5.1)

lands, the "Tendamba" in the "Dagaaba" dialect holds a duty beyond mere guardianship. They also perform land rituals that have cultural and spiritual significance. However, despite their role, the "Tendamba" do not possess the authority to divide or allocate sections of land. They are also recognized as the mediators of most land conflicts in traditional settings. The ownership structure of lands in UWR is multi-tiered [55]. Communal lands in the UWR of Ghana are divided into clan territories, family domains, and individual holdings, each with its rights and responsibilities. Traditional chieftaincy institutions play a role in local land politics and development strategies but do not control land use or have the authority to assign land. Women in the region contribute to sustainable resource management by harvesting shea nuts from family-owned lands and some areas within the community boundaries. The study selected four CREMAs out of the five existing in the UWR region, namely Chakali Sungmaalu CREMA in Wa East, Dorimo Paramountcy and Wechiua CREMAs in Wa West, and Zukpiri CREMA in Nadowli-Kaleo. The chosen CREMAs were deemed to represent the region's CREMAs significantly. However, the Sissala-Kassena-Fraah-Bulenga CREMA in the Sissala East Municipal was excluded from the study.

1.4 Methodology

We employed quantitative and qualitative methods to investigate the impact of community-led conservation initiatives on local livelihoods [56]. To evaluate the impact of CREMAs in improving livelihoods and enhancing climate change resilience in the semi-arid region of UWR, we compared the impact of CREMAs and non-CREMA conservation practices on shea resource outcomes in UWR.

1.5 Quantitative data collection and analysis

Data was collected between November 10th, 2022, and January 31st, 2023, from 517 agricultural households based on the criteria of an agricultural household specified in the 2017/18 Census of Agriculture by the Ghana Statistical Services [50]. An agricultural household is defined as one where at least one member is involved in farming. The study was conducted in two phases following [53]. We obtained data using a two-stage sampling method to represent the population [53]. Using a systematic sampling technique, we surveyed 517 households across 36 communities in Wa East, Wa West, and Nadowli-Kaleo districts with 167, 229, and 121 participants (Table 1). The districts were included because they are part of the broader study on "the impact of Community Resource Management Areas (CREMA) in improving livelihoods and climate change resilience." [53]. We aimed to ensure that the sample size of 517 households accurately reflected the estimated population of 2,604 households. We created a comprehensive list of households, from which we randomly selected one household from the first five on the list and then systematically selected every fifth household to participate in the survey [53]. Our sampling method produced an unbiased and well-balanced survey outcome. We interviewed 517 primary farmers representing each household, provided they were at least 18 years old and excluded minors from the study. All participants consented by giving a verbal agreement. Out of the 520 households identified, we were able to interview 517 household representatives, resulting in a response rate of 99%. We obtained verbal consent from all participants who volunteered to participate and had a participant's spouse, another adult household member, and a local community opinion leader (such as an Assembly member or Unit Committee member) present during the consent process. These individuals were knowledgeable and informed about the study's objectives and ethical implications. We collected data on various topics related to the farmers and their households, including demographics, sociocultural characteristics, socioeconomic factors, shea yield, and biodiversity conservation.

The study's outcome variable is the self-reported amount of shea yield harvested over three production seasons, and it is measured on a continuous scale. We constructed a scenario asking participants to reflect on the last three shea harvest seasons before the study to obtain this information. We estimated the quantity of shea nuts (yield) their household harvested during each period in either CREMA or non-CREMA communities. We used a single question to gather the seasonal harvest data: "How many bags (kg) or containers (kg) of shea nuts did you or your household harvest in the seasons of May–August 2020, May–August 2021, and May–August 2022?" The study focused on the "community conservation approach" as the focal independent variable. It was coded as a binary measure (0 = CREMA) and (1 = non-CREMA). The difference is that CREMA communities utilize the CREMA approach while non-CREMA communities do not. The categorization allowed us to compare shea yield from the two areas.

The demographic and socio-cultural variables included the household gender (0 = male, 1 = female) to gain insights into household decision-making dynamics. Additionally, other variables were coded as follows: gender of the respondent (0 = male, 1 = female), age (0 = 18–29, 1 = 30–39, 2 = 40–49, 3 = 50–59, 4 = 60 +), education (0 = no formal education, 1 = primary, 2 = secondary or above), marital status (0 = single, 1 = married, 2 = widowed/divorced), religion (0 = Christian,

Table 1 Communities showing shea harvest locations

S/N	Community	Status	Zone	District
1	Mantare	CREMA	Zukpiri CREMA	Nadowli-Kaleo
2	Zukpiri	CREMA	Zukpiri CREMA	Nadowli-Kaleo
3	Meguo	CREMA	Zukpiri CREMA	Nadowli-Kaleo
4	Puni	CREMA	Zukpiri CREMA	Nadowli-Kaleo
5	Kpagidinga	Non-CREMA	Zukpiri CREMA	Nadowli-Kaleo
6	Takyiripie	Non-CREMA	Zukpiri CREMA	Nadowli-Kaleo
7	Niiri	Non-CREMA	Zukpiri CREMA	Nadowli-Kaleo
8	Konne	Non-CREMA	Zukpiri CREMA	Nadowli-Kaleo
9	Kuuri	Non-CREMA	Zukpiri CREMA	Nadowli-Kaleo
10	Kusale	CREMA	Dorimo CREMA	Wa West
11	Olli	CREMA	Dorimo CREMA	Wa West
12	Sielaa	CREMA	Dorimo CREMA	Wa West
49	Buka	CREMA	Dorimo CREMA	Wa West
14	Dabo	CREMA	Dorimo CREMA	Wa West
15	Kankanzie	Non-CREMA	Dorimo CREMA	Wa West
16	Guoro	Non-CREMA	Dorimo CREMA	Wa West
17	Sanzie	Non-CREMA	Dorimo CREMA	Wa West
18	Nyagli	Non-CREMA	Dorimo CREMA	Wa West
19	Dodoma	CREMA	Wechiau CREMA	Wa West
20	Kpanfa	CREMA	Wechiau CREMA	Wa West
21	Kantu	CREMA	Wechiau CREMA	Wa West
22	Talawonaa	CREMA	Wechiau CREMA	Wa West
23	Janbusi	CREMA	Wechiau CREMA	Wa West
24	Balawa	Non-CREMA	Wechiau CREMA	Wa West
25	Kangba	Non-CREMA	Wechiau CREMA	Wa West
26	Siiru	Non-CREMA	Wechiau CREMA	Wa West
27	Lanyiri	Non-CREMA	Wechiau CREMA	Wa West
28	Ducie	CREMA	Chakali-Sungmaalu CREMA	Wa East
29	Motigu	CREMA	Chakali-Sungmaalu CREMA	Wa East
30	Gurenbelle	CREMA	Chakali-Sungmaalu CREMA	Wa East
31	Jeyiri	CREMA	Chakali-Sungmaalu CREMA	Wa East
32	Mamboi-Dangyuokura	Non-CREMA	Chakali-Sungmaalu CREMA	Wa East
33	Hanbagnikolee	Non-CREMA	Chakali-Sungmaalu CREMA	Wa East
34	Dupare	Non-CREMA	Chakali-Sungmaalu CREMA	Wa East
35	Bugini	Non-CREMA	Chakali-Sungmaalu CREMA	Wa East
36	Chaggu-paala	Non-CREMA	Chakali-Sungmaalu CREMA	Wa East

1 = Muslim, 2 = African tradition). We included ethnicity (0 = Dagaaba, 1 = Sissala, 2 = Brifo, 3 = Waala) backgrounds that can shape perspectives on conservation (see Pienaah et al., 2023). Household composition was coded as the presence of children in a household (0 = no child present, 1 = children present), household size (0 = 1–4, 1 = 5–8, 2 = 9 above), and wealth quintile (0 = Poorest, 1 = Poorer, 2 = Middle, 3 = Richer, 4 = Richest) to understand how economic pressures and family needs might affect conservation efforts and Shea harvesting practices. Next, we analyzed the resource access and utilization category, which included factors such as self-rated access to shea resources (0 = poor, 1 = good), investment in shea collecting tools (continuous variable in terms of cost in Ghanaian currency; [GH₵]), planting shea-trees (0 = no, 1 = yes) and training on shea-related technologies (0 = no, 1 = yes). These metrics provided information about the community's dedication to shea conservation and sustainability efforts. Finally, we explored the impact of Financial and External factors, focusing on access to credit (0 = no, 1 = yes) and the broader macro-environmental factors. We also examined how the COVID-19 pandemic has affected shea production (0 = no, 1 = yes).

We utilized univariate, bivariate, and multivariate analyses [57]. First, in our univariate analysis, we analyzed each variable individually to understand its distribution and main characteristics. Next, we examined the relationship between each independent variable (wealth, gender, access to credit, and household size) and our dependent/outcome variable (shea yield) at the bivariate level. Since our outcome variables for each season are continuous, we used multivariate linear regression models to understand the combined seasonal relationships with the independent variables per season. The regression coefficients we obtained from this analysis show how the outcome changes when there is a one-unit change in the predictor variable while keeping all predictors constant. This allowed us to determine the direction and magnitude of the relationship between each independent variable and the outcome (shea yield). Positive coefficients indicated an increase in the outcome when there was an increase in the predictor variable, while negative values indicated the effect. The significance levels confirmed that these associations were statistically valid, ensuring our findings were reliable and easily understood.

1.6 Qualitative data collection and analysis

This aspect of the study focused on understanding the lived experiences and knowledge of women involved in shea nut harvesting. We conducted eight focus group discussions (FGDs) with women from CREMA and non-CREMA communities. Four FGDs were held in CREMA communities, with 26 women participating, while the other four FGDs were held in non-CREMA communities, with 25 women participating. A total of 51 women aged between 18 and 70 years participated in the study, with the number of participants per FGD ranging from 6 to 8 individuals. To ensure that we included participants with experience and insights into shea resources and conservation, we specifically selected women who had lived in their communities for a while and were actively involved in the Shea collection. Before the discussions began, we provided information about the study to the women. The FGDs were recorded in local dialects and transcribed in English with assistance from research assistants (RAs). Overall, each FGD lasted between 1 to 2 h. FGDs allowed the women to express their thoughts and views in an informal environment, fostering active participation and interaction.

Ultimately, the FGDs promoted peer learning by encouraging group members to engage in debates and meaningful interactions, leading to agreement on opinions and perspectives as all participants were women [58]. Audio recordings were transcribed verbatim and proofread for consistency. We coded the transcripts following Strauss and Corbin's line-by-line coding method [59]. This process helped us identify emerging themes aligned with our research objectives and questions. We used various techniques to ensure the accuracy and reliability of our research findings. These included member validation and investigator triangulation [59, 60]. Our analysis revealed significant patterns in women's experiences in natural resource conservation, differences in household wealth, access to credit, and Shea resources. To ensure the credibility of our findings, we incorporated quotes from focus groups and mentioned participants' ages, educational backgrounds, and community types. The University of Western Ontario Non-Medical Research Ethics Board (NMREB), Canada, ethically approved the study.

2 Results

2.1 Univariate analysis

Table 2 shows the sample characteristics of the study participants. The mean shea harvest for the May–August seasons of 2022, 2021, and 2020 were 94.90 kg, 135.58 kg, and 150.01 kg, respectively. Around 32.30% are in the CREMA initiative, while 67.70% do not follow conservation practices (non-CREMA). Male household heads comprise the majority at 88.59%. About 83% of the participants had good access to shea resources, while 59.77% lacked access to credit services. Despite shea's prominence in the industry, about 95.94% have yet to plant shea trees. On average, shea harvesting equipment and tools cost around GH₵ 118.76 (USD8.12). Most households (72.15%) have not received shea processing and production training. Finally, COVID-19 has negatively impacted the production of 59.96% of the participants.

2.2 Bivariate results

A bivariate linear regression in Table 3 revealed significant factors affecting shea yield harvested over three seasons, indicating the complex interplay between conservation practices, demographic attributes, household characteristics, and resource access. We found that non-CREMA locations saw a substantial decrease in shea yield harvests in all three seasons ($\alpha = -97.743$, $p < 0.001$; $\alpha = -88.992$, $p < 0.001$; $\alpha = -78.158$, $p < 0.001$) compared to CREMAs respectively. Gender disparities were evident, with female-headed households yielding less shea compared to their male counterparts, highlighting potential issues in access or control over resources. Age groups 40–49 and 50–59 showed a positive increase in

Table 2 Descriptive statistics of the sample

Variable	Percentages: (n = 517)
Seasonal shea yields harvested May–August 2022	94.90 (mean), SD: 172.00
Seasonal shea yields harvested May–August 2021	135.58 (mean), SD: 204.55
Seasonal shea yields harvested May–August 2020	150.01(mean), SD: 215.43
Conservation approach in the community	
CREMA	32.30
Non-CREMA	67.70
Gender of respondent	
Male	62.86
Female	37.14
Gender of household	
Male	88.59
Female	11.41
Educational level	
No formal education	71.95
Primary	18.57
Secondary or above	9.48
Age	
18–29	19.15
30–39	18.76
40–49	26.31
50–59	19.73
60 +	16.06
Marital status	
Single	10.83
Married	77.37
Divorced/Widowed/Separated	11.80
Religion	
Christian	55.51
Muslim	29.79
African tradition	14.70
Ethnicity	
Dagaaba	60.54
Sissala	15.28
Brifo	12.38
Waala	11.80
Children in household	
No children	35.01
Children presence	64.99
Household size	
1–4	26.89
5–8	43.71
9 +	29.40
Household wealth	
Poorest	24.95
Poorer	16.63
Middle	19.92
Richer	17.60
Richest	20.89
Self-rated access to shea	
Poor	57.83
Good	42.17

Table 2 (continued)

Variable	Percentages: (n = 517)
Access to credit	
No	59.77
Yes	40.23
Shea planting	
No	95.94
Yes	4.06
Harvesting equipment and tools cost (GH₵)	118.76 (mean), SD: 285.45
Improved training on shea	
No	72.15
Yes	27.85
Effect of Covid-19 on production	
No	40.04
Yes	59.96

1USD = GH₵14.62 as of November 2022

Min minimum, *Max* Maximum, *SD* Standard deviation, *GH¢* Ghana cedis currency

shea yields in the second season compared to age groups 18–29, suggesting that experience or accumulated resources may benefit shea production. Religious affiliation played a role, with Muslims and those practicing African traditional religions reporting higher yields than their Christian counterparts, possibly reflecting cultural or community-specific farming practices. Ethnicity also influenced shea yields, with Sissala and Waala ethnic groups outperforming Dagaaba, indicating ethnic variations in farming techniques or resource access. The presence of children and larger household sizes correlated with increased Shea yields, likely due to the availability of labor. Wealthier households (richer and richest) consistently achieved higher yields across all seasons compared to the poorest, emphasizing the importance of economic resources. Access to credit and self-rated access to shea resources were crucial, with both showing a positive increase in yields, underscoring the significance of financial inclusion and resource availability. Investments in shea planting and harvesting equipment and training on shea production and processing were significantly associated with improved yields, highlighting the role of capital investment and knowledge in enhancing agricultural productivity. These findings illustrate the complex contributing factor of shea yield, suggesting that interventions to improve shea production should consider a wide range of conservation, economic, social, and cultural factors.

2.3 Multivariate regression analysis

Table 4 presents the multivariate results. The results of the study indicate that non-CREMA areas produced consistently lower shea yields than their CREMA counterparts. The decline was significant, with a 96.464-unit decrease ($\alpha = -96.464$ $P < 0.01$) in the May–August 2020 season. This decline was further reduced to 64.866 units ($\alpha = -64.866$ $P < 0.01$) in the 2021 season and to 53.725 units ($\alpha = -53.725$; $P < 0.01$) in 2022. The differences between CREMA and non-CREMA sites were statistically significant throughout all seasons, highlighting the importance of conservation strategies, particularly CREMA, in promoting conservation and sustainable shea yield harvesting. During our FGD, we found that human activities such as bushfires, illegal logging, fuelwood extraction, agricultural mechanization, infrastructural development, land sales, and illegal mining are the primary causes of declining shea yield. Participants also acknowledged climate change-driven factors such as pests and diseases contributing to the decline of shea resources. Participants recalled that the decline in Shea harvests is also attributed to a combination of factors, including environmental neglect, inadequate bylaws enforcement, and a lack of conservation legislation at the local and national levels. Due to the diversity of our communities, individuals have differing interests in environmental resources, which include political considerations. Participants One participant echoed this sentiment, stating that.

A few years ago, loggers claimed to have been granted permission by the government of Ghana to extract rosewood from our farmlands. Unfortunately, this decision significantly impacted the shea landscape, resulting in the loss of younger trees. In addition, some loggers also harvested mature shea trees, arguing that they were no longer productive. Regrettably, many traditional leaders supported this action, motivated by self-interest (54, no formal education. Non-CREMA).

Table 3 Bivariate linear regression of seasonal shea yield harvest

Variable	Season 1: May–August 2020 Coefficient (SE)	Season 2: May–August 2021 Coefficient (SE)	Season 3: May–August 2022 Coefficient (SE)
Conservation approach in community (ref: CREMA)			
Non-CREMA	−97.743 (28.399)***	−88.992 (25.659)***	−78.158 (24.429)***
Gender of the respondent (ref: male)			
Female	−1.968 (27.206)	−0.901 (24.914)	30.691 (23.796)
Gender of household head (ref: male)			
Female	−94.382 (39.703)**	−100.101 (35.587)***	−57.597 (33.566)
Education (ref: no formal education)			
Primary	−14.553 (32.629)	−21.541 (30.751)	−38.346 (29.695)
Secondary or above	−78.062 (57.712)	−49.266 (47.889)	−10.233 (43.810)
Age (ref: 18–29)			
30–39	16.897 (45.765)	13.459 (41.649)	24.967 (39.421)
40–49	46.411 (40.114)	60.278 (36.928)	81.946 (34.638)**
50–59	77.847 (43.779)	53.853 (40.354)	74.824 (37.821)**
60 +	−12.717 (45.510)	−5.924 (41.444)	−0.0452 (38.448)
Marital status (ref: single)			
Married	74.307 (48.576)	65.026 (43.307)	72.258 (38.477)
Divorced/Widowed/Separated	−38.221 (58.945)	−38.727 (52.333)	1.137 (47.745)
Religion (ref: Christian)			
Muslim	134.636 (29.024)***	140.003 (26.329)***	107.639 (24.923)***
African tradition	81.093 (34.760)**	50.759 (32.344)	49.723 (30.260)
Ethnicity (ref: Dagaaba)			
Sissala	90.781 (33.982)***	65.597 (32.966)*	36.802 (29.697)
Brifo	−53.28546 35.001	−45.693 (32.446)	34.611 (30.485)
Waala	113.279 (43.999)**	136.175 (35.462)***	133.074 (32.039)***
Children (ref: no children present)			
Children present	10.545 (28.323)	36.428 (25.500)	61.133 (24.539)**
Household size (ref: 1–4)			
5–8	18.357 (33.282)	33.520 (30.189)	19.444 (28.614)
9 +	117.936 (34.694)***	133.225 (31.023)***	142.587 (29.278)***
Household wealth (ref: poorest)			
Poorer	39.053 (39.462)	31.727 (36.067)	9.945 (31.911)
Middle	23.766 (37.691)	62.802 (34.608)	42.925 (30.602)
Richer	185.737 (37.434)***	130.633 (34.186)***	77.796 (31.911)**
Richest	184.471 (34.160)***	203.454 (31.609)***	214.955 (28.071)***
Self-rated access to shea (ref: poor)			
Good	5.084 (27.433)	46.333 (24.811)	57.935 (23.381)**
Access to credit (ref: no)			
Yes	122.800 (25.363)***	117.183 (23.136)***	108.084 (21.720)***
Shea planting (ref: no)			
Yes	174.160 (60.432)***	140.587 (59.846)***	160.990 (54.713)***
Harvesting equipment and tools cost (GH₵)	0.126 (0.034)***	0.089 (0.032)***	0.059 (0.0320)
Improved training on shea (ref: no)			
Yes	99.128 (29.991)***	65.799 (27.220)***	50.995 (26.832)
Effect of Covid-19 on production (ref: no)			
Yes	13.014 (27.829)	3.590 (25.278)	23.572 (23.832)

SE standard error, *CI* confidence interval

***p < 0.001, **p < 0.01, *p < 0.05, P < 0.1

Table 4 Multivariate linear regression comparing seasonal shea yield in CREMA and non-CREMA locations

Variable	Season 1: May–August 2020 Coefficient (SE)	Season 2: May–August 2021 Coefficient (SE)	Season 3: May–August 2022 Coefficient (SE)
Conservation approach in community (ref: CREMA)			
Non-CREMA	−96.464 (28.860)***	−64.866 (26.340)**	−53.725 (24.138)**
Gender of the respondent (ref: male)			
Female	43.863 (29.562)	27.332 (28.494)	52.427 (25.138)**
Gender of household head (ref: male)			
Female	−43.342 (50.523)	−57.139 (47.003)	−41.133 (39.728)
Education (ref: no formal education)			
Primary	−45.419 (32.950)	−57.713 (32.826)	−53.075 (29.587)
Secondary or above	−84.624 (56.424)	−81.894 (49.136)	−33.351 (43.856)
Age (ref: 18–29)			
30–39	−57.107 (44.554)	−39.831 (43.021)	16.893 (38.429)
40–49	6.517 (42.037)	21.397 (41.759)	66.969 (37.825)
50–59	20.527 (47.004)	11.698 (45.631)	40.057 (41.862)
60 +	−48.171 (50.311)	−35.359 (48.957)	9.940 (42.792)
Marital status (ref: single)			
Married	−39.686 (49.576)	−30.285 (47.422)	−32.105 (40.128)
Divorced/Widowed/Separated	−96.275 (66.736)	−52.800 (61.349)	−57.679 (52.022)
Religion (ref: Christian)			
Muslim	−12.943 (37.508)	35.028 (34.927)	15.352 (30.322)
African tradition	78.033 (34.830)**	27.126 (33.465)	15.054 (28.748)
Ethnicity (ref: Dagaaba)			
Sissala	104.053 (43.023)**	21.414 (40.971)	−12.778 (35.152)
Brifo	9.335 (39.344)	10.732 (37.266)	26.899 (32.629)
Waala	74.213 (48.747)	36.248 (42.095)	25.263 (35.727)
Children (ref: no children present)			
Children present	−51.804 (28.968)	−18.328 (27.347)	6.669 (25.471)
Household size (ref: 1–4)			
5–8	−34.957 (32.564)	−6.172 (31.119)	−20.363 (28.597)
9 +	23.746 (36.589)	36.211 (35.033)	41.946 (32.271)
Household wealth (ref: poorest)			
Poorer	47.424 (38.633)	33.728 (36.498)	17.470 (32.435)
Middle	8.289 (38.094)	36.451 (36.537)	18.093 (32.111)
Richer	106.292 (39.658)***	63.429 (37.047)	24.149 (33.430)
Richest	122.868 (38.648)***	127.733 (37.567)**	146.240 (32.962)***
Self-rated access to shea (ref: poor)			
Good	2.576 (25.244)	33.973 (23.670)	43.450 (20.976)**
Access to credit (ref: no)			
Yes	72.035 (25.873)***	59.622 (24.398)**	42.981 (21.810)*
Shea planting (ref: no)			
Yes	46.542 (62.043)	32.066 (61.305)	63.946 (53.493)
Harvesting equipment and tools cost (GH₵)	0.084 (0.0322)***	0.057 (0.0316)	0.046 (0.0285)
Improved training on shea (ref: no)			
Yes	57.384 (30.597)	43.083 (27.509)	13.053 (25.465)
Effect of Covid-19 on production (ref: no)			
Yes	2.019 (28.038)	−19.904 (25.435)	16.610 (22.781)
R-squared	0.354	0.298	0.420
Adjusted R-squared	0.275	0.219	0.334

***p < 0.001, **p < 0.01, *p < 0.05, P < 0.1

SE standard error, *CI* confidence interval

However, another participant echoed this sentiment, stating that.

Embracing the CREMA approach has led to improvements in tree population and yield because the communities within CREMAs take responsibility for environmental conservation, unlike the non-CREMA model, where strict environmental measures are not enforced (43, secondary education, CREMA).

Another participant acknowledged that there was still a chance for improvement in non-CREMA communities and stated an example of another community outside of CREMAs that has conserved their environments for decades. She mentioned.

The Goziiri community in Nandom municipal of the UWR offers a commendable non-CREMA conservation model that other communities could follow. The community has upheld a strict ban on anti-environmental practices like bushfires for over thirty years. Traditional leadership, comprising united community members, collaboratively and inclusively addresses undesirable environmental practices. The community's efforts have been recognized, and it has reaped the rewards of improved livelihoods and ecosystem services (37, formal education, non-CREMA).

Gender differences were observed in the second season, where females reported significantly higher shea yields ($\alpha = 52.427$; $P < 0.01$) than their male counterparts. Thus, women were more engaged in activities around shea, such as harvesting and processing, than men. This often has nothing to do with being a woman in the biological sense. Women tend to have fewer opportunities than men from the same community, which is why they are often more patient and meticulous (which might be misunderstood as grace or poise) with menial and repetitive work than men tend to be. These gender dynamics play a crucial role in shaping the state and trajectory of the Shea industry. This was further corroborated in the FGDs; one participant shared her experience.

For generations, women have been the beating heart of the shea tradition (from collection to processing shea butter). Our dedication and expertise have turned this task into an art, providing our livelihood. (44, primary education. Non-CREMA).

In yet another comment about gender roles in the shea industry, another participant recounted,

While men contribute to shea's collection, it is undeniable that women take the lead. Throughout generations, we, the women, have embraced the tradition of shea gathering. These trees and their abundance represent not our present but a tribute to our ancestors and a promise to future generations (37, no formal education, CREMA).

We also found socioeconomic disparities as a driver of shea nut harvesting. From the multivariate results, households with higher wealth tended to have higher yields of shea nuts. The richest households ($\alpha = 146.240$; $P < 0.001$) recorded significantly higher yields than the poorest households. From a grassroots perspective, these observations highlight the connection between wealth and access to environmental resources like shea nuts, with wealthier households accessing more shea nuts than poor households. We observed from FDG that, even within common pool resource areas, the poorer households have limited shea nut harvest compared to the richer households. This reflects that households' socioeconomic status and productivity correlate quite strongly in the context of shea harvesting. This was also emphasized in the FGDs. One of the participants provided insight by stating that.

The wealthiest households collect increased quantities of shea nuts and utilize modern conveniences such as "Motorking" [tricycle motors] to transport the nuts from the farms to their homes, which relieves women from carrying loads on their heads over long distances (43, no formal education, non-CREMA).

During the FGDs, we also found that wealthier households have more purchasing power and better access to social and economic networks. This allows them to leverage paid laborers and improved technologies such as shea collection tools, resulting in higher yields and solidifying their financial advantage. A participant narrated how some wealthier households hired their women's Village Savings and Loans Association (VSLA) on several production seasons to collect Shea nuts on farmlands. She said,

Many of us are women who live in poverty and do not have our lands. Wealthy households hire us to collect shea nuts on their lands and even in the shared pool areas, where we are all supposed to access natural resources. These households also buy the nuts from us at lower prices, which makes them better off. Even though we are paid to collect Shea nuts for them, I often feel left behind because I need resources and support to harvest my own and be self-sufficient (43, no formal education, non-CREMA).

The significance of access to shea resources is apparent in determining the outcomes of shea harvesting. According to our research, individuals with unrestricted access to shea resources achieve higher harvest levels consistently ($\alpha = 43.450$; $P < 0.01$). This underscores the importance of having resources and ensuring proper distribution, mainly where Shea production and trade are closely linked with the local socio-economic fabric. A participant shared a thought-provoking analogy in the FGD, highlighting that.

Imagine having the knowledge and skills to harvest shea but needing help to access lands rich in shea trees. Unfortunately, this is the reality for many women, especially widows. In the UWR, land ownership is traditionally male-controlled (patriarchal), leaving women with limited options for collecting shea. While some women have access to their husbands' farmlands or uncultivated lands, restrictions exist for those whose husbands or other household members do not own or have adequate farmland. In the case of widows, some completely lose access to farmland or have minimal access due to the absence of their spouse. After their husband's passing, his farmland automatically belonged to his male relatives, leaving many widows constrained in their access to land and environmental resources, such as shea nuts (58, no formal education, CREMA).

Another participant reiterated the importance of fair access to shea resources.

It is not just about having access but about having access when needed. shea trees would not wait for us; if we cannot harvest them on time, their fruits go to waste or are taken by others (51, no formal education, non-CREMA).

The results also indicate that access to credit is a significant factor in increasing household yields. Households with access to credit ($\alpha = 42.981$; $P < 0.05$) experience a surge in yield compared to those without. This was further highlighted during the FGD. One participant shared her experience:

A small loan can be transformative. It is about getting the funds and the opportunities that come with them. I upgraded my tools and learned techniques through training, which significantly improved my yields (51, no formal education, non-CREMA).

Another participant reflected on their journey and said:

Credit was like a breath of fresh air for me. It allowed me to go from struggling as a harvester to becoming a figure in my community because I had the resources needed for innovation and improvement (51, no formal education, CREMA).

3 Discussion

Unchecked environmental degradation in the UWR region affects women whose livelihoods depend on shared resources such as shea trees. In this study, we comparatively examined the relationship between community-driven conservation and the productivity of shea trees (i.e., yield). Our findings revealed that the CREMA model is associated with increased shea yield, demonstrating the effectiveness of community-driven conservation efforts. Also, factors that influence shea yield include gender, wealth, access to Shea resources, and access to credit. From an FPE standpoint, our study adds a crucial but frequently neglected component to the continuing debate on conservation approaches worldwide.

From the FPE standpoint, women in the CREMA areas have increased shea livelihood benefits based on the findings highlighting the positive impact of CREMA on shea yield. The findings are consistent with the increased effect of community-driven conservation livelihoods observed in SSA [61, 62]. Similarly, Wehesa et al. reported on how effective traditional resource governance institutions shaped integrated landscape approaches like the Indigenous Community Conserved Areas (ICCAs) model [8]. Specifically in Ghana, previous studies have also highlighted the benefits of community-led conservation strategies supporting the idea that CREMA promotes holistic environmental stewardship, ultimately leading to improved yields [63, 64]. These firsthand accounts align with existing discourse that often highlights the benefits of conservation strategies grounded in knowledge and community involvement [17, 65, 66]. However, shifting from the CREMA approach to non-CREMA alternative conservation strategies can disrupt yield and ecosystem balance. Miller et al. further reinforce this argument by suggesting that deviating from established and community-driven initiatives may inadvertently result in less favorable benefits [67]. Essentially, the sense of community and teamwork that conservation strategies like CREMA promote is a foundation for achieving the possible harvest of Shea yield.

The impact of gender on shea nut harvests is significant. Women play a crucial role in the harvesting process, with their specialized knowledge and practices significantly impacting the quantity and quality of the yield. This gendered domain is well recognized by FPE, which emphasizes supporting women's participation in shea harvesting [23, 28, 68, 69]. In addition, the awareness of gender-specific skills within the community is a crucial reminder of the need for policies that actively utilize and promote women's knowledge within the shea sector [28, 70]. Such policies are necessary for the growth and development of this field, and they can significantly impact the industry's overall success [70]. By recognizing and prioritizing the unique skills and perspectives that women bring to the table, organizations can create a more inclusive and diverse work environment that fosters innovation and growth.

Socio-economic inequalities, such as wealth, significantly impact the intricate process of harvesting shea. In the context of the FPE, the presence or absence of financial resources can determine whether women and their households can easily access and harvest shea nuts. Our findings resonate with prior scholarly works of Jasaw et al. in Ghana, which states that having resources gives individuals an advantage in the season of shea harvesting and processing (including value addition like packaging) [71]. Also, Pienaah et al. reported that, with adequate financial resources, women could afford tools, receive training, and access prime shea harvesting locations [15]. This puts them ahead in maximizing their yields. However, it is essential to recognize that wealth and its advantages are not the only story. Delving deeper into the socio-dynamics of shea harvesting communities reveals another side of the coin. Marginalized gatherers need help with resource availability. They need help adopting harvesting techniques, navigating market dynamics, and building networks with gatherers for knowledge sharing and best practices. One notable observation from our study is how wealth acts as a gatekeeper in this domain. Economic disparities create dividing lines that restrict access to resources and intangible assets like knowledge and networks—like what we see in many other agricultural sectors. These significant disparities highlight the need for interventions. It is crucial to focus on creating a distribution of resources and opportunities to foster the flourishing of the shea harvesting ecosystem. By bridging this socioeconomic divide, communities could be resilient in Shea harvesting.

The connection between shea harvesting and access is incredibly significant. Our study has shown a link; households with access tend to gather more shea than those with limited access. Access is not about proximity but is closely tied to how land ownership works in each community. One key factor that determines access is the farm size of each household. A household with a plot of farmland can access all the resources on that land, including shea. This is quite different from households without plots. The plot size directly impacts how much shea can be harvested, giving an advantage to those with larger land holdings. Additionally, these larger plots often have a significant population of shea trees, which adds more potential for harvesting. However, this pattern gets interesting when we look at community-owned lands and their role in the community's Shea harvesting dynamics. No household owns these lands; they are common pool resources. Regardless of private land ownership (or lack thereof), every household can freely collect shea from these grounds. This allows households with limited or no farmland to participate in the shea economy. Our research aligns with the study conducted by Kuusaana in Ghana's UWR, which revealed a concerning trend in peri-urban areas where land ownership does not fully guarantee the right to harvest shea trees even after the land has been sold to the new owner [72]. In response to this by the new owners, some even protested in urban areas where shea trees are being cut down to end the difference. This issue is significant regarding the changing traditional land rights and ownership practices. Some family leaders are now reclaiming their rights to both land and trees from new landowners. This poses a severe threat to the long-term sustainability of shea trees.

The connection between having access to credit and achieving success in shea harvesting is evident based on our study. Interestingly, this correlation aligns with patterns observed in previous studies [73, 74]. We have found that households with access to credit have increased shea harvest compared to those without resources. When households have access to credit, they can invest in harvesting tools, hiring labor, and improving agricultural practices [75] to enhance the health of shea trees. This direct infusion of funds enables them to optimize their processes, resulting in increased quantity and higher quality of shea harvested. Conversely, those without access may face outdated or no harvesting tools and limited labor availability. This limitation follows a trend in agriculture and non-agricultural sectors where access to capital (credit) often determines how scalable and efficient operations can be, as observed in Nigeria [76]. Furthermore, having the ability to obtain credit implies integration into the formal financial system and building future creditworthiness. These households may also understand market dynamics better, which allows them to benefit from knowing the favorable selling points for their produce. Such households can optimize the benefits of bigger harvests and access to credit. However, like in other industries, credit can also be risky. Recognizing the dangers of becoming overly indebted in markets that experience fluctuations is essential. By drawing parallels from other sectors, it becomes clear that approaching credit with a balance of ambition and caution is crucial.

This research study has limitations, as do all others. We started with self-reported data from respondents, particularly on the amount of shea harvested. This is an estimate that must be interpreted with caution. Biases, memory recall, and the desire to seem reasonable may affect data accuracy. Additionally, our data may only apply to some Ghanaian communities or locations with similar conservation projects. Despite these limitations, our brief study period gave us a picture of community dynamics in the Shea collection in the UWR of Ghana. Future research might reveal how Shea harvesting patterns and trends vary over time. The qualitative component of this study, represented by 8 FGDs, was not extensive. Many FGDs may have revealed different, more nuanced, detailed community opinions and insights.

4 Conclusions and policy implications

The analysis shows that community-led conservation efforts, socio-economic factors, and access to agricultural resources are crucial for enhancing shea tree productivity. Conservation approaches like CREMA contribute significantly to higher shea yield, emphasizing the effectiveness of community-led initiatives in promoting environmental sustainability and agricultural productivity. Considering these findings, policy interventions should be focused on promoting and expanding community-led conservation programs, enhancing access to credit and financial resources for shea dependents and smallholder farmers, providing tailored financial products (shea credit schemes), investing in agricultural and environmental training, and providing subsidies, or financial incentives for purchasing harvesting and processing equipment to enhance productivity. Implementing the recommendations could contribute to alleviating poverty (SDG 1) by increasing rural incomes, enhancing food security (SDG 2), promoting gender equality (SDG 5) through equal access to resources for women, and supporting economic growth (SDG 8) by creating sustainable livelihoods. Additionally, they align with responsible consumption and production (SDG 12) and climate action (SDG 13) by promoting biodiversity and ecosystem resilience and the sustainable management of terrestrial ecosystems (SDG 15), which is crucial for the habitats of shea trees. Implementing these policy recommendations not only aims to improve shea production but also supports broader goals of environmental sustainability, social equity, and economic development, illustrating how targeted interventions in environmental conservation can contribute to global sustainability efforts.

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Data availability All data and materials generated or analyzed during this study are included in this paper.

Declarations

Ethics approval and consent to participate The Non-Medical Research Ethics Board (NMREB) at the University of Western Ontario, Canada, reviewed and approved this research protocol involving human subjects. The approval was granted in accordance with the applicable guidelines and regulations for conducting research with human participants. All required institutional approvals and mandated training were obtained before the study.

Competing interests The authors declare no competing interests.

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