Contribution of Climate Smart Agriculture Practices to Household Food Availability in Refugee Settlement Areas: A Case of Yumbe District, Uganda

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ABSTRACT

This study investigated the contribution of Climate Smart Agriculture (CSA) practices to household food availability in refugee settlement areas of Yumbe District, Uganda. The research was motivated by increasing pressure on land due to refugee settlement and agricultural expansion, which prompted government and non-governmental organizations to promote CSA practices from 2018 onwards. Despite these efforts, limited empirical evidence existed on the actual impact of CSA interventions on household food availability in refugee contexts. The study was conducted in Bidibidi settlement and host communities, targeting 375 farming households. Data were collected on household socio-demographic characteristics, CSA practices, and food availability indicators. Descriptive statistics were used to profile households, while binary logistic regression was applied to estimate the relationship between CSA practices and household food availability. Results revealed that agroforestry ($p = 0.096$) and irrigation ($p = 0.048$) significantly improved household food availability, whereas kitchen gardening ($p = 0.067$) negatively influenced food availability due to its limited scale. The findings highlight that while most households had access to agricultural land (97.1%), ownership was low (37.1%), particularly among refugees who rely on temporary allocations. Women constituted the majority of household heads (56.3%), underscoring their central role in food security within refugee settlements. The study concludes that CSA practices, especially agroforestry and irrigation, enhance resilience and productivity, thereby contributing to household food security, while small-scale kitchen gardening alone is insufficient to meet household food needs. Policy recommendations include scaling up agroforestry and irrigation interventions, strengthening gender-responsive programming to empower female farmers, and improving land access arrangements for refugees and host communities. Overall, the study provides evidence that CSA practices can play a transformative role in enhancing food availability and resilience in refugee contexts, with implications for both national agricultural policy and regional refugee management strategies.

Keywords: Climate Smart Agriculture, Household Food Availability, Food Consumption Score, Refugee Settlement, Agroforestry.

INTRODUCTION

Agriculture remains the backbone of global food security and economic development, yet it is increasingly threatened by climate change, land scarcity, and rapid population growth. Worldwide, climate variability has disrupted traditional farming systems, reduced yields, and heightened vulnerability among smallholder farmers, particularly in fragile contexts. To address these challenges, Climate Smart Agriculture (CSA) has emerged as a strategic approach that integrates productivity, resilience, and sustainability. CSA practices including agroforestry, irrigation, soil conservation, and crop diversification are promoted globally as solutions to mitigate climate risks while simultaneously enhancing food security (Branca et al., 2011). However, the adoption and effectiveness of these practices vary across regions, depending on socio-economic realities, institutional support, and resource availability.

In Sub-Saharan Africa, agriculture is predominantly rain-fed and highly vulnerable to climate shocks. The region experiences recurrent droughts, floods, and erratic rainfall patterns, which undermine food production and

exacerbate poverty (Wekesa et al., 2018). Smallholder farmers, who form the majority of the agricultural workforce, often lack access to modern technologies, credit, and extension services, limiting their adaptive capacity. Refugee populations in Sub-Saharan Africa face even greater challenges, as displacement disrupts livelihoods and reduces access to productive resources. Studies in Kenya and Rwanda have shown that refugees often struggle to secure land and inputs, making them heavily reliant on humanitarian aid (Turyamureeba, 2017; Bilgili et al., 2017). These conditions underscore the urgent need to investigate how CSA practices can strengthen food security in refugee contexts across the region.

Uganda presents a unique case within Sub-Saharan Africa. The country hosts one of the largest refugee populations globally, with settlements such as Bidibidi in Yumbe District accommodating hundreds of thousands of displaced persons. Uganda's progressive refugee policy grants refugees' access to land, freedom of movement, and the right to engage in economic activities (Betts et al., 2019). This policy framework has enabled refugees to participate in agricultural production alongside host communities. However, increasing refugee influxes have exerted immense pressure on land resources, leading to smaller plot allocations and heightened competition for agricultural opportunities (Berke & Larsen, 2022). While government and non-governmental organizations have promoted CSA practices since 2018 to address these challenges, limited empirical evidence exists on their actual contribution to household food availability in refugee settlements.

Yumbe District, located in Northern Uganda, is particularly significant in this context. The district hosts Bidibidi settlement, one of the largest refugee settlements in the world, alongside vibrant host communities engaged in subsistence and market-oriented agriculture. Despite favourable agro-ecological conditions, households in Yumbe continue to experience food insecurity due to land constraints, limited access to inputs, and reliance on rain-fed agriculture. Previous studies have highlighted that while refugees and host communities often access land for cultivation, ownership remains restricted, especially for refugees who depend on temporary allocations (Uganda Constitution, 1995; Pilling, 2017). Moreover, demographic patterns show that women constitute the majority of household heads in refugee settlements, underscoring their central role in food security but also highlighting gendered vulnerabilities in resource access (UNHCR, 2021; Dawa, 2018). The continuous influx of refugees into Yumbe District has further strained available resources, making the adoption of CSA practices both urgent and necessary.

The problem therefore lies in the paradox between Uganda's progressive refugee policy which provides land access and livelihood opportunities and the growing pressure caused by massive refugee inflows. While CSA practices have been promoted as a solution since 2018, there is limited documentation of their actual impact on household food availability in refugee settlement areas. Without empirical evidence, it is difficult to determine whether CSA interventions are effectively addressing food insecurity or whether households remain vulnerable due to shrinking land allocations and limited resources. Against this backdrop, the present study seeks to fill a critical knowledge gap by examining the contribution of CSA practices to household food availability in Bidibidi settlement and host communities of Yumbe District. By employing a mixed-methods approach, the research aims to generate evidence on the measurable impacts of CSA practices on household food availability. The findings are expected to inform policy, investment, and development strategies that enhance the resilience and competitiveness of refugee and host community agriculture in Uganda. Ultimately, this study responds to the pressing need for context-specific solutions that strengthen food security in refugee settlement areas while contributing to broader debates on sustainable agriculture in Sub-Saharan Africa.

MATERIALS AND METHODS

Study area

The study was done in Bidibidi refugee settlement (zone1) and the surrounding communities of Romogi sub county in Yumbe District, which are located in West Nile region of Uganda. Zone1 of Bidibidi settlement was chosen because it was the first zone to receive South Sudanese refugees in 2016 (Dawa,2018). This caused tremendous negative impact on the region by refugee population in a quest for space for shelter and later clearing forests for firewood and farming. Yumbe district borders Southern Sudan in the North, Moyo district in the East, Obongi district and Adjuman districts in the South, and Terego, Maracha and Koboko districts in the West. The district had a population of 669,300 people according to (UBOS, 2020) population projections. Of those,

241290 were refugees in Bidibidi refugee settlement as per office of the prime minister records of same year 2020. The Bidibidi settlement is located at N 3 341.8114, E 31 26 47.688. It is about 15km East of Yumbe town. According to UNHCR (2019), the district covers a land area of 61.012 square kilometers of which 41 square kilometers were arable land while the remaining portion of household settlement.

The topography of the study area is 850 meters above sea level. The area as well as the entire district is largely flat. Soils are loamy with gravels spotted in isolated parts of the study area of Bidibidi. The area experiences tropical climate with bimodal rainfall. The first wet season is from March to May with an interlude of a sunny season in June prior to the wettest season that is August to November (Saka. et al, 2005). The long dry season begins late November until mid or sometimes at the end of March during which minimal rainfall of 60 mm/month is received. The area receives an average total rainfall of 1,250 mm. Mean monthly evaporation ranges from 130mm-180mm (Yumbe DDP, 2015).

Research design

A cross-sectional household survey method was used for this study. Surveys allowed for the collection of large amounts of data from a sizable population in a highly economical way. According to Fivevidya (2019), survey method was best suited for   descriptive research as it studies the opinion, behaviors, attributes and feelings of an individual or a group of people. Household surveys allowed for collection of quantitative data which could be analyzed qualitatively using descriptive and inferential statistics. To get an accurate profile of households, events and situations, a descriptive survey research was employed.

Sample selection

Romogi Sub county had a total of 7,460 households at the time of the study from which a sample size of 375 respondents was drawn from a population of 7460 households. Sample size was determined using Krejcie & Morgan tables for determining sample sizes for finite populations in Bibibidi settlement, zone1 in Romogi sub county, Yumbe district.

Data collection

The study utilized both primary and secondary data. Primary data was collected using face-to-face interviews conducted by well-trained enumerators. Secondary data was collected by reviewing other scholarly papers and government publications. To ascertain data on demographic and social economic characteristics, respondents were asked to respond to basic questions regarding their demographic and socio-economic characteristics. Questions included the respondents' sex, age, household size, number of children, and number of children below 18 and if any of the children is disabled. Other questions were inquiring about the education levels, sources of income, involvement in agriculture, access to land, size of land, land ownership. The age of the respondents was captured by asking the respondents the age brackets in which they fell. The brackets included 18-35, 36-60, and above 60 years.

Food Consumption Scores (FCS) were used as proxy for food availability. Respondents were asked to state how many times they consumed each of the food categories in the previous one week and the number was recorded. The enumerator then multiplied this number by the assigned weight per food category to get the total per food category. To ascertain the FCS for the respondent, the enumerator summed up totals for each of the respondents.

Data analysis

The collected data was entered and analyzed using SPSS software and presented in frequency tables for descriptive statistics. To determine effect of practicing different CSA practices on household food availability, binary logistic regression model was used. Food Consumption Score (FCS) was used as a proxy indicator of household food availability. A dummy code of 1 was assigned to acceptable FCS total score of 35.5 and above while 0 was assigned for not acceptable FCS total score of less than 35.5 (WFP, 2008). For each household, the FCS was computed by multiplying each food group frequency by each food group weight and then summing these scores to get household total FCS score that was used to know whether the household has acceptable FCS

or not acceptable FCS for the dummy code 1/0 respectively to be assigned. The frequencies of applying different CSA practices were used as explanatory variables in the binary logistic regression. It was anticipated that the longer the household practiced CSA technology, the more the practice impacted food availability in the household.

The binary logistic model

The logit (P) is the natural log of this odds ratio,

Logit (P) = ln[P/(1-P)] = ln(odds).

ln [P/(1-P)] = $\mathbf{a}$ + $\mathbf{b}$ Xi

Where:

"ln" is the natural logarithm, logexp, where e=2.71828

"P" is the probability that Y for cases equals 1, p (Y=1)

"1-p" is the probability that Y for cases equals 0, 1 – p(Y=1)

"P/(1-P)" is the odds ratio.

ln[P/1-P] is the log odds, or "logit"

$P/(1-P) = e^{a+bX}$.

$P = e^{a+bX}/1 + e^{a+bX}$

For n=7 number of predictors, the Model can be written as below:

$P = e^{a+b1X1 +b2X2+.......+b7X7}/1 + e^{a+b1X1+b2X2+........+b7X7}$

Where: b_1-b_7 are coefficients and X_1 –X_7 are the predictors.

The predictors X_1, X_2,….., X_7 are defined as follows:

X_1 is climate adapted crop varieties

X_2 = managing planting dates

X_3 = kitchen/backyard gardening,

X_4 = intercropping,

X_5 = water and soil conservation practices

X_6 = agroforestry, and

X_7 irrigation

RESULTS

Socio-Demographic Characteristics

The study revealed that most household heads in Bidibidi refugee settlement and host communities were female (56.3%), compared to 43.7% male(table 1). Age distribution showed that most household heads were between

36–60 years (49.6%), followed by youths aged 18–35 (46.7%), while only 3.7% were above 60 years.

Table 1: Social demographic characteristics of refugee and host community households in Bidibidi refugee settlement-zone1, Romogi sub county, Yumbe district

	Frequency	Percent	Valid Percent	Cumulative Percent
Sex of household head				
Male	164	43.7	43.7	43.7
Female	211	56.3	56.3	100
Total	375	100	100	
Age of household head				
18-35	175	46.7	46.7	46.7
36-60	186	49.6	49.6	96.3
Above 60	14	3.7	3.7	100
Total	375	100	100	
Access to Agriculture Land				
Yes	364	97.1	97.1	97.1
No	11	2.9	2.9	100
Total	375	100	100	
Land ownership				
Yes	139	37.1	37.1	37.1
No	236	62.9	62.9	100
Total	375	100	100	

Land access and ownership

Almost all households (97.1%) reported access to agricultural land, though only 37.1% owned the land they cultivated. Refugee households accessed land through hire or temporary allocations negotiated by the Office of the Prime Minister (OPM) with host community landlords. The majority (62.9%) therefore depended on hired or allocated land.

Climate smart agriculture practices and household food availability

This section presents results of objective 3, that is, relationship between CSA practices and household food availability. Binary logit model was used to predict this relationship.

Table 2: Effect of different CSA practices on household food availability

	B	Sig. (P)	Exp(B)
Climate adapted varieties	0.024	0.311	1.025
Kitchen/back yard gardening	-0.061	0.067*	0.941
Intercropping	0.024	0.386	1.024
Water & soil conservation practices	0.008	0.803	1.008
Agroforestry	0.051	0.096*	1.052
Irrigation	0.047	0.048**	1.048
Constant	0.879	0.001	2.409

*Significant at 10%, ** at 5%, *** at 1% level

Binary logit analysis showed that agroforestry and irrigation practices positively influenced household food availability, significant at 10% and 5% levels respectively(table 2). Irrigation contributed most to household food availability, enabling year-round production. Households practicing agroforestry have 1.051 times higher odds of having acceptable food availability compared to those not practicing agroforestry that is, practicing agroforestry increases the odds of acceptable food availability by 5.1%. For irrigation (Exp(B)=1.048), similarly, its practice increases the odds of acceptable food availability by 4.8%. Conversely, kitchen gardening negatively influenced food availability, with households relying solely on backyard gardens showing a 6.1% reduction in odds to belonging to a sufficient food availability category.

DISCUSSION

The predominance of female household heads in Bidibidi settlement reflects broader demographic trends in refugee populations, where women and children often comprise more than 50% due to men's mobility in search of work or return to conflict zones for seasonal farming (Dawa, 2018; Bilgili et al., 2017). This result of higher female population in Yumbe District (52.5%) is consistent with what was reported in the district development plan (2015), and UNHCR (2021) statistics where 52% of refugees in Bidibidi were women. Similar findings have been reported in Rwanda, where women constitute the majority of refugee populations and are more engaged in livelihood activities (Bilgili, 2017). This gendered distribution highlights the importance of tailoring agricultural interventions to women, who are the primary custodians of household food security in refugee settings. The age distribution which showed persons above 60years to be 3.7% are consistent with UNHCR (2021) data, which reported that older persons comprise only 3% of the Bidibidi refugee population.

Access to land was high (97.1%), but ownership remained limited to 37.1% of households, reflecting Uganda's progressive refugee policy that allows land use but restricts ownership (Betts et al., 2019). Compared to Kenya and Tanzania, Uganda provides larger plots for settlement and agriculture, enhancing self-reliance (Turyamureeba, 2017; UNHCR,2023). However, the reduction in plot sizes over time due to increasing refugee inflows (Berke & Larsen, 2022) raises concerns about sustainability. These findings align with Bernard et al. (2022), who noted that subsistence agriculture land allocations in Bidibidi increased initially but became constrained as refugee numbers grew.

The positive impact of agroforestry and irrigation on household food availability corroborates findings from Kenya, where Wekesa et al. (2018) reported that improved varieties, agroforestry, and soil conservation practices enhanced food security. Branca et al. (2011) and Kalyebara & Bruchara (2008) similarly confirmed that

agroforestry improves yields by reducing soil erosion and maintaining soil fertility. Irrigation's contribution to year-round food availability is consistent with studies across East Africa, which emphasize irrigation as a critical CSA practice for mitigating rainfall variability (Branca et al., 2011). In contrast, kitchen gardening was found to negatively affect food availability, likely due to its small scale and limited capacity to meet household food needs. This differs from some studies that highlight kitchen gardens as important for dietary diversity (FAO, 2019), suggesting that while they provide vegetables, they cannot substitute for staple crop production in refugee contexts.

Overall, the findings demonstrate that CSA practices such as agroforestry and irrigation significantly enhance household food availability in refugee settlements, while reliance on small-scale kitchen gardening is insufficient. These results underscore the need for scaling up CSA interventions that combine productivity, resilience, and sustainability, thereby contributing to both household food security and broader climate change mitigation goals.

CONCLUSIONS

This study examined the contribution of climate smart agriculture (CSA) practices to household food availability in Bidibidi refugee settlement and host communities in Yumbe District, Uganda. Despite several climate smart agriculture practices promoted by government and other actors, this study found that practicing irrigation and the practice of agroforestry are associated with high food consumption scores for refugees and host community members of Bidibidi settlement.

The study also concludes that uptake if irrigation technologies and the practice of agroforestry are instrumental for households to attain high scores in food availability. This implies that irrigation technologies and the different components of agroforestry systems provide ready food, and of different varieties all year round, hence high performance by households that practice these CSA practices. On the other hand, kitchen gardening presents a negative effect due to its limited scale.

The findings highlight that although most households had access to agricultural land, ownership remained low, particularly among refugees, reflecting Uganda's progressive but restrictive land policy. The demographic profile showed that women constituted the majority of household heads, underscoring their central role in food security and livelihoods within refugee settlements.

The general conclusion is that, to achieve food availability, promotion of irrigation technologies, and widespread uptake of agroforestry need to be embraced. These CSA practices, when effectively adopted, can enhance resilience, improve productivity, and contribute to household food availability in refugee contexts.These, however, come with farmer's personal experience, access to CSA technologies and access to irrigation water.

POLICY RECOMMENDATIONS

Based on the study findings discussion and summary conclusions, the researchers recommend the following actions.

1. **Scale up CSA interventions:** Government agencies, NGOs, and development partners should prioritize the promotion of agroforestry and irrigation technologies in refugee settlements. These practices have proven to significantly enhance household food availability and should be integrated into livelihood support programs.

2. **Gender-responsive programming:** Given the predominance of female household heads, agricultural interventions by government and NGOs must be tailored to women's needs, including access to inputs, training, and credit facilities. Empowering women farmers will directly strengthen household food security.

3. **Land access and tenure security:** While Uganda's refugee policy provides land for settlement and agriculture, the shrinking plot sizes threaten sustainability. Policies should explore innovative land-sharing agreements and long-term tenure arrangements to ensure continued access for both refugees and host communities.

4. **Capacity building and extension services:** Strengthening agricultural extension services with a focus on CSA practices will improve adoption rates. Training programs should emphasize integrated approaches that combine irrigation, agroforestry, and improved varieties to maximize productivity.

5. **Policy harmonization and regional learning:** Uganda's accommodative refugee policy offers lessons for neighbouring countries with stricter land and livelihood restrictions. Regional dialogue and harmonization of refugee agricultural policies could enhance food security across East Africa.

6. **Monitoring and evaluation:** Continuous assessment of CSA interventions should be institutionalized to track adoption, productivity gains, and household food security outcomes. Evidence-based monitoring will guide adaptive programming and ensure long-term impact.

FUTURE RESEARCH DIRECTION

While this study has provided valuable insights into the contribution of climate smart agriculture (CSA) practices to household food availability in refugee settlements, several areas warrant further investigation. First, future research should explore the long-term sustainability of CSA interventions in refugee contexts, particularly how irrigation and agroforestry practices can be maintained under conditions of limited land tenure security and fluctuating resource availability. Longitudinal studies would help assess whether these practices continue to deliver food security benefits over time.

Second, there is need for deeper examination of gendered adoption and outcomes of CSA practices. Given that women constitute the majority of household heads in refugee settlements, understanding how gender roles, access to resources, and decision-making power influence CSA uptake and productivity could provide more targeted recommendations. Comparative studies across different refugee settlements and host communities would highlight variations in gender dynamics and inform more inclusive programming.

Finally, future research should investigate the market integration and economic viability of CSA practices beyond household food availability. While this study focused on subsistence outcomes, assessing how CSA interventions contribute to income generation, value addition, and participation in local and regional markets would broaden understanding of their role in wealth creation. Such studies could also examine policy frameworks and institutional support mechanisms that enable refugees and host communities to scale CSA practices into commercially viable enterprises.

DECLARATIONS

1. Funding: This study was conducted using researchers' own funds with no direct research grant from any funding organization.

2. Conflicts of Interest: The authors declare no conflicts of interest.

3. Ethics Approval: Ethical clearance for this study was secured from Uganda National Council for High Education(NCHE)'s Research Ethics Committee (REC) prior to field data collection.

4. Acknowledgement of Author Contributions: The first author collected the data, analysed the data and the wrote the report. The second author provided supervision and conceptual guidance throughout the entire study process.

5. Data Availability: Raw data is not publicly available due to ethical considerations to keep research participants anonymous. However, with specific adherence to international data protection guidelines, anonymous extracts of the data can be availed upon written request addressed to the first author clearly stating the intended use of the requested data.

6. Study Limitations: The study was faced with potential recall bias in self-reported CSA practice frequencies given that smallholder farmers were not keeping farm records. Secondly, the use of FCS as a proxy (which

captures dietary diversity and frequency but not quantities consumed) could only provide proxy measures to food availability but not exact quantitative measure of food quantities availability in each household. Finally, the study was geographically limited to one settlement despite the assumption that findings would apply to other refugee contexts.

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