



OPEN ACCESS

EDITED BY

Otgonbayar Demberel,
National University of
Mongolia, Mongolia

REVIEWED BY

Inoussa Zagre,
UNFCCC, Germany
Mesmin Tchindjang,
University of Yaounde I, Cameroon

*CORRESPONDENCE

Abdullahi Abdulkadir Mohamed,
✉ abdalaabdikadir2020@gmail.com

RECEIVED 29 April 2026

REVISED 04 June 2026

ACCEPTED 11 June 2026

PUBLISHED 20 July 2026

CITATION

Mohamed AA, Atwongyeire D and
Nagawa G (2026) From perception to
action: attitudes and climate change
adaptation practices among smallholder
farmers in Nakivale refugee settlement.
Front. Earth Sci. 14:1868338.
doi: 10.3389/feart.2026.1868338

COPYRIGHT

© 2026 Mohamed, Atwongyeire and
Nagawa. This is an open-access article
distributed under the terms of the
[Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/)
(CC BY). The use, distribution or
reproduction in other forums is
permitted, provided the original
author(s) and the copyright owner(s) are
credited and that the original
publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or
reproduction is permitted which does
not comply with these terms.

From perception to action: attitudes and climate change adaptation practices among smallholder farmers in Nakivale refugee settlement

Abdullahi Abdulkadir Mohamed *, Doreen Atwongyeire and
Goretty Nagawa

Department of Agriculture, Agribusiness and Environmental Sciences, Bishop Stuart University,
Mbarara, Uganda

Introduction: Smallholder farmers in refugee settlements constitute one of the most climate-vulnerable populations globally, yet their attitudes and practices toward climate change management remain poorly understood. This study assessed the attitudes and practices of smallholder crop farmers toward climate change management in Nakivale Refugee Settlement, Uganda and examined the association between attitudes and adoption of CSA practices.

Methods: A cross-sectional mixed-methods design was employed. Quantitative data were collected from 384 smallholder farmers using structured questionnaires; qualitative data were gathered through key informant interviews and field observations. Descriptive statistics, chi-square tests and binary logistic regression were used for analysis.

Results: A majority of farmers (65%) held mixed attitudes while 32% demonstrated positive attitudes and 3% negative attitudes. Most farmers expressed willingness to adopt CSA practices and accepted personal responsibility. Seventy-nine percent had adopted at least one CSA practice, with crop diversification and agroforestry being most prevalent. Key barriers to adoption included lack of financial resources, inadequate inputs, limited access to training and land tenure insecurity. While attitude was significantly associated with CSA adoption in chi-square analysis ($p < 0.001$), logistic regression controlling for socio-demographic factors showed that positive attitude was not consistently associated with adoption, underscoring the importance of structural barriers.

Discussion: Farmers in Nakivale have mixed to positive attitudes toward climate change adaptation and have begun adopting diverse resilience practices, yet structural and resource barriers limit the translation of willing attitudes into sustained action. Targeted financial support, improved extension services and land tenure security are critical for deepening CSA adoption in this vulnerable refugee farming community.

KEYWORDS

attitudes, climate-smart agriculture, CSA adoption, practices, refugee settlement, smallholder farmers, Uganda

1 Introduction

Climate change is widely recognized as one of the most pressing threats to agricultural productivity and food security, particularly in sub-Saharan Africa, where smallholder farming systems are predominantly rain-fed and resource-constrained (IPCC, 2022; Prajapati et al., 2024). Refugee populations represent a uniquely vulnerable subset of the affected, combining climate exposure with compounding vulnerabilities including displacement, insecure land tenure, limited institutional access and poverty (FAO, 2020; UNHCR, 2023).

Uganda is the largest refugee-hosting country in Africa and third globally, accommodating millions of displaced persons from conflict-affected countries including the Democratic Republic of Congo (DRC), South Sudan and Somalia (UNHCR, 2023). Nakivale Refugee Settlement, located in Isingiro District of southwestern Uganda, is one of the oldest and largest refugee settlements on the continent, hosting approximately 51,132 households across three administrative zones: Base Camp, Juru and Rubondo (Ronald, 2022) (Figure 1). Agriculture is the primary livelihood for the majority of its residents, making the community acutely sensitive to climate variability such as unpredictable rainfall, prolonged droughts and flash flooding (Muhangi, Ainamani & Opio, 2022).

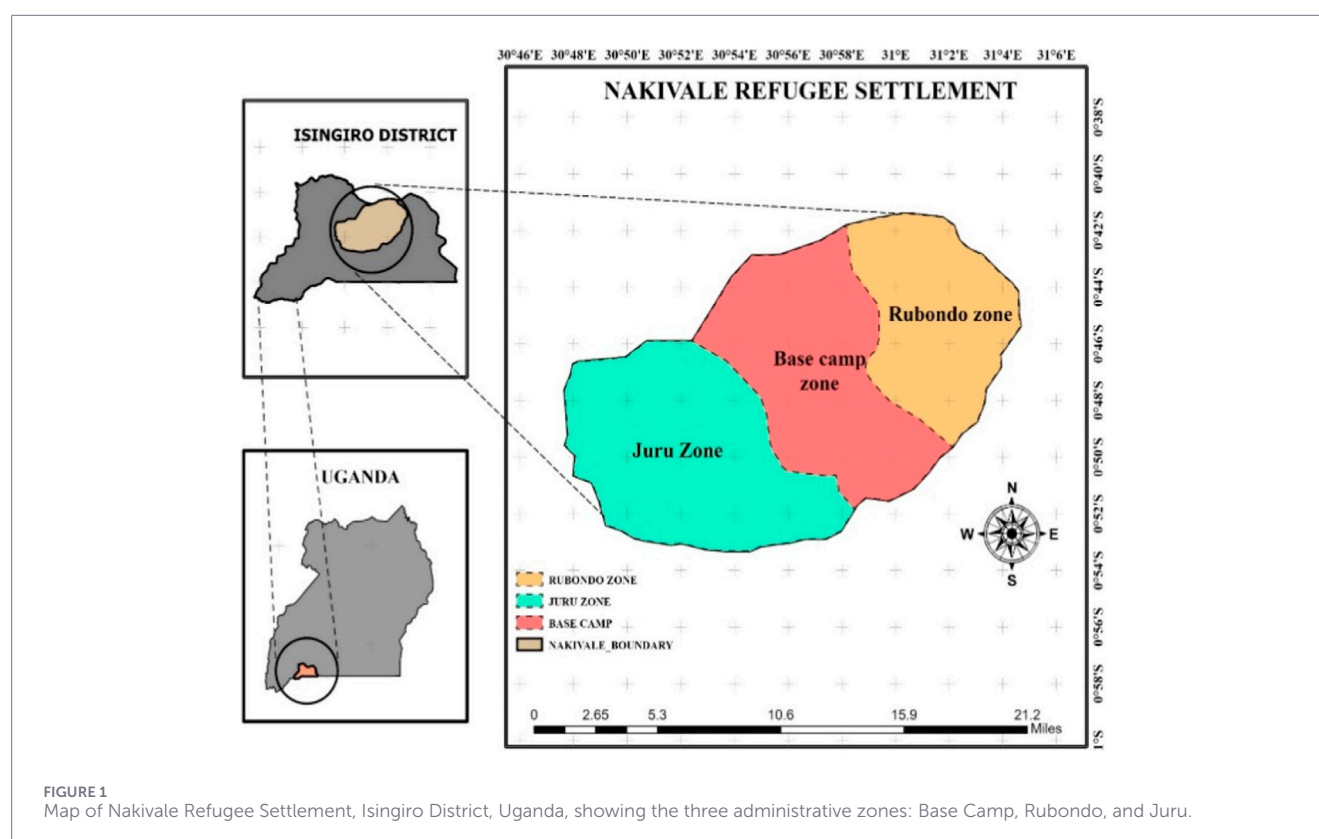
The Knowledge, Attitudes and Practices (KAP) framework provides a well-validated conceptual lens for examining the behavioral dimensions of climate change management among farmers (Nguyen, Seddaiu & Roggero, 2019; Liao et al., 2022). Within this framework, attitudes represent a farmer's positive or negative evaluation of climate change and their willingness to engage in adaptive behavior (Ajzen, 1991; Ndambiri et al., 2013), while

practices refer to the concrete actions adopted in response to climatic risks. Understanding the interplay between attitudes and practices is essential for designing targeted, context-sensitive interventions.

Despite a growing body of literature on climate change adaptation in sub-Saharan Africa, studies specifically examining refugee farming communities remain scarce (FAO, 2019 Nhemachena and Hassan, 2008). Most existing research focuses on host communities or generalized rural populations, failing to account for the distinct structural constraints, policy environments and livelihood dynamics that characterize displacement settings. This gap limits the relevance of mainstream adaptation frameworks for refugee farmers.

The present paper focuses exclusively on the attitudes and practices components, examining how farmers' perceptions and dispositions toward climate change management relate to their adoption of CSA practices and identifying the structural factors that mediate or constrain this relationship. The specific objectives of this paper are: (i) to evaluate the attitudes of smallholder crop farmers toward climate change management in Nakivale refugee settlement; (ii) to profile the CSA practices adopted by these farmers; and (iii) to examine the association between attitudes and CSA practice adoption.

This study is grounded in two interrelated behavioral theories. The Knowledge, Attitudes and Practices (KAP) model provides an organising framework for describing the three domains. However, we do not assume a strict, unidirectional linear progression from knowledge to attitude to practice. Instead, we draw on Ajzen's (1991) and Ajzen's (2002) Theory of Planned Behavior (TPB), which posits that behavioral intentions are shaped by attitudes, subjective norms, and perceived behavioral control. In the context



of smallholder farmers in refugee settings, perceived behavioral control is critically constrained by access to land, capital, inputs, and institutional support. This may explain discrepancies between positive attitudes and limited adoption rates. Thus, while we use KAP to structure our description, TPB informs our interpretation of the attitude-action gap, with perceived behavioral control as a key mediating factor. Research across sub-Saharan Africa consistently reports that smallholder farmers hold broadly positive attitudes toward climate change and express willingness to adopt adaptation measures. [Belay et al. \(2022\)](#) found that most smallholder farmers in southern Ethiopia recognized the seriousness of climate change threats to their livelihoods. Similarly, [Farin et al. \(2024\)](#) reported that rice farmers in the Philippines demonstrated positive perceptions of climate-smart practices. [Kaase-Bwanga \(2019\)](#) observed that Ugandan farming communities widely acknowledged climate change impacts but had limited coping strategies, underscoring the attitude-action gap.

Attitude is influenced by several socio-demographic factors. Education is consistently identified as a key determinant: [Maddison \(2007\)](#) and [Deressa et al. \(2009\)](#) found that more educated farmers hold more positive and nuanced attitudes toward climate adaptation. [Evangelista et al. \(2016\)](#) further noted that community-level exposure to climate information and extension training significantly shapes attitudinal dispositions.

Climate-smart agriculture (CSA) is broadly defined as agriculture that sustainably increases productivity, enhances resilience and reduces or removes greenhouse gas emissions where possible ([FAO, 2010](#)). Common CSA practices include crop diversification, agroforestry, conservation tillage, drought-resistant varieties and water-harvesting techniques.

Adoption of these practices in sub-Saharan Africa remains uneven. [Ndamani and Watanabe \(2015\)](#) identified information access, income and farm size as key factors associated with adoption. [Mubiru et al. \(2017\)](#) found that in Uganda, farmers exposed to NGO or extension-led training were significantly more likely to adopt CSA. In refugee settlement contexts, adoption is further constrained by land tenure insecurity and dependence on humanitarian aid, making the adoption environment structurally distinct from general rural farming communities ([Muhangi et al., 2022](#)).

The relationship between attitude and practice adoption is well-documented but nuanced. While positive attitudes are a necessary precondition, [Mugisha and Diiro \(2010\)](#) caution that attitude alone does not drive adoption in the absence of enabling resources. [Kassie et al. \(2015\)](#) found that favorable attitudes toward climate change significantly predicted adoption of multiple adaptation strategies in Ethiopia, while other studies have shown that contextual barriers such as poverty and limited market access mediate this relationship substantially.

2 Materials and methods

2.1 Study area

The study was conducted in Nakivale Refugee Settlement, Isingiro District, southwestern Uganda. Established in 1958 and

formally gazetted in 1960, Nakivale is one of the Africa's oldest refugee settlement, covering approximately 184 square kilometers and comprising 74 villages across three administrative zones: Base Camp, Juru and Rubondo. The settlement is predominantly agricultural, characterized by rolling hills, seasonal water sources and a climate subject to two rainy seasons annually. Smallholder crop farming serves as the primary livelihood for the majority of its approximately 51,132 resident households.

Life in Nakivale settlement is characterized by subsistence farming as the primary livelihood. Most households cultivate maize, beans, cassava, and sorghum on small plots (0.5–1 acre). The settlement has several primary schools, a few secondary schools, and basic health centres, though resources are stretched. Commercial activities include small retail shops, food stalls, and weekly markets where farmers sell surplus produce. Many refugees also engage in casual labour, brick making, or small-scale trade to supplement farm income. Social infrastructure such as roads, piped water, and electricity is limited, with most households relying on boreholes and solar lamps.

2.2 Study design

A descriptive cross-sectional study design integrating quantitative and qualitative approaches was employed. The mixed-methods design enabled triangulation of findings across survey instruments, key informant interviews (KIIs) and direct field observation, thereby enhancing the validity and contextual depth of results.

2.3 Sample and sampling

Since the total population size (N) is unknown, the study utilized [Cochran's \(1977\)](#) formula for sample size determination suitable for large or undefined populations. A sample of 384 smallholder crop farmers was determined from the target population. Multistage sampling was applied: the three administrative zones were first selected purposively, followed by random selection of villages and systematic random selection of households within villages. Within each household, the primary farming decision-maker was interviewed.

For key informant interviews, purposive sampling was used to recruit 12 informants including agricultural extension officers, representatives of NGOs operating in Nakivale (including Action Against Hunger), local government officials and community leaders. Field observation was conducted at selected farming sites across the three zones.

The sampling frame consisted of all registered smallholder crop-farming households in Nakivale settlement according to the UNHCR and office of the Prime Minister (OPM) household registry. From the 74 villages across the three zones (Base camp, Juru and Rubondo) we randomly selected 12 villages (4 per zone) proportional to the estimated population size of each zone. Within each selected village, we calculated a sampling interval (k) by dividing the total number of households in the village by the proportional allocation of the 384-sample target. The first household was selected randomly and every kth household thereafter was

included. If a household did not contain a crop-farming decision-maker, the next household was substituted.

2.4 Data collection instruments

The quantitative survey instrument comprised three sections: (A) socio-demographic characteristics; (B) attitude-related items measured on a five-point Likert scale (Strongly Agree to Strongly Disagree); and (C) practice-related items assessing adoption of CSA practices, reasons for adoption or non-adoption and challenges faced. The attitude scale included ten items covering perceived severity, personal responsibility, institutional support expectations, self-efficacy and behavioral intentions. The attitude scale was pilot-tested with 30 smallholder farmers (not included in the final sample) in a non-study village within Nakivale settlement to assess clarity, comprehension and length. Minor wording adjustments were made based on pilot feedback. The internal consistency of 10-item attitude scale was assessed using Cronbach's alpha which showed excellent reliability ($\alpha = 0.86$). The questionnaire was originally developed in English, then translated into Swahili by translators. Back-translation English was performed to check for semantic equivalence. Data collection was conducted in the participant's preferred language.

The qualitative guide for key informant interviews covered farmers' perceptions of climate risks, barriers and facilitators to CSA adoption and the role of institutions. Field observation used a structured checklist to document observable farming practices and environmental conditions.

2.5 Data analysis

Quantitative data were entered and cleaned in R studio. Descriptive statistics (frequencies, percentages) were computed for socio-demographic variables and individual attitude and practice items. Composite attitude scores were derived by summing Likert responses and respondents were categorized into negative (score ≤ 20), mixed (21–30) and positive (≥ 31) attitude groups. Chi-square goodness-of-fit tests and Pearson contingency coefficients assessed distributions and associations. Binary logistic regression models were constructed to examine the association between attitudes and CSA practice, controlling for socio-demographic predictors. Qualitative data from interviews and observations were transcribed and analyzed using thematic analysis, with themes inductively derived and validated against quantitative patterns.

2.6 Ethical considerations

Ethical approval was obtained from the Research Ethics Committee (REC) of Bishop Stuart University. Field acceptance letters were secured from settlement authorities prior to data collection. Written informed consent was obtained from all participants. Anonymity and confidentiality were maintained throughout; no identifying information was recorded. Participation was entirely voluntary.

TABLE 1 Socio-demographic characteristics of respondents (N = 384).

Variable	Group	Frequency (N = 384)	Proportion (%)
Gender			
	Female	175	45.6
	Male	209	54.4
Educational Level			
	No formal education	168	43.8
	Primary	126	32.8
	Secondary	84	21.9
	Tertiary	6	1.6
Farming duration			
	Less than 1 year	3	0.8
	1–5 years	65	16.9
	6–10 years	259	67.4
	More than 10 years	57	14.8
Occupational status			
	Agriculture	223	58.1
	Construction	34	8.9
	Trade	127	33.1
Age			
	18–35	84	21.9
	36–50	243	63.3
	Above 50	57	14.8
Household members			
	1–3	91	23.7
	4–6	184	47.9
	7–9	94	24.5
	More than 10	15	3.9
Family income (Monthly)			
	0–100,000	64	16.7
	100,000–200,000	140	36.5
	200,000–300,000	89	23.2
	300,000–400,000	65	16.9
	400,000–500,000	26	6.8
Farm size			
	0–0.5	25	6.5
	0.6–1	195	50.8
	Above 1	164	42.7

3 Results

3.1 Socio-demographic characteristics

Of the 384 respondents, 54.4% ($n = 209$) were male and 45.6% ($n = 175$) were female. The majority (63.3%) were aged 36–50 years. Regarding education, 43.8% had no formal education, 32.8% had attained primary level, 21.9% secondary and only 1.6% tertiary. Most respondents (67.4%) had farmed for 6–10 years. Agriculture was the primary occupation for 58.1%, followed by trade (33.1%) and construction (8.9%). Nearly half (47.9%) had 4–6 household members. Monthly household income was predominantly in the range of UGX 100,000–200,000 (36.5%). Farm sizes were mostly 0.6–1.0 acres (50.8%). These socio-demographic characteristics reflect a predominantly low-income, low-education, experienced farming population living under constrained livelihood conditions typical of protracted displacement (Table 1).

3.2 Attitudes toward climate change management

Composite attitude scoring classified 32% ($n = 123$) of respondents as having positive attitudes, 65% ($n = 250$) mixed attitudes and 3% ($n = 11$) negative attitudes ($\chi^2 (2) = 223.42$, $p < 0.001$). This distribution indicates a predominantly mixed attitudinal profile, with a substantial minority holding positive views. Table 2 presents item-level attitude responses. The most endorsed attitude statement was that government and NGOs should provide greater support for climate change management (92.2% agree/strongly agree). Personal responsibility was affirmed by 91.6% and 90.1% recognized climate change as a serious threat to farming productivity. Confidence in personal ability to take adaptive action was expressed by 90.9%. Willingness to adopt CSA practices was indicated by 87.0% of respondents. A large majority (83.8%) also acknowledged that their own farming activities contribute to climate change and 79.4% agreed that traditional farming methods are no longer sufficient to cope with changing climatic conditions.

3.3 Socio-demographic predictors of attitude

Ordinal logistic regression was conducted to identify socio-demographic factors significantly associated attitude levels (Table 3). Compared to respondents with no formal education, those with primary education had 2.12 times higher odds of holding a more positive attitudes (95% CI: 1.25–3.62, $p = 0.006$), and those with secondary tertiary education had 4.52 times higher odds (95% CI: 2.50–8.28, $p = < 0.001$). Among income categories, only the highest bracket (UGX 400,000–500,000) was significantly associated with more positive attitudes (OR = 3.05, 95% CI: 1.11–8.62, $p = 0.032$). Gender, age and farm size were not statistically significant predictors (all $p > 0.05$).

3.4 CSA practices adopted

A substantial majority of respondents (79%, $n = 304$) had adopted at least one CSA practice. Among adopters, crop diversification was the most prevalent practice (69.0%), followed by agroforestry (55.7%), use of drought-resistant crop varieties (49.5%), conservation tillage (29.7%) and water-harvesting techniques (14.6%) (Table 4). Chi-square tests confirmed statistically significant differences in practice adoption between adopters and non-adopters across all five practices ($p < 0.001$) (Table 3).

Among the 304 adopters, the primary motivations for adoption were increased crop yield and productivity (29.1% of responses), followed by guidance from extension workers or NGOs (23.5%) and better resilience to drought and extreme weather (21.7%). Availability of financial or technical support accounted for 16.0% of responses, while reduced crop failure risk accounted for 9.7%.

Among the 80 non-adopters, unavailability of necessary materials was the most frequently cited barrier (35.8%), followed by limited access to financial resources (25.7%), land tenure insecurity (24.3%), lack of access to training or extension services (10.1%) and limited awareness or knowledge (4.1%).

3.5 Challenges and resources needed to overcome

Table 5 summarizes the key challenges and resources needed to support CSA adoption across all 384 respondents. Lack of financial resources was the most widely reported challenge (81.0%), followed by lack of improved seeds and tools (75.5%), limited access to information and training (62.5%), unpredictable weather patterns (60.4%) and land tenure issues (14.3%). When asked about priority resources needed, financial support ranked first (82.8%), followed by access to improved seeds and tools (78.6%), training and education (68.2%) and irrigation equipment (54.9%).

3.6 Association between attitude and CSA practice adoption

Chi-square analysis confirmed significantly bivariate associations between attitude levels and all five CSA practices (all $p < 0.05$). However, binary logistic regression models that controlled for socio-demographic factors (education, income, gender, age, farm size) revealed a more nuanced picture (Table 6). Positive attitude (compared to mixed) was not consistently associated with higher adoption. For three practices—crop diversification, conservation tillage and water-harvesting—positive attitude was associated with significantly lower odds of adoption (OR ranging from 0.23 to 0.44, $p < 0.05$). For drought-resistant crops, the association was negative but not statistically significant (OR = 0.60, $P < 0.087$). Only for agroforestry did positive attitude show a non-significant trend toward higher adoption (OR = 1.68, $p = 0.140$). The small group of farmers with negative attitudes ($n = 11$) showed unstable estimates due to low sample size. These findings suggest that after accounting for structural factors, attitude alone does not drive adoption and in

TABLE 2 Attitudes of smallholder crop farmers toward climate change management (N = 384).

Attitude statement	Agree (%)	Disagree (%)	Neutral (%)	Strongly agree (%)	Strongly disagree (%)
Climate change is a serious issue that affects farming productivity	74.0	2.6	7.0	16.1	0.3
Farmers should take personal responsibility for managing climate change effects	72.1	2.1	6.3	19.5	0.0
Adopting climate-resilient practices can improve agricultural productivity	68.2	1.8	12.8	17.2	0.0
Government and NGOs should provide more support in climate change management	72.9	2.3	4.9	19.3	0.5
I am willing to adopt climate-smart agricultural practices	69.3	2.9	9.9	17.7	0.3
Climate change is mainly caused by human activities	60.2	7.6	14.8	14.1	3.4
Traditional farming methods are no longer sufficient to cope with climate change	63.0	3.9	16.7	16.4	0.0
Climate change adaptation should be a priority for policymakers and local leaders	65.4	4.2	14.1	15.6	0.8
I believe my farming activities contribute to climate change	68.2	4.4	11.7	15.6	0.0
I feel confident in my ability to take action to reduce climate change impacts	69.0	3.1	5.7	21.9	0.3

TABLE 3 Ordinal logistic regression for socio-demographic factors influencing attitudes toward climate change management.

Predictor	Odds ratio	95% CI	P-value
Education (ref: No formal)			
Primary	2.12	1.25–3.62	0.006
Secondary/Tertiary	4.52	2.50–8.28	<0.001
Income (ref: 0–100,000 UGX)			
100,000–200,000	1.46	0.75–2.93	0.275
200,000–300,000	0.89	0.42–1.92	0.762
300,000–400,000	1.64	0.73–3.72	0.233
400,000–500,000	3.05	1.11–8.62	0.032

Odds ratios from ordinal logistic regression. Attitude ordered: Negative < Mixed < Positive. No-significant predictors (gender, age, farm size) not shown.

some cases, positive attitudes may reflect awareness of risk without the resources to act, leading to lower observed adoption. Table 6. Logistic regression: Association between attitude level and adoption of CSA practices (OR and 95% CI).

3.7 Qualitative findings: thematic analysis of barriers and enablers

Thematic analysis of key informant interviews (n = 12) and field observations revealed three major themes regarding the translation of attitudes into CSA adoption.

3.7.1 Theme 1: “Ready but blocked” – The attitude-action gap

Most farmers expressed willingness to adopt CSA practices, but this was consistently overshadowed by resource constraints. One extension worker stated:

“Farmers here are ready to take responsibility. They’re not just waiting for help – but the problem is, they lack the resources and support to act fully.” (Key informant interview, extension worker)

An NGO representative echoed this, noting:

“Even when farmers know what to do, they often cannot afford the tools or inputs they need.” (Key informant interview, NGO staff)

This theme reinforces the quantitative finding that positive attitude alone does not predict adoption; structural barriers (lack of finance, inputs) must be addressed.

3.7.2 Theme 2: “Land is everything” – Tenure insecurity as a disincentive

Land tenure insecurity emerged as a critical structural barrier. Field observations confirmed that most farms lacked permanent soil and water conservation structures, consistent with the low adoption of water-harvesting techniques (14.6% in the quantitative data).

TABLE 4 CSA practices adopted by smallholder farmers, Nakivale refugee settlement (N = 384).

CSA practice	Adopters (N = 304)	%	Non-adopters (N = 80)	%	Chi-square (χ^2)	p-value
Crop diversification	265	69.01	38	9.90	227.17	<0.001***
Agroforestry	214	55.73	89	23.18	86.92	0.001***
Conservation tillage	114	29.69	189	49.22	47.86	0.001***
Use of drought-resistant crops	190	49.48	113	29.43	49.05	0.001***
Water harvesting techniques	56	14.58	247	64.32	168.39	0.001***

Significance Codes '1***'.

TABLE 5 Challenges faced and resources needed to overcome by smallholder farmers (N = 384, multiple responses).

Item	Frequency	%
Challenges		
Lack of financial resources	311	81.0
Lack of access to improved seeds and tools	290	75.5
Limited access to information and training	240	62.5
Unpredictable weather patterns	232	60.4
Land tenure issues	55	14.3
Resources needed		
Financial support	318	82.8
Access to improved seeds and tools	302	78.6
Training and education	262	68.2
Irrigation equipment	211	54.9

While no direct quote on land was recorded in interviews, the frequent mention of land tenure issues in the quantitative survey (24.3% of non-adopters) and observations of temporary farming structures indicate that farmers hesitate to invest in long-term improvements on allocated land.

3.7.3 Theme 3: "Show us, do not just tell us" – Preferences for practical, low-cost practices

Farmers and extension workers reported that practices requiring minimal upfront investment—such as crop diversification and agroforestry—were most widely adopted. One extension worker observed:

"We see many farmers now growing a variety of crops as a way to spread risk – diversification has become a key strategy." (Key informant interview, extension worker)

An NGO representative confirmed:

"Crop diversification is the most visible change. It's something farmers can do with the resources they have." (Key informant interview, NGO staff)

TABLE 6 Binary logistic regression: association between attitude level and adoption of CSA practices (odds ratios and 95% confidence intervals). Models control for education, income, gender, age and farm size. Reference attitude category = mixed.

CSA practices	Attitude level	Odds ratio	95% CI	p-value
Crop diversification	Positive (vs. mixed)	0.23	0.08–0.71	0.011
	Negative (vs. mixed)	8.62	1.30–57.31	0.026
Agroforestry	Positive (vs. mixed)	1.68	0.84–3.36	0.140
	Negative (vs. mixed)	4.75	0.46–49.26	0.191
Conservation tillage	Positive (vs. mixed)	0.44	0.25–0.79	0.006
	Negative (vs. mixed)	1.98	0.33–11.99	0.456
Drought-resistant crops	Positive (vs. mixed)	0.60	0.34–1.08	0.087
	Negative (vs. mixed)	0.30	0.05–1.97	0.209
Water-harvesting techniques	Positive (vs. mixed)	0.34	0.16–0.70	0.003
	Negative (vs. mixed)	0.56	0.09–3.58	0.543

Regarding financial barriers, another extension worker stated:

"The biggest problem is money – farmers want to adapt, but without financial support, their hands are tied." (Key informant interview, extension worker)

These insights highlight that farmers prefer practical, low-cost, and immediately beneficial practices, and that financial support is a prerequisite for adopting more capital-intensive measures such as water harvesting or conservation tillage.

4 Discussion

4.1 Predominantly positive attitudes

The finding that 86% of smallholder farmers in Nakivale hold positive attitudes toward climate change management is notable and broadly consistent with literature from comparable settings (Belay et al., 2022; Farin et al., 2024). The near-universal recognition of climate change as a serious threat to farming productivity (90.1%) and the strong sense of personal responsibility (91.6%) reflect a community that is not passive but is constrained by structural realities. This attitudinal profile contrasts sharply with the relatively low adoption of technically demanding practices such as water-harvesting (14.6%), suggesting that attitude alone cannot bridge the action gap.

Qualitative findings reinforce this interpretation. Extension workers interviewed consistently described farmers as “ready to take responsibility” but stymied by lack of resources. This tension between willing attitudes and structural constraints aligns theoretically with Ajzen’s (1991) TPB construct of perceived behavioral control: when individuals perceive that they lack control over resources and conditions necessary for action, positive attitudes fail to translate into practice.

The expectation of institutional support (92.2%) is particularly high, reflecting the broader political economy of refugee settlements where humanitarian aid and NGO programming have historically shaped livelihoods. This underscores the importance of aligning attitude formation with institutional delivery mechanisms. When farmers express willingness to adopt but expect external facilitation, interventions that provide inputs, training and financial access are likely to activate latent adaptive capacity.

4.2 Role of education in shaping attitudes

Education emerged as the most significant socio-demographic predictor of positive attitudes (primary: $p = 0.014$; tertiary: $p < 0.001$), consistent with findings from Maddison (2007) and Deressa et al. (2009). Education increases exposure to climate information, strengthens analytical capacity and improves access to and engagement with extension services. The strong effect of tertiary education, while relevant for a small proportion of the sample, underscores its qualitative influence on attitudinal sophistication.

Notably, gender and age were not significant predictors a finding that diverges from some Sub-Saharan African studies reporting gender-differentiated climate perceptions (Gbetibouo, 2009) but aligns with others from refugee contexts (Muhangi et al., 2022), where shared displacement experiences may attenuate gender-based differences in attitude formation. The income finding (UGX 200,000–300,000 bracket showing less positive attitudes) is more difficult to interpret but may reflect a segment of the population experiencing the most acute income insecurity, creating fatalistic rather than adaptive orientations.

4.3 CSA practice adoption: extent and determinants

The 79% overall adoption rate, while initially encouraging, masks significant heterogeneity across practices. Crop diversification (69.0%) and agroforestry (55.7%) are the most resource-accessible practices and require relatively limited upfront capital, explaining their dominance. In contrast, water-harvesting techniques which require infrastructure investment were adopted by only 14.6%, highlighting the resource-mediated nature of adoption.

The motivational hierarchy among adopters is revealing: improved yields (29.1%) and guidance from extension workers/NGOs (23.5%) rank above intrinsic resilience motivations. This suggests that adoption decisions are driven as much by pragmatic productivity expectations and external facilitation as by intrinsic concern for climate resilience. This aligns with Filho and Jacob (2020) and Mubiru et al. (2017), who found that extension services are among the most effective adoption catalysts in Uganda.

The barrier profile among non-adopters dominated by material unavailability (35.8%), financial constraints (25.7%) and land tenure insecurity (24.3%) points to structural constraints that attitude change alone cannot resolve. Qualitative findings reinforce this pattern: extension workers consistently described farmers as ‘ready but blocked’ by lack of resources, and noted that crop diversification—a low-cost practice—was the most visible adaptation strategy. Comparable findings have been reported in other refugee settlement contexts. These parallels suggest that structural constraints—rather than lack of awareness or positive attitudes—are the primary impediments to climate action across displaced farming populations. Unlike some host community studies where education and income strongly predict adoption (Deressa et al., 2009), our findings show that even among better-educated refugees, adoption remains low without targeted institutional support. Land tenure is a particularly acute constraint in refugee settlements, where land allocation is managed administratively and farmers lack legal ownership, reducing incentives for long-term investment in soil and water infrastructure (Muhangi et al., 2022). The finding that only 4.1% of non-adopters cited limited awareness or knowledge as their barrier confirms that information deficits are not the primary constraint to adoption in this population.

4.4 Attitude as a predictor of CSA adoption

The divergence between chi-square and logistic regression findings on the attitude-adoption relationship is analytically important. Chi-square analysis demonstrated strong bivariate associations between attitude levels all five CSA practices. However, logistic regression that controlled for socio-demographic factors (education, income, gender, age, farm size) revealed that attitude level had limited and inconsistent independent association with adoption. Positive attitude (compared to mixed) was significantly associated with lower odds of adoption for crop diversification, conservation tillage and water-harvesting ($OR = 0.23–0.44$, $p < 0.05$) and showed a non-significant negative trend for drought-resistant crops ($OR = 0.60$, $p = 0.087$). Only for agroforestry did positive attitude show a non-significant trend toward higher adoption

(OR = 1.68, $p = 0.140$). These counter-intuitive findings—where positive attitudes are associated with lower adoption suggest that farmers who are more aware of climate risks may also be more aware of their resource constraints, leading to inaction. This pattern is consistent with the Theory of planned behavior (Ajzen, 1991): when perceived behavioral control (access to land, capital, inputs) is low, even positive attitudes may not translate into action. The very small group of farmers with negative attitudes ($n = 11$) produced unstable estimates and should be interpreted with cautions.

This findings does not dismiss the importance of attitudes. Rather, it suggests that favorable attitudes create receptivity that can only be activated through structural enablers. Farmer field school, participatory extension and incentive programs that simultaneously address resource access and provide practical support are likely to yield stronger adoption outcomes than interventions focused solely on attitude change.

5.5 Limitations. Several limitations should be acknowledged. First, the cross-sectional design prevents causal inference; we can only report associations not causality. Second, self-reported data on attitudes and practices may be subject to social desirability bias, where farmers overstate their willingness or adoption. Third, the very small number of respondents with higher education ($n = 6$) and with negative attitudes ($n = 11$) limited statistical power and required collapsing categories, which may have masked nuanced differences. Fourth, the study was conducted in a single refugee settlement in Uganda, which may limit generalizability to other displacement settings with different policies or agro-ecological conditions. Fifth, the binary logistic regression models for some practices produced wide confidence intervals for the negative attitude category due to sparse data. Sixth, Additionally, marital status was not collected, which may have limited understanding of household decision-making dynamics related to climate adaptation. Future research using longitudinal designs, large samples and objective measures of adoption would strengthen causal conclusions.

5 Conclusions

This study provides empirical evidence that smallholder crop farmers in Nakivale Refugee Settlement hold overwhelmingly positive attitudes toward climate change management, with strong expressions of personal responsibility, belief in the efficacy of CSA practices and expectations of institutional support. Seventy-nine percent have adopted at least one CSA practice, with crop diversification and agroforestry being most prevalent due to their relative accessibility.

However, the translation of positive attitudes into comprehensive CSA adoption is significantly mediated by structural barriers particularly financial constraints, inadequate inputs and land tenure insecurity that are intrinsic features of the refugee settlement context. Logistic regression reveals that attitude level alone is an inconsistent predictor of adoption behavior, underscoring the need for interventions that address structural enablers alongside attitudinal and knowledge dimensions.

The findings carry implications across three levels:

For policy: Climate adaptation programming in refugee settings must go beyond awareness campaigns to integrate financial support mechanisms, subsidized inputs, cooperative credit access and land tenure reforms that provide smallholder farmers with the conditions necessary to act on positive attitudes.

For practice: NGOs and extension agencies should prioritize participatory, hands-on training approaches such as farmer field schools and demonstration plots that connect attitudinal readiness to practical skills and resource access. Radio and community-based channels should be leveraged to deliver localized, context-specific CSA information.

For research: Future studies should employ longitudinal designs to assess how attitude-driven adoption evolves over time with changing resource access. Qualitative research into the socio-cultural factors shaping attitudes including gender norms, community identity and refugee legal status would enrich understanding of the attitudinal landscape in displacement settings.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Bishop Stuart University Research Ethics Committee and OPM. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participant's; legal guardians/next of kin.

Author contributions

AM: Conceptualization, Writing – review and editing, Methodology, Formal Analysis, Writing – original draft. DA: Writing – review and editing, Supervision. GN: Writing – review and editing, Supervision.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Conflict of interest

The authors declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

References

- Ajzen, I. (1991). The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50 (2), 179–211. doi:10.1016/0749-5978(91)90020-T
- Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *J. Appl. Soc. Psychol.* 32 (4), 665–683. doi:10.1111/j.1559-1816.2002.tb00236.x
- Belay, A., Oludhe, C., Mirzabaev, A., Recha, J. W., Berhane, Z., Osano, P. M., et al. (2022). Knowledge of climate change and adaptation by smallholder farmers: evidence from southern Ethiopia. *Heliyon* 8 (12), e12089. doi:10.1016/j.heliyon.2022.e12089
- Cochran, W. G. (1977). *Sampling Techniques*. 3rd Edn. New York: John Wiley and Sons.
- Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., and Yusuf, M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile basin of Ethiopia. *Glob. Environ. Change* 19 (2), 248–255. doi:10.1016/j.gloenvcha.2009.01.002
- Evangelista, R. J. P., Cruz, A. C., and Lasco, R. D. (2016). Knowledge, attitude and practice of smallholder farmers regarding climate change and agroforestry: a case study of farmers in Peñablanca, Cagayan. *J. Environ. Sci. Manag.* 1, 42–55. doi:10.47125/jesam/2016_sp1/04
- FAO (2010). Climate-smart agriculture: policies, practices and financing for food security, adaptation and mitigation. *Food Agric. Organ. U. N.*
- FAO (2019). *The State of Food and Agriculture: Moving Forward on Food Loss and Waste Reduction*. Rome, Italy: Food and Agriculture Organization of the United Nations.
- FAO (2020). *The State of Food and Agriculture 2020: Overcoming Agricultural Challenges for Climate Resilience*. Rome, Italy: Food and Agriculture Organization of the United Nations.
- Farin, E. N., Sazon, R. R., Sazon, R. A., Rogayan, D. V., Manglicmot, K. B., Mendoza, S. G., et al. (2024). Knowledge, attitude, and practices on climate change among rice farmers in Central Luzon, Philippines. *Nat. Environ. Pollut. Technol.* 23 (1), 485–490. doi:10.46488/NEPT.2024.v23i01.044
- Filho, W. L., and Jacob, D. (2020). Handbook of climate services. *Clim. Change Manag.* doi:10.1007/978-3-030-36875-3
- Gbetibouo, G. A. (2009). Understanding farmers' perceptions and adaptations to climate change and variability: the case of the Limpopo Basin. *South Africa. IFPRI Discuss. Pap.* 849
- IPCC (2022). "Climate change 2022: impacts, adaptation and vulnerability," in *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.
- Kaase-Bwanga, E. (2019). Farmers' knowledge, attitudes and practices about climate change in Uganda. *Afr. J. Environ. Sci. Technol.* 13 (2), 87–96.
- Kassie, M., Jaleta, M., and Mattei, A. (2015). Synergies and trade-offs in resilient agri-food systems: the effects of climate-smart agriculture on farm-level outcomes. *Environ. Sci. Policy* 54, 216–228.
- Liao, X., Nguyen, T. P. L., and Sasaki, N. (2022). Use of the knowledge, attitude, and practice (KAP) model to examine sustainable agriculture in Thailand. *Reg. Sustain.* 3 (1), 41–52. doi:10.1016/j.regus.2022.03.005
- Maddison, D. (2007). *The Perception of and Adaptation to Climate Change in Africa*. Paper 4308. *World Bank Policy Res. Work.*
- Mubiru, D. N., Nambi, A. A., Nakibirwa, K., and Komutunga, E. (2017). Adaptation strategies to climate change by smallholder farmers in Uganda. *Afr. J. Agric. Res.* 12 (21), 1851–1862.
- Mugisha, J., and Diirro, G. (2010). Explaining the adoption of improved maize varieties and its effects on yields among smallholder farmers in Uganda. *Middle-East J. Sci. Res.* 5 (1), 6–13.
- Muhangi, J., Ainamani, H., and Opio, F. (2022). Contribution of agriculture in the enhancement of refugees' livelihoods in nakivale settlement. *Open J. Appl. Sci.* 12 (9), 1505–1526. doi:10.4236/ojapps.2022.129103
- Ndamani, F., and Watanabe, T. (2015). Farmers' perceptions about water management under climate change and options for adaptation in northern Ghana. *Water* 7 (4), 1580–1601.
- Ndambiri, H. K., Ritho, C., Mbogoh, S. G., Ng'ang'a, S. I., Muiruri, E. J., Nyangweso, P. M., et al. (2013). Analysis of farmers' perceptions of the effects of climate change in Kenya: the case of Kyuso district. *J. Environ. Earth Sci.* 3 (9), 74–83.
- Nguyen, T. P. L., Seddaiu, G., and Roggero, P. P. (2019). Declarative or procedural knowledge? Knowledge for enhancing farmers' mitigation and adaptation behaviour to climate change. *J. Rural Stud.* 67, 46–56. doi:10.1016/j.jrurstud.2019.02.005
- Nhemachena, C., and Hassan, R. (2008). "Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa," in *IFPRI Discussion Paper 00714*. Washington, DC: International Food Policy Research Institute. Available online at: <https://hdl.handle.net/10568/21659>.
- Prajapati, H. A., Yadav, K., Hanamasagar, Y., Kumar, M. B., Khan, T., Belagalla, N., et al. (2024). Impact of climate change on global agriculture: challenges and adaptation. *Int. J. Environ. Clim. Change* 14 (4), 372–379. doi:10.9734/ijec/2024/v14i44123
- Ronald, M. A. (2022). An assessment of economic and environmental impacts of refugees in Nakivale, Uganda. *Migr. Dev.* 11 (3), 433–449. doi:10.1080/21632324.2020.1787105
- UNHCR (2023). "Uganda fact sheet — nakivale refugee settlement," in *United Nations High Commissioner for Refugees*.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.