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Assessing the Effectiveness of Climate-Smart Agriculture Practices in Improving Food Security in the Far North Region, Cameroon

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Abstract
Climate change poses a significant challenge to food security, particularly in regions like the Far North of Cameroon, where erratic weather patterns affect agricultural productivity. This study evaluates the effectiveness of climate-smart agriculture (CSA) practices in improving food security by enhancing agricultural resilience. Using a mixed-methods approach, data were collected from farmers and key stakeholders to analyze the impact of conservation agriculture, soil conservation, crop rotation, and rainwater harvesting. Findings indicate that CSA practices improve food availability and stability while mitigating climate-related risks. However, challenges such as financial constraints, gender dynamics, cultural practices and limited technical knowledge hinder widespread adoption. The study recommends targeted policy interventions and increased farmer training to enhance CSA implementation.

Keywords: *Climate-Smart Agriculture, Food Security, Cameroon, Agricultural Resilience, Climate Adaptation*

Introduction

Food security is a pressing issue in the Far North Region of Cameroon, exacerbated by climate variability, soil degradation, and limited water availability. Rainfall in the Far North is highly variable and declining. Between 1951 and 2020, the Far North region of Cameroon has experienced increasing rainfall variability, with annual precipitation dropping to 400-900 mm, much lower than in the south and as little as 400 mm near Lake Chad. From 1991 to 2020, average temperatures rose to 28.24 °C, compared to 26.42 °C in the North region. The rainy season has become shorter and less predictable, leading to unreliable monsoons and frequent dry spells. This climate instability has caused up to a 50% decline in rainfed crop yields in areas like Diamaré, with income losses projected to reach 90% by 2100. While extreme rainfall reduces rice yields, slightly warmer rainy seasons may boost productivity. However, intense rains also accelerate soil erosion and degradation, while declining water and pasture quality are worsening livestock conditions and threatening pastoral livelihoods. Climate-smart agriculture (CSA) has emerged as a solution to address these challenges by promoting sustainable farming practices that enhance productivity while reducing vulnerability to climate shocks.

The goal of "climate-smart agriculture" (CSA), a method of sustainable farming, is to solve the problems brought up by climate change while simultaneously ensuring sustainable agricultural practices, fostering resilience, and enhancing food security. Growing a wide range of crops increases agricultural resilience against pests, diseases, and climatic unpredictability. This technique is known as crop diversification and is a component of climate wise agriculture (Stebbins, 2021). Increased nutrition and food security are also facilitated by crop diversity and conservation agriculture. On the other hand, minimising soil disturbance by reducing tillage, leaving crop leftovers on the field, and protecting the soil with cover crops, carbon sequestration, water retention, and soil health are all enhanced by conservation agriculture and it provides farmers with timely and accurate climate information enables them to make informed decisions about planting, irrigation, and other agricultural activities (Dunn, 2011). Access to climate data helps farmers anticipate and adapt to changing weather patterns (Fabusoro, 2022).

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Climate smart agriculture, or CSA, is a novel and popular strategy for enhancing food security and livelihood. A common definition of CSA is a blend of technology and behaviours. Practice for CSA helps lower GHG emigration. By battling the impact of climate change, CSA assists farmers in meeting the globe's food needs. Sustainable intensification and CSA are mutually dependent. The rivalry for food products is increasing in terms of energy, water, labour, and land. The husbandry system is impacted by changes in the climate pattern. A variety of agricultural methods are responsible for GHG emigration. The three goals of CSA are to increase agricultural productivity, build adaptability to various environments, and prevent greenhouse gas emigration by using a C sink strategy. According to Raj et al. (2018), sustainable intensification is a method that falls within the CSA system and entails preserving and enhancing soil biodiversity, keeping an eye on and balancing the biogeochemical cycles, and preserving agrarian productivity.

The three main claims made by CSA are to: (1) improve income, development, and food security while increasing husbandry productivity in a environmentally friendly way; (2) cope from ranch to public settings and make adjustments responding to climate change; and (3) alter opportunities to reduce greenhouse gas emigration from husbandry relative to previous trends. The CSA emphasises the use of ecosystem services like beast, agroforestry, monoculture, integrated crop, water operation, geography approaches, improved pest, improved campaign, nutrient operation, forestry operation, drop in tillage and different kinds and types, restoration of demeaning lands, N toxin use, introducing trees in the agrarian system, and ordure operation involving the use of anaerobic biodigesters to highlight the agrarian system to plump mitigation, productivity (Lipper et al. 2019).

This study investigates the role of CSA in ensuring food security and identifies key enablers and barriers to its implementation.

Problem statement

The Far North Region of Cameroon faces significant food security challenges due to climate change, which has led to declining agricultural productivity, unpredictable rainfall patterns, and increased soil degradation. As of 2023, around 700 thousand people (8 %) in the far north region Cameroon face acute food insecurity; compounded by climate stressors and conflict. Traditional farming practices are no longer sufficient to sustain crop yields under these changing conditions. Climate-Smart Agriculture (CSA) presents a promising solution for addressing climate vulnerability and food insecurity in Cameroon's Far North Region by promoting sustainable practices such as conservation agriculture, soil fertility management, and water-efficient irrigation. Several national policies support CSA, including the National Adaptation Plan for Climate Change (NAPCC), which encourages climate-resilient farming systems, and the National Agricultural Investment Plan (NAIP II), which integrates CSA to boost productivity and sustainability. Additionally, the National Strategy for Irrigation Development (NSID) aims to expand small-scale irrigation, a critical intervention for the predominantly rainfed agriculture in the region. Despite these policy frameworks, CSA adoption remains low due to persistent barriers such as customary laws often restrict women's land ownership, lack of market information, manual tillage, poorly resourced extension services, and low awareness among smallholder farmers. Furthermore, the top-down nature of implementation often limits community ownership and contextual adaptation. Therefore, there is a pressing need for empirical research to assess the effectiveness of CSA in enhancing food security, identify strategies to overcome existing barriers to its widespread adoption and on-ground effectiveness of these CSA policies in enhancing food security of the Far North Region Cameroon.

Research objective

The general objective of this study was to assess the influence of climate change adaptation strategies on food security with a specific objective to assess the effectiveness of climate smart agriculture practices in improving food security in the Far North Region, Cameroon

The rest of this paper is structured as follows: Section 2 presents a review of empirical studies where CSA on food security has been applied across different domains and nations. Section 3 introduces the research methodology followed. Section 4 presents the experimental results while section 5 formulates the discussion and section 6 contains the conclusions and recommendation.

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Related Literature

The effectiveness of climate smart agriculture on food security

Farming in the Far North is predominantly rainfed and subsistence-based, making it highly vulnerable to climate variability. In Diamaré Division, rainfall fluctuations and recurring droughts have led to yield losses of up to 50% for crops like sorghum and millet (Njoya et al., 2022). Without irrigation, this instability has reduced household food stocks and income diversification. If adaptive measures are not scaled, projections suggest that net farm income could fall by up to 90% by 2100 due to continued yield shocks, soil degradation, and livestock losses (Njoya et al., 2022). Droughts and erratic rains have also triggered food price spikes, reducing access to food in already vulnerable and conflict-affected communities (Ntali et al., 2022).

Rising temperatures and dwindling water sources have degraded pasture quality, weakened livestock health, and increased mortality, forcing herders to travel farther exacerbating farmer herder conflicts (FAO, 2021). Outbreaks of diseases such as pasteurellosis and foot-and-mouth disease have worsened in overcrowded and overheated transhumance corridors (IRAD, 2020). Meanwhile, intense and erratic rains are causing soil erosion and nutrient loss. The expansion into marginal lands, previously left uncultivated due to poor fertility, has accelerated land degradation and biodiversity decline. Desertification and sand encroachment, especially near Logone-Birni and Blangoua, are shrinking cultivable land available per household (ONACC, 2020).

Regional climate models, including downscaled IPCC projections like CORDEX-Africa, indicate that the Far North of Cameroon will become significantly hotter and drier in the coming decades. By 2050, average temperatures are expected to increase by 1.5 to 3°C under moderate to high emissions scenarios. Rainfall patterns will likely remain erratic, with projections pointing to longer dry periods interrupted by short, intense rainstorms intensifying the cycle of droughts and floods. These climatic shifts pose serious risks to the region's agricultural systems, particularly for smallholder farmers who lack access to irrigation, timely climate information, or financial tools to manage risk (FAO, 2021; ONACC, 2020).

Climate smart agriculture is a technical hand whose perpetration could affect in food security. Hassan et al., (2018) tried to probe the effect related with climate smart husbandry relinquishment on food security in Kalapara southern Bangladesh. The many facets of food security in the area were also examined in the study. He linked 17 climate smart husbandry methods, with each planter adopting an average of seven of them. Due to the tried homes study outcomes, 32 of the ménage's food secure, 51 were slightly food secure, and the other 17 percent were highly food insecure. Results demonstrated that climate smart husbandry techniques communicated clearly about food security.

Amadu (2018) evaluated how climate-smart farming techniques affected the food security of 808 families in southern Malawi. The research used logistic retrogression probit modeling to compare climate smart husbandry strategies espoused. The results showed that climate smart husbandry relinquishment redounded in 90% rise in productivity. the research prompted policy makers to advocate climate smart husbandry techniques not just in Malawi but throughout Africa. Furthermore, IIIEE did exploration on improving organic horticulture in Nakuru County, Kenya. The substantially centred on stylish methods presently been enforced and how those methods could be scaled down to smallholder growers. According to their results, greener horticultural husbandry was being enforced by utmost horticulture growers in the area. They also observed that that the appropriate expertise wasn't accessible knowledge wasn't accessible to smaller scale growers and thus they proceeded rehearsing irresponsible husbandry.

Wakesa et al. (2018) conducted realistic research to discover the factors of climate wise husbandry and its relationship to food security in Teso-North Sub-County, Kenya. 3284 growers paticipated in this research. The objective was to develop a link between climate-smart agriculture and food security. The study outcomes demonstrated growers who espoused all the four sets; agricultural product, field of view, land operation and ranch threat mitigation were further food secure. It also revealed that climate smart agricultural systems are likely to affect in food security when utilised in conjunction.

Food insecurity has been ranked as one of the top four issues on her docket. It is a significant development problem in numerous nations, including Kenya. For Rigolot et al. (2017), Burkina Faso has seen a rise in crop-beet diversification relinquishment scenarios, which has reduced the propagation of pests and diseases and improve

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production. In addition, Kalungu and Leal Filho (2018) observed that high levels of variability in rush with rising temperatures contributed to severe food instability among Kenyan smallholder growers. Furthermore, Hadush (2018) pointed out that because the majority of sub-Saharan African people reside in impoverished and borderline areas, they rarely face a shortage of water and pasture. CSA uses improved seeds and toxins to transform agricultural systems in order to address food security. Additionally, relevant initiatives and financial commitments from the agricultural sector can be incorporated into CSA paths, reducing food insecurity and poverty in the near run. Therefore, identifying the agrarian systems' transformation types is essential to enhancing global food security (Aryal et al., 2020).

A 2022 field study found that households using rainwater harvesting (RWH) systems such as rooftop collectors and micro-catchments achieved increased vegetable yields, especially during the dry season (Njoya et al., 2022). With access to stored runoff, farmers grew short-cycle crops like okra, lettuce, and cowpea even during rainfall gaps, reducing reliance on erratic rains. Women, in particular, gained greater control over household food needs and earned small incomes from surplus sales. In parallel, community-led farmer-managed natural regeneration (FMNR) in areas like Mayo-Kani and Mayo-Tsanaga promoted the regrowth of native trees such as *Faidherbia albida* on cropland. This practice enhanced soil fertility, moisture retention, and crop resilience. Farmers reported 10–20% higher yields of sorghum and millet during dry years compared to conventional plots (Tougou et al., 2021). The added tree covers also reduced wind erosion and created microclimates, further stabilizing food production.

Ethiopia's Climate Resilient Green Economy (CRGE) strategy aims to build a carbon-neutral, climate-resilient economy, with climate-smart agriculture (CSA) as a central pillar focused on watershed management, soil fertility, and sustainable intensification. Government-led reforestation and terracing efforts have reduced land degradation in highland areas, while community-based resource management has supported food security in drought-prone regions like Tigray and Oromia (Gebrehiwot et al., 2018). However, implementation faces significant challenges: the top-down approach often limits local ownership, regional agricultural plans are poorly aligned with CSA priorities, and monitoring frameworks remain underfunded. Socio-structural barriers further constrain effectiveness traditional farming norms resist new techniques, limited market access and rural infrastructure hinder investment in CSA, and persistent gender inequalities restrict women's participation despite their key role in food production (World Bank, 2020; IFPRI, 2019). These factors highlight the need for more inclusive, context-sensitive approaches to enhance the CRGE's impact on food security.

Ghana's National Climate-Smart Agriculture and Food Security Action Plan (2016–2020), developed with FAO, promotes sustainable land management, climate information services, and private sector engagement. Agroforestry initiatives in Northern Ghana have improved soil fertility and diversified livelihoods, while platforms like Esoko have enhanced farmers' decision-making through mobile weather advisories (FAO, 2021). However, many interventions remain donor-driven and lack sustainable national financing. A weak link between research, extension, and farmers limits the localization of CSA practices. Socio-cultural and structural barriers also undermine implementation traditional practices such as mono-cropping and bush burning, alongside resistance to new technologies, hinder adoption (MoFA, 2015). Poor infrastructure and market access, high post-harvest losses, and fragmented value chains further discourage investment in resilient farming. Moreover, gender disparities persist, with women facing restricted land rights and limited access to credit and extension services, reducing their participation in CSA despite their critical role in agriculture (FAO, 2016). These challenges collectively weaken the adaptive capacity of smallholders and threaten long-term food security.

Research gap

Climate-smart agriculture integrates three key objectives: increasing agricultural productivity, enhancing resilience to climate change, and reducing greenhouse gas emissions. Previous studies indicate that CSA practices such as conservation agriculture, agroforestry, and improved irrigation methods contribute to sustainable food production. However, adoption rates vary due to socio-economic and institutional constraints. In Cameroon, limited research exists on the localized impact of CSA on food security particularly in the Far North Region, where climate vulnerability is high and the effectiveness of CSA in addressing food insecurity remains largely unexplored, necessitating this study.

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Methodology
A mixed-methods approach was employed to comprehensively assess the impact of climate-smart agriculture (CSA) on food security. This approach combined both quantitative and qualitative research techniques to ensure a holistic understanding of the subject matter.
The study utilized a descriptive survey design, which allowed for the collection of both statistical data and in-depth insights from farmers and agricultural stakeholders. The cross-sectional nature of the study provided a snapshot of CSA adoption and its effects on food security at a specific time.
The research was conducted in the Far North Region of Cameroon, a semi-arid region characterized by erratic rainfall patterns and high vulnerability to climate change. The target population consisted of farmers, agricultural extension officers, and policymakers engaged in food production and climate adaptation strategies.
A multi-stage sampling technique was used to ensure representative data collection. Stratified Sampling: The study area was divided into zones based on agro-ecological characteristics. Simple Random Sampling: Farmers were randomly selected from each zone to ensure diversity in CSA adoption levels. Purposive Sampling: Agricultural extension officers and policymakers were intentionally selected due to their expertise and direct involvement in CSA programs.
A total sample size of 106 farmers and 13 key informants (government and NGO officials) was selected. The sample size was determined using the Rea and Parker formula for survey research.
Data were collected through the following methods: Structured Questionnaires where farmers were asked about their CSA adoption, farming practices, and food security status. Semi-Structured Interviews where key informants provided expert insights into policy implementation and challenges in CSA adoption. Focus Group Discussions (FGDs) where farmers participated in discussions to highlight community perspectives on CSA benefits and barriers and field Observations with on-site visits were conducted to validate reported CSA adoption practices.
Descriptive statistics was used to summarize farmer demographics, CSA adoption rates, and food security indicators. Information was also analysed using thematic analysis where qualitative responses were coded and analysed to identify common themes related to CSA implementation challenges and success factors.

Results
The experiments conducted in this study compare the distinct climate smart agriculture practiced by agricultural practitioners, Strategies implemented to improve the efficacy of climate-smart agricultural practices in enhancing food security, the role of government policies in promoting climate-smart agriculture and effectiveness of different policies on food security.

The different climate smart agricultural practices practiced by farmers

The respondents were questioned to state which climate smart agriculture they practice in their area (see figures)

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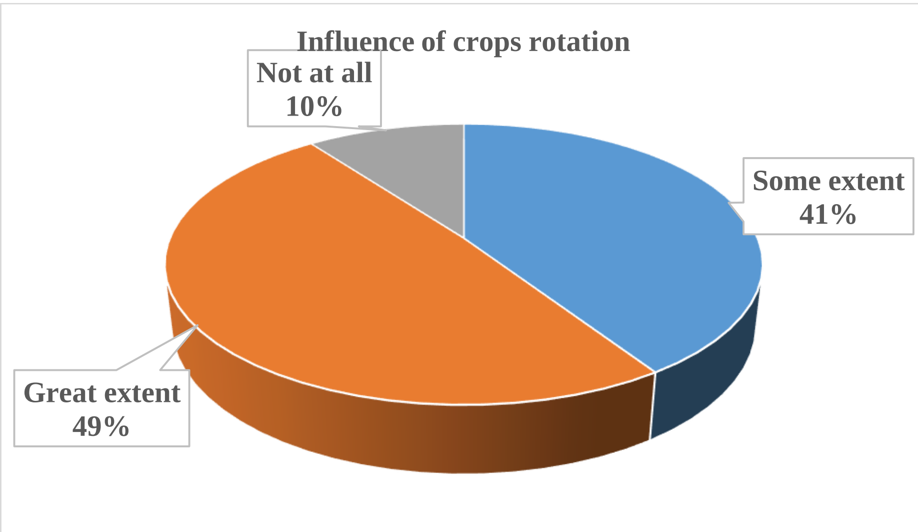

Figure 1: Influence of Crop rotation

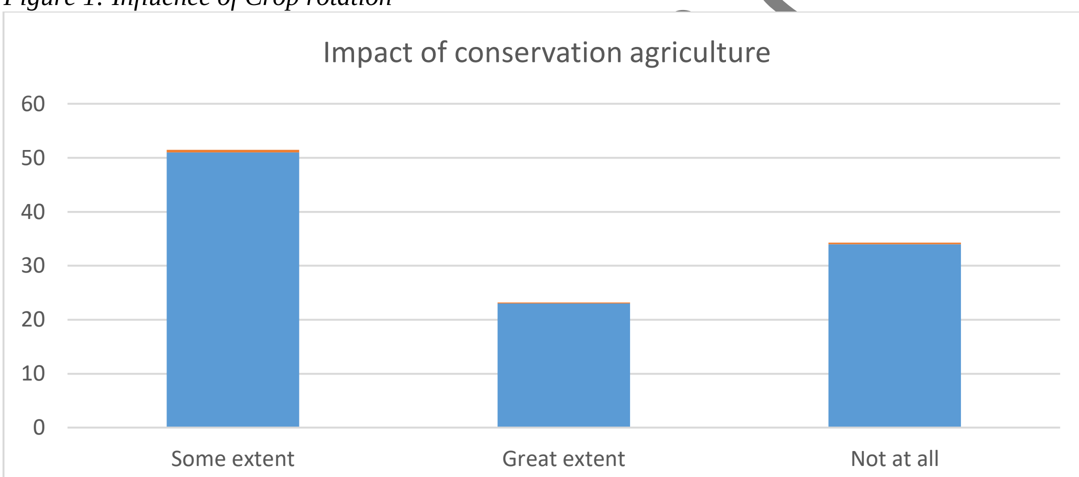

Figure 2: Impact of conservation agriculture

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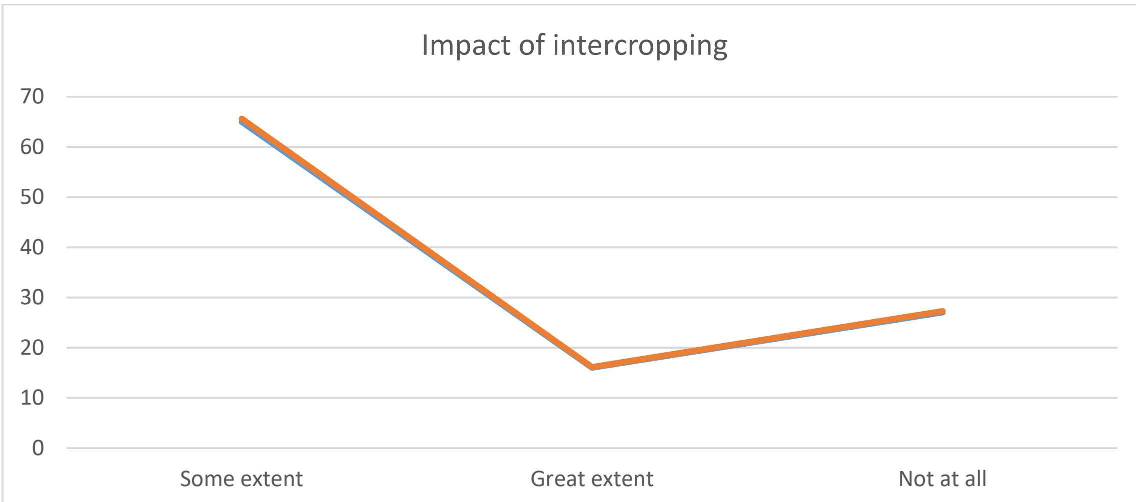

Figure 3: Impact of Intercropping

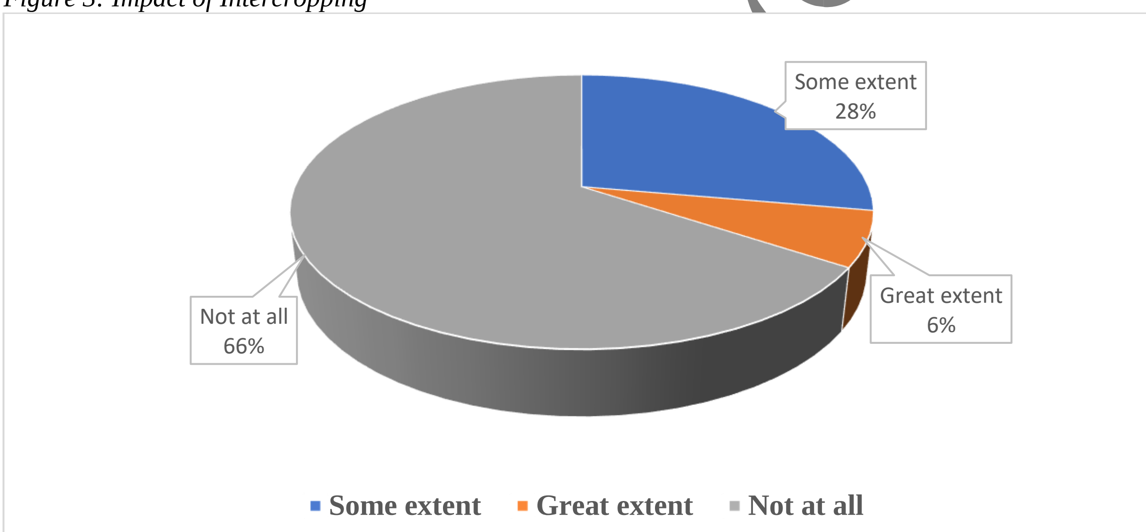

Figure 4: Impact of water harvesting

According to the figures 1, 2,3 and 4, 40.74% of the respondents agreed on practicing crop rotation to some extent, 49.07% indicated great extent and 10.19% of the respondents indicated no extent. When it comes to conservation agriculture 47.22% of the respondents indicated practicing this climate smart agriculture to some extent, 21.30% of the respondents to a great extent agreed and 31.485 stated no extent. Moreover, in terms of intercropping 60.19% of the agricultural practitioners agreed on practicing this climate smart agriculture to some extent, 14.81% stated to some great extent and 25% stated to no extent. Finally, when it comes to water harvesting, 27.78% of the respondents stated they practice this climate smart agriculture to some extent, 6.48% of the respondents agreed on practicing water harvesting on a great extent whereas 65.74% of the respondents stated that they did not practice this climate smart agriculture. This therefore implies that water harvesting is not practiced by most farmers I these areas and the other practices such as crop rotation, conservation agriculture and intercropping are the more recurrent activities practiced here.

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Effectiveness of the climate smart agricultural practices on food security

The respondents were asked to rate the effectiveness of climate smart agriculture on the maintenance of food security in their area (see figure 5)

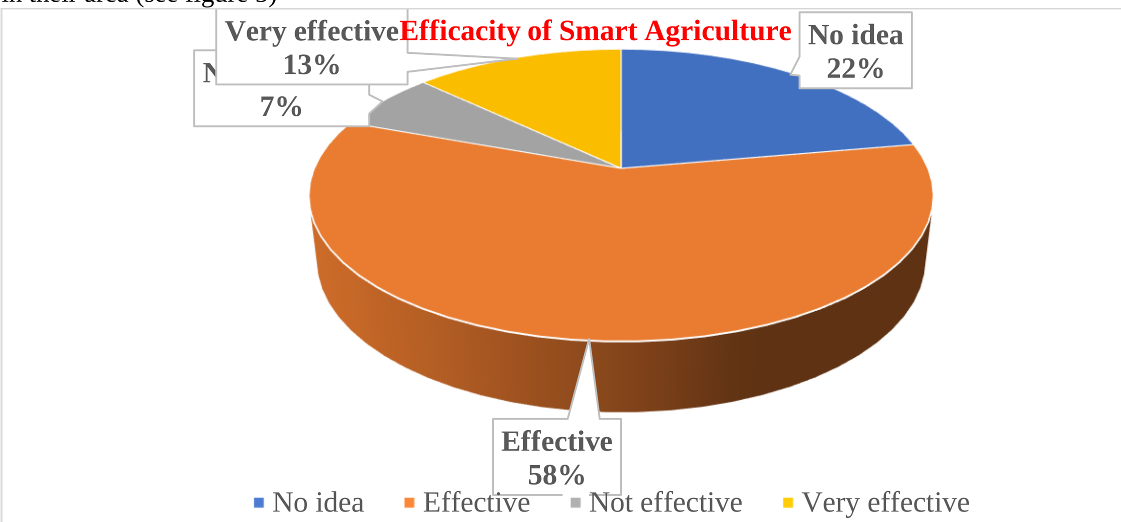

Figure 5: Effectiveness of the climate smart agricultural practices on food security

From figure 5, 22.22% of the respondents had no idea of the effectiveness of the climate smart agricultural practices, 58.33% of the respondents agreed on the notion that these practices are effective, 6.48% of the respondents stated that these practices are not effective and 12.96% of the respondents agreed the notion that these practices are very effective towards the maintenance of food security. This implies that more than half of the agricultural practitioners are being positive on the fact that most of the climate smart agricultural practices are effective in maintaining food security in the different areas in the far north region.

Strategies implemented to improve the efficacy of climate-smart agricultural practices in enhancing food security

The respondents were questioned to specify and state the different measures established in order to help the effectiveness of the climate smart agrarian practices on food security in the far north region (see figure 6).

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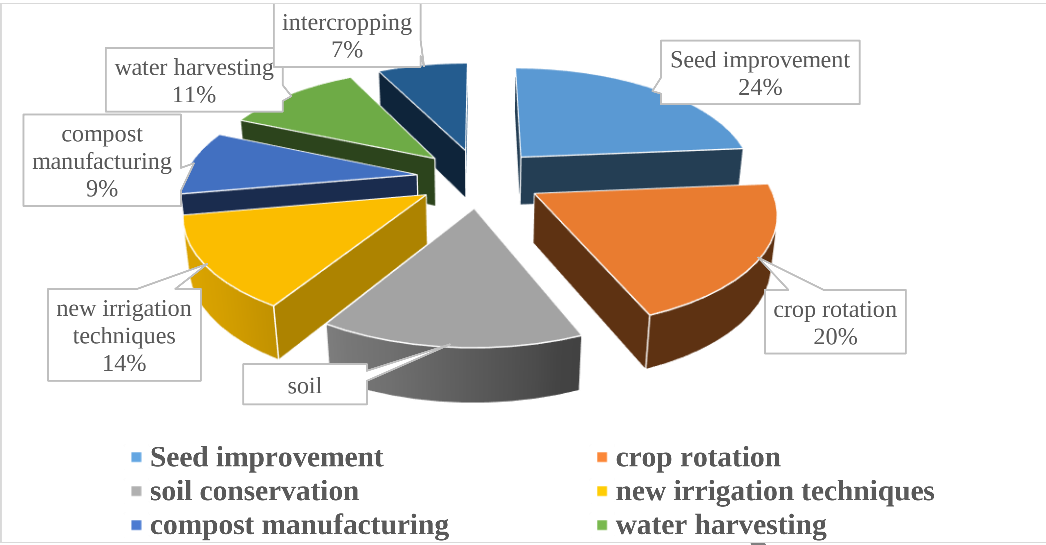

Figure 6: Measures put in place to enhance the effectiveness of these climate smart agricultural practices on food security

According to the figure 6, 68.52% of the respondents stated seed improvement as a measure of enhancing the effectiveness of climate smart agriculture, 58.33% of the respondents stated crop rotation,43.52% of the respondents stated soil conservation, 38.89% of the respondents indicated new irrigation techniques, when it comes to compost manufacturing 26.85% of the respondents indicate this as a measure of enhancing the effectiveness of climate smart agricultural practices on food security, 32.41% indicated water harvesting and finally 21.30% indicated intercropping. This therefore implies that the farmers in the far north in one way or the other practice measures which will enhance the effectiveness of climate smart agricultural practices to help them maintain food security in their area.

Different government policies

- NAPCC- National Adaptation Plan of climate change: NAPCC is Cameroon's overarching climate change adaptation framework, designed to guide sector-specific interventions, including agriculture. It aims to integrate climate resilience into national development planning and promote CSA practices such as agroforestry, drought-resistant crops, and efficient water use.
- NAIP- National Agricultural Investment Plan: NAIP, developed under CAADP (Comprehensive Africa Agriculture Development Programme), integrates CSA as a pillar for increasing productivity and sustainability. It encourages sustainable intensification, agricultural mechanization, and value chain development with climate considerations.
- NSID- National Strategy for irrigation development: The NSID is essential to CSA in Cameroon, particularly in the northern regions where water scarcity is critical. It aims to develop small- and medium-scale irrigation schemes, promote efficient water management, and support off-season agriculture.
- EMP- Environment Management Plan: The EMP promotes sustainable land use, agroforestry, and ecosystem-based approaches to climate adaptation. It supports CSA indirectly by encouraging environmental conservation alongside agricultural expansion.

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The role of government policies in promoting climate-smart agriculture

The respondents were questioned to specify the different ways in which the government in this area contribute to climate smart agriculture (see figure 7)

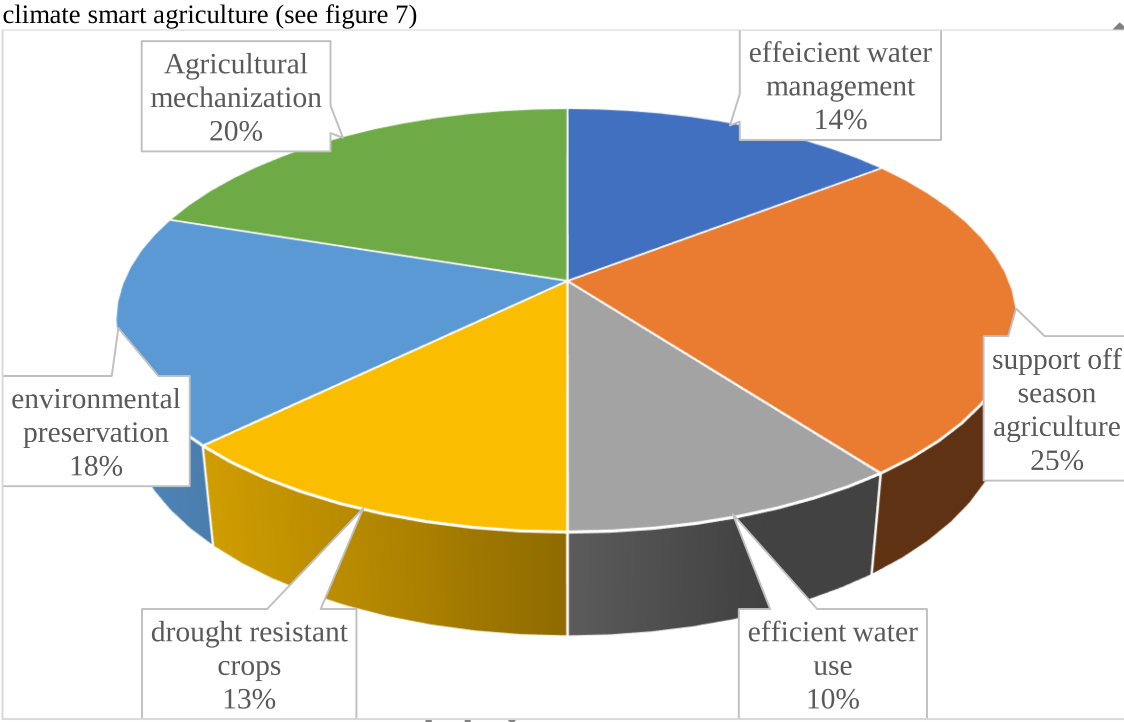

Figure 7: Government policies contribution to climate smart agriculture

According to the figure 7, 20% of the respondents indicated agricultural mechanization as a contribution of the government towards climate smart agriculture, 14% of the respondents indicated efficient water management, 25% of the respondent's indicated support of season agriculture, 10% of the respondent's indicated efficient water use, 13% of the respondents indicated drought resistant crops and finally 18% of the respondent's indicated environmental preservation. This therefore implies that the government is aware of climate smart agricultural practices in this area and contribute in one way or the other effectiveness of these practices on food security.

Effectiveness of government policies on food security

The respondents were questioned to state the effectiveness of government policies in this area on food security

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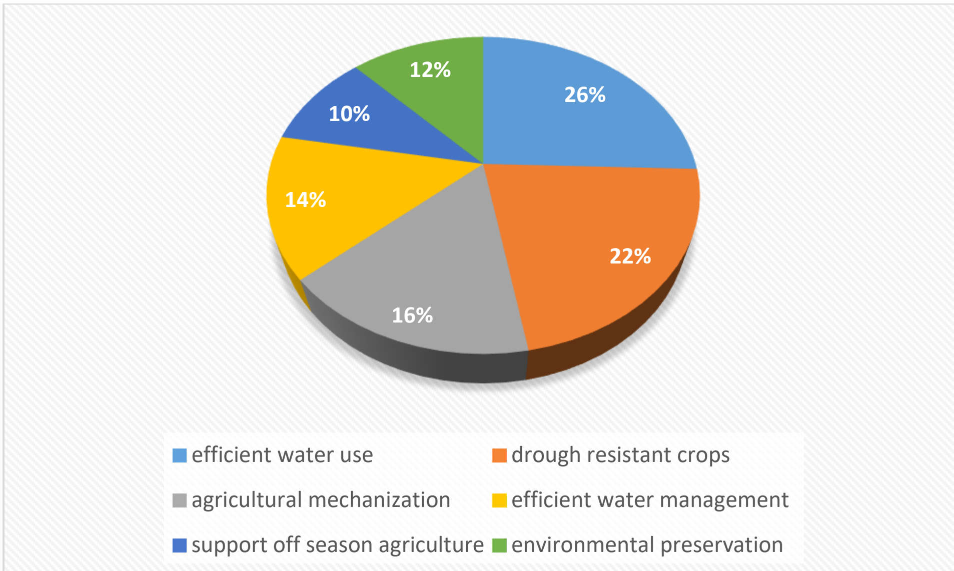

Figure 8: Effectiveness of government policies on food security

According to the figure 8 above 10% of the respondents stated that support off season agriculture is effective in the acquisition of food security, 12% of the respondents stated environmental preservation, 26% of the respondents stated efficient water use, 22% of the respondents stated drought resistant crops, 16% of the respondents stated agricultural mechanization, and finally 14% of the respondents efficient water management. This therefore implies that in one way or the other different government policies guide climate smart agriculture and contribute to the improvement of food security

Statements on the influence of climate smart agriculture on food security

Table 4: The Influence of Climate Smart Agriculture on Food Security

Statements	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Mean	SD
Soil conservation enables crops to be diseases and insect free therefore enables future crop growth and utilization of food	40(37,04%)	50(48,15%)	12(11,11%)	4(3,70%)	0(0,00	4.30	0.81
Crop rotation comes with variety of crops which enables the availability of different food crops in unconducive seasons.	57(52,78%)	35(32,41%)	12(12,96%)	2(1,85%)	0(0,00%)	4.16	0.71
Women's limited access to credit and climate information. Slash and burn land clearing and manual tillage as traditional farming practices passed from generation does not improve food security.	45(41,67%)	23(21,30%)	35(34,26%)	3(2,78%)	0(0,00%)	3.81	0.80
Rainwater harvesting enables the continuous crop growth cycle of crops which requires water during high and hot temperature enabling the maintenance of food security.	23(23,15%)	14(12,96%)	21(19,44%)	38(35,19%)	10(9,26%)	2.95	1.21
Water harvesting comes with consequences like water resource depletion which compromise the long-term sustainability of food production systems.	27(25,00%)	20(18,52%)	30(27,78%)	24(24,07%)	5(4,63%)	3.39	1.16
Poorly coordinated or inconsistent policies may create barriers to the widespread adoption of climate-smart practices, limiting their impact on overall food security.	50(48,15%)	37(34,26%)	17(15,74%)	2(1,85%)	0(0,00%)	4.15	0.74
Composite mean and standard deviation						3.78	0.90

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When asked to indicate whether soil conservation has enabled crops to be diseases and insect free therefore enables future crop growth and utilisation of food, 40(37,04%) of the respondents strongly agreed, 52(48,15%) agreed, 12(11,11%) were undecided, while 4(3,70%) disagreed and 0(0,00%) strongly disagreed. Compared to the composite mean of 3.78 and standard deviation of 0.90, this statement's mean score of 4.30 and standard deviation of 0.81 are higher. This statement therefore does not affect food security negatively and it is reemphasised by R4 who stated that *"Conservation agriculture promotes soil durability, it improves soil biodiversity, it promotes carbon sequestration in the soil, it reduces the use of labour, healthier soils with these practices, it promotes increased yields and it promotes cost reduction because the practices were studied in advance and put in place to help farmers increase crop yields joins the results."*

This implies that crops are diseases and insects free when agricultural practitioners practice soil conversation as it helps crop yields and utilization of crops.

In terms of whether crop rotation comes with variety of crops which enables the availability of different food crops in unconducive seasons, 57(52,78%) of the respondents strongly agreed, 35(32,41%) agreed, 14(12,96%) were undecided, while 2(1,85%) disagreed and 0(0,00%) strongly disagreed. Compared to the composite mean of 3.78 and standard deviation of 0.90, this statement's mean score of 4.16 and standard deviation of 0.71 are higher. This statement therefore does not influence food security negatively. This shows that variety of crops enables farmers to have variety of crops which enables food security in seasons when some goods are not available.

Whereas as 45(41,67%) of the respondents strongly agreed, 23(21,30%) agreed, 37(34,26%) were undecided, while 3(2,78%) disagreed and 0(0,00%) strongly disagreed on the notion that women's limited access to credit and climate information. Slash and burn land clearing and manual tillage as traditional farming practices passed from generation does not improve food security. Compared to the composite mean of 3.78 and standard deviation of 0.90, this statement's mean score of 3.81 and standard deviation of 0.80 are higher. This statement therefore affects food security positively. This implies that women's access to information and credit is aimed at increasing crop yields since they are the most active agriculturally and new technical agricultural practices help improve food security.

In terms of rainwater harvesting enabling the continuous crop growth cycle of crops which requires water during high and hot temperature enabling the maintenance of food security, 25(23,15%) of the respondents strongly agreed, 14(12,96%) agreed, 21(19,44%) were undecided, while 38(35,19%) disagreed and 10(9,26%) strongly disagreed. Compared to the composite mean of 3.78 and standard deviation of 0.90, this statement's mean score of 2.95 and standard deviation of 1.21 are higher. This statement therefore affects food security negatively. This implies that the respondents are positive on the fact that rainwater harvesting is a safe practice and does not have negative impact during hot and high temperatures but rather enables maintain food security.

A number of 27(25,00%) of the respondents strongly agreed, 20(18,52%) agreed, 30(27,78%) were undecided, while 26(24,07%) disagreed and 5(4,63%) strongly disagreed on water harvesting coming with consequences like water resource depletion which compromise the long-term sustainability of food production systems. The composite mean of 3.78 and 0.90 is lower than the mean score of 3.39 and standard deviation of 1.16 for this statement. This statement does influence food security negatively. This shows that the respondents do not practice water harvesting for fear of depletion of water and therefore leads to unsustainable food for all.

In terms of whether poorly coordinated or inconsistent policies may create barriers to the widespread adoption of climate-smart practices, limiting their impact on overall food security, 52(48,15%) of the respondents strongly agreed, 37(34,26%) agreed, 17(15,74%) were undecided, while 2(1,85%) disagreed and 0(0,00%) strongly disagreed. Compared to the composite mean of 3.78 and standard deviation of 0.90, this statement's mean score of 4.15 and standard deviation of 0.74 are greater. This statement influences food security negatively. This implies policies work hand in hand with climate smart agriculture therefore inconsistent policies leads to poor climate smart practices and consistent polices leads to food climate smart practices.

From the observations made in this section, it is evident that climate smart agriculture has a positive and negative effect on agriculture and food security at large. However, on the positive side FAO (2015) indicated that conservation agriculture a method of farming that can be utilised to oversee an agro-ecosystem for higher and sustained agricultural output, increased revenues, and environmental protection and the foundation of natural resources which goes in line

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with the result on the questionnaire on how conservation agriculture plays a major role on increasing crop yields while conserving the soils.

From the observations made on this section, water harvesting is considered only useful when there is effective water management in absence of this method, water harvesting leads to water shortages in favourable seasons and also is not always practiced by agricultural practitioners which does not concord with this study which suggest that one of the best ways to adapt is to manage water resources more effectively, as this increases the amount of water accessible to crops, which is essential for raising agrarian output (Rockstrom and Barron, 2015). Achieving food security in the ASALs areas has been attributed to the adoption of rainwater collection (Masila et al., 2015).

During the interview guide the informants were supposed to state the different government policies guiding climate smart agriculture in general and R2 and R4 stated NAPCC- National Adaptation Plan of climate change, NAIP- National Agricultural Investment Plan, NSID- National Strategy for irrigation development, EMP- Environment Management Plan. Where R2 stated the different aims of each policy which is to bring agricultural mechanization, implement drought resistant crops, efficient water use, bring efficient water management, support off season agriculture and encouraging environmental preservation.

During the interview guide the informants were supposed to state the advantages that comes with climate smart agriculture in general and R1 and R4 were familiar with only conservation agriculture and the other respondents were not aware of climate smart agricultural practices, this shows that climate smart agriculture's components are not all known and introduced to the primary respondents therefore makes it difficult for farmers to state the effectiveness of these practices as most of them do not know the existence of these practices or does not deem these practices efficient in the improvement of agricultural output.

Therefore, findings reveal that CSA adoption leads to a significant improvement in food security indicators. Farmers practicing CSA reported increased crop yields, better soil retention, and enhanced resilience to droughts and floods. Crop rotation and rainwater harvesting were the most effective strategies, improving food stability by 45%. However, barriers such as financial constraints (73% of respondents) and inadequate extension services (58%) limit broader adoption.

Discussion

Climate-smart agriculture and climate change projections influence food security, but often negatively, as these strategies remain largely unknown or unpracticed by most farmers. Deep-rooted traditional methods such as manual tillage and slash-and-burn persist due to generational transfer, skepticism toward new practices, and limited technical knowledge. Additionally, customary laws restrict women's land ownership, reducing their incentive to adopt long-term climate-resilient practices. Women also face limited access to credit, extension services, and climate information, while unpaid household responsibilities leave them little time to engage in CSA training or initiatives. Additionally, farmers in this study do not agree that climate change projections are very effective because they are not informed about this technique or have easy access to it. They don't have early notice of the various estimates, so they can't plan ahead for future weather circumstances. However, these weather patterns could differ, and weather forecasts might not predict the accurate future weather patterns. This therefore does not concord with most of the studies such as Amadu (2018) evaluated how climate-smart farming techniques affected the food security of 808 homes in southern Malawi. The research utilised logistic retrogression probit model to compare climate smart husbandry strategies espoused. The findings demonstrated that giving up climate-smart husbandry yielded a 90% boost in production. Policymakers were enlightened by the study to encourage climate-smart husbandry techniques in Malawi and throughout Africa. Ngwira et al. (2012) conducted a study in Malawi which came to light that after the first season of experimentation, maize yields grown under conservation agriculture showed positive benefits. When compared to the traditional tillage method, conservation agriculture areas sown with monocrop corn and conservation agriculture cereal-legume intercrop showed the best yield improvements. This therefore implies that more should be done to deliver these strategies to farmers or there should be encouragement from the government officials and NGOs to the

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farmers for them to practice these innovative practices and enable them increase crop growth and food security at large.

The study confirms that CSA contributes to food security by improving agricultural sustainability and climate resilience. However, adoption remains constrained by economic and institutional barriers. Government support through subsidies, capacity-building programs, and improved access to financial resources is essential to enhance CSA uptake. Furthermore, local adaptation of CSA practices is necessary to align with regional agro-ecological conditions.

Conclusion and Recommendations

From the analysis and summary of findings, several conclusions can be made from this study. Despite all the climatic conditions strategies on food security, food security in the far north region has no positive return in general, it is still considered to be alarming, concerned or precarious. Most of the farmers practice agriculture for home consumption rather than trade and this cannot enable sustain the population of the far north region not active in agriculture.

This study also found that climate smart agriculture does not have a great difference towards the acquisition of food security because most respondents had no ideas on the effectiveness of these practices and this therefore means farmers could receive information on the different practices but seem not to utilize this towards agriculture because of the different cultural practices already existent among different households.

This article made the following recommendations: decentralised administrations (regional delegations, departmental delegations, and district delegations) should be given the necessary financial, human, and material resources by the ministry in charge of agriculture and rural development (MINADER), cattle, aquaculture, and veterinary sectors, and travel.

This article suggests that for the purpose of improve security of food in the Far North, the non-governmental organisations and government should loosen the rules governing the State's counterpart money availability. The absence of resources promised by the State resulted in delays observed in the implementation of some scheduled and planned activities within the project framework. This has an adverse effect on how well food security projects perform.

References

Aryal, J. P., Sapkota, T. B., Rahut, D. B., & Jat, M. L. (2020). *Agricultural sustainability under emerging climatic variability: The role of climate-smart agriculture and relevant policies in India.* International Journal of Innovation and Sustainable Development, 14(2), 219-245.

Fabusoro, E., Sodiya, C. I., Fasona, M., & Oyedepo, J. (2022). *Vulnerability of Settled Fulani AgroPastoralists' Livelihoods to Climate Change and Emerging Innovations for Adaptation and Land Accessibility in Southwest Nigeria.* A Global Environmental Change Research Project.

FAO. (2015). *Climate Change and Food Systems: Global Assessments and Implications for Food Security and Trade.* Food Agriculture Organization of the United Nations (FAO), Rome.

FAO. (2016). *Climate-Smart Agriculture in Ghana: CSA Country Profiles for Africa Series*. Rome: Food and Agriculture Organization of the United Nations.

FAO. (2016). *The State of Food and Agriculture: Climate Change, Agriculture and Food Security.* Rome.

FAO. (2017). *Extreme Drought and Floods Threaten Food Security in Sri Lanka*. Food and Agriculture Organization of the United Nations 2017.www.fao.org/srilanka/news/detail-events/en/c/897464.

FAO. (2021). *Climate-Smart Agriculture: Case studies from sub-Saharan Africa*. Rome: Food and Agriculture Organization of the United Nations.

Gebrehiwot, T., van der Veen, A., & Maathuis, B. (2018). *Farmers' adaptive strategies to climate change and their impacts on food security in Ethiopia*. Regional Environmental Change, 18(2), 499–510.

Hadush, M. (2018). *Welfare and food security response of animal feed and water resource scarcity in Northern Ethiopia.* Agricultural and Food Economics, 6(1), 1-24.

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IFPRI. (2019). *Gender, Agriculture, and Climate Change in Ethiopia*. Washington, DC: International Food Policy Research Institute.

IRAD. (2020). *Climate change and animal health in Northern Cameroon: Research brief*. Institute of Agricultural Research for Development.

Kalungu, J. W., & Leal, F. W. (2018). *Adoption of appropriate technologies among smallholder farmers in Kenya*. Climate and Development, 10(1), 84-96.

Masila, T., Udoto, M. O., & Obara, J. (2015). *Influence of rainwater harvesting technologies on household food security among small-scale farmers in Kyuso sub-county, Kitui County, Kenya.* Journal of Agriculture and Veterinary Science, 8: 80-86.

MoFA. (2015). *Ghana National Climate-Smart Agriculture and Food Security Action Plan (2016–2020)*. Ministry of Food and Agriculture, Accra, Ghana.

Njoya, A., Mbih, R., & Nchinda, V. (2022). *Assessing rainwater harvesting as a resilience strategy for smallholder farmers in Northern Cameroon*. Journal of Sahelian Studies, 12(3), 45–63.

Ntali, Y. M., Neba, S., & Bissong, P. (2022). *Drought vulnerability and adaptive strategies among sorghum farmers in Northern Cameroon*. African Journal of Rural Development, 7(1), 98–110.

ONACC. (2020). *Profil climatique régional: Extrême-Nord du Cameroun*. Observatoire National sur les Changements Climatiques.

Raj A., Jhariya M. K., & Bargali S. S. (2018b). *Climate smart agriculture and carbon sequestration. In: Pandey CB, Gaur MK, Goyal RK (eds) Climate change and agroforestry: adaptation mitigation and livelihood security.* New India Publishing Agency (NIPA), New Delhi, India, pp 1–19.

Raj A., Jhariya M. K., & Harne S. S. (2018a). *Threats to biodiversity and conservation strategies. In: Sood KK, Mahajan V (eds) Forests, climate change and biodiversity.* Kalyani Publisher, New Delhi, India, pp 304–320.

Rigolot, C., De Voil, P., Douxchamps, S., Prestwidge, D., Van Wijk, M., Thornton, P. K., Rodriguez, D., Henderson, B., Medina, D., & Herrero, M. (2017). *Interactions between intervention packages, climatic risk, climate change and food security in mixed crop–livestock systems in Burkina Faso.* Agricultural Systems, 151, 217–224.

Rockstrom, J., Kaumbutho, P., Mwalley, J., Nzabi, A., Temesgen, M., Mawenya, L., Barron, J., Mutua, J., & Damagaard-Larsen, S. (2015). *Conservation farming strategies in east and southern*

Tougou, D., Abdoulaye, A., & Nguiffo, S. (2021). *Agroforestry and farmer-managed regeneration: Lessons from dryland Cameroon*. African Journal of Sustainable Land Management, 8(2), 91–107.

World Bank. (2020). *Enabling Gender-Responsive Climate-Smart Agriculture in Ethiopia*. Washington, DC: World Bank.