

POLICY PAPER

Advancing Climate-Smart Agriculture in Ghana

PREPARED BY

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Commissioned by the Ghana Climate Innovation Centre (GCIC).



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This report is a testament to the collective effort of all involved, and we look forward to seeing its recommendations drive meaningful change in Ghana's agricultural sector.

Thank you all.

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Executive Summary

Agriculture remains the backbone of Ghana's economy, contributing approximately 20% of GDP and employing over 40% of the workforce. However, climate change poses a significant threat to the sector, with erratic rainfall, rising temperatures, droughts, and flooding undermining productivity and food security. Given these challenges, Climate-Smart Agriculture (CSA) has emerged as a viable solution to build resilience, enhance productivity, and reduce greenhouse gas emissions.

This report, commissioned by Ghana Climate Innovation Centre (GCIC) and undertaken by Mayiya Investments Limited (MIL), examines the adoption and scaling of CSA practices in Ghana. The study identifies key barriers, assesses economic and environmental benefits, and provides actionable policy recommendations to integrate CSA into Ghana's agricultural development strategies.

Key Findings:

1. Current CSA Practices and Initiatives:

Ghana has made progress in promoting CSA through various national and donor-funded programs, including the Ghana Climate-Smart Agriculture Programme, Adaptation Fund Project, GASIP, and USAID Feed the Future initiatives. Success stories include agroforestry in cocoa farming, conservation agriculture in the Savannah zone, and improved water management practices.

2. Barriers to CSA Adoption:

- Limited awareness and knowledge: Many farmers lack training and extension services to implement CSA effectively.
- Financial constraints: Smallholder farmers struggle to access credit and financing for CSA inputs and technologies.
- Weak policy and institutional support: The absence of a comprehensive CSA policy framework hinders large-scale adoption.
- Market access limitations: Poor infrastructure and price instability reduce incentives for CSA adoption.
- Gender and social inequities: Women and youth face difficulties in accessing land,

finance, and decision-making platforms.

3. Economic and Environmental Benefits:

- Increased productivity and income: CSA adoption has led to yield improvements of up to 50% in key staple crops.
- Enhanced resilience to climate shocks: Practices such as agroforestry, minimum tillage, and water harvesting improve soil moisture retention and reduce the risk of crop failure.
- Improved environmental sustainability: CSA techniques help conserve soil fertility, reduce greenhouse gas emissions, and enhance biodiversity.

Recommendations

To accelerate the adoption and scaling of CSA in Ghana, the report proposes the following:

- Strengthen extension services: Expand farmer training and integrate digital platforms to improve knowledge transfer.
- Increase financial support: Develop CSA-focused credit schemes, grants, and subsidies to enhance farmer investments in climate-resilient practices.
- Enhance market access: Improve rural infrastructure, establish price incentives, and promote CSA-branded products.
- Foster multi-stakeholder collaboration: Strengthen partnerships between policymakers, private sector actors, research institutions, and farmer organizations.
- Mainstream gender inclusion: Ensure targeted support for women and youth in CSA initiatives through land access reforms and tailored financing models.

Conclusion

The findings of this study emphasize the urgent need for policy alignment, institutional strengthening, and targeted investments to scale CSA adoption across Ghana's agro-ecological zones. Implementing these recommendations will enhance climate resilience, safeguard food security, and drive sustainable economic growth in Ghana's agricultural sector.

This report serves as a strategic roadmap for government agencies, development partners, private investors, and farming communities to advance CSA as a mainstream agricultural practice in Ghana.

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Abbreviations

ASAP	-	Adaptation for Smallholder Agriculture Programme
CBA	-	Cost Benefit Analysis
CSA	-	Climate Smart Agriculture
DAF	-	Dynamic Agroforestry
FAO	-	Food and Agriculture Organization
FGDs	-	Focus Group Discussions
GASIP	-	Ghana Agriculture Sector Investment Programme
GCIC	-	Ghana Climate Innovation Center
GSS	-	Ghana Statistical Service
ICRAF	-	International Centre for Research in Agroforestry
KIIs	-	Key Information Interviews
NGO	-	Nongovernmental Organization
REP	-	Rural Enterprise Programme
SIP	-	Savannah Investment Programme
SME's	-	Small and Medium Enterprises
UNDP	-	United Nations Development Programme

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Section 1: Introduction and background to the study and approach

1.1 Introduction to the report

Climate change presents one of the most critical threats to agricultural sustainability and food security in Ghana. As a country where agriculture employs over 40% of the labor force and contributes nearly 20% to national GDP (GSS, 2024), the sector's high dependence on rain-fed systems renders it highly vulnerable to climate-induced shocks such as erratic rainfall, prolonged droughts, increasing temperatures, and frequent flooding. These climatic disruptions not only compromise crop yields and livestock productivity but also exacerbate rural poverty and food insecurity.

In response to these pressing challenges, Climate-Smart Agriculture (CSA) has gained prominence globally and nationally as a transformative approach to adapt agricultural systems to climate change while ensuring productivity, sustainability, and mitigation co-benefits. CSA integrates three pillars: (1) sustainably increasing agricultural productivity and incomes, (2) enhancing resilience to climate change, and (3) reducing greenhouse gas emissions where possible. Ghana has adopted CSA in several donor-supported and national programs, such as the Ghana Climate-Smart Agriculture Programme and projects under IFAD, FAO, and UNDP, among others.

Despite these efforts, the adoption of CSA remains fragmented and constrained by a combination of policy, financial, institutional, and socio-cultural barriers. Previous studies have documented gaps in farmer awareness, weak extension systems, inadequate CSA-specific policies, limited access to finance and technology, and structural inequalities faced by women and youth.

While some regions and initiatives have seen success—such as agroforestry in the cocoa sector, conservation agriculture in the Northern Region, and drip irrigation in coastal zones—these have not been scaled to achieve systemic transformation. There is limited empirical synthesis of what is working, what barriers persist, and what reforms are most urgent.

This study, commissioned by the Ghana Climate Innovation Centre (GCIC), was undertaken by Mayiya Investments Limited (MIL) to address these knowledge and policy gaps. It explores the current landscape of CSA implementation in Ghana, assesses its environmental and economic benefits, and identifies the systemic bottlenecks to adoption. It also proposes strategic policy and institutional reforms to scale CSA practices in alignment with Ghana's climate commitments under the Paris Agreement and Sustainable Development Goals (SDGs), especially SDGs 2, 13, and 15.

By contributing a rigorous and evidence-informed analysis of CSA in Ghana, this study aims to support policymakers, donors, and private sector actors to integrate CSA more effectively into agricultural development strategies and investments.

1.2 Structure of report

This report is structured as follows:

- Section 1: Introduction and background to the study, providing the rationale, relevance, and context.
- Section 2: Context and importance of agriculture in Ghana, detailing its economic contribution and vulnerability to climate change.
- Section 3: Introduction to Climate-Smart Agriculture (CSA), including its definition, pillars, and importance.

- Section 4: Current state of CSA implementation in Ghana, reviewing key programs, initiatives, successes, and existing gaps.
- Section 5: Methodology, outlining the study design, data collection, and analytical framework.
- Section 6: Findings from the study, including barriers to adoption, economic and environmental benefits, and stakeholder perspectives.
- Section 7: Strategic recommendations for scaling CSA adoption and strengthening the policy environment.
- Section 8: Conclusion and implications for policy, programming, and future research.

Section 2: Context and Importance of Agriculture in Ghana

Beyond its economic output, agriculture in Ghana plays a vital role in ensuring national food security, reducing poverty, and supporting rural livelihoods. It supplies raw materials for agro-processing industries, contributes significantly to export earnings especially through cocoa and emerging non-traditional exports and serves as a critical driver of inclusive growth.

Agriculture also acts as a social safety net for many households, particularly in times of economic shocks, and plays a central role in climate resilience through sustainable land management and ecosystem services. Its centrality to employment, food systems, and rural livelihoods positions it as a critical focus area for national policies aimed at economic transformation, poverty reduction, and climate resilience.

It is a critical sector for livelihoods, food security, and rural development, with staple crops such as maize, rice, groundnut, cowpea and cassava, as well as cash crops like cocoa, playing a pivotal role in national and household economies. The sector also

serves as the foundation for agro-industrial development, providing raw materials for the food, beverage, and textile industries.

However, Ghana's agricultural sector is highly dependent on rain-fed systems, making it vulnerable to the increasing threats of climate change. Rising temperatures, erratic rainfall, prolonged dry spells, and increasing flooding situations pose significant risks to food production which affect yields, soil fertility, and livestock survival (UNDP, 2019). These situations further exacerbate the challenges of sustainable food production resulting in high incidence of food insecurity, and increasing poverty levels. Ghana's agriculture remains predominantly rain-fed, leaving the sector highly exposed to the growing impacts of climate change. Shifting weather patterns including unpredictable rainfall, extended dry spells, rising temperatures, and recurrent flooding are increasingly disrupting farming activities. These climate-related stressors undermine crop productivity, degrade soil quality, threaten livestock systems, and jeopardize the stability of rural livelihoods. As a result, food insecurity and poverty in agricultural communities are deepening, raising serious concerns about the long-term resilience and sustainability of the sector (UNDP, 2019).

The Ministry of Food and Agriculture (2020) warned that if no strategic measures are taken, Ghana's agricultural productivity will decline, limiting the country's ability to feed its growing population and maintain economic stability.

Given these challenges, the need for climate-smart solutions has become urgent. Climate-Smart Agriculture has emerged as a transformational approach to increase productivity, enhance resilience to climate shocks, and promote environmental sustainability. CSA integrates sustainable practices such as conservation agriculture, agroforestry, soil and water management, and improved crop varieties, ensuring that agriculture remains viable in the face of climate change (FAO, 2021).

The research aligns with the three core pillars of CSA, namely:

1. Sustainable increase in agricultural productivity and incomes
2. Enhanced resilience to climate change and variability
3. Reduction in greenhouse gas emissions, where feasible

The study also emphasizes the importance of site-specific, scalable solutions that respond to local conditions and address the needs of smallholder farmers, who form the backbone of Ghana's agricultural economy. By leveraging CSA practices, Ghana has the opportunity to build a resilient and sustainable food system, ensure food security and sovereignty, rural employment, and long-term economic growth.

Section 3: Introduction to Climate-Smart Agriculture

Ghana's agricultural sector is facing increasing disruptions due to climate change, threatening the livelihoods of millions of farmers who depend on rain-fed agriculture. The country is experiencing erratic rainfall patterns, rising temperatures, prolonged droughts, and frequent flooding, which collectively undermine agricultural productivity and food security (UNDP, 2019). These climatic changes are not only reducing crop yields and soil fertility but also exacerbating pest and disease outbreaks, making it increasingly difficult for farmers to sustain production levels (FAO, 2021).

One of the most significant challenges posed by climate change is the unpredictability of rainfall considering the heavy dependence on rain-fed agricultural systems. Rainy seasons have become increasingly irregular, with delayed onset and early cessation, disrupting planting, growth/maturity and harvesting cycles. In recent years, droughts have intensified, particularly in the Savannah and Transition zones, leading to severe moisture stress in staple crops such as maize, rice, and sorghum. Farmers who rely solely on rainfall for irrigation often experience poor germination rates, stunted crop growth, and yield losses of up to 50% (Ministry of Food and Agriculture, 2020).

Average temperatures in Ghana have been rising at approximately 0.21°C per decade, leading to increased evapo-transpiration rates, soil moisture depletion, and heat stress on crops and livestock (World Bank, 2020). In the northern regions, temperatures often exceed 40°C, causing heat-induced wilting and reduced productivity of key crops such as groundnuts and soybeans. Heat stress also affects livestock production, as higher temperatures reduce pasture quality and increase water demands for animals.

At the other extreme, increased frequency and intensity of flooding in lowland and riverine areas pose severe risks to agriculture. Heavy rainfall often leads to flash floods, which wash away topsoil, essential nutrients, and newly planted crops, rendering large tracts of land unproductive. In the Volta and Northern regions, recurrent flooding has also damaged irrigation infrastructure and farmlands, displacing farming communities and exacerbating food insecurity.

Climate variability has altered pest and disease dynamics, leading to higher incidences of fall armyworm infestations in maize, cassava mosaic disease, and shea tree dieback (FAO, 2021). Warmer temperatures and erratic rainfall create favorable conditions for pests and plant pathogens, which further reduce yields and increase the cost of pest management for farmers.

If these challenges are not urgently addressed, Ghana's agricultural productivity will continue to decline, threatening the country's ability to feed its growing population and sustain rural economies. Smallholder farmers, who constitute the backbone of Ghana's agricultural sector, are the most vulnerable to these climatic shocks due to limited access to the needed resources to finance irrigation, climate-resilient crop varieties, and climate smart farm management.

The integration of Climate-Smart Agriculture is now a necessity rather than an option. CSA practices such as drought-resistant crop varieties, conservation agriculture practices, improved soil and water management, and agroforestry provide practical solutions to mitigate the impact of climate risks and enhance resilience. Investing in CSA can help stabilize yields, improve soil health, and secure rural livelihoods, ensuring that agriculture remains a viable economic driver for Ghana despite the changing climate.

This study, conducted by Mayiya Investments Limited for Ghana Climate Innovation Centre, seeks to identify and

scale climate-resilient agricultural solutions that can safeguard food security and rural livelihoods against the adverse impacts of climate change. Through the adoption of scientifically proven CSA approaches, Ghana can build a more resilient and sustainable agricultural sector, ensuring long-term prosperity for farming communities.

Climate-Smart Agriculture is a transformative approach that integrates sustainable farming practices with climate resilience to ensure long-term agricultural productivity, save the environment and ensure societal cohesion.

Developed as a response to the increasing vulnerabilities of food systems to climate change, CSA promotes practices that enhance food security, rural livelihoods, and environmental sustainability. It is an adaptive and solutions-driven framework that helps farmers mitigate risks associated with erratic weather patterns, declining soil fertility, and rising temperatures (FAO, 2013).

CSA is built on three core pillars, each playing a critical role in ensuring the sustainability of agricultural systems:

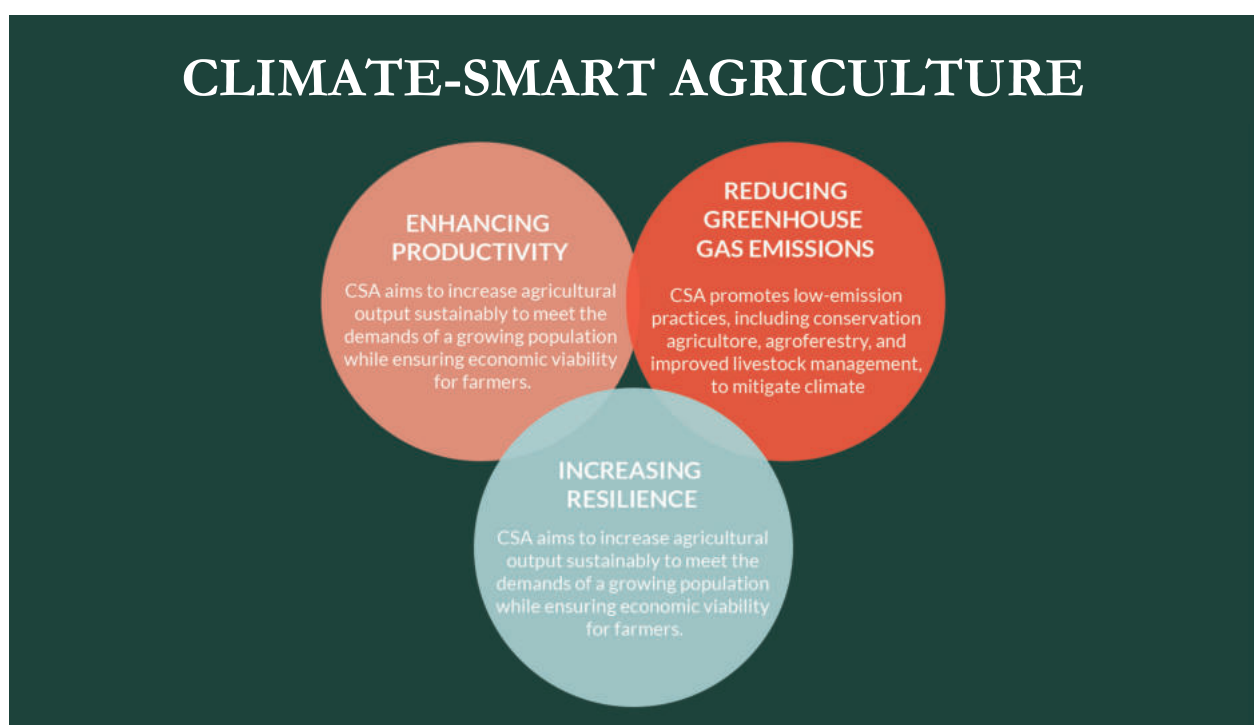


Figure 1: Climate-Smart Agriculture Diagram

1. **Enhancing Productivity:** CSA aims to increase agricultural output sustainably to meet the demands of a growing population while ensuring economic viability for farmers. This involves adopting improved crop varieties, precision farming, and efficient water-use techniques to optimize yields without depleting natural resources.
2. **Increasing Resilience:** Given the growing risks of droughts, floods, and heat stress, CSA strengthens the adaptive capacity of farming systems. Strategies such as soil and water conservation, crop diversification, and integrated pest management help farmers cope with climate variability and build long-term resilience.
3. **Reducing Greenhouse Gas Emissions:** Agriculture contributes significantly to global emissions through land-use changes, deforestation, and methane emissions from livestock and rice cultivation. CSA promotes low-emission practices, including conservation agriculture, agroforestry, and improved livestock management, to mitigate climate impacts while maintaining productivity.

Addressing the intersection of climate change and agriculture, CSA provides a strategic solution for Ghana, where millions of farmers depend on rain-fed agriculture. Given the increasing climate risks in Ghana, investing in CSA will enable farmers to produce more food while ensuring long-term environmental sustainability and economic stability.

This study seeks to promote climate-resilient agricultural practices that align with the CSA framework. By scaling up CSA adoption, Ghana can build a more robust, sustainable, and climate-resilient agricultural sector, ensuring prosperity for future generations.

Section 4: Current state of CSA implementation in Ghana

The research team conducted a comprehensive desk review and engaged with key national and local stakeholders to assess the current status of CSA implementation in Ghana. This consultative process revealed notable progress in CSA adoption, primarily through a wide range of national and donor-funded initiatives that aim to enhance productivity, climate resilience, and environmental sustainability within the agricultural sector.

Ghana's CSA journey is marked by a series of pioneering interventions that promote practices such as agroforestry, conservation agriculture, integrated soil and water management, and the use of climate-resilient crop varieties. These efforts have been particularly impactful in climate-vulnerable regions such as the Savannah and Transition Zones.

Ghana has made significant progress in the adoption of CSA through various projects and initiatives aimed at enhancing agricultural productivity, resilience to climate change, and environmental sustainability. Several national and donor-funded initiatives have been implemented to promote CSA practices such as agroforestry, conservation agriculture, soil and water management, and the adoption of climate-resilient crop varieties. However, despite these efforts, several gaps and challenges persist, limiting the widespread adoption and upscale of CSA practices.

In terms of progress in CSA adoption, several key projects have played a pivotal role in advancing CSA across Ghana:

1. Ghana Climate-Smart Agriculture Programme (2016-2020): Implemented by the Ministry of Food and Agriculture (MoFA), this program promoted efficient irrigation systems, conservation agriculture, and agroforestry to enhance food security and sustainability.
2. Adaptation Fund Project (2016-2022): A collaboration with UNDP in northern Ghana, focusing on drought-resistant crops, rainwater harvesting, and sustainable land management.
3. Ghana Agriculture Sector Investment Programme (GASIP): Funded by IFAD, it provides support for CSA practices through access to finance, input supply, and farmer capacity-building.
4. Fairtrade Africa's Climate-Smart Cocoa Project: Focused on ensuring cocoa sustainability through dynamic agroforestry (DAF) and eco-friendly farming techniques.
5. USAID Feed the Future Programs (2016-2021): These initiatives emphasized climate-matched seeds, conservation agriculture, and improved water-use efficiency.
6. International Centre for Research in Agroforestry (ICRAF) Projects: Conducting research on agroforestry, soil health, and the role of trees in climate resilience.
7. Care International Conservation Agriculture project -CAP (2007-2011) funded by Howard Buffet Foundation and implemented in northern Ghana.

These interventions have contributed to building resilience in the agricultural sector, especially in Ghana's Savannah and Transition Zones, where climate variability is more pronounced.

Success Stories and Pilot Initiatives.

Ghana has witnessed encouraging successes in the adoption of Climate-Smart Agriculture (CSA), particularly at the smallholder level. These pilot efforts have proven effective in demonstrating the potential for CSA to deliver both climate and economic benefits. Through the desk review and stakeholder consultations including interviews and survey inputs, the research team uncovered powerful stories and feedback that reinforce the value of these practices.

Agroforestry Practices in the Cocoa Sector

In the Western and Central Regions, farmers integrating trees such as *Albizia* and *Gliricidia sepium* into cocoa farms have seen cocoa yields increase by up to 15%, while also improving biodiversity and providing additional sources of income through timber and fruit trees.

“The shade trees not only protect our cocoa from extreme heat but also improve the soil. We now harvest more and spend less on chemicals.” – Farmer, Sefwi Wiawso

Conservation Agriculture in the Savannah Zone

Minimum tillage, mulching, and crop rotation have proven effective among farmers in Northern Ghana. Several farmers reported a 40–50% increase in yields, improved soil structure, and better moisture retention, even during dry spells. “Practicing conservation farming has turned my once-dry field into fertile land. Even my neighbors are copying now.” – Lead Farmer, Savelugu

Drip Irrigation in Coastal and Forest Zones

Smallholder horticulture producers using drip irrigation systems in parts of the Greater Accra and Eastern Regions have reduced water usage by over 40% while increasing productivity and crop uniformity. “Before, we wasted so much water. With drip systems, I get better vegetables and save water and money.” – Vegetable Farmer, Kasoa

Adoption of Climate-Resilient Crop Varieties

Drought-tolerant maize, rice, and sorghum varieties introduced through programs such as GASIP and USAID interventions have shown promising outcomes in stabilizing yields under erratic rainfall patterns.

“Even when the rains delayed, my maize still did well. The new seed is truly a game changer.” – Woman Farmer, Upper East Region

These successes demonstrate the potential for CSA to drive agricultural transformation in Ghana. However, scaling these efforts remains a significant challenge.

These successes demonstrate the potential for CSA to drive agricultural transformation in Ghana. Pertinent challenges and gaps identified as barriers to upscale efforts and adoption include;

1. Limited Awareness and Knowledge: Many farmers remain unaware of CSA benefits. This situation is borne out of underfunded and understaffed extension services, which has reduced the ability to transfer knowledge to smallholder farmers.
2. Financial Constraints: Smallholder farmers lack access to credit and financing to invest in CSA technologies such as irrigation systems, improved seeds, and mechanization.

3. Weak Policy and Institutional Support: There is no comprehensive CSA policy framework, and CSA is not fully integrated into national agricultural strategies, limiting government-led scaling efforts.

4. Market Barriers: Farmers face difficulties in accessing reliable markets for CSA-produced goods and premiums for “clean” production systems, reducing incentives to adopt sustainable farming practices.

5. Gender Inequality and Social Exclusion: Women and youth face land tenure issues, limited access to financing, and lack of decision-making powers, restricting their ability to adopt CSA innovations.

6. Environmental and Climatic Uncertainties: Erratic rainfall, extreme temperatures, and unpredictable climatic patterns make it difficult for farmers to plan and implement CSA techniques effectively.

To enhance CSA adoption in Ghana, targeted interventions must focus on improving extension services, expanding financial support, strengthening policy frameworks, and increasing farmer training programs. Public-private partnerships and community-driven approaches can bridge the gaps in financing, market access, and knowledge dissemination, ensuring that CSA becomes a mainstream practice for Ghanaian farmers.

By scaling CSA innovations, Ghana can achieve climate resilience, food security, and economic stability for its agricultural sector while ensuring sustainable environmental management.

Rationale of the study

The widespread adoption and scaling of Climate-Smart Agriculture practices are essential to Ghana's sustainable development agenda. These practices not only build climate resilience but also enhance food security and promote long-term economic stability. Agriculture continues to be the fulcrum of the country with enormous employment and income generation ability particularly for the working population whilst providing a safe anchor for GDP growth (GSS, 2021). However, the sector faces mounting challenges due to climate change, which has intensified the frequency and severity of erratic rainfall, droughts, rising temperatures, and flooding—all of which threaten agricultural productivity and rural livelihoods (FAO, 2021).

To address these challenges, CSA presents a transformative approach, integrating sustainable farming practices with climate adaptation and mitigation strategies. The implementation of CSA aligns with Ghana's Nationally Determined Contributions (NDCs) under the Paris Agreement, supporting national goals to reduce greenhouse gas emissions, enhance resilience in agriculture, and promote sustainable land and water management (MoFA, 2020). Moreover, CSA is fundamental to achieving the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land) whilst remotely addressing SDG 1 (No Poverty).

This policy paper seeks to provide practical recommendations for overcoming barriers to CSA adoption and scaling. Despite increasing recognition of CSA's benefits, key challenges persist, including limited access to financing, weak extension services, inadequate policy support, and knowledge gaps among farmers. By addressing these constraints, this study contributes to shaping informed policies and investment strategies that can accelerate CSA adoption

across Ghana's diverse agro-ecological zones. The paper is particularly relevant for policymakers, development partners, and private sector stakeholders, providing a strategic roadmap for integrating CSA into national agricultural policies, financing mechanisms, and extension services. The study also emphasizes the importance of targeted support for women, youth, and vulnerable farmers, ensuring an inclusive approach to CSA implementation.

By mainstreaming CSA, Ghana can enhance agricultural productivity, strengthen rural livelihoods, and build resilience against climate risks while promoting sustainable land use and environmental conservation. This study, therefore, serves as a critical knowledge resource, equipping stakeholders with the evidence-based insights needed to drive CSA adoption and long-term agricultural sustainability.

Objectives of the study

This policy paper aims to analyze the current state of Climate-Smart Agriculture in Ghana and provide actionable recommendations to enhance adoption and upscaling efforts. By addressing the barriers and opportunities in CSA implementation, the study will contribute to strengthening Ghana's agricultural resilience, improving food security, and achieving national and global climate commitments.

The key objectives of this study are:

1. To identify barriers limiting the adoption and scaling of CSA practices in Ghana
 - Assess key challenges such as financial constraints, policy gaps, limited awareness, weak extension services, and socio-economic inequalities that hinder CSA adoption.
 - Examine the specific challenges faced by smallholder farmers, women, youth, and agribusinesses in accessing CSA technologies and resources.

2. To assess the economic and environmental benefits of CSA implementation

- Evaluate the impact of CSA on agricultural productivity, income generation, and food security for Ghanaian farmers.
- Analyze how CSA contributes to reducing greenhouse gas emissions, improving soil fertility, and enhancing water conservation.
- Examine case studies of successful CSA initiatives in Ghana and other comparable agricultural economies.

3. To provide strategic recommendations for integrating CSA into Ghana's agricultural and climate policies

- Propose policy reforms, institutional frameworks, and financing mechanisms to enhance CSA adoption at national and local levels.
- Highlight investment opportunities for development partners, private sector actors, and policymakers in CSA promotion.
- Recommend scalable models for farmer training, extension services, and climate-resilient agricultural practices.

By achieving these objectives, the study seeks to support evidence-based policymaking and stakeholder-driven solutions that will enhance the sustainability, resilience, and productivity of Ghana's agricultural sector in the face of climate change.

5.0 Study Methodology

This section outlines the methodology used in the study, which integrates a case study approach with mixed qualitative and quantitative data collection tools. The methodology ensures a thorough analysis of the barriers to CSA adoption and the assessment of its economic and environmental benefits. The study was conducted through three key activities: desk review, quantitative field data collection, and Key Informant Interviews.

5.1 Desk Study and Literature Review

The study commenced with an extensive literature review to examine prior research, program reports, policy frameworks, and strategy documents related to CSA implementation in Ghana. Key sources included national climate adaptation plans, CSA program evaluations, peer-reviewed journals, and grey literature from development partners and research institutions. The review informed the design of the data collection tools and helped frame key issues such as financing, institutional barriers, and technical adoption challenges. It also established a baseline for assessing findings from the fieldwork and case studies.

5.2 Research Design and Case Study Approach

A case study approach was adopted as the central methodological framework, allowing the research team to conduct in-depth investigations of CSA practices across diverse ecological contexts. Nine case studies were purposively selected from three ecological zones (Coastal, Forest, and Savannah) to represent a range of CSA interventions. Each case was chosen based on criteria such as agro-ecological diversity, institutional model, type of CSA practice

(e.g., agroforestry, conservation agriculture, soil and water management), and stakeholder involvement.

These cases formed the basis for both qualitative inquiry and quantitative assessments.

5.3 Data Collection

The study employed multiple data collection techniques:

- Key Informant Interviews (KIIs)-20 were conducted with stakeholders from MoFA, NGOs, private sector actors, CSA practitioners, and local governments. These interviews provided expert insights into institutional, technical, and financial barriers to CSA scaling.
- Focus Group Discussions (FGDs)-10 and interviews were held with farmers, extension agents, and community leaders within the selected case study areas. These discussions captured localized experiences with CSA adoption, implementation challenges, and perceptions of benefits.
- Surveys were administered to 54 farmer participants using structured questionnaires. The survey captured demographic profiles, adoption motivations, farm performance, CSA input costs, yields, revenues and perceived environmental impacts.
- Field Observations through transect walks across farms provided practical insights into the implementation processes and physical attributes of CSA practices. Photographs and observation checklists were used to document on-farm CSA structures and techniques.

5.4 Sampling Strategy

Sampling combined purposive, stratified, and snowball techniques:

- Purposive sampling ensured that the most relevant CSA initiatives were captured across zones.
- Stratified sampling was used for the surveys to include farmers from different zones and socio-economic backgrounds.
- Snowball sampling allowed the team to identify additional expert stakeholders for KIIs, ensuring a broad base of knowledge input.

5.5 Data Analysis

- To ensure credibility and utility, a stakeholder validation workshop was conducted and draft findings presented. Participants were drawn from policymakers, CSA experts, farmers, development partners, and private sector actors. Feedback received helped to refine the final recommendations and improve the coherence and policy relevance of the report.
- Overall, this methodology provides a solid basis for generating actionable insights, backed by case-based evidence, literature synthesis, and stakeholder perspectives.



Section 6.0 Findings from the study

6.1 Overview of CSA projects and practices in Ghana

6.1.1 Current CSA project.

The team through literature review and interview with key stakeholders identified some current initiatives around CSA in Ghana. There are several initiatives and projects focused on promoting Climate-Smart Agriculture practices in Ghana to boost food security and livelihoods while tackling climate challenges.

For example, the Ghana Climate-Smart Agriculture Programme (2016-2020) spearheaded this national effort through the Ministry of Food and Agriculture, using techniques like efficient irrigation, conservation farming and agroforestry to replenish soils. The focus was on improving water management, drought resistance, crop varieties and sustainable land use. The Adaptation Fund project in northern Ghana (2016-2022) a collaboration with UNDP also supported drought-resistant crops, rainwater harvesting and land management to strengthen agriculture against shifting conditions.

The International Fund for Agricultural Development (IFAD) has supported various projects focusing on CSA in Ghana to enhance agricultural resilience and sustainability. Some notable projects funded by IFAD includes; the Adaptation for Smallholder Agriculture Programme (ASAP), Ghana Agriculture Sector Investment Programme (GASIP), Rural Enterprises Programme (REP) and Savannah Investment Programme (SIP) Implemented between 2013 till date through partnerships with the Ghanaian government.

The USAID Feed the Future program such as Ghana Agriculture and Natural Resource Management (USAID AGNRM) 2016-2021 applies conservation agriculture, climate-matched seeds and improved water use.

In the cocoa sector, Fairtrade Africa's Climate-Smart Cocoa Project ensures cocoa's sustainability through dynamic agroforestry (DAF), conservation and eco-friendly practices. The Green Climate Fund strategic plan 2024-2027 seeks to enhance Ghana's rural communities by promoting integrated CSA, for example drought-resistant livestock and crops, agroecology and more.

ICRAF conducts valuable agroforestry and soil research, especially on trees' roles in resilience and mitigation. Collectively, these collaborations between government entities, donors, NGOs and communities work to safeguard agriculture from climate impacts and increase production for Ghanaians. Together they bring a diversity of sustainable livestock, crop, water and technology solutions.

The Sustainable Agriculture and Natural Resource Management (CRSP) project, implemented by SARI in the Upper West Region, focused on small-scale farmers and introduced techniques such as zero-till farming, crop rotation, residue management, and tied ridging. These techniques were well-received, with adoption rates between 30% and 60%, and their implementation was facilitated through farmer field schools. However, limited funding affected coverage. Similarly, the CODE-WA project, funded by ICRISAT-Niamey and targeting women smallholder farmers in Jonga, introduced crop diversity through sorghum, millet, and moringa to enhance adaptation. The farmer field school approach and sensory analysis were key to its success, but the project faced funding limitations, restricting it to one community.

The STMA I & II and AGG projects, supported by the Bill and Melinda Gates Foundation through IITA, conducted on-farm trials for stress-resistant maize varieties across the Upper East, Upper West, and Ashanti Regions. These initiatives developed high-yielding varieties but were limited to a few communities due to resource constraints. The Farmers' Service Centre Cooperatives (FSCCs) project, implemented by Technoserve and the Department of Cooperatives, aimed to support farmer groups in Nadowli-Kaleo, DBI, and Wa East through inventory credit schemes, post-harvest management, and privatized ownership models. These interventions improved incomes and group dynamics but highlighted the need for stronger financial mechanisms.

The ADVANCE 1 & 2 programs, funded by USAID and implemented across all districts in the Upper West Region, targeted small-scale farmer groups, particularly women. These projects provided training on Good Agronomic Practices (GAPs), record-keeping support, and access to tractors and shellers. They significantly increased farmer group numbers and promoted small-scale farmers to commercial farming levels. Meanwhile, the Emergency Rice Project by MoFA and SARI in Wa East introduced upland rice varieties and trained farmers and Agricultural Extension Agents (AEAs) on GAPs. Demonstrations and seed fairs improved adoption rates, though some logistical challenges were encountered.

Other notable projects include the Northern Rural Growth Project (NRGP) and the Sustainable Land and Water Management Project (SLWMP). The NRGF developed Farmer-Based Organizations (FBOs) and linked them to financial institutions, though challenges such as difficulty accessing matching grants persisted. The SLWMP promoted sustainable land management practices like tree planting, cereal-legume rotations, and bunding. These efforts were accompanied by watershed plans and timely logistics support, enhancing farmer ownership of the projects.

The Agricultural Services Sub-Sector Investment Program (AgSSIP) and the Livestock Development Project in Sissala West addressed logistics, improved planting materials, and livestock production. While they achieved capacity building and technology dissemination, setbacks emerged after project completions. Additionally, the Modernizing Agriculture in Ghana (MAG) initiative enhanced extension services, improved access to markets, and introduced climate-smart practices like drought-tolerant crop varieties and composting. These interventions significantly boosted productivity and reduced post-harvest losses.

Finally, projects such as the Climate Resilient Agriculture and Food System (CRAFS) in East Mamprusi trained farmers in bund construction and tree crop cultivation, while the Agriculture Technology Transfer initiative improved farmer knowledge on fertilizer use and conservation agriculture. Both projects highlighted the importance of farmer education and effective collaboration with local institutions for sustainable outcomes.

These initiatives collectively demonstrate the impact of targeted interventions on agricultural resilience and productivity in Ghana, addressing challenges such as climate change, resource constraints, and market access. However, funding limitations and sustainability issues remain areas for improvement.

List of past and ongoing programmes were compiled as part of the study (Appendix 1).

6.1.2 Overview of CSA practices in Ghana

Climate-Smart Agriculture is an approach defined by the Food and Agriculture Organization (FAO) as a means of transforming agricultural systems to support food security under changing climatic conditions. According to the World Bank, CSA is a set of agricultural practices and technologies which simultaneously boost productivity, enhance resilience and reduce GHG emissions. Although it is built on existing agricultural knowledge, technologies, and sustainability principles, CSA is distinct in several ways.

- First, it has a specific focus on addressing weather change inside the agrifood system.
- Secondly, CSA systematically considers the synergies and tradeoffs that exist among productivity, adaptation, and mitigation.
- Thirdly, CSA encompasses several practices and technologies which can be tailor-made to particular agro-ecological conditions and socio-financial contexts along with the adoption of weather-resilient crop varieties, conservation agriculture techniques, agroforestry, precision farming, water control strategies, and advanced livestock management.

Historical Context and Evolution: Globally, CSA emerged as a response to climate change's impact on food security. In Africa, CSA has gained momentum, especially with the establishment of regional frameworks like the African Union's Climate-Smart Agriculture Framework and initiatives led by organizations like NEPAD and FAO.

CSA is an approach that simultaneously addresses the challenges of food security and climate change. Its origins can be traced back to growing awareness of the impacts of climate change. The Food and Agriculture

Organization of the United Nations (FAO) formally introduced the concept at the Hague Conference on Agriculture, Food Security and Climate Change in 2010.

CSA was developed to be consistent with agricultural development with the goals of climate adaptation, mitigation and sustainability (FAO, 2010). An official CSA Agricultural system evolved in response to environmental challenges. The Green Revolution of the mid-20th century greatly increased food production using high-yielding crop varieties, chemical fertilizers, and machinery. But this revolution has led to environmental degradation. Soil degradation and water shortage urged experts to rethink agricultural strategies in the 1980s and 1990s. In response to this issue Sustainable agricultural practices started to gain attention (Pretty, 2008).

With increasing awareness of climate change, CSA has expanded from traditional sustainable agriculture to climate recovery and carbon sequestration. A focus on resilience has become essential because extreme weather events, droughts, and unpredictable seasons pose new risks to food production systems.

In the early 2000s, agriculture increasingly recognized the need to adapt to climate change through carbon sequestration. However, it is also alleviated through more efficient resource use (Campbell et al., 2014).

Over the years, the CSA has evolved to focus on three pillars: (1) increasing sustainable agricultural yields and incomes, (2) building adaptation and resilience to climate change, and (3) reducing and/or eliminating greenhouse gas emissions where possible. This development reflects a broader understanding of how agriculture interacts with the global environmental system, and the importance of balancing human needs with ecosystem management (Lipper et al., 2014).

CSA is now integrated into global agricultural development programs. It influences policies and practices aimed at achieving sustainable food systems in the face of climate change. International organizations, governments, and research institutions continue to develop and implement CSA guidelines to address the complex interplay of food security and climate flexibility.

The global CSA framework is largely influenced by the Sustainable Development Goals (SDGs) and the Paris Climate Agreement, which emphasize sustainable agricultural development while addressing climate change challenges. In Ghana, CSA is guided by policies such as the National Climate-Smart Agriculture and Food Security Action Plan (2016–2020), which aligns with the global CSA framework and local agricultural priorities.

Globally, CSA practices are diverse and vary by region. Common CSA techniques include:

- **Agroforestry:** Incorporating trees into agricultural systems to improve biodiversity, soil fertility, and carbon sequestration.
- **Conservation Agriculture:** Emphasizing minimal soil disturbance, crop rotation, and maintaining soil cover to improve soil health and water retention.
- **Integrated Pest Management (IPM):** Reducing reliance on chemical inputs by adopting biological pest control and sustainable farming methods.
- **Climate-Resilient Seeds:** Developing drought-tolerant and disease-resistant crop varieties.
- **Water Conservation:** Implementing techniques such as rainwater harvesting and drip irrigation to conserve water in drought-prone areas.

In Ghana, successful CSA practices include the promotion of drought-resistant crops, rainwater harvesting, and crop diversification. Traditional knowledge, particularly among rural communities,

plays a key role in CSA implementation. Farmers often use indigenous knowledge, such as the cultivation of legume-based rotations and the use of organic fertilizers to enhance soil fertility.

CSA is increasingly recognized in Ghana as a critical approach for building climate resilience and enhancing agricultural productivity.

In Ghana, various CSA practices are being implemented, reflecting the diversity of agricultural systems across the country. For instance, agroforestry is becoming increasingly popular among smallholder farmers in the northern region, where it helps to enhance biodiversity, improve soil health, and provide additional income sources through timber and non-timber products (Sain et al., 2017). Specific initiatives have been documented in areas such as the Upper West Region, where farmers are integrating tree crops with traditional crops to maximize yields. In the forest regions of Ghana, dynamic agroforestry practices have been adopted as the CSA approach.

Conservation agriculture has also gained traction, particularly in pilot programs in the Ashanti Region and northern Ghana. This practice emphasizes minimal soil disturbance, maintaining permanent soil cover, and crop diversification (crop rotation and intercropping) which collectively contribute to improved soil fertility and water retention. Despite its benefits, adoption rates remain inconsistent due to the deep-rooted traditional farming practices prevalent in many communities (USAID, 2016).

Another significant practice is the integration of regenerative agriculture techniques, which focus on restoring soil health, increasing biodiversity, and enhancing ecosystem services. This approach is particularly relevant in regions like the Volta Region, where farmers are experimenting with cover cropping and holistic grazing to regenerate degraded lands. Regenerative practices not only improve productivity but also build resilience against climate extremes (Ng'ang'a et al., 2017).

Moreover, **integrated crop-livestock systems** are being promoted in areas such as the Central Region, where the synergies between crop production and livestock farming enhance nutrient cycling and resource use efficiency. This practice is particularly beneficial for mixed farming systems, but challenges remain in resource allocation and knowledge sharing among farmers.

The use of **improved seed varieties** has seen active promotion by government and non-governmental organizations across various regions, including the Northern Region, where drought-resistant and high-yield seed varieties are crucial for coping with erratic weather patterns. However, access and affordability of these seeds continue to hinder widespread adoption (Williams et al., 2021).

Water management practices are also critical, with initiatives focused on rainwater harvesting and drip irrigation gaining traction in the Eastern Region. These methods help farmers manage water resources more effectively, reducing reliance on rain-fed agriculture.

Farmers perspectives on CSA

Out of the 54 farmers surveyed across the various ecological zones of Ghana, the adoption rates for CSA practices highlight the potential for transformative agricultural methods. These farmers, predominantly male (86.7%) and aged 45+ (66.7%), bring significant experience to the table, with 53.4% having over 10 years of farming practice and 73.3% holding tertiary education qualifications, which positions them to understand and apply innovative techniques effectively.

Key CSA practices adoption rate from figure 1. indicates significant adoption of conservation agriculture (85.7%), improved crop varieties (71.4%), and soil fertility management (57.1%). Agroforestry (42.9%) and water management techniques (35.7%) showed moderate uptake, indicating opportunities for increased promotion and education.

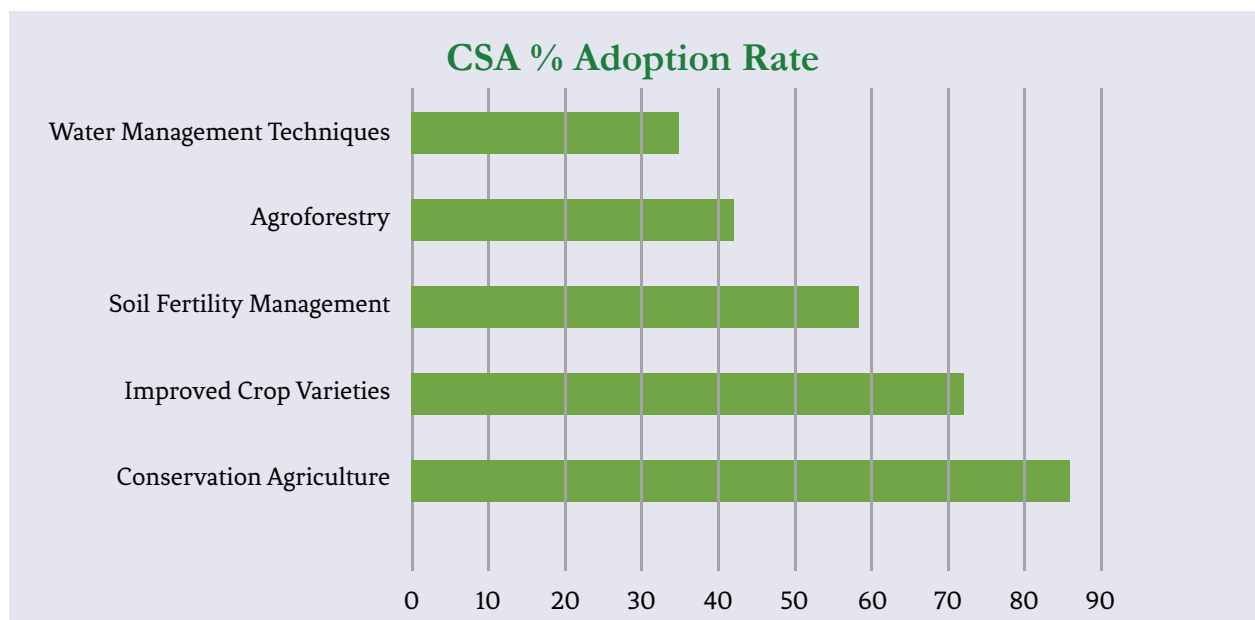


Figure 2: CSA practices Adoption Rate of Farmers

The study highlights the diversity of CSA practices across Ghana's ecological zones, their unique characteristics, and the tangible benefits reported by practitioners. It emphasizes the adaptability of CSA to local conditions and its role in enhancing resilience and productivity. These practices contribute to improved resource use efficiency and resilience, critical for addressing the challenges posed by climate change in Ghana.

Climate-Smart Agriculture offers solutions to the challenges posed by climate change on agricultural production.

Agricultural techniques or practices that contribute to achieving these pillars are considered climate-smart. However, individual techniques often perform differently across the three pillars. To maximize benefits and create a balanced impact, these practices must be integrated into a comprehensive CSA approach, combining their strengths to complement one another (World Bank, 2015; FAO, 2015).

In Ghana, CSA is recognized as a critical approach to addressing environmental degradation, enhancing agricultural productivity, and building resilience to climate change impacts. Ghana's agricultural sector, much like that of many other Sub-Saharan African countries, faces pressing challenges such as soil erosion, declining soil fertility, and unpredictable rainfall patterns—all of which threaten the livelihoods of smallholder farmers and the country's food security.

Key practices of CSA in Ghana

The three foundational principles of CSA—minimum or zero tillage, permanent soil cover, and crop diversification—have shown promise in Ghana for their potential to transform traditional farming systems and stabilize crop production. In fact these form the foundation Climate Adaptation which is a CSA practice adaptive across all ecological zones.

1. Minimum or Zero Tillage:

By reducing soil disturbance, CSA helps maintain soil structure, retains soil moisture, and minimizes erosion. This practice addresses common issues in Ghanaian agriculture, where conventional tillage often leads to nutrient loss and soil degradation. With reduced tillage, soils retain organic matter and support beneficial microorganisms, fostering a healthier soil environment for crops. Fuseni Bubon employs minimal tillage to conserve water and prevent soil degradation. He also uses grass and stone bunding to mitigate soil erosion and maintain fertility. "This method holds enough water for plants and protects the soil," Fuseni noted.



Image 1: Pictorial view of zero tillage at Loggu in the Upper West Region

2. Permanent Soil Cover:

CSA promotes the use of crop residues or cover crops to protect the soil surface. This practice has proven valuable in Ghana's semi-arid and savannah regions, where it can reduce moisture evaporation, prevent erosion, and improve water infiltration. Soil cover also contributes to weed suppression, reducing the need for chemical inputs and lowering production costs. Over time the residue decomposes to increase soil organic carbon and improves the structure of the soil. Dead cover cropping was identified as very common in the transitional and savana zones. This provides an avenue for the promotion of live soil cover such as canavalia and mucuna in these areas to support adopters of the practice.

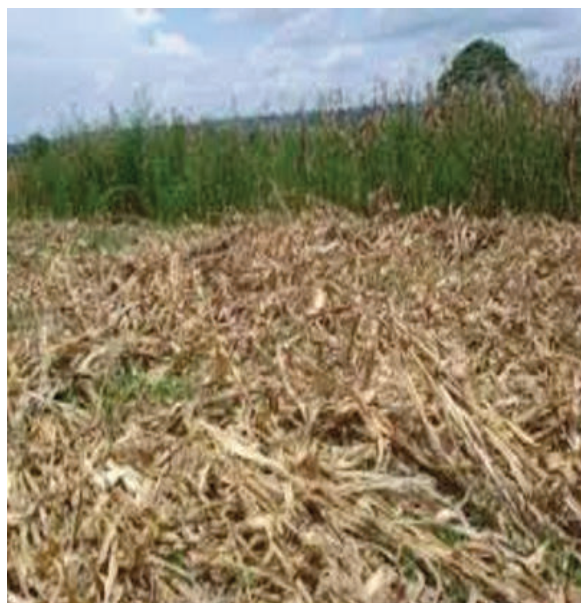


Image 2: Pictorial view on soil cover in Nkawie in Ashanti Region

3. Crop Diversification/Diversified Farming Systems:

By encouraging crop rotation and intercropping, CSA enhances biodiversity and nutrient cycling in the soil, making agricultural systems more resilient. In Ghana, crop diversification helps reduce pest and disease pressures, builds resilience against market fluctuations, and supports the health of the soil by naturally replenishing nutrients. James Opoakpojor utilizes an integrated farming system that combines fish, chickens, ducks, rabbits, goats, bees, mushrooms, and various crops like plantains, pawpaw, and cassava. He leverages animal waste as organic fertilizer and household urine as a natural weedicide. "Waste from the poultry farm fertilizes my crops, and I use household urine instead of weedicides," James shared.



Image 3: Pictorial view of crop diversification in Walewale in the North East



Figure 3: Key Principles of CSA

4. Water Management:

Rainwater harvesting and small-scale irrigation systems are prevalent. Farmers use storage tanks and pits to collect rainwater, ensuring a steady water supply during prolonged dry seasons. The practitioner remarked, "With rainwater harvesting through soil and water harvesting techniques, I no longer worry about water shortages affecting my crops." Improved yields and reduced input costs have contributed to enhanced household income stability and food security in the region.



Image 4: Picture of Zai pit technology in North East region

5. Regenerative Agriculture:

Practices such as minimum tillage, cover cropping, and mulching help to improve soil moisture retention and reduce erosion. These methods have been widely adopted due to their visible benefits in maintaining soil fertility and enhancing crop yields. Revitalizing degraded, arid land (e.g., sandy soils in Gundoug) by planting diverse vegetation and trees to enhance fertility and mitigate climate change effects.



Image 5: Regenerative Agriculture in Gundoug in the Bono East region

6. Agroforestry:

Nitrogen-fixing tree species, such as *Faidherbia albida*, and other indigenous tree species including shea, dawadawa, etc are integrated into farming systems to improve soil fertility and provide shade for crops during extreme heat. Nana Kwaw grows a variety of crops including mango, royal palm, oil palm, guava, cashew, and neem trees, rejecting monocropping. He uses neem leaves as a pest repellent and allows animals to roam free, contributing to natural fertilization. "When you apply [man-made] fertilizers, they feed only the plants, not the soil. Compost nourishes both the soil and the plants," Nana explained. "Through mulching and agroforestry, my farm retains more water, and my yields have doubled in the last two seasons." The integration of agroforestry has also provided additional income streams through the sale of tree products like fuelwood and fruits.



Image 6: Agroforestry in CSA Forikrom in the Bono East Region

7. Integrated Farming Systems:

- Rearing multiple livestock (fish, chickens, ducks, rabbits, goats) alongside crops (plantain, pawpaw, cassava).
- Waste from animals used as fertilizer for crops, and crop waste fed to animals (circular nutrient flow).

8. Use of Organic Inputs:

- Household urine used as an alternative to weedicides and pesticides.
- Animal droppings and farm weeds utilized as natural compost.

9. Biodiversity and Polycropping:

- Planting diverse crops like mango, cashew, neem, avocado, yam, and oil palm to maintain soil fertility and encourage ecological balance.
- Avoidance of monocropping to protect soil health and mitigate pests and diseases naturally.

10. Pest and Weed Control:

- Neem trees used as natural pest repellents.
- Avoidance of synthetic chemicals like glyphosates.
- Natural Pest Control:

Farmers use natural solutions like neem leaves, bitter leaves, and even human urine mixed with potash to manage pests and weeds. “We mix urine, potash from cocoa pods, and African black soap to kill weeds,” James reported.

11. Soil Fertility Management:

- Adoption of composting to nourish the soil organically instead of synthetic fertilizers.
- Encouraging grazing by livestock to naturally fertilize fields.

The Savannah zone exhibits large tracks of land suitable for cultivation but is constrained by poor soil quality and water scarcity. Farmers in the north have embraced CSA practices as a means to adapt to these harsh climatic conditions while maximizing productivity.



Climate Smart Agricultural Practices in the Savannah Zone of Ghana.

In Ghana's savannah agro ecological zone, climate-smart agricultural practices are critical to effectively adapt to the negative impacts of climate change and variability as well as assure food security and overall agricultural productivity. The savannah zone covers the five regions of the north and is plagued by challenges such as intermittent rainfall, droughts and soil degradation. Therefore, CSA practices are crucial to building resilience against these vulnerabilities whilst increasing the adaptive capacities of farmers.

For instance, conservation agriculture is extensively being promoted by various stakeholders in the agricultural sector and is partly adopted by farmers in the zone. The CA principle of crop diversification (crop rotation and intercropping) is widely adopted by farmers, while the adoption of principles, minimum soil disturbance and maintenance of dry season soil cover remains low largely due to inadequate tillage equipment, bush fires, and indiscriminate grazing practices.

Agroforestry is widely adopted, either consciously or unconsciously by farmers, with the incorporation of economic trees such as shea, cashew, mango, dawadawa in most farms. The use of drought resistant crop varieties is continuously promoted and accepted by farmers. Mulching is traditionally practiced on selected crops such as yam and dry season vegetable production to conserve soil moisture.

In terms of farmer training and capacity building, majority of agricultural projects, NGOs and the Department of Agriculture promote CSA practices through field demonstrations, farmer field days, training programmes, radio and other innovative extension approaches to disseminate CSA information to farmers.

Farmers within the zone are being trained and encouraged by agricultural stakeholders to explore alternative livelihood sources such as shea butter production, beekeeping, soap making and other agro-processing activities in a quest to reduce intense cultivation of the land.

On the contrary, CSA practices such as rainwater harvesting techniques, smart irrigation systems, composting and biochar production, early warning systems to predict weather, pest and disease and integrated pest management strategies are underdeveloped and require more attention. Conclusively, CSA practices have the potential to reduce the impact of climate change on farming, ensure food security and sovereignty, sustain land productivity and improve livelihoods. CSA is critical for the savannah agroecological zone to build resilience against future climate risk to agriculture.

The Transition zone serves as an intermediate region with a mix of Savannah and forest characteristics. It benefits from moderate rainfall and fertile soils, making it a key agricultural hub for diverse crops.

The Transition zone has better access to markets and agricultural extension services compared to the Savannah zone. This region showcases a balanced integration of traditional farming methods with modern CSA practices. Farmers in this zone have experienced reduced pest infestations and increased crop productivity. One farmer shared, "Using improved maize varieties and intercropping with legumes has not only boosted my yields but also cut down my expenses on fertilizers." Another noted, "Agroforestry has been a game-changer. The trees protect my crops from strong winds and extreme hot weather, and I earn extra income from selling fruits." Improved soil health and market access have further solidified the region's agricultural output.

CSA Practices Most Common in the Transitional Zone

The transitional area of Ghana has its peculiar agroecology combining the ecological setting of the Savannahs and the semi-deciduous zones. Essentially, providing hybrid ecological conditions to support agro-food systems. This blurb would illustrate some common CSA practices in the transitional zone of Ghana.

Agroforestry– The zone heavily practices agroforestry largely focusing on cashew and cocoa systems. Food crops such as yam, cocoyam, cassava, maize, plantain, are mostly intercropped with the main crop until canopy formation. Some cocoa farmers are under organic, fair trade, and Rainforest Alliance (RA) certification which promote Eco safe practices.

Nana Kwaw grows a variety of crops including mango, royal palm, oil palm, guava, cashew, and neem trees, rejecting monocropping. He uses neem leaves as a pest repellent and allows animals to roam free, contributing to natural fertilization.

“When you apply [man-made] fertilizers, they feed only the plants, not the soil. Compost nourishes both the soil and the plants,” Nana explained.

Organic Vegetable Production – The transitional zone has a high level of poultry production and vegetable farmers use poultry manure in producing vegetables. The main vegetables cultivated in the zone are tomato, carrots, cucumber, green pepper, and garden eggs. Integrated Pest Management (IPM) practices are most prevalent in vegetable production especially organic pesticides and crop rotations.

Irrigation Farming – Irrigation farming is not very common in most food system of the transitional zone due to the bimodal rainfall system although there is a huge potential. Irrigation farming is used in vegetable production and early-stage agroforestry establishment.

Use of Soil Cover – The transitional zone adopts soil cover (mainly crop residue) from previous season’s production. A few farmers use live cover crops but mostly *Mucuna*. Slash and burn practices are also very minimal in practice due to what most farmers believe in local Palance as “Pro ka” which means natural organic decomposition. This practice improves soil microbial activity which increases soil fertility.

The Coastal and Forest zones are marked by high humidity, relatively stable rainfall, and susceptibility to flooding and soil erosion. CSA practices here emphasize soil and water conservation, as well as biodiversity preservation.

In this region CSA is characterised by the use of efficient irrigation systems to maximize water use and reduce dependency on inconsistent rainfall. Farmers plant high-value tree species like cocoa, plantain, coconut and oil palm alongside food crops to diversify incomes and improve ecosystem health. The Coastal and Forest zones boast fertile soils but are prone to extreme weather events like storms and flooding. Farmers have leveraged CSA practices to mitigate these risks and sustain agricultural productivity in the Central and cocoa growing regions, cocoa farmers have embraced shade-grown cocoa systems by planting indigenous trees such as Mahogany, *Albizia*, *Terminalia superba* and *Gliricidia sepium* alongside their cocoa crops. According to research conducted by the International Institute of Tropical Agriculture (IITA, 2020), this agroforestry practice increased cocoa yields by 15% due to the improved microclimatic conditions created by the shade trees. Additionally, the integration of trees has enhanced biodiversity, providing habitats for beneficial insects and birds, and generated supplementary income for farmers through the sale of timber, further strengthening their economic resilience.

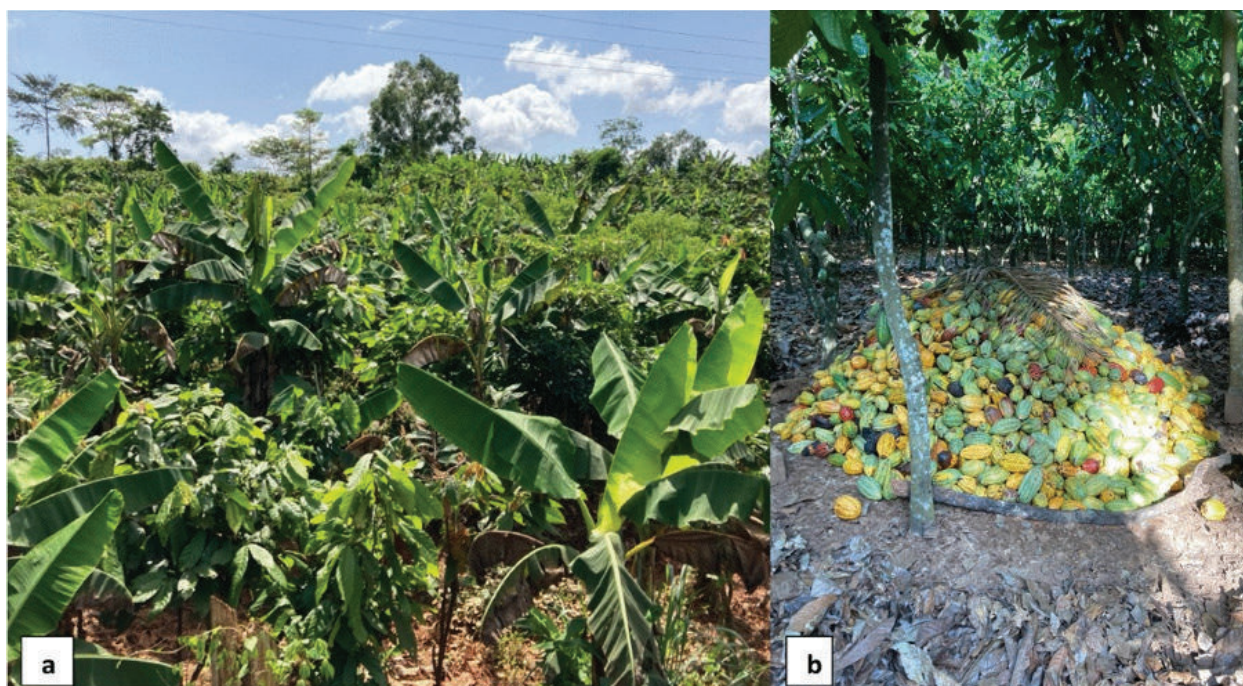


Image 7: Dynamic Agroforestry in Assin Fosu in the Central Region.

Contour farming and terracing have significantly reduced soil loss and improved crop yields. A practitioner highlighted, "My fields used to lose so much topsoil during heavy rains, but since I started contour farming, my crops are thriving."

Agroforestry has provided long-term economic benefits through the production of cash crops and timber. Another farmer noted, "Combining cocoa with other crops like plantains has helped me maximize my land use while earning steady income year-round."

Drip irrigation systems have also been lauded for their efficiency, with one practitioner stating, "Drip irrigation has cut my water usage in half, and my yields have improved by 30%." These successes have underscored the transformative impact of CSA practices in these zones.

CSA presents a sustainable pathway for Ghana's agricultural sector, addressing soil health, productivity, and resilience challenges. While the road to widespread CSA adoption may involve overcoming resource and knowledge barriers, the potential benefits for smallholder farmers and national food security make CSA a worthwhile investment.

By focusing on CSA, Ghana can work towards building a resilient agricultural sector that supports both economic and environmental goals whilst actively contributing to the country's attainment of the NDCs.

6.2 Benefits of implementing CSA practices.

The implementation of Climate-Smart Agriculture (CSA) practices across Ghana has demonstrated considerable economic and environmental benefits, with outcomes varying across the Savannah, Transition, and Coastal/Forest agro-ecological zones. These results affirm CSA as a transformative pathway for sustainable agricultural growth, climate resilience, and poverty alleviation, especially for smallholder farmers who are most vulnerable to climate variability.

CSA enhances crop productivity, stabilizes food systems, and improves rural incomes by integrating practices that boost soil health, increase water-use efficiency, reduce dependency on agrochemicals, and cost saving in the long run. In a country where agriculture remains the backbone of rural economies, CSA supports Ghana's broader goals of food security, reduced poverty, and environmental sustainability.

The implementation of CSA practices across Ghana has yielded significant economic and environmental benefits. These benefits vary across the Savannah, Transition, and Coastal/Forest zones, reflecting the unique characteristics and challenges of each region.

The findings highlight CSA as a viable pathway for sustainable agricultural growth and poverty alleviation in Ghana. For smallholder farmers, CSA offers numerous benefits, including:

- **Increased Crop Yields and Income:** CSA practices improve soil fertility, enhance water efficiency, and increase crop resilience, leading to higher yields and potentially higher incomes for farmers. This is particularly significant in Ghana, where the agricultural sector is the backbone of rural economies.
- **Enhanced Food Security:** By stabilizing crop production and reducing the risks of crop failure, CSA contributes to household and national food security. It supports Ghana's goal of reducing rural poverty and dependence on food imports by making agricultural systems more resilient to environmental shocks.
- **Environmental Sustainability:** CSA helps protect Ghana's natural resources by promoting sustainable land and water management practices. These practices can mitigate the impacts of climate change by improving carbon sequestration in the soil and reducing the need for chemical inputs.

The findings below provide an in-depth analysis of these outcomes with specific examples drawn from the study data.

6.2.1 Success Stories of CSA Practices from Practitioners.

1. Crop Production

Farmers like James Opoakpojor have integrated crop diversity on their farms,

growing plantains, pawpaw, cassava, and organic mushrooms. This diversified cropping system minimizes pest outbreaks and optimizes nutrient recycling. Waste from poultry is used as fertilizer for crops, while plant waste feeds livestock, forming a self-sustaining agroecological system. "The waste produced by the animals is used to feed the soil on which the plants grow, and waste from the plants feeds the animals."

2. Livestock Integration

CSA embraces livestock integration, as seen in James Opoakpojor's farm with chickens, ducks, rabbits, and goats. Livestock droppings are used as natural fertilizer, boosting soil health and crop yields. "Animal droppings and crop residue on the farm serve as fertilizer."

3. Natural Pest and Weed Control

Farmers like Opoakpojor and Bubon use natural methods such as neem leaves, bitter leaves, and even human urine to manage pests and weeds, avoiding harmful agrochemicals. "The latest discovery we have made is the use of human urine to kill weeds... African black soap mixed with urine and potash works effectively."

4. Agroforestry and Soil Conservation

Fuseni Bubon planted trees like moringa, cashew, and mango to combat land degradation. Grass and stone bunding techniques are employed to prevent erosion. These practices transformed barren land into lush vegetation, creating microclimates conducive to farming. "When there are trees on your farm, they shed their leaves, moderate sunshine, and add nutrients to the soil."

5. Minimal Tillage and Soil Health Management

Minimal tillage is employed to retain soil structure and moisture, essential for crop survival in arid conditions. "This helps plants hold enough water for them to grow well compared to using tractors, which destroy the land."

6.2.2 The Economic Benefits of CSA

The adoption of CSA practices has led to significant economic benefits for farmers. With 93.3% of the surveyed farmers reporting positive financial impacts, the benefits include increased crop yields (71.4%), reduced input costs (57.1%), and higher farm income (57.1%). This financial transformation underscores the potential for CSA to enhance the livelihoods of farmers, particularly those with substantial farming experience (53.4% had over 10 years of practice).

The high levels of education among the farmers (73.3% tertiary) further supported their ability to capitalize on these practices, integrating them effectively into their farming systems to maximize economic returns.

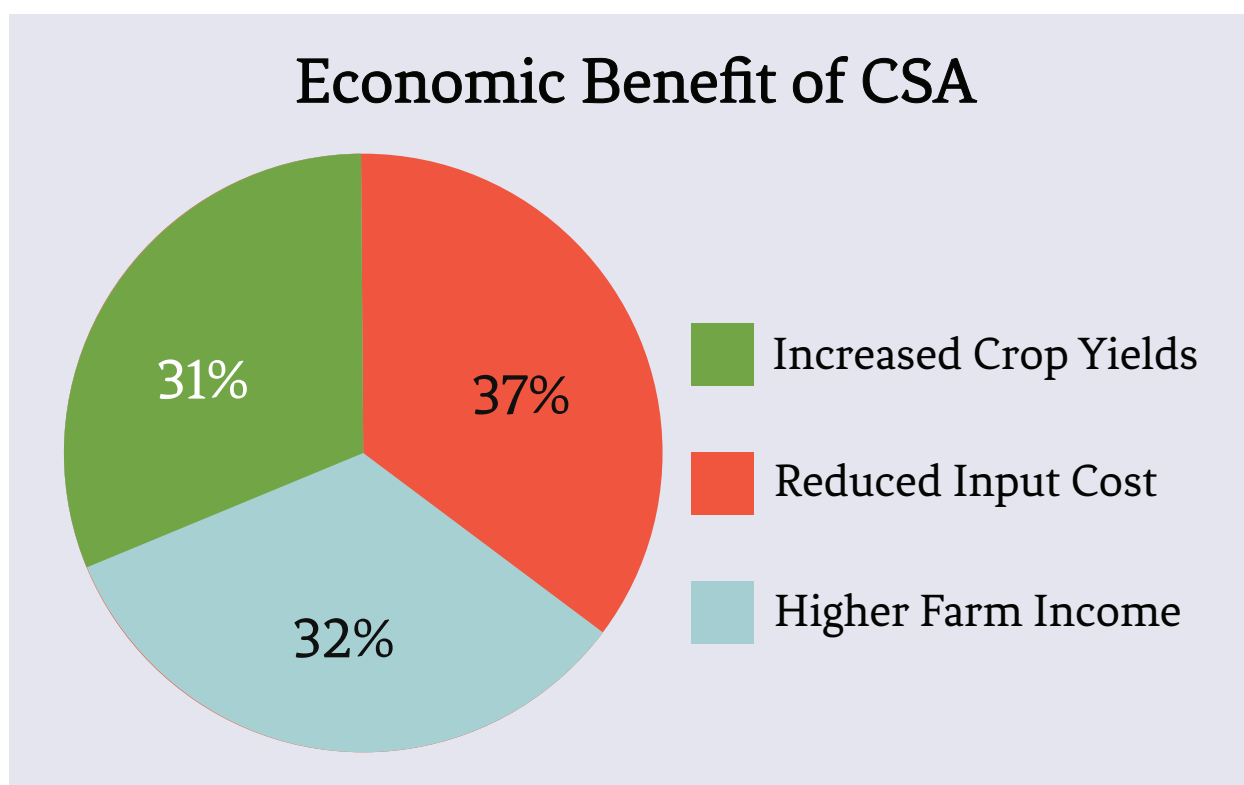


Figure 4: Economic Benefits of CSA

1. Enhanced Soil Fertility = Lower Fertilizer Costs + More Profits

Farmers using compost and animal manure (instead of only chemical fertilizers) in places like Upper East and Northern Ghana report a 25–40% reduction in fertilizer expenses. For a maize farmer cultivating 2 acres, this could mean saving up to GHS 600 per season, while also improving soil quality for future harvests.

2. Sustainable Resource Use = Reduced Input Dependency

By reusing crop residues, producing biochar, or applying livestock waste, farmers create closed-loop systems. In Techiman, tomato growers reported cutting external input needs by 30%, translating into significant cost savings and increased farm self-sufficiency.

3. Climate Resilience = Fewer Crop Losses During Droughts

Polycropping (e.g., maize with cowpea) and the use of drought-tolerant varieties shield farmers from complete losses. In the 2022 dry spell, farmers in Sissala East who practiced polycropping had at least 60% yield retention, compared to only 30% in single-crop systems—helping protect GHS 2,000–3,000 worth of farm income per household.

4. Reduced Health Costs = Safer Farming & More Days of Work

Switching from synthetic pesticides to biopesticides like neem extract reduces illness. In the Ashanti Region, farmers reported fewer hospital visits (saving ~GHS 150 annually) and fewer days lost to pesticide-related health problems, increasing productivity.

5. Biodiversity Conservation = Long-Term Ecological Services

Agroforestry (intercropping with trees) supports pollinators, natural pest control, and moisture retention. Mango and moringa intercropping in Northern Ghana not only improves yields but also opens up new income streams through fruit and leaf sales (up to GHS 1,000/year).

6. Economic Savings = Reduced Reliance on Expensive Agrochemicals

By producing inputs on-farm (e.g., compost, natural pest control), farmers avoid price shocks. A farmer using compost and homemade pest solutions could save over GHS 800 annually compared to one relying on synthetic inputs alone.

7. Improved Yields + Land Restoration = Higher Revenue from Marginal Lands

On previously degraded plots in Bawku and Tolon, CSA techniques (like zai pits and cover cropping) have restored land productivity from 0.5 MT/ha to 2.5 MT/ha for maize—translating into an extra GHS 1,200–2,000 per acre depending on market prices.

8. Increased Crop Yields and Income Stability

- In the Savannah zone, conservation agriculture practices such as minimum tillage and mulching have resulted in yield increases of up to 50% by farmer that have adopted the same. A farmer in the Upper East Region remarked, "Before adopting mulching, my millet barely survived the dry spells, but now my yield is consistent, and I have enough to sell at the market."

Improved crop yields have translated directly into increased household incomes and greater food security.

- In the Transition zone, the adoption of drought-resistant crop varieties and intercropping systems has reduced farmers' dependence on external fertilizers and pesticides. A farmer in Ejura shared, "By intercropping maize with beans, I've saved money on inputs and still achieved higher yields. My family's income has grown by 30% this season." This economic benefit is critical for smallholder farmers who rely heavily on agriculture for their livelihoods.
- In the Coastal and Forest zones, agroforestry systems integrating cocoa with food crops have diversified income streams. Farmers reported earning additional revenue from fruits and timber while maintaining steady cash flow from cocoa. A cocoa farmer in the Central Region stated, "Planting coconut trees along my cocoa farm has given me an extra income source, which helps me invest in better farm management."

9. Cost Savings through Resource Efficiency

- Drip irrigation in the Coastal and Forest zones has significantly reduced water usage, cutting costs associated with water procurement. For instance, farmers in the Volta Region noted a 40% reduction in water expenses due to efficient irrigation techniques.
- In the Savannah zone, agroforestry practices, such as planting nitrogen-fixing trees, have reduced farmers' reliance on expensive chemical fertilizers, saving an average of GHS 500 per hectare annually.

10. Enhanced Market Access

- Farmers practicing CSA have reported better access to premium markets due to higher-quality produce and increased volumes.

In the Transition zone, farmers using improved post-harvest storage techniques have reduced losses by 25%, allowing them to meet market demands consistently. One farmer stated, "With proper storage, I can sell my produce when prices are higher, which has boosted my earnings."

6.2.3 Environmental Benefits of CSA

CSA practices have delivered significant environmental benefits across Ghana's diverse agro-ecological zones, supporting both ecosystem restoration and sustainable agricultural development. Insights from field interviews, case studies, and expert consultations demonstrate that CSA is not only a strategy for productivity but also a framework for environmental stewardship.

Soil Health Improvement

Across all zones, CSA practices have improved soil fertility and reduced erosion. In the Savannah zone, minimum tillage and mulching have enhanced soil organic matter, leading to more resilient cropping systems. A practitioner noted, "My soil was becoming barren, but with mulching, I can now grow crops even in harsh conditions." In the Coastal and Forest zones, contour farming and terracing have minimized topsoil loss during heavy rains, preserving the land's productive capacity for future generations. Composting, organic manure application, and integration of livestock systems have boosted soil microbial activity and nutrient retention.

Carbon Sequestration and Climate Mitigation

Agroforestry systems in the Transition and Coastal zones contribute to carbon sequestration, mitigating greenhouse gas emissions. In the Western Region, farmers planting boundary trees along cocoa farms reported that the shaded environment has increased biodiversity while capturing significant amounts of carbon. Experts emphasized that crop residue retention and organic amendments also enhance carbon storage in soils, supporting long-term climate mitigation.

Water Resource Conservation

CSA techniques such as rainwater harvesting in the Savannah zone and drip irrigation in Coastal and Forest zones have greatly improved water-use efficiency. These practices allow farmers to maintain production during periods of water scarcity, reducing over-extraction from natural water bodies. Conservation agriculture also improves soil water retention, making farms more drought-resilient.

Biodiversity Enhancement

Agroforestry and polycropping practices encourage the growth of diverse flora and fauna. In the Ashanti Region, a farmer shared: "My farm attracts more birds and insects now, which has helped with pest control and pollination." The use of natural pest control—such as neem leaves, bitter leaves, and biological insecticides—has reduced chemical pollution and promoted ecological balance.

Climate Resilience

CSA enhances resilience to climate shocks. Farmers in the Savannah zone reported that rainwater harvesting systems enabled them to withstand extended dry seasons without significant crop loss. Improved crop varieties adopted in the Transition zone have adapted well to fluctuating rainfall patterns, ensuring consistent harvests. These strategies enhance the capacity of smallholder farmers to manage climate variability.

Reduction in Chemical Dependency

Respondents emphasized the reduction in synthetic agrochemical use due to CSA practices. Organic inputs and natural soil amendments reduce the need for chemical fertilizers and pesticides, resulting in lower environmental toxicity and improved health outcomes for farmers.

Specific Examples Across Zones

- **Savannah Zone:**
 - A farmer in the Northern Region practicing minimum tillage and mulching achieved a 60% yield increase in sorghum while reducing soil erosion by 30%.
 - Rainwater harvesting systems in the Upper East Region enabled two cropping cycles annually, doubling income potential.
- **Transition Zone:**
 - Intercropping maize with legumes in Ejura improved soil nitrogen levels, reducing the need for synthetic fertilizers and resulting in a 40% cost savings per hectare.
 - Agroforestry systems incorporating *Gliricidia sepium* provided firewood and stabilized soil on hilly farms.
- **Coastal and Forest Zones:**
 - Farmers in the Central Region using contour farming saw cassava yields increase by 25%, with significantly reduced topsoil loss.
 - Agroforestry systems integrating cocoa with plantains and coconut trees in the Volta Region created diverse revenue streams and enriched biodiversity.

Expert Validation: CSA experts surveyed in the study highlighted that these environmental benefits stem from improved soil structure, enhanced water retention, greater biodiversity, and reduced chemical runoff. One expert stated, "CSA controls erosion, improves life in the soil, enhances organic matter, and ensures long-term productivity."

In summary, CSA in Ghana is delivering environmental co-benefits that support sustainable agriculture. By improving soil health, water efficiency, and ecological stability, CSA strengthens the resilience of agricultural systems to climate risks while contributing to global climate and biodiversity goals.

Why Ghana Must Adopt a National CSA Strategy

Ghana faces increasing climate change impacts such as rising temperatures, erratic rainfall, and prolonged droughts, which threaten food security and livelihoods, particularly in the northern regions and the transition zone. CSA practices offer sustainable solutions to these challenges. By integrating these approaches into a national strategy, the government can ensure ecological resilience, improved agricultural productivity, and enhanced livelihoods for rural communities.

The stories of farmers like James, Nana, and Fuseni demonstrate the transformative potential of CSA practices in Ghana. These methods not only yield high-quality, chemical-free produce but also protect and restore ecosystems. Moreover, the economic benefits extend beyond individual farmers to entire communities, as Fuseni notes:

"The whole community benefits from my farming practices. People come to me for organic turkey berries even when they are prescribed at the hospital."

Adopting CSA at scale aligns with Ghana's sustainability goals, enabling it to meet international climate commitments while addressing pressing local challenges. By investing in training, research, and financial incentives for CSA, the government can position Ghana as a leader in sustainable agriculture.

Adopting a national CSA/agroecology strategy is not just a necessity but a pragmatic solution for Ghana's agricultural challenges. Evidence from farmers like James, Nana, and Fuseni demonstrates the transformative potential of CSA practices in combating climate change, improving soil health, and increasing farm productivity. Through agroecology, barren lands have been revitalized, yielding lush vegetation and creating self-sustaining ecosystems.

Moreover, CSA practices reduce reliance on synthetic inputs, ensuring healthier produce and protecting human and environmental health. The economic resilience of these farmers showcases the potential to boost incomes and improve food security nationwide. As Mr. Bubon noted, “Agroecology moderates sunshine, improves biodiversity, and tackles global climate challenges.”

A national CSA strategy will foster capacity building, promote sustainable practices, and attract investments in green farming. By scaling these proven methods, Ghana can create a more climate-resilient agricultural system, addressing food insecurity and improving livelihoods. This national effort will help transition farmers from chemical-dependent systems to regenerative agriculture, ensuring long-term food security, climate resilience, and economic growth.



6.2.4 Cost Benefit Analysis

Cost-Benefit Analysis of Climate-Smart Agriculture Across Ecological Zones in Ghana

This section presents a detailed Cost-Benefit Analysis (CBA) of CSA practices adopted across Ghana’s three major ecological zones: Savannah, Transition, and Coastal/Forest. The analysis assesses the economic viability of selected CSA interventions based on data collected from farmer case studies, key informant interviews, and literature review.

Economic Evaluation Methodology

The cost-benefit analysis (CBA) approach used in this study adopts the following general economic evaluation formula:

$$\text{Net Present Value (NPV)} = \sum (B_t - C_t) / (1 + r)^t$$

Where:

B_t = Benefits in year t

C_t = Costs in year t

r = Discount rate (10% used in this study)

t = Time (in years)

The analysis covers a five-year projection, focusing on yield improvements, input savings, and profitability over time. The benefits are quantified as income generated from increased yields and savings on inputs, while costs include investments in seeds, fertilizer, labour, and water-saving infrastructure. The net present value indicates the value of the farmer's investment today over a five year period. The rule of thumb for NPV assessment is to accept all projects with positive NPV. An NPV of zero indicates that there is a breakeven of the investment in the fifth year and positive figures could be recorded from the sixth year (*ceteris paribus*). The NPV further uses real figures for projection considering the fact that it applies the principle of "discount factor" in the computation process. Although outcomes are recorded in absolute figures, the implication of those figures are real taking into account the time value of money.

1. Savannah Zone (Maclog Farms - Soybean/Sorghum)

Key CSA practices undertaken by Maclog Farms include minimum tillage, mulching, rainwater harvesting, and agroforestry. Yields for sorghum increased by 60%, while soil erosion was reduced significantly. Rainwater harvesting supported double cropping, boosting annual revenue. Based on the analysis of the case study for the Savannah zone on the soybean and sorghum combination, it was realized that the farmer would get 15 times more from his initial investment using the pessimistic scenario in five years' time if he continues to adopt his current practices. The pessimistic scenario indicates what happens in a worse case considering the farmer's current practices. This is a huge boost for the upscaling of CA practices largely because variable costs such as labour, fertilizer, pesticides, herbicides use continue to decline over time whilst revenues increase at an increasing rate. This situation would further drive variable cost to insignificant levels.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	400 (bags) soybean x 500 = 200,000 200,000/1.61 = GHS 124,223	7,500 (seeds) + 5,200 (labour) = 12,700 12,700/1.61 = GHS 7,888	124,223/7,888 = 15.74	Low initial cost of tillage and reduced variable cost over time leads to high BCRs even considering the pessimistic scenario Secondly, the volatile nature of soybean prices affects revenue uncertainty but these risks are offset by low variable cost over time.
Baseline	650 (bags) soybean x 700 = 455,000 GHS455,000/1.61 = GHS 282,608	10,000 (seeds) + 9,000 (labour) = GHS19,000/1.61 = GHS 11,801	282,608/11,801 = 23.94	
Optimistic	1,000 (bags) soybean x 900 = GHS900,000/1.61 = GHS 559,006	12,500 (seeds) + 10,000 = GHS22,500/1.61 = GHS 13,975	559,006/13,975 = 40.00	

Agroforestry practices is one of the foremost CSA practices due to its combined effect on the environment as well as soil health. These contributions enhance sustained productivity and income. The study revealed cashew-shea agroforestry practices with cereals or legumes stands the chance of increasing land productivity by 50%. The probabilistic CBA model revealed that the combination of cashew-shea using baseline data would lead to a BCR of 21.93 implying that for every GHS1 of investment made in the cashew-shea agroforestry system would generate benefit of about 21 times over 8 years. This situation is expected to increase considering the fact that shea fruiting may increase at an increasing rate from the tenth year whilst cashew yields would be producing at peak levels. This is particularly the case since the variable cost per unit would be virtually insignificant with such a system. The use of Farmer Managed Natural Regeneration (FMNR) approaches in growing shea would further reduce the cost of seedlings for an integrated cashew shea agroforestry system. Also, considering a pessimistic approach, the farmer is still better-off with such a system with the farmer reaping about 13 times of every GHS1 invested. Table 2 illustrates the cashew-shea agroforestry-based scenario for the Savannah zone.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	300 cashew x 500 =150,000 150,000/2.14 = GHS 70,093	3,000 -(seedlings) + 8,000 (inputs) = 11,000 8,000/2.14 = GHS 5,140	70,093/5,140 =13.75	High initial cost of farm establishment. However, variable cost over time reduces drastically leading to high BCRs even under a pessimistic scenario
Baseline	420 cashew x 680 = 285,600 GHS285,000/2.14 = GHS 133,177	2,500 (seedlings) + 10,500 (inputs) = GHS9,000/2.14 =GHS 6,074	133,177/6,074 = 21.93	Secondly, the price controls introduced in the sector increases price and revenue certainty and reduces market risk. Adoption of CSA practices anticipated to increase yields resulting in an overall positive outcome
Optimistic	550 cashew x 750 = GHS412,500/2.14 = GHS 192,757	3,000 (seedlings) + 13,500 (inputs)= GHS16,500/2.14 =GHS 7,710	192,757/7,710 = 25.00	

Table 3 illustrates a probabilistic CBA scenario for the savannah zone with the crop-livestock integration with particular focus of maize/sorghum-cattle integration. The model sought to evaluate under different scenarios with 55 cattle as baseline and modelling at different prices in the pessimistic and optimistic categories. The model indicates that the BCR for the baseline level as well as pessimistic categories would yield virtually the same (11 times) returns over a 5-year period whilst the optimistic scenario would yield 15 times returns for every GHS1 of investment made into this system. The major cost of production in this system is feed and medication cost (endo and ecto-parasitic attacks). The later stands the chance of been heavily reduced considering the ecological zone of domiciliary. Feed cost is further reduced in the dry season since most of the feed is generated from the stalks or residues from crop production prepared and stored for utilization. The case study further revealed a reduction in labour cost in shepherding the cattle in dry season since during the period the cattle is kept mostly in an intensive system with occasional free-range grazing. The increased overall revenue generation from crop production for the first four years of implementation whilst revenues from the cashew cascades revenues generated over the period in cumulative terms.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	55 cattle x 8,000 = 440,000 440,000/1.61 = GHS 273,291	3,000 -(seedlings) + 8,000 (inputs) = 11,000 8,000/2.14 = GHS 5,140	273,291/24,844	Relatively low initial cost resulting from the agro-ecology under consideration. Variable cost is high for the initial resulting in an overall cost for the first 3 years. This leads to minimum BCRs for baseline and pessimistic scenario Secondly, price and market forces may lead to low unit prices. However, the diverse revenues from crops, beef, and milk would smoothen the risk curve positively.
Baseline	55 cattle x 10,000 = 550,600 GHS550,000/1.61 = GHS 341,614	10,000 (medication) + 40,000 (feed and labour) = GHS50,000/1.61 =GHS 31,055	341,614/31,055 = 11.00	
Optimistic	55 cattle x 15,000 = GHS825,000/1.61 = GHS 512,422	3,000 (medication) + 50,000 (feed and labour) = GHS53,500/1.61 =GHS 33,229	512,422/33,229 = 15.42	

2. Transition Zone (Nana ABOFAB – Maize-Yam Intercropping)

CSA practices assessed included drought-tolerant seed varieties, intercropping, agroforestry, and composting. Intercropping reduced input costs and improved soil fertility, while drought-tolerant seeds stabilized yield under variable weather conditions. The table 4 illustrates three scenarios (pessimistic, baseline, and optimistic) for CSA maize production in the transitional zone with yam as an associate crop. The various scenarios demonstrate the profitability of maize intercropping under CSA. For every cedi invested in CSA maize production in the transitional zone, a minimum return of 13 times the investment amount is likely to be obtained over a 5-year period considering a combination of food crop intercropping. Although maize is the main crop, yam is a high value crops which augments the revenue streams of maize increasing total revenue from the land. Crops like yam are not high fertilizer demanding and with organic fertilizer, crop residue cover retention, and mulching, soil structure is gradually increased contributing to overall yields of all the crops. Operational cost such as labour cost is further reduced over time whilst yields become more predictable with steady consistent increases over time.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	600 maize x 600 = 360,000 360,000/1.61 = GHS 223,602	15,000 (labour) + 12,500 (inputs) = 27,500 27,500/1.61 = GHS 17,080	223,602/17,080 = 13.09	High BCR is as a result of progressive low cost of maize production particularly with the integration of yam and vegetables such as pepper. The risk of price volatility could be smoothed or reduced through cost effective approaches like weeding, and fertilizer application.
Baseline	700 maize x 750 = 525,000 GHS 525,000/1.61 = GHS 326,087	20,000 (labour) + 17,500 (inputs) = GHS37,500/1.61 = GHS 23,291	326,087/23,291 = 14.00	
Optimistic	1000 maize x 1000 = 800,000 GHS1,000,000/1.61 = GHS 621,118	30,000 (labour) + 40,000 (inputs) = GHS70,000/1.61 = GHS 43,478	621,118/43,478 = 14.29	

3. Transition Zone (Kofi Agyeman - Cocoa Agroforestry System with Plantain and Cassava)

CSA practices such as contour farming, agroforestry integration with cocoa, plantain, and cassava were assessed. The region saw improved soil structure, reduced water consumption by 40%, and higher quality produce fetching premium prices in niche markets such as certification programs by Licensed Buying Companies (LBCs). Based on the diverse nature of the agroforestry system adopted, the farmer is mostly likely to get about 20 times his initial investment in his cocoa agroforestry system regardless of the scenario under consideration over a 5-year period. This would even yield better results if the farmer is consistent with his CSA practice and is able to harvest more yield from all the other crops on his cocoa farm or increase his land productivity. The increased BCR is also as a result of subsidies enjoyed by cocoa farmers in the area coupled with the fact that the transition zone enjoys a bi-modal rainy season with the potential of increased revenue from secondary crops such as plantain and cassava.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	256 cocoa x 3000 =768,000 +5,500 (subsidy) 773,500/1.61 = GHS 480,434	25,000 (labour) + 10,000 (inputs) = 35,000 30,000/1.61 = GHS 21,739	480,434/21,739 =21.14	High BCR is as a result of progressive low cost of maize production particularly with the integration of yam and vegetables such as pepper.
Baseline	320 cocoa x 3,200 = 1,024,000 +7,000 (subsidy) GHS 1,031,000/1.61 = GHS 640,372	30,000 (labour) + 12,000 (inputs) = GHS42,000/1.61 =GHS 26,086	640,372/26,086 = 24.52	High BCR is as a results of price premiums given to cocoa farmers in bonuses and certification programs coupled
Optimistic	448 cocoa x 3,200 = 1,433,600 + 8,500 (subsidy) GHS1,442,100/1.61 = GHS 895,714	40,000 (labour) + 16,000 (inputs) = GHS56,000/1.61 =GHS 34,782	895,714/34,782 = 25.75	

The final scenario for the transition zone was vegetable-based CSA system considering pepper and tomato as a case study. From the baseline study, it was realized that pepper CSA production with tomato had a BCR of 18.51 indicating that investments in the CSA would yield a return that is 18 times. Results from the probabilistic CBA model under pessimistic scenario revealed a BCR of 17.14 indicating a very significantly positive return under risky situations of minimum price and yield levels. Cost in this system was low in the overall analysis considering the short maturity period of especially tomato which increased overall revenue of the produce generated from the land. With the incorporation of organic fertilizer and rotations, cost of weed control and pest control resulted in the low production cost.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	200 pepper x 1,500 = 300,000 300,000/1.61 = GHS 186,335	10,000 (labour) + 7,500 (inputs) = 17,500 17,500/1.61 = GHS 10,869	186,335/10,869 = 17.14	High BCR is as a result of increased revenue and cost-efficient practices such as crop rotations, and organic fertilizer application
Baseline	250 pepper x 2,000 = 500,000 GHS 500,000/1.61 = GHS 310,559	15,000 (labour) + 12,000 (inputs) = GHS27,000/1.61 = GHS 16,770	310,559/16,770 = 18.51	
Optimistic	310 pepper x 2,500 = 775,000 GHS775,000/1.61 = GHS 481,336	20,000 (labour) + 16,000(inputs) = GHS36,000/1.61 = GHS 22,360	481,336/22,360 = 21.53	

4. Southern Zone (Kofi Agyeman – Crop Based System CSA with Plantain and Cassava)

Plantain and cassava are high value crops in the southern zone of the country. An intercropping of these two crops contributes to an improved soil health due to the microclimate provided for microbial activities on the farm. From probabilistic CBA model, it can be observed that returns on initial investment over a 5-year period would result in a significant positive increase. From all the scenarios, a minimum of 11 times returns on every GH1 spent on plantain-cassava system would be realized. The crops have a shorter maturity period and farmers are able to turn-over production cycles within every 6 – 48 months depending on the type and variety produced. Price volatilities are quite high for these crops due to their high perishable nature. Securing ready markets ahead of production at pre-determined prices, quantities and dates may help deal with the price vulnerabilities. Cost of pest and weed control are minimum in this production system accounting for low variable cost right from initial production years.

Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	150 bags cassava x 1,000 =150,000 150,000/1.61 = GHS 93,168	6,000 (labour) + 7,000 (inputs) = 13,000 17,500/1.61 = GHS 8,074	93,168/8,087 =11.53	High BCR due to low production cost right from the investment year. This cost further reduces over the years strengthening the BCR position even better which reflects in the optimistic scenario. Overall, the BCR is positive and significantly high for all scenarios.
Baseline	190 cassava x 2,000 = 380,000 GHS 380,000/1.61 = GHS 236,024	9,500 (labour) + 9,000 (inputs) = GHS18,500/1.61 =GHS 11,490	236,024/11,490 = 20.54	
Optimistic	250 cassava x 2,500 = 625,000 GHS625,000/1.61 = GHS 388,198	120,000 (labour) + 9,000(inputs) = GHS21,000/1.61 =GHS 13,043	388,198/13,043 = 29.76	

5. Southern Zone (Kofi Agyeman – Aquaculture Based System CSA with Fisheries as a Case Study)

Plantain and cassava are high value crops in the southern zone of the country. An intercropping of these two crops contributes to an improved soil health due to the microclimate provided for microbial activities on the farm. From probabilistic CBA model, it can be observed that returns on initial investment over a 5-year period would result in a significant positive increase. From all the scenarios, a minimum of 11 times returns on every GH1 spent on plantain-cassava system would be realized. The crops have a shorter maturity period and farmers are able to turn-over production cycles within every 6 – 48 months depending on the type and variety produced. Price volatilities are quite high for these crops due to their high perishable nature. Securing ready markets ahead of production at pre-determined prices, quantities and dates may help deal with the price vulnerabilities. Cost of pest and weed control are minimum in this production system accounting for low variable cost right from initial production years.

Table 8: Probabilistic CBA Aquaculture system with fisheries as a Case Study				
Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	30,000 fish x 35 = 525,000 1,050,000/1.61 = GHS 652,173	60,000 (labour) + 100,000 (inputs) = 160,000 160,000/1.61 = GHS 99,378	652,173/99,378 = 6.56	BCR figures for all scenarios demonstrates the low cost of production due to the increased use of local materials in a CSA system. Revenue risk could be reduced through short maturing crops (vegetables or maize) integration into the system
Baseline	40,000 fish x 45 = 1,600,000 GHS 1,800,000/1.61 = GHS 1,118,012	100,000 (labour) + 150,000 (inputs) = GHS250,000/1.61 =GHS 155,279	1,118,012/155,279 = 7.20	
Optimistic	55,000 fish x 55 = 3,025,000 GHS3,025,000/1.61 = GHS 1,878,881	150,000 (labour) + 200,000(inputs) = GHS350,000/1.61 =GHS 217,391	1,878,881/217,391 = 8.64	

Southern Zone (Kofi Agyeman – Livestock Based CSA with Poultry as a Case Study)

Table 9 shows the probabilistic CBA with poultry as a case study. Under this system, feed production is more indigenous with limited reliance on foreign feed such as concentrates. The study evaluated the broiler system which has the potential of ensuring up to four cycles of production. From the study, it was evidently clear that the CSA poultry production methods such as using located produced feed sources, water and feed efficiency mechanisms such as the nozzle regulated feeding system, and energy efficient heating system for brooding chicks had significant positive effect on cost efficiency. Results from the probabilistic CBA model revealed that, under the pessimistic scenario with 10,000 birds over a 5-year period, a BCR of 11.42 is realized implying that, with every GH1 of investment, an equivalent of 11 times in benefits would be realized for practitioners of the system. This system could further be enhanced under a pessimistic scenario should the system incorporate crop production into CSA poultry system.

Table 9: Comparative analysis of BCR and net benefit of CSA as a Case Study				
Scenario	Discounted Total Revenue (GHS)	Total Costs (GHS)	BCR	Key Insight/Commentary
Pessimistic	10,000 broilers x 80 = 800,000 800,000/1.61 = GHS 496,894	20,000 (labour) + 50,000 (inputs) = 70,000 70,000/1.61 = GHS 43,478	496,894/43,478 = 11.42	High BCR is as a quick turn over cycles of production annually and cost-efficient system in place Income diversification could help reduce market risk and improve overall revenue generation.
Baseline	20,000 broilers x 100 = 2,000,000 GHS 2,000,000/1.61 = GHS 1,242,236	30,000 (labour) + 70,000 (inputs) = GHS 100,000/1.61 = GHS 62,111	1,242,236/62,111 = 20.00	
Optimistic	30,000 broilers x 140 = 4,200,000 GHS 4,200,000/1.61 = GHS 2,608,695	50,000 (labour) + 120,000 (inputs) = GHS 170,000/1.61 = GHS 105,590	2,608,695/105,590 = 24.70	

6. Comparative Analysis of CSA and Conventional Farming

A comparative analysis of BCR and net benefit of CSA and conventional practices was also conducted with the intent of demonstrating empirically the benefits of both systems. Results from the analysis were then used as a proxy for the prediction of risk exposure for both systems. It was evidently clear that net benefits for CSA across the ecological zones far outperformed the estimated conventional benefits. This was further reflected in the BCR analysis where the value for CSA was 4-5 times higher than that of conventional practices over the same investment period of five years. Consequently, the risk assessment showed a moderate risk exposure of CSA over time compared to conventional practices. The most uncertain variable in a CSA system was price which is borne out of the open market system operated for most agricultural produce clearly determined by demand and supply forces. However, the gains made from cost effective practices (eg. fertilizer, herbicides, labour, pesticides etc) over time will reduce the impact of such price volatility in a CSA system since yield will be consistently predictable. Furthermore, practices such as agroforestry and food crop diversification offer the CSA farmer to take advantage of good years of secondary crops to offset part of the losses occasioned through price volatilities of the main or primary crop. In the case of conventional practices, it was observed that variable cost will continue to increase because the activities would be performed in full year-on-year and inputs such as fertilizer usage may also increase due to the excessive pressure on the soil without effective replacement of lost nutrients in the soil. Risk in a conventional system is thus high as predictability of both yield and price becomes uncertain and impact becomes higher for the conventional farmer. Finally, based on the CBA computations for the various agro-ecologies, it is recommended that promotion of practices should be tailored or agroecology specific to ensure maximum utility of adopting the practices.

Table 10: Probabilistic CBA with Cashew-Shea Agroforestry Based CSA as a Case Study			
Metric	CSA (Average Across Farms)	Conventional (Estimated)	Advantage
Net Benefit (GHS/year)	396,000 - 1,442,100	200,000 - 800,000	+48-140%
BCR	20 - 100	5 - 20	4-5x higher
Risk Exposure	Moderate (price volatility)	High (Soil degradation, yield drops, and price volatility)	CSA wins

6.3 Comparative Analysis of CSA and Conventional Farming

Despite the proven benefits of Climate-Smart Agriculture (CSA), widespread adoption across Ghana remains hindered by a range of socio-economic, institutional, and environmental challenges. These constraints, as revealed through interviews, case studies, and literature reviews, differ across the Savannah, Transition, and Coastal/Forest zones.

1. Limited Awareness and Knowledge of CSA Practices

Across all zones, many farmers lack knowledge of CSA practices such as agroforestry, conservation agriculture, and water harvesting techniques. This knowledge gap is underscored by 93.3% of respondents citing lack of training as a key barrier. This aligns with earlier findings by Partey et al. (2020), which found that awareness and extension coverage were critical bottlenecks in CSA diffusion.

2. Financial Constraints Smallholder Farmers

Farmers face high upfront costs and limited access to affordable financing for CSA technologies. About 93.3% of surveyed farmers noted financing as their biggest hurdle. The World Bank (2018) similarly identified inadequate financial services as a primary constraint to CSA investment

3. Weak Agricultural Extension Services

CSA adoption is further constrained by limited outreach from extension agents. Field data from the Transition zone revealed farmers receive infrequent and often non-specialized visits. This confirms MoFA's own assessment (MoFA, 2021), which highlights the critical shortage of trained CSA extension officers.

4. Market Access Limitations

CSA farmers often struggle with post-harvest losses, poor infrastructure, and limited links to high-value markets. In the Savannah zone, poor roads and high transport costs reduce market incentives for CSA adoption. Similar concerns were noted in the 2021 Ghana Agricultural Sector Progress Review.

5. Cultural and Traditional Practices

Ingrained farming traditions often contradict CSA principles. Slash-and-burn land clearing and reluctance toward agroforestry were common among Savannah zone farmers. As observed in studies by FAO (2020), transitioning from conventional to sustainable farming requires behavioural change, which is often

6. Gender Inequities Female Farmers

Farmers face disproportionate challenges, including land insecurity and exclusion from training and credit schemes. These findings align with reports by IFPRI (2019), which emphasize that gender-responsive CSA initiatives are key to inclusive adoption.

7. Climate Variability and Risk Aversion

Unpredictable rainfall and extreme events make it risky for farmers to invest in new CSA practices. Farmers in the Northern Region expressed concern over failed harvests due to erratic weather, consistent with observations by Bryan et al. (2013) that climate uncertainty deters long-term agricultural investments.

8. Weak Policy and Institutional Support

The lack of dedicated CSA policy frameworks and poor institutional coordination limit CSA scaling. Farmers and experts noted fragmented programming and absence of CSA-specific subsidies. This challenge has been widely cited in national policy reviews (MoFA, 2022; GCNet, 2020).

9. Poor Access to Climate Information

Timely weather forecasts and climate data are crucial for CSA planning. Yet, many farmers reported relying on informal sources or guesswork. This supports the findings of the CGIAR CCAFS program (2018), which emphasized the importance of climate services in CSA uptake.

10. Technological and Infrastructure Deficiencies

CSA relies on access to technology—improved seeds, irrigation tools, storage facilities—all of which remain inaccessible to many rural farmers. This mirrors global patterns, where limited rural infrastructure has slowed CSA adoption (FAO, 2017).

11. Low Stakeholder Collaboration

Stakeholder fragmentation—across government, private sector, NGOs, and farmers—undermines the coherence of CSA initiatives. Respondents emphasized the need for more integrated approaches. As noted by Snapp et al. (2015), multi-stakeholder collaboration is essential for sustainable climate adaptation.

12. Social and Behavioural Barriers

Risk aversion, low literacy, and adherence to long-standing practices make behavior change difficult. This constraint was especially evident in Coastal zone interviews and corresponds with literature stressing the role of social learning in CSA (Wossen et al., 2017).

Barriers to CSA adoption in Ghana are deeply interlinked. They span informational, financial, institutional, and cultural domains. Overcoming these barriers will require coordinated, context-specific interventions that include targeted policy reforms, investment in extension systems, inclusive financing, and multi-actor partnerships. The findings of this study, supported by field data and triangulated with existing literature, provide a robust foundation for designing scalable CSA strategies in Ghana.

7.0 Recommendations

Based on the study's field data, literature review, and stakeholder consultations, the following ten actionable policy recommendations are proposed to enhance the adoption and scaling of CSA in Ghana:

1. Strengthen Agricultural Extension Services

Enhance the capacity and coverage of extension systems by training more officers in CSA principles and deploying them strategically across underserved zones. Use ICT tools (mobile apps, SMS) to provide real-time agronomic support and reach farmers in remote areas.

2. Facilitate Affordable Access to CSA Financing

Develop CSA-specific financial products, such as low-interest credit and micro-insurance, in partnership with financial institutions. Establish targeted subsidy schemes and input financing models for key CSA practices like irrigation, composting, and drought-tolerant seeds.

3. Promote Targeted Farmer Training and Demonstration

Design region-specific training curricula that reflect the agroecological conditions and local languages. Establish CSA demonstration sites in each zone to foster peer learning and practical exposure to successful practices.

4. Improve Market Access for CSA Produce

Invest in rural infrastructure (roads, storage, transportation) to reduce transaction costs. Facilitate farmer aggregation and contract farming arrangements to guarantee markets and better prices for CSA-based produce.

5. Ensure Gender-Responsive CSA Programming

Design CSA interventions that address barriers faced by women and marginalized groups—ensuring equitable access to land, finance, inputs, and decision-making. Mainstream gender analysis in CSA program design and delivery.

6. Expand Climate Information Services

Invest in user-friendly, localized climate forecast services and train farmers to interpret and use weather data. Leverage radio, SMS, and community-based information hubs to ensure wide access.

7. Institutionalize CSA in National Agricultural Policy

Mainstream CSA into agricultural and environmental policies. Develop national CSA action plans that include funding strategies, measurable targets, and a harmonized institutional framework to guide implementation.

8. Enhance Cross-Sectoral Collaboration

Establish national and regional CSA stakeholder platforms to coordinate action among farmers, researchers, NGOs, and agribusinesses. Encourage public-private partnerships to support scaling and investment in CSA technologies.

9. Expand Technological Access and Infrastructure

Promote access to CSA-supportive technologies such as drip irrigation kits, biochar tools, mobile soil testing units, and improved seed varieties. Build community-based resource centers to support distribution and maintenance.

10. Strengthen Monitoring and Evaluation Systems

Develop national CSA monitoring frameworks to track adoption, measure impact on yields, soil health, and resilience, and guide adaptive programming. Align CSA indicators with Ghana's climate and SDG commitments. These recommendations are drawn from empirical data collected across the three ecological zones and are intended to offer feasible, evidence-based interventions to enhance the scalability and sustainability of CSA adoption in Ghana.

11. Promote Renewable Energy in Agriculture

There is an urgent need to reduce farmers' dependence on fossil fuels and improve the sustainability of agricultural systems. By integrating renewable energy solutions such as solar-powered irrigation pumps, solar dryers, and biogas systems, farmers can increase productivity while reducing emissions. Scaling these technologies across rural communities, especially in off-grid areas, will make farming more resilient, cost-effective, and environmentally friendly.

7. Institutionalize CSA in National Agricultural Policy

Mainstream CSA into agricultural and environmental policies. Develop national CSA action plans that include funding strategies, measurable targets, and a harmonized institutional framework to guide implementation.

12. Expand the Use of Biodegradable Mulching Materials

To support soil health and climate adaptation, biodegradable materials like compostable material, plant residues, or organic mats should be promoted as alternatives to plastic mulch. These materials help retain moisture, suppress weeds, and minimize environmental harm. Successful pilot initiatives should be expanded to other regions, coupled with awareness campaigns, training, and financial incentives to support farmer adoption.

13. Help Farmers Benefit from Carbon Credit Opportunities

Many CSA practices such as agroforestry, conservation tillage, and improved composting capture or reduce greenhouse gas emissions. However, most farmers are not yet tapping into carbon markets due to knowledge gaps and structural barriers. Ghana should work with carbon market intermediaries and local organizations to help farmers quantify their contributions and access carbon credits. This could unlock new income streams and directly reward

14. Leverage Digital Tools to Spread and Track CSA Practices

Technology offers a powerful way to scale CSA adoption. Mobile apps, SMS platforms, and digital advisory tools can provide timely information on weather forecasts, pest outbreaks, and best CSA practices. Satellite and drone imagery can also help monitor environmental impact. Public-private partnerships should be encouraged to make these innovations more accessible and affordable, especially for young farmers and women in rural areas.

15. Introduce Climate-Linked Agricultural Insurance

For many farmers, the fear of crop failure or climate-related losses is a major barrier to innovation. Introducing agricultural insurance products that reward CSA practices such as reduced premiums for drought-tolerant seeds, soil conservation, or efficient water use can shift this risk perception. Bundled services that combine inputs, finance, and insurance will further empower farmers to adopt climate-smart practices confidently.

16. Creating a Supportive Policy Environment for CSA

Beyond field-level interventions, Ghana needs enabling policies that drive long-term transformation in the agricultural sector:

- Mainstream CSA into national and district-level agricultural plans, ensuring consistent investment and coordination.
- Provide incentives for private sector investment in CSA technologies through tax relief, green loans, and innovation grants.
- Establish a national CSA monitoring and evaluation framework to track adoption, outcomes, and environmental impact across regions.

- Foster inter-ministerial coordination (Agriculture, Environment, Finance, Energy) to align CSA efforts with Ghana's climate goals, such as the Nationally Determined Contributions (NDCs) and the Food Systems Transformation Roadmap.
- Empower local research institutions and universities to drive innovation, validate farmer-led solutions, and integrate indigenous knowledge into CSA programming.

8.0 Conclusions on the study

This study highlights the transformative potential of CSA practices in addressing the challenges of climate change in Ghana's agricultural sector. Implementing CSA practices across the Savannah, Transition, and Coastal/Forest zones has demonstrated significant economic and environmental benefits, including increased crop yields, improved income stability, enhanced soil health, and greater resilience to climate variability.

However, the study also underscores several barriers to the widespread adoption and scaling of CSA practices, such as limited awareness, financial constraints, inadequate extension services, and gender inequities. Addressing these challenges is critical to unlocking the full potential of CSA and ensuring sustainable agricultural development in Ghana.

The recommendations provided in this report offer actionable steps to enhance the adoption and scaling of CSA practices. By strengthening extension services, improving financial access, promoting gender inclusion, and fostering collaboration among stakeholders, Ghana can build a resilient agricultural system that supports livelihoods, mitigates climate risks, and ensures food security for future generations.

In conclusion, advancing CSA in Ghana requires a collective effort from farmers, government agencies, NGOs, researchers, and the private sector. By working together to overcome the identified barriers and implement the proposed solutions, Ghana can lead the way in sustainable and climate-smart agricultural development in Africa.



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Appendix:

Annex 1: Stakeholders consulted during the CSA study		
Name of Stakeholder	Category	Location
Ministry of Food and Agriculture (MoFA) -Northern belt	Policy Makers	Wa
Ministry of Food and Agriculture (MoFA) -Middle belt	Policy Makers	Kumasi
Ministry of Food and Agriculture (MoFA) -Southern belt	Policy Makers	Accra
Ghana Cocoa Board (COCOBOD)-Southern	Research Institution	Accra
Environmental Protection Agency -Northern Belt (Tamale)	Policy Makers	Tamale
EPA-Middle (Kumasi or Sunyani)	Policy Makers	Kumasi
EPA-Southern	Policy Makers	Accra
Crops Research Institute	Research Institution	Accra
SARI-Northern Belt-Tamale	Research Institution	Tamale
AboFam-Techiman	NGO	Techiman
Commercial Farmers Association of Ghana	Agribusiness	Tamale
Conservation Agriculture Centres in Ghana-Nkawie-Middle belt	Agribusiness	Kumasi
Conservation Agriculture Mechanization Services Providers-Wa	Agribusiness	Wa
NASTAG (National Seed Trade Association of Ghana)	NGO	Accra
Agroecology Networks -Northern sector	NGO	Wa
Agroecology Networks	NGO	Accra
Care International Ghana	NGO	Tamale
Ghana Organic Platform	NGO	Accra
TECAS	Agribusiness	Wa
CIKOD	NGO	Wa
Eco Restore	Agribusiness	Tamale
FAO	Policy makers	Accra

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Annex 1: Stakeholders consulted during the CSA study		
Name of Stakeholder	Category	Location
ActionAid Ghana	NGO	Accra
GIZ-MOAP NW	NGO	Wa
Vibrant Village	NGO	Wa
SAPIP	NGO	Tamale
Damongo Agric College	Research Institution	Damongo
Peasant Farmers Association-Accra	NGO	Accra
CASE STUDIES		
Northern Zone (Dry Sahelian Climate):Case study 1: Livestock based CSA, Case study 2: Crop based soybean/sorghum based CSA, Case study 3 : Agroforestry based CSA		
CSA Farmers-northern zone-Baabile in UWR	Farmers	Baabile
Farmers-northern zone-CEAL Ghana in Walewale	Farmers	Walewale
Farmers-northern zone -case study	Farmers	Loggu-Wa
Middle Zone (Forest Zone):Agriculture Focus: Tree crops based CSA (cashew/cocoa agroforestry), Crop based CSA (maize, yam), Vegetable crop based CSA (tomatoes, onion,		
Farmers in middle belt-case study	Farmers	
Okoakpajor Youth and development center	Farmers	Techiman
Farmers in middle Zone-Nkawie CA	Farmers	Nkawie
Southern Zone (Coastal Belt):Agriculture Focus: Crop based CSA (plantain /cassava), Aquaculture based CSA (fisheries), Poultry based CSA		
Farmers in southern Zone-Cassava farmer	Farmers	Cape Coast
CIKOD	Farmers	Accra
Eco Restore	Farmers	Asesseseso-Eastern Region

Appendix:

Experts in Conservation Agriculture	
Cyril Yabepone-Tamale	CSA RESEARCHERS /EXPERTS
Kofi Boa-Kumasi	CSA RESEARCHERS /EXPERTS
Dr Kombiok James-Tamale	CSA RESEARCHERS /EXPERTS
Dr. Saaka Boah-Damongo	CSA RESEARCHERS /EXPERTS
Joseph Angkyelaa	CSA RESEARCHERS /EXPERTS
Prosper Wie	CSA RESEARCHERS /EXPERTS
Professor Abubakari AbdulHalim	CSA RESEARCHERS /EXPERTS
Dr Shaibu Azumah Baani	CSA RESEARCHERS /EXPERTS
Yelibora Martin-Damongo	CSA RESEARCHERS /EXPERTS
Issifu Sulemena-CEAL	CSA RESEARCHERS /EXPERTS

Annex 2: list of past and current CSA projects

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- USAID Feed the Future Initiative; USAID AGNRM (2016-2021) and ADVANCE 1 & 2 programs. <https://www.feedthefuture.gov>
- Fairtrade Africa; Climate-Smart Cocoa Project and its impact on cocoa sustainability. <https://www.fairtradeafrica.net>
- Green Climate Fund (GCF) Strategic Plan (2024-2027) and CSA-related initiatives. <https://www.greenclimate.fund>
- International Centre for Research in Agroforestry (ICRAF), Research on agroforestry, soil health, and tree roles in resilience. <https://www.worldagroforestry.org>
- Savanna Agricultural Research Institute (SARI) Reports on the CRSP project, Emergency Rice Project, and related studies. <https://www.csir-sari.org>
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) CODE-WA project targeting women smallholder farmers. <https://www.icrisat.org>
- Bill and Melinda Gates Foundation; STMA I & II and AGG projects for stress-resistant maize varieties. <https://www.gatesfoundation.org>
- Technoserve; Farmers' Service Centre Cooperatives (FSCCs) project. <https://www.technoserve.org>
- Northern Rural Growth Project (NRGP); Documentation on FBOs and financial linkages in Ghana. <https://mofa.gov.gh>

Annex 2: list of past and current CSA projects

- Sustainable Land and Water Management Project (SLWMP); Reports on sustainable practices and watershed management. <https://www.worldbank.org/en/news/feature/2019/11/20/sustainable-land-and-water-management-project-in-ghana>
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