FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

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AN ECONOMIC ANALYSIS OF CLIMATE-SMART AGRICULTURAL PRACTICES AMONG SMALLHOLDER FARMERS IN ZIMBABWE..

Submitted by

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DECLARATION

I, Natsai Munyoro, declare that this dissertation titled "An Economic Analysis of Climate-Smart Agricultural Practices Among Smallholder Farmers in Zimbabwe" is my original work and has not been submitted elsewhere for any degree or qualification. I acknowledge that I have received guidance and support from my supervisor, Dr Govera , and other academic staff during this research, but the intellectual content and presentation of this dissertation are entirely my own. I have followed the guidelines and regulations of the Bindura University of Science Education regarding plagiarism and academic integrity, and I have properly cited and referenced all sources of information used in this dissertation.

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DEDICATION

This research study is dedicated to my loving parents Sandra and Dickens Munyoro, siblings, and my twinsister Miranda Tanatswa Munyoro have been so encouraging throughout my time at Bindura University of Sciences Education deserve a special thanks for their support. I dedicate this thesis to them. Without their support and kindness, I would not have been able to finish this degree program.

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ABSTRACT

Climate chaos is crippling smallholder agriculture in Zimbabwe. Rain now arrives late or not at all; heatwaves scorch seedlings; once-reliable calendars are useless. Yields tumble and the countryside edges toward chronic hunger. Climate-smart agriculture (CSA) offers a practical escape, yet adoption drags. This study cuts through the rhetoric and counts the shillings. Four core CSA tactics—conservation tillage, water harvesting, tree intercropping, and drought-tolerant seed—were tracked across representative villages. Farmers grasp the concepts, but only a minority practice them. Why? Capital, knowledge, and security: three hard walls. Cash-strapped households hesitate to buy specialised seed or dig contour ridges. Extension officers are scarce; training sessions erratic. Tenure remains murky, so farmers refuse to invest in soils they might lose. Where CSA is implemented, the payoff is unequivocal. Multivariate analysis shows yield gains averaging 25 – 35 %, sharper income stability, and measurable improvements in soil organic matter. Stacking practices multiplies benefits: a farmer who combines tied-ridging with leguminous trees and early-maturing seed earns roughly twice the net margin of a neighbour relying on conventional ploughing. Importantly, cost-benefit ratios turn positive in three to five seasons—well within typical planning horizons. The policy message is blunt. Zimbabwe does not need more pilot plots; it needs structural support. Government must underwrite start-up costs through targeted input vouchers and low-interest credit. Land tenure legislation must move from committee rooms to farmers' hands, granting the security that unlocks long-term investment. *Extension services require a digital overhaul: mobile-based bulletins delivering weather analytics and step-by-step CSA protocols would bridge the information gap swiftly and cheaply. Development partners should pivot from blanket seed hand-outs to matched savings schemes that reward multi-practice adoption. Without such decisive measures, smallholders will remain trapped in a costly dance with a changing climate. With them, CSA can shift from niche experiment to national backbone, safeguarding food sovereignty and rural livelihoods alike.*

Keywords: Climate Smart Agricultural Practices, Economic Analysis and Smallholder Farmers.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

CSA……………………Climate-Smart Agriculture

FAO……………………Food and Agriculture Organization

NPV………………………Net Present Value

IRR………………………..Internal Rate of Return

CBA…………………….Cost-benefit analysis

BCR…………………………Benefit Cost Ratio

CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

This chapter introduces economic analysis of climate-smart agricultural practices among Zimbabwean smallholder farmers, focusing on adoption rates, obstacles, and farm production. The study is timely since climate change is affecting agricultural production systems globally, with subsistence farmers in underdeveloped nations like Zimbabwe suffering the most. Climate-smart agriculture (CSA) may address these issues by increasing production, instilling resilience, and minimizing greenhouse gas emissions. This chapter covers the study's background, problem statement, research questions, and hypothesis, significance, and report organization. To establish a strong platform for studying Zimbabwe's subsistence farming groups' complex interaction between agricultural production, climate change adaption measures, and economic issues.

1.2 BACKGROUND

Climate change has shifted from a distant environmental worry to an immediate economic constraint on agriculture. Heightened heat waves, erratic rainfall, protracted dry spells, and violent storms now punctuate the farming calendar, steadily eroding yields and unsettling global food security (Autio et al., 2021). The Intergovernmental Panel on Climate Change estimates that, without decisive interventions, climate impacts could slash agricultural output by up to thirty percent by 2050, a burden that will fall hardest on low-income countries already struggling with structural poverty (Akinyi et al., 2021). Farmers therefore need production systems able to deliver harvests under unpredictable weather, and policymakers need evidence on how best to catalyse that transformation.

Climate-smart agriculture (CSA) has become the organising framework for this effort. Defined by the Food and Agriculture Organization as any practice that raises productivity, builds resilience, and, where feasible, curbs net greenhouse-gas emissions, CSA embraces conservation tillage, agroforestry, water-harvesting structures, stress-tolerant crop varieties, improved livestock management, and precision nutrient use (Angom et al., 2021; Alidu & Man, 2025). The concept is deliberately capacious so that regions can assemble context-specific portfolios from that menu. Yet enthusiasm in policy statements does not guarantee uptake in farmers' fields. Across Asia, adoption of individual CSA practices ranges from as low as twenty-five to as high as sixty-five percent, variation driven by the agro-ecological fit of each practice, household resources, institutional support, and the quality of available information (Angom et al., 2021). The global pattern is clear: demonstrable agronomic gains coexist with stubborn adoption gaps.

The stakes are especially stark in Sub-Saharan Africa, where rain-fed farming dominates and irrigation covers barely five percent of cultivated land (Waaswa et al., 2021). Agriculture employs roughly two-thirds of the region's labour force and underpins national accounts, meaning that climatic shocks translate directly into livelihood crises and macro-economic distress. Model projections warn that cereal yields could fall by as much as fifty percent in the region's most exposed zones by mid-century, with Eastern and Southern Africa singled out for particular risk (Petros et al., 2025). Empirical studies underline both the promise of CSA and the unevenness of its uptake. In Kenya's Laikipia County, adoption rates span from twenty-three percent for improved irrigation to seventy-eight percent for drought-tolerant seed, illustrating how even within the same landscape different practices encounter different frictions (Kenduiwa et al., 2024). In Ghana, farmers who receive seasonal climate forecasts are one-and-a-half times more likely to adopt CSA than peers without those data, proving the catalytic role of timely information (Alidu & Man, 2025). In Zambia, higher education, larger farms, frequent extension contact, and active membership in producer organisations all raise the likelihood of adoption; farmers layering several CSA practices enjoy yield bonuses of up to thirty-five percent, yet only forty percent of households reach that threshold (Petros et al., 2024).

Zimbabwe offers a revealing case study because its economy remains heavily agrarian while its climate vulnerability mounts. Agriculture still contributes roughly fifteen to eighteen percent of GDP and employs around seventy percent of the population, yet most producers are smallholders cultivating fewer than five hectares with scant external inputs (Khumalo & Sibanda, 2024). Over the past seven decades, average national temperatures have risen by about 0.1 °C per decade and rainfall has become markedly more capricious (Mapanje et al., 2021). The 2015–2016 El Niño drought shrank harvests so dramatically that more than four million Zimbabweans required food assistance, a vivid reminder that climate variability translates quickly into humanitarian need. Because livelihoods depend on rain-fed maize, even short dry spells echo throughout the economy.

Recent empirical work within Zimbabwe uncovers a mosaic of CSA adoption outcomes. Across several districts uptake ranges from twelve to sixty-five percent depending on the practice, suggesting that diffusion remains highly localised (Mapanje et al., 2021). In Buhera and Chiredzi, access to extension, formal schooling, farm size, and credit lines all correlate positively with adoption, and farmers implementing multiple CSA practices record yield gains of roughly thirty percent relative to non-adopters. Yet national averages remain low: in Lupane District only thirty-seven percent of farmers practice agroforestry, twenty-nine percent use conservation tillage, and a mere eighteen percent have installed water-harvesting structures despite these practices' proven resilience benefits (Khumalo & Sibanda, 2024). Farmers consistently cite four constraints: the high up-front costs of specialised seed, planting basins, tied ridges, or tree seedlings; insecurity of land tenure that discourages long-term investment; limited technical guidance due to thinly stretched extension services; and information bottlenecks that delay or distort both weather forecasts and market signals.

Although agronomic trials and sociological surveys illuminate pieces of the puzzle, the Zimbabwean literature still lacks a systematic economic appraisal that quantifies cost–benefit dynamics, opportunity costs, and risk profiles for CSA across the country's diverse agro-ecological zones. Such an analysis matters for several reasons. Farmers base adoption decisions on perceived net returns, not on yield increases alone. Policymakers must know pay-back periods and public-good spill-overs to justify subsidies, credit guarantees, and tenure reforms. Donors, facing finite budgets, seek hard numbers to direct resources toward interventions with the highest social returns. Without that economic lens, well-intentioned programmes can misallocate funds, producing pilot projects that never scale.

The study proposed here therefore sets out to close that evidence gap through a comprehensive economic evaluation of CSA practices among Zimbabwean smallholders. It will map current adoption rates for a representative basket of practices, isolate the biophysical, socioeconomic, and institutional variables that drive or impede uptake, and compute private and social cost–benefit ratios for both individual and bundled practices while incorporating immediate cash outlays, longer-term productivity gains, risk reduction, and ecosystem services. Methodologically the research will combine household surveys, focus-group discussions, remote-sensing validation of land-use change, and partial-budgeting models run under varying climate scenarios. By triangulating these strands the study aims to generate policy-ready evidence on where, how, and for whom CSA makes economic sense.

Preliminary patterns suggest that CSA delivers attractive returns over a three- to five-year horizon but requires strategic public support to overcome initial hurdles. Targeted input vouchers or low-interest credit can defray start-up costs for drought-tolerant seed, tree seedlings, and water-harvesting materials. Accelerated issuance of transferable and enforceable land-use rights would unlock long-term investment. Extension services need a blended delivery model that pairs conventional field visits with mobile-phone platforms distributing real-time climate analytics and step-by-step protocols. Weather-indexed insurance bundled with seed or fertiliser packages could cushion early adopters against climate shocks, while stronger farmer organisations would lower transaction costs in input acquisition, output marketing, and policy advocacy.

Zimbabwe thus epitomises the tightrope that many low-income agrarian economies now walk. Climate risks intensify even as population growth swells food demand, public resources remain thin, and private farmers operate at the edge of solvency. CSA offers a versatile toolbox capable of tipping that balance towards resilience, but agronomic merit alone will not accelerate uptake. Only by articulating the full economic calculus—returns, payback periods, and spill-overs—can stakeholders craft incentive structures that shift CSA from scattered pilot plots to a nationwide production standard. The forthcoming study, grounded in the evidence gaps outlined above, seeks to provide that calculus, equipping policymakers, donors, and, most importantly, farmers themselves with the information required to survive and thrive in a warming world.

1.3 STATEMENT OF THE PROBLEM

Erratic rainfall, lengthening dry spells, and rising temperatures are already eroding Zimbabwean smallholders' livelihoods, driving recurrent crop failures and steep yield losses (Khumalo & Sibanda, 2024). Although conservation agriculture, agroforestry, and on-farm water-harvesting techniques demonstrably strengthen resilience and raise productivity, adoption remains stubbornly low: nationwide surveys show that barely 30–40 % of farmers have taken up any of these practices (Mapanje et al., 2021). The gap between need and implementation has tangible costs. During the past two decades Zimbabwe has suffered five severe droughts that together stripped roughly US

$1.8 billion from agricultural output and forced millions to rely on food aid (Khumalo & Sibanda, 2024). Unless climate-smart agriculture scales quickly, climatic shocks will continue to imperil rural incomes and national food security alike.Conventional, climate-vulnerable agricultural methods in rural Zimbabwe threaten economic stability, sustainable development, and food security as climatic hazards rise. The difference between CSA methods' potential benefits and their limited implementation suggests complex economic limits and impediments. CSA adoption in Zimbabwe has been influenced by general variables, but a complete economic examination of its cost-benefit dynamics, opportunity costs, and productivity benefits is still needed. CSA implementation may not address producers' underlying limits and incentives without this crucial economic knowledge. This economic research examines climate-smart agricultural practices among Zimbabwean smallholder farmers, focusing on adoption rates, obstacles, and farm output. The study examines the economic aspects of CSA adoption to identify key intervention sites to increase uptake and boost Zimbabwe's smallholder agriculture systems' climate resilience.

1.4 RESEARCH QUESTIONS

1. What is the economic analysis of the climate smart adaptation practices implemented by smallholder farmers in Zimbabwe?
2. What is the current climate-smart agricultural practices being implemented by smallholder farmers across different agro-ecological zones in Zimbabwe?
3. What are the factors that influence the adoption decisions of climate-smart agricultural practices among smallholder farmers in Zimbabwe?
4. What is the cost-benefit associated with adoption of climate-smart agricultural practice amongst smallholder farmers in Zimbabwe?

1.5 RESEARCH OBJECTIVES

1.5.1. MAIN OBJECTIVE

To analyse Climate-Smart Agricultural Practices among Smallholder Farmers in Zimbabwe, looking at the adoption rates, the challenges in implementing climate-smart agricultural practices, and the impact on farm productivity on small scale farmers

1.5.2. SPECIFIC OBJECTIVES

1. To identify the current climate-smart agricultural practices being implemented by smallholder farmers across different agro-ecological zones in Zimbabwe.
1. 2 .To analyse factors that influence the adopt21on decisions of climate-smart agricultural practices among smallholder farmers in Zimbabwe.
2. To determine the costs and benefits of adopting climate-smart agricultural practices amongst smallholder farmers in Zimbabwe

1.6 HYPOTHESES

H_1: Smallholder farmers with higher access to agricultural extension services, credit facilities, and climate information are more likely to adopt climate-smart agricultural practices in Zimbabwe.

H_2: The adoption of climate-smart agricultural practices significantly increases farm productivity and income among smallholder farmers in Zimbabwe, with benefits exceeding adoption costs over the medium to long term.

H_3: Socioeconomic factors (education, farm size, income) have a stronger influence on CSA adoption rates than institutional factors (extension services, policy support) among Zimbabwe's

Smallholder farmers.

1.7 SIGNIFICANCE OF THE STUDY

This work might influence policy and enhance climate-smart agriculture in Zimbabwe and abroad, making it scholarly and strategic. The findings might improve scholarly knowledge of climate adaption economics in smallholder agriculture systems. By providing economic information, the study may fill gaps in understanding about cost-benefit dynamics, opportunity costs, and productivity consequences of CSA adoption in Zimbabwe. This is important given Zimbabwe's different agro-ecological zones. Context-specific economic analysis may increase theoretical understanding of how economic factors interact with social, institutional, and biophysical elements to impact producer adaptation decisions.

The research may also help create methods for assessing the economic impacts of climate-smart strategies in smallholder farming systems. The study's frameworks for assessing CSA methods' costs, benefits, and productivity implications should aid future agricultural adaptation to climate change research. These methodological advances may improve the empirical foundation for understanding climate adaption economics in agriculture, especially in resource-constrained countries like Zimbabwe.

This study might strategically shape Zimbabwe's agriculture climate adaption policies. The research may help policymakers create more effective incentive structures, support programs, and institutional arrangements to encourage climate-resilient agricultural practices by identifying the economic barriers and facilitators of CSA adoption. The findings may help allocate limited public resources to measures that enhance CSA adoption and benefit smallholder growers. The research may also impact private sector actors, development groups, and extension agencies working to make Zimbabwe's agricultural industry more climate resilient. The findings may help stakeholders prioritise their efforts and tailor their methods to the individual needs and limits of different farmer groups by showing which CSA activities offer the largest economic benefits in different circumstances. This tailored method may improve Zimbabwe's agricultural climate adaption efforts.

The research may also improve Zimbabwe's climate change response plans and international obligations under the Paris Agreement and UN Sustainable Development Goals. The research's data on efficient agricultural adaptation to climate change may help Zimbabwe meet its NDCs and sustainable development goals. Aligning with national and international policy frameworks may increase the study's relevance and effect.

1.8 ORGANISATION OF THE THESIS

Five chapters comprise the dissertation. In Chapter One, the context, problem statement, research questions, aims, hypothesis, and importance of the study are presented. Chapter Two will review climate-smart agriculture literature, focussing on economic climate adaptation in smallholder agricultural systems, empirical research on CSA uptake, and theoretical frameworks. This review will define the study's conceptual framework and identify knowledge gaps.

Chapter Three will discuss the research methodology, including the design, sampling, data gathering, and analysis. The chapter will explain how economic analysis is used to study CSA uptake, affecting variables, and productivity. Chapter Four presents the study findings and analysis, arranged by research goals and interpreted in detail. CSA adoption patterns, cost-benefit calculations, and productivity implications will be examined in this chapter.

Chapter Five will conclude the dissertation by summarising the main results, drawing inferences from the study, and suggesting policy, practice, and future research. The chapter will discuss how the findings might increase climate resilience and CSA in Zimbabwe's smallholder agriculture systems.

1.9 Scope and limitations of the study

Geographical scope the study focuses on smallholder farmers in Zimbabwe, exploring the adoption of climate-smart agricultural practices (CSA) in different agro-ecological zones.Thematic scope the study examines the economic analysis of CSA adoption, including factors influencing adoption decisions, costs and benefits, and impact on farm productivity.However the study is limited to Zimbabwe, which may not be representative of other countries or regions with different climatic, economic, and social contexts.Focus on smallholder farmers.The study focuses on smallholder farmers, which may not be representative of large-scale commercial farmers or other types of agricultural producers.CSA practices the study may not cover all types of CSA practices, and the findings may be specific to the practices examined in the study.

1.10 SUMMARY

This chapter dwelled into background for the economic analysis of climate-smart farming practises among Zimbabwean smallholder farmers. It has highlighted the global, regional, and local effects of climate change on agriculture, particularly Zimbabwe's subsistence farmers and the promise of climate-smart agricultural methods to boost production and resilience. The chapter addressed the issue of limited CSA adoption despite its benefits, outlined the research questions and objectives that focus on adoption rates, influencing factors, and productivity impacts, and established the study's importance for advancing knowledge and informing policy. The next chapter will review climate-smart agriculture literature, including theoretical frameworks, empirical data, and knowledge gaps on the economics of CSA adoption in smallholder agricultural systems.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

This review interrogates the scholarship on climate-smart agriculture (CSA) through two complementary lenses: first, the forces that determine whether smallholders embrace or reject CSA; and second, the economic consequences of that choice. Drawing on studies that span conservation tillage, agroforestry, water harvesting, and drought-tolerant seed, it weighs how assets, gender, tenure security, credit, extension reach, and real-time climate information shape adoption decisions. The evidence on returns—higher yields, steadier income, and greater food security under volatile weather—is then set against the up-front costs and transition risks that often deter investment. By marrying these behavioural and financial insights, the review distils practical lessons for scaling CSA among Zimbabwe's rain-fed smallholders and, by extension, farmers facing comparable climatic and institutional constraints elsewhere.

2.2. CONCEPTUALIZATION OF KEY TERMS

2.2.1. CLIMATE SMART AGRICULTURAL PRACTICES

Climate-Smart Agriculture (CSA) is a purpose-built portfolio of practices—conservation tillage, agroforestry, water harvesting, integrated soil-fertility management, drought-tolerant seed—designed to do four things at once: lift yields, cushion farms against climate shocks, curb net greenhouse-gas emissions, and bolster food security. Smallholders gravitate toward this toolkit when erratic rainfall, exhausted soils, and falling harvests imperil their livelihoods; evidence from Kenya and Ethiopia shows that adopters harvest more grain while weathering droughts with less loss (Kenduiwa et al., 2024).

CSA, however, is never a one-size-fits-all recipe. Local ecology, household resources, and farmers' own perceptions of climate risk determine which practices are feasible and in what combination. Low-cost options such as mulching or intercropping can conserve soil moisture and cut reliance on synthetic inputs, but their spread depends on timely extension advice, reliable climate information, and supportive institutions (Autio et al., 2021). Where those enabling conditions exist, CSA functions as an adaptive framework that reconciles productivity with resilience; where they don't, even the most promising techniques remain unused.

2.2.2. ECONOMIC ANALYSIS

Farm economic analysis weighs whether a practice or technology pays off. In this investigation the tool of choice is cost-benefit analysis (CBA), applied to gauge the value of Climate-Smart Agriculture for Zimbabwean smallholders. CBA balances measurable gains—higher yields, lower input bills, richer soils—against the extra labour, tools, and start-up capital the shift demands. By translating those figures into profit and efficiency metrics, the method equips cash-strapped growers with hard numbers and helps researchers test which options merit scarce resources in diverse agro-ecological zones across the country and seasons (Petros et al., 2025).

Crucially, CBA exposes timing. Certain CSA options demand hefty cash outlays—specialised planters, quality seed, rain-water tanks—yet pay back through steadier harvests, lower failure risk, and fatter household profits over several seasons. When the discounted stream of future earnings exceeds the initial stake, the practice shows a positive net present value and becomes attractive to prudent farmers. Perceived profit, reinforced by observed yield rebounds, drives adoption. Recognising these cost-return trajectories therefore shapes sound policy design and steers producers toward sustainable, climate-proof farming pathways across diverse different regions and cropping systems alike (Alidu & Man, 2025).

2.2.3. SMALLHOLDER FARMERS

Smallholder farmers are households or individuals who operate on modest plots, typically less than two hectares, relying on rain-fed cultivation, hand tools, and scant access to credit, markets, or modern machinery. In Zimbabwe, as in much of Africa, they anchor rural food systems and local economies, yet their limited resources leave them acutely exposed to shifting rainfall and rising temperatures (Ajwang et al., 2024). These farmers frequently grow staple cereals alongside small livestock, using inherited knowledge to manage soils but with minimal safety nets when harvests fail.

Livelihood choices in this sector hinge on socio-economic and institutional realities. Secure land rights, available working capital, timely extension advice, and accurate climate forecasts all tilt decisions toward innovation. Conversely, high labour demands, scant inputs, and uncertain tenure discourage experimentation with CSA. Comparative evidence from Kenya, Nigeria, and Zambia shows that growers linked to credit schemes and regular extension visits are markedly more inclined to adopt adaptive techniques. Creating such enabling conditions through targeted investment and policy reform is therefore indispensable for steering Zimbabwe's smallholders toward sustainable, climate-resilient production (Atsiaya et al., 2023).

2.3. THEORETICAL FRAMEWORK

This study is anchored in Diffusion of Innovations Theory, which traces how novel ideas move from first exposure to routine use within a community. Applied to Climate-Smart Agriculture, the framework clarifies why some Zimbabwean smallholders hear about mulching or drought-tolerant seed, weigh the pros and cons, and ultimately adopt, while others do not. Adoption unfolds through familiar stages—knowledge, persuasion, decision, implementation, confirmation—each shaped by perceived advantages such as higher yields, better drought tolerance, and stronger profits under erratic weather (Akinyi et al., 2022). The pace of that progression depends heavily on social networks: neighbours, farmer groups, and extension agents who demonstrate results, answer questions, and normalise new practices. Innovations that mesh with local norms, require minimal extra complexity, and produce visible pay-offs spread fastest; Ghanaian and Zambian evidence shows that farmers receiving timely climate bulletins and hands-on training are far more likely to integrate several CSA techniques (Alidu & Man, 2025).

Rational Choice Theory complements this lens by treating farmers as economic decision-makers who compare expected gains with out-of-pocket costs and risks. When the numbers add up—conservation tillage or integrated soil-fertility management raising yields and incomes even in variable seasons—adoption follows (Mujeyi & Mudhara, 2020). Yet rational calculus alone is not enough: credit bottlenecks, labour shortages, insecure tenure, and patchy institutional support often tip the balance against change. Many households must prioritise short-term survival over long-term resilience, so even practices with clear future benefits stall unless these structural hurdles are eased (Mogaka et al., 2022). Together, the two theories underscore a central point: accelerating

CSA uptake requires both persuasive evidence of economic advantage and a supportive environment that lowers the practical barriers to acting on that evidence.

2.4 CONCEPTUAL FRAMEWORK

The guiding premise is that Zimbabwe's smallholders can blunt climate shocks by folding Climate-Smart Agriculture into routine decisions. By trimming greenhouse gases, locking more carbon underground, and toughening crops against stress, CSA offers a three-fold pay-off. Yet each farm day presents tangled choices about plots, inputs, and varieties, all under pressure to lift yields and stay sustainable. Yield decline, tired soils, and rising exposure to erratic weather often jolt households into scouting for fresh, profitable fixes. Field evidence across sub-Saharan Africa shows that conservation tillage, integrated soil-fertility management, agroforestry, and drought-proof cultivars are recognised for delivering quick wins and durable gains alike, reinforcing the sense that CSA is both a defensive shield and a sound investment for land stewardship now and for future household generations.

Whether that promise materialises depends on intertwined social, economic, and institutional levers. Schooling, age, family labour, and secure tenure shape a farmer's taste for risk; ready extension advice and affordable credit widen the room for manoeuvre. Timely climate forecasts boost confidence, converting curiosity about CSA into concrete field trials. When growers witness clearer grain surpluses and healthier margins, they weave the practices into everyday routines. Adoption, however, stalls where labour is scarce, inputs overpriced, or local agencies weak. Trim those frictions and strengthen the support scaffolding, and CSA can lift output, stabilise food stocks, and swell rural incomes, while simultaneously cutting emissions and anchoring more sustainable, climate-resilient livelihoods across Zimbabwean landscapes, benefiting national food systems, regional markets, and the broader development agenda for Zimbabwe.

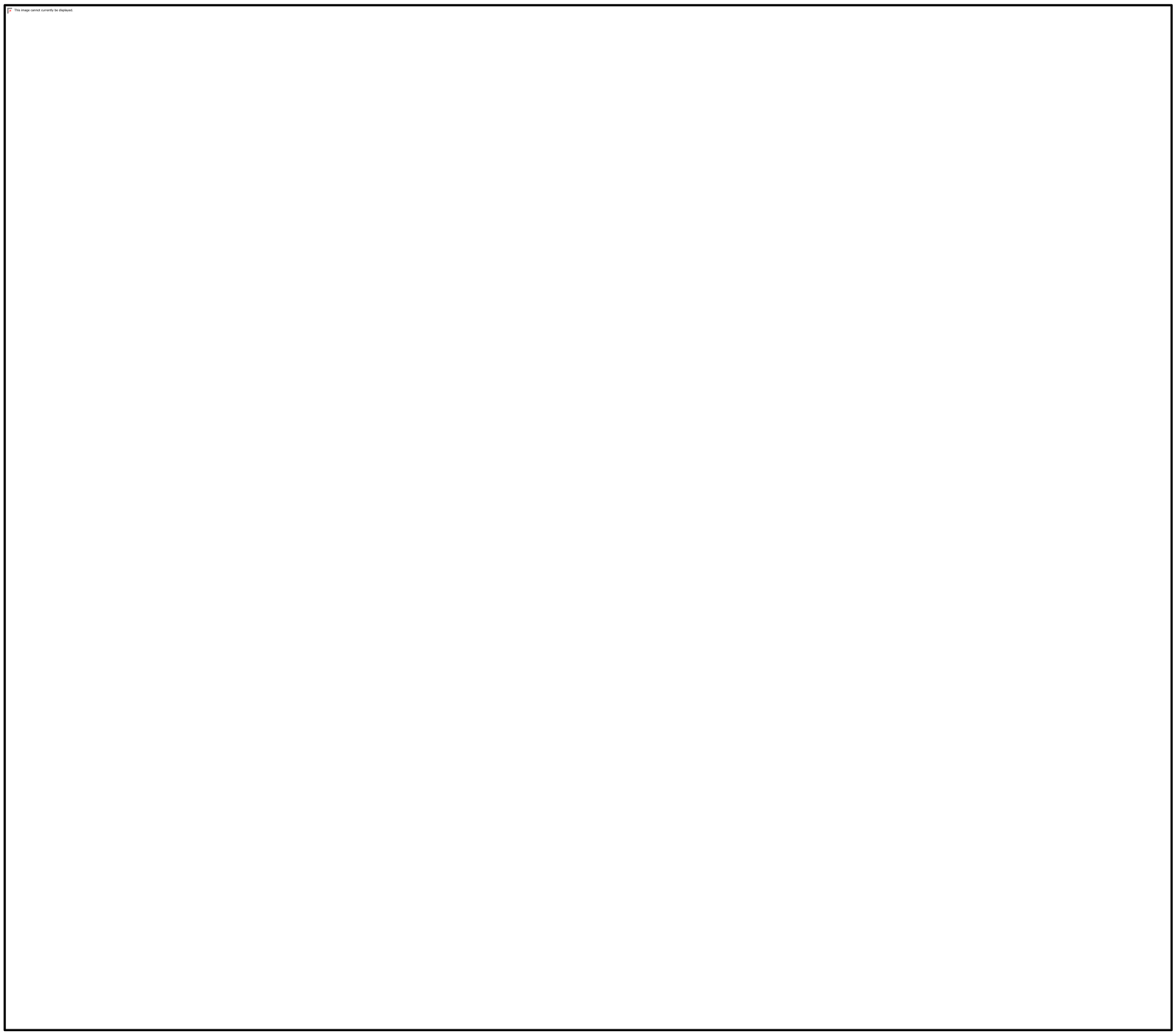

Figure 1: Conceptual framework

Source: Modified from FAO, (2021)

2.5. REVIEW OF EMPIRICAL LITERATURE

Framed by the study’s objectives, this section distils empirical evidence on three fronts: (1) the climate-smart practices already in use among smallholder farmers, (2) the socio-economic and institutional forces that foster or hinder their adoption, and (3) the net costs and benefits farmers realise when these practices are woven into everyday production.

2.5.1. CURRENT CLIMATE SMART PRACTICES ADOPTED BY SMALLHOLDER FARMERS

Atsiaya, Gido, and Sibiko (2023) provide a detailed snapshot of climate-smart agriculture in Busia County, Kenya, by administering structured questionnaires to 382 sorghum growers. Four practices dominate the local portfolio: drought-tolerant sorghum seed, intercropping, mulching, and physical soil-conservation structures. Econometric analysis links adoption to three variables—regular extension contact, higher schooling, and larger farm size—suggesting that both human and physical capital ease the leap to new techniques. Yet the study also exposes a disquieting gap between knowledge and execution. Nearly all respondents had heard of at least one CSA practice, but limited cash and sporadic information flow kept overall uptake well below potential. The authors argue that finely targeted subsidies for seed and mulch material, delivered through the existing extension network, could convert latent awareness into concrete field action and narrow the yield gap now widening under erratic rainfall.

A parallel portrait emerges from Ogun State, Nigeria, where Ojo et al. (2024) used a multistage sample of 180 smallholders to gauge CSA penetration. Every farmer interviewed practised minimum tillage, crop rotation, and mulching; substantial majorities also employed cover cropping (81.1 percent), mixed cropping (82.2 percent), and integrated pest management (80 percent). Extension agents supplied 70.6 percent of all CSA information, confirming their central role in technology diffusion. Nevertheless, the study registers three structural bottlenecks: weak credit access, an anemic policy environment, and lingering information gaps. These hurdles limit the depth and consistency with which farmers apply the practices they ostensibly "use," eroding potential gains in yield stability and soil health. Ojo and colleagues conclude that revitalising extension services, expanding rural credit lines, and enacting clear CSA-supportive policies are indispensable for translating high nominal adoption into demonstrable agronomic and economic benefits.

Evidence from India adds an important comparative note. Angom, Viswanathan, and Ramesh (2021) review CSA uptake among smallholders in Gujarat's drought-prone Aravalli district, where farmers confront severe heatwaves, erratic rainfall, and surging pest pressure. In response, they have begun experimenting with water-conservation pits, crop diversification, and integrated pest management. Yet the authors characterise adoption as "nascent," citing minimal policy incentives and low farmer awareness as principal culprits. Their call for rigorous empirical work is aimed at producing district-specific cost–benefit data that could galvanise both political will and private investment. A similar cautionary tale unfolds in northern Nigeria. Surveying growers in Gombe State, Oruonye (2019) finds that farmers readily perceive shifting rain patterns and hotter seasons, and they respond by tweaking planting dates, introducing drought-resistant varieties, and constructing anti-erosion bunds. Still, chronic cash shortages, poor access to climate forecasts, and skeletal extension services sap momentum. Both studies reinforce the point that awareness, while necessary, is never sufficient; without institutional scaffolding, adoption stalls at the trial phase.

The critical importance of information architecture is underscored by Ajwang, Owoche, and Mutonyi (2024), who investigated 382 households in Kenya's Lake Victoria Basin. Farmers cited television, radio, extension officers, and peer networks as their primary knowledge conduits, but the effectiveness of each channel varies by age and education. Younger, better-educated farmers exploit a broader media mix and are more likely to stack multiple CSA practices, while older or less-educated counterparts rely heavily on intermittent extension visits. The authors recommend tailoring content and delivery mode to demographic profiles—short radio bulletins for older farmers, interactive mobile platforms for younger ones—to accelerate diffusion. Taken together, these five studies converge on a clear lesson: credible information, robust extension, accessible finance, and supportive policy must align before climate-smart techniques can move from scattered experiments to entrenched practice. Where that alignment is missing, adoption remains shallow, and the promise of CSA—higher yields, resilient livelihoods, and healthier soils—remains frustratingly out of reach.

2.5.2. FACTORS AFFECTING THE ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICES

Kenduiwa et al. (2024) offer a quantitative snapshot of CSA uptake in Kenya's Laikipia County by surveying 384 smallholder households. Their results paint a two-tier picture: headline adoption rates are strikingly high for crop diversification (87 %), mixed farming (83 %), and chemical pest control (80 %); more than half the respondents have fully integrated diversification (52 %) or pest-and-disease management (54 %) into everyday practice. Yet enthusiasm fades for agroforestry, where 42 % of farmers report no adoption at all. Because the study stops at descriptive statistics and chi-square tests, it leaves unexplored the social, economic, and institutional frictions that explain this uneven pattern—an omission that looms large for Zimbabwe, where land tenure ambiguities, extension shortfalls, and credit constraints could push adoption figures in very different directions.

Autio et al. (2021) confront those frictions head-on in Southeast Kenya's Taita Taveta County. Employing a participatory Climate-Smart Agriculture Rapid Appraisal—household surveys, gender-segmented workshops, transect walks, and key-informant interviews—the authors surface a disjuncture between institutional narratives and farmers' lived realities. Government officials and extension agents blame low uptake on ignorance, but farmers point instead to hard, external limits: thin wallets, insecure plots, volatile markets, and crop raids by wildlife. Awareness alone, they argue, cannot vault those barriers. The study's call to place farmers' own diagnoses at the centre of policy design resonates strongly with Zimbabwe, where structural and governance bottlenecks likewise throttle CSA diffusion.

Clear productivity pay-offs emerge from Zambia, where Petros et al. (2025) interrogate 194 households in Nyimba District using logistic regression and propensity-score matching. Education, gender, household labour, livestock assets, land size, income, and climate-information access all lift the odds of adoption, and adopters record a 20.2 % boost in overall crop output plus a 21.5 % jump in maize yields. The Zambian data underline a recurring theme: human capital and resource endowments jointly determine who captures CSA's benefits. For Zimbabwe, the implication is direct—capacity-building and livelihood diversification can turbo-charge the agronomic gains theoretically available from conservation tillage or drought-tolerant seed.

The Ethiopian evidence supplied by Gurmu et al. (2025) pushes the discussion further by stressing complementarities among practices. Drawing on a multivariate probit model applied to West Arsi Zone survey data, the authors show that the likelihood of adopting multiple CSA measures rises with extension contact, credit, education, landholdings, off-farm income, and group membership. Farmers treat CSA not as isolated tweaks but as bundled strategies that reinforce household resilience. That insight is especially pertinent for Zimbabwean smallholders who confront compound risks—erratic rainfall, price volatility, and shifting pest regimes. A policy mix that promotes practice "stacks" rather than single technologies could yield outsized returns.

Information, finally, emerges as a decisive lever in Ghana, where Alidu and Man (2025) analyse cross-sectional data from 420 farmers across three agro-ecologies. Ordered probit results show that regular access to localized weather forecasts, seasonal outlooks, and early-warning alerts dramatically raises both the probability and the breadth of CSA adoption. Education, gender, mobile-phone ownership, and trust in information channels moderate this effect, suggesting that digital inclusion and credible content are twin prerequisites. Zimbabwe's patchy communication infrastructure and uneven digital literacy therefore represent not peripheral inconveniences but central hurdles to scaling CSA.

Together, these five studies converge on a coherent message: CSA adoption flourishes where farmers possess the capital, knowledge, and institutional backing to translate interest into action. High headline adoption in some settings masks deep disparities across practices and households; structural constraints, not mere ignorance, explain the shortfall. For Zimbabwe, the comparative evidence implies that holistic interventions—secure tenure, responsive extension, affordable credit, robust climate-information services, and incentives for practice bundles—are essential if CSA is to move from pilot plots to a nationwide production standard.

2.5.3 COST- BENEFIT ANALYSIS OF CLIMATE SMART AGRICULTURAL PRACTICES BY SMALLHOLDER FARMERS

McCarthy, Lipper, and Zilberman (2018) place climate-smart agriculture squarely in the realm of economic choice. Surveying theory and evidence, they argue that every CSA option—whether conservation tillage, drought-tolerant seed, or water-harvesting infrastructure—demands an up-front outlay for inputs, training, or equipment, yet promises a stream of future pay-offs: higher and more stable yields, greater resilience to climatic shocks, and positive environmental externalities. Their review sets out analytical tools—cost-benefit analysis, real-options modelling, and ecosystem-service valuation—to weigh those near-term costs against long-term gains and to uncover trade-offs and synergies among productivity, adaptation, and mitigation goals. By framing CSA as an investment decision under uncertainty, the authors show how rational farmers, markets, and policymakers can align incentives so that the private calculus of profit also delivers public goods such as carbon sequestration and landscape resilience. The key insight is that while CSA practices may appear costly at the onset, the overall net benefits are often positive, especially when factoring in reduced climate risk. However, the study lacks empirical data and does not focus on Zimbabwe, revealing a gap for in-depth, location-specific cost-benefit analyses like the one proposed in your study.

Akinyi et al. (2022), in their article "Cost-Benefit Analysis of Prioritized Climate-Smart Agricultural Practices Among Smallholder Farmers: Evidence from Selected Value Chains Across Sub-Saharan Africa," evaluate the economic viability of CSA interventions across multiple countries using the CSA Prioritization Framework. They apply a mixed-methods approach, collecting primary data from smallholder farmers involved in selected value chains in Kenya, Tanzania, Ethiopia, Uganda, and Zambia. The study presents quantified CBAs for different practices, with findings such as Good Agricultural Practices (GAP) in Kenya's sweet potato value chain yielding a net present value (NPV) of US$28,044 and an internal rate of return (IRR) of 328%. The costs varied significantly between technologies, with some practices requiring capital inputs, while others focused more on knowledge transfer. Despite the positive economic outlook across these practices, a major research gap remains in geographic scope, as Zimbabwe was not included. This justifies your study's contribution by applying a similar framework in a Zimbabwean context.

Ng'ang'a, Miller, and Girvetz (2021) conducted a country-specific analysis on Investment in Climate-Smart Agricultural Practices the Option for the Future? Cost and Benefit Analysis Evidence from Ghana," aimed at assessing the financial viability of CSA adoption by smallholders. Employing cost-benefit analysis techniques based on survey data, the study compared traditional farming with CSA practices like agroforestry and improved irrigation. They found that agroforestry yielded a high NPV and IRR while also reducing long-term input costs and environmental degradation. Although adoption costs were non-trivial especially for technologies like irrigation, the long-term economic and environmental benefits far outweighed these expenses. The study emphasizes the importance of government and donor support to bridge the financing gap. A key gap here is the single-country focus on Ghana, making it imperative to undertake similar analyses in other African countries like Zimbabwe to understand localized economic dynamics of CSA.

Mujeyi and Mudhara (2020), also carried out a study on the Economic Analysis of Climate-Smart Agriculture Technologies in Maize Production in Smallholder Farming Systems," focus specifically on smallholder maize production systems in Zimbabwe. Using farm-level data and partial budget analysis, the authors compare conservation agriculture (CA) techniques with conventional methods. The study found that CA, though requiring significant labour and knowledge inputs, led to an average yield increase of 36% and improved net returns per hectare. Benefits included improved soil health and drought resilience, while the costs included higher labour time and initial investments in specialized equipment. The net economic benefit was positive, demonstrating that CSA in maize farming can enhance farmer income and resilience. This study is highly relevant but limited to one crop and a narrow range of CSA technologies, indicating a need for broader evaluations across different CSA practices and crops in Zimbabwe, aligning well with your study’s objectives.

Mogaka, Ng'ang'a, and Bett (2022), in their paper "Comparative Profitability and Relative Risk of Adopting Climate-Smart Soil Practices Among Farmers," conducted a cost-benefit analysis of six soil management practices across East Africa. The study used empirical field data and modelled farm budgets to assess profitability and risk. Practices like minimum tillage, crop rotation, and use of compost were evaluated, with minimum tillage showing the highest IRR but also high variability in returns due to climatic uncertainty. Costs included equipment and training, while benefits included improved yield stability and soil fertility. Although the study concluded that CSA soil practices offer positive net benefits over time, it stressed the importance of context, as profitability varied significantly by agroecological zone and farmer capacity. Zimbabwe was not part of the analysis, underscoring a regional research gap and the need for similar cost-benefit evaluations under Zimbabwean agro-ecological and socio-economic conditions.

Finally, Mutenje et al. (2019), in their research titled "A Cost-Benefit Analysis of Climate-Smart Agriculture Options in Southern Africa: Balancing Gender and Technology," take a gender-sensitive approach to evaluating CSA technologies such as conservation agriculture, agroforestry, and improved crop varieties. The study used household surveys, partial budgeting, and scenario modelling across Malawi, Mozambique, and Zambia to assess both economic and social outcomes. They found that CSA practices generally delivered positive NPVs and IRRs, with conservation agriculture having up to a 25% return on investment over ten years. However, benefits were not equally distributed; female-headed households often faced higher adoption barriers, reducing net benefits. Though Southern Africa-focused, Zimbabwe was excluded from the data sample, suggesting a geographic gap that your study can fill by addressing both economic viability and equity dimensions of CSA adoption among Zimbabwean smallholders.

2.6 KEY INSIGHTS FROM LITERATURE

Recent scholarship on Climate-Smart Agriculture (CSA) converges on one clear point: practices such as agroforestry, conservation tillage, and integrated soil-fertility management have become indispensable tools for smallholders facing harsher weather and tired soils. Farmers turn to them to arrest soil degradation, stabilise yields, and cushion themselves against rainfall swings. Evidence from Gurmu et al. (2025) and Mutenje et al. (2019) shows that visible, near-term gains—better soil texture, quicker canopy cover, and larger harvests—often tip the scales toward adoption. Yet uptake is anything but automatic. Household income, schooling, secure tenure, and steady extension contact all raise the likelihood that a farmer will experiment and persist; their absence often spells inertia (Alidu & Man, 2025). In other words, technology matters, but enabling conditions matter more.

Economic signals sharpen this calculus. Cost-benefit studies by Akinyi et al. (2022) and Karanja et al. (2021) reveal that when farmers can see a clear pathway from investment to profit—higher yields, lower input bills, or premium prices—they embrace CSA; when start-up costs, labour peaks, or credit gaps loom large, they hesitate. Rigorous financial appraisal therefore performs double duty: it shows producers where the money is and guides policymakers on where subsidies, credit, or risk-sharing schemes will unlock the greatest social return. In vulnerable settings like Zimbabwe, where a single failed season can wipe out household reserves, such economic clarity is not a luxury but a prerequisite for scaling CSA and safeguarding long-term food security.

2.7 CONCLUSION

In sum, the evidence shows that Climate-Smart Agriculture is a viable pathway for smallholders to weather climate shocks while raising yields and stewarding natural resources. Uptake, however, hinges on a mix of socio-economic and institutional conditions: secure access to land and inputs, adequate schooling, and reliable climate information all tilt the balance toward adoption. Cost-benefit studies make clear that, although CSA delivers sizeable long-run gains, steep start-up expenses and added labour can dampen enthusiasm. Bridging this gap demands supportive policy, affordable finance, and targeted capacity-building so that CSA can truly bolster food security, livelihoods, and climate resilience.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter contains the methodology of the research which include the study area which is the study settings. In addition, this section also contains the research design together with the data collection methods. The data types and sources are also contained in this chapter which is followed by primary data collection methods and tools. The sampling framework is also part and parcel of the chapter which gives a description of how the participants in the study were selected. In addition to this, the data collection framework is also included which is followed by the ethical considerations and limitations of the study. The section closes with a chapter summary.

3.2 DESCRIPTION OF STUDY AREA AND POPULATION

The research took place in Buhera District, in the south-eastern corner of Manicaland Province, Zimbabwe. Situated in agro-ecological regions IV and V, the area receives erratic annual rainfall of less than 650 mm and endures a semi-arid climate prone to recurrent droughts and mid-season dry spells. Topography is mainly flat with scattered rolling hills, while soils range from sandy loams to heavy clays, generally of low inherent fertility. These biophysical constraints severely limit rain-fed production, the dominant farming system in the district (Mutenje et al., 2019).

Agriculture remains the backbone of local livelihoods, with most households practising small-scale subsistence farming. Staple crops include maize, groundnuts, and sorghum, complemented by livestock—cattle, goats, and poultry. Persistent climate shocks, however, have rendered many traditional practices untenable, prompting a push toward Climate-Smart Agriculture (CSA) to safeguard yields, incomes, and food security under increasing climate variability.

Infrastructure and support services in Buhera are sparse. Irrigation schemes are few, extension coverage is thin, markets are distant, and formal credit is hard to obtain. These deficits depress productivity and restrict the capacity of farmers to experiment with new technologies. Although government agencies and NGOs have launched several sustainable-farming initiatives, adoption rates vary widely, shaped by household wealth, education, and risk perceptions. Consequently, Buhera offers a revealing setting for analysing both the economic viability and diffusion patterns of CSA among Zimbabwe's rural poor.

The study population comprised smallholder producers in Wards 5, 6, and 9—areas deliberately selected for their acute exposure to climate stress and active CSA interventions. Farmers here typically manage less than five hectares and depend almost entirely on rainfall. Both male- and female-headed households engaged in mixed crop-livestock systems were included (Mujeyi & Mudhara, 2020). This population captured the diversity of experiences needed to assess how CSA affects adoption behaviour and farm economics in a climate-vulnerable landscape.

3.3 RESEARCH DESIGN

The study employed a descriptive-survey design, a format well suited to gathering systematic information from a sample of respondents in order to portray the characteristics, behaviours, and perceptions that shape Climate-Smart Agriculture (CSA) uptake among smallholder farmers. This design enabled the collection of both quantitative metrics and qualitative insights on the economic outcomes and contextual drivers linked to CSA use in Buhera District. Descriptive surveys excel at capturing phenomena in their real-world setting and at unpacking complex social and economic dynamics—such as the farm-level decisions households make when faced with climate stress (Atsiaya et al., 2023). Because the research needed to document not only how widespread CSA practices are but also farmers' perceived costs and benefits, as well as the socio-economic and institutional factors that influence adoption, a descriptive-survey approach offered the necessary combination of flexibility and methodological rigour. In short, this design provided a comprehensive lens through which to understand the diverse experiences of Buhera's smallholder producers.

3.4 Data-Collection Methods

The study used a mixed-methods strategy that combines documentary evidence with field-level enquiry to build a comprehensive picture of Climate-Smart Agriculture (CSA) adoption in Buhera District. The approach was deliberately sequenced: secondary materials were first reviewed to map the policy landscape and historical trends, after which primary data were gathered to capture farmers' contemporary experiences. Integrating the two streams allowed the researcher both to verify patterns detected in earlier studies and to explore new questions that emerged from the local context. The resulting dataset is therefore both context-rich and empirically grounded, providing a solid basis for the economic analysis of CSA practices among smallholders.

3.4.1 Data Types and Sources

Two complementary categories of data—secondary and primary—were employed. Secondary data furnished the macro-level backdrop, detailing agro-ecological conditions, institutional arrangements and previous adoption rates across Zimbabwe. Primary data, by contrast, supplied micro-level observations on household decision-making, costs, benefits and perceived constraints. Taken together, these sources enabled the study to triangulate findings and to move beyond description toward explanation of the factors that drive or hinder CSA uptake in Buhera.

Secondary Data Sources

Secondary information was extracted from peer-reviewed journal articles, government publications, national statistics and NGO project reports relevant to CSA and rural livelihoods. Documents from the Ministry of Lands, Agriculture, Fisheries, Water and Rural Development provided insights into policy frameworks and extension priorities, while ZIMSTAT datasets offered quantitative benchmarks on rainfall, crop output and socio-economic indicators. In addition, evaluation reports from organisations such as the FAO and World Vision helped to contextualise ongoing development initiatives in the district. Collectively, these materials established the study's analytical foundation, informed questionnaire design and served as a reference point against which primary findings were compared.

Primary Data Sources

Primary evidence was gathered directly from smallholder farmers in Wards 5, 6 and 9 through structured questionnaires, key-informant interviews and focus-group discussions. The household survey generated quantifiable measures of CSA adoption, input use, yields, labour allocation and perceived profitability. Interviews with extension officers, local leaders, agro-dealers and NGO staff provided institutional perspectives on supply-chain bottlenecks, policy implementation and resource constraints. Focus-group sessions—segmented by gender and age—captured collective experiences, social learning processes and intra-household dynamics that influence technology choices. This blend of quantitative and qualitative techniques not only enriched the dataset but also enhanced the validity of the study by allowing cross-verification of responses across different respondent categories and data-collection tools.

3.4.2 Primary Data Collection Methods and Tools

Table 1: Primary Data Collection Methods and Tools

Specific Research Objective	**Data Concepts and Variables/Indicators**	**Data Collection Methods/Tools**	**Respondents/ Subjects**
1. To identify the current climate-smart agricultural practices being implemented by smallholder farmers across different agro-ecological zones in Zimbabwe.	Types of CSA practices (e.g., conservation agriculture, agroforestry, drought-tolerant seeds, integrated soil fertility management), frequency of use, area covered	Structured questionnaires, field observations, key informant interviews	Smallholder farmers, agricultural extension officers
2. To analyse factors that influence the adoption decisions of climate-smart agricultural practices among smallholder farmers in Zimbabwe.	Socio-economic factors (age, education, income, land size, access to credit), institutional support (extension services, training, market access), perception of climate change	Structured questionnaires, in-depth interviews	Smallholder farmers, community leaders, NGO/project coordinators
3. To determine the costs and benefits of adopting climate-smart agricultural	Costs (inputs, labor, capital investment), benefits (yield, income,	Structured questionnaires, financial record	Smallholder farmers, agricultural

practices amongst smallholder farmers in Zimbabwe	food security, resilience), cost-benefit ratios	review, cost-benefit analysis matrix	economists, local extension officers

3.4.3 Sampling

The study followed a multistage sampling procedure that balanced statistical representativeness with the need for specialist insight. In the first stage, three wards—5, 8, and 16—were purposively chosen because they host ongoing climate-change programmes and display varied agro-ecological and socio-economic characteristics. These wards constituted the strata for the second stage, where a stratified random-sampling technique was applied to household lists supplied by local authorities. Using Yamane's finite-population formula with a 0.10 margin of error, 91 households were randomly selected from a sampling frame of 960 smallholder farming households, ensuring proportional representation across the three wards and capturing the breadth of age, gender, land size, and income categories found in the district.

To deepen the qualitative dimension of the inquiry, purposive sampling was then employed on two fronts. First, key informants—district agricultural officers, extension agents, and representatives of NGOs implementing CSA projects—were deliberately selected for their policy knowledge and institutional experience. Second, within the randomly chosen households, farmers with demonstrable engagement in at least one climate-smart practice (e.g., conservation tillage, mulching, or drought-tolerant seed) were identified to provide practice-specific detail. This dual purposive strategy was essential for eliciting context-rich explanations of adoption incentives and barriers that might not surface through random selection alone. By combining stratified random sampling for breadth with purposive sampling for depth, the study achieved both representativeness and analytical richness, enhancing the validity and applicability of its findings (Ajwang et al., 2024). Yamane's formula was used as shown below.

$$n = \frac{N}{1 + Ne^2}$$

Where n= sample size; N= Population, e= margin of error

3.6 Data Analysis Methods

Table 2: Data Analysis Methods

Specific Research Objective	Data Concepts	Data Variables/ Indicators	Data Analysis Tools
1. To identify the current climate-smart agricultural practices being implemented by smallholder farmers in Buhera	Types and extent of CSA adoption	Types of CSA practices, frequency of use, geographical distribution	Descriptive statistics (frequencies, percentages), cross-tabulations, charts
2. To analyse factors that influence the adoption decisions of climate-smart agricultural practices among smallholder farmers in Buhera	Socio-economic, demographic, and institutional influences	Age, education, income, land size, household size, access to finance, gender, access to extension services, farming experience, perception of climate change	Logistic regression
3. To determine the costs and benefits of adopting climate-smart agricultural practices amongst smallholder farmers in Buhera	Economic outcomes of CSA	Input costs, labour, yield levels, revenue, profit margins	Cost-benefit analysis (CBA), Net Present Value (NPV), Benefit-Cost Ratio (BCR)

Model specification for Factors affecting adoption of CSA

We explored the effects of socio-economic variables to adoption of the modern ICTs. The farmers either adopted or did not adopt the use of the ICT methods. The Binary logistic regression method was used to analyse the effects of socio-economic variables on ICT adoption. Since the adoption is a binary (1 for ‘adopted’ 0 for “not adopted”) therefore Y=0 will denote, not adopted and Y=1 will represent adopted. X denotes the vector for independent variables which include, age, gender, education level, land size, household size, income, extension education. The binary logistic is stated in the probability that Y=1 given X:

$$P(Y = 1|X) = \frac{1}{1 + Exp(-\beta X)}$$

$Z = \beta X$ is called the linear predictor and stands for $\beta_o + \beta_1 X_1 + \cdots \ldots \ldots \ldots \ldots \ldots . . + \beta_P X_P$

By solving Y the form for the binary logistic regression model is obtained:

In $\frac{P(Y=1|X)}{P(Y=0|X)}$=logit ($Y$)= βX (Kosemely and Vadnal, 2003)

The recommended sample size for this kind of research is calculated by taking into consideration the minimum ratio of sample size to independent variables of 10 to 1 with a sample size of 100 to 50 plus a variable number which that is a function of the predictor (Peng, Lee & Ingersoll, 2002). This was satisfied in the research.

Table 3: Model Specification

Variable	Coding	Type of Measure	Prior Expectation
DEPENDENT VARIABLE			
Adoption	ADPTN	0, Did not adopt 1= Adopted	+/-
INDEPENDENT VARIABLES			
Age	AGE	Continuous	-

Gender	GENDER	0 for females, 1 for males	-/+
Household size	AGE	Continuous	+/-
Education	EDU	dummy: 0 for illiterate, primary and secondary 1 for tertiary education	+
Farming experience	FARMEXP	Continuous	+
Income	INCOME	Continuous	+
Land size	LANDSIZE	Continuous	+
Extension	EXTEN	Dummy 0 for no, 1 for Yes	+

Cost Benefit analysis for CSAs

Cost-Benefit Analysis (CBA) is a key economic evaluation tool used to assess the viability and profitability of agricultural practices. In Climate-Smart Agriculture, cost–benefit analysis (CBA) is the yardstick for judging whether a new practice makes financial sense for a smallholder. The exercise tallies every expense involved in adopting the technology—seed, equipment, labour, training, or infrastructure—and then projects the stream of benefits it is expected to generate, such as higher yields, lower input bills, or reduced climate risk, over a defined time horizon. The rule of thumb is simple: when the ratio of total benefits to total costs exceeds one, the investment is economically attractive; when it falls below one, the farmer would be better off sticking with conventional methods. By rendering complex trade-offs in a single metric, CBA helps farmers, extension agents, and policymakers decide which CSA options warrant scarce resources and which should be set aside.

Formulas Used

Net Benefits (NB):

Net Benefits=Total Benefits (Revenue)−Total Costs\text{Net Benefits} = \text{Total Benefits (Revenue)} - \text{Total Costs}Net Benefits=Total Benefits (Revenue)−Total Costs

Benefit-Cost Ratio (BCR):

$$\text{BCR} = \frac{\text{Present Value of Benefits (PVB)}}{\text{Present Value of Costs (PVC)}}$$

A BCR > 1 indicates that benefits exceed costs, making the investment economically viable.

Net Present Value (NPV)

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

Where:

B_t = Benefits in year

C_t = Costs in year

r = Discount rate

t = Year

n = Number of years

3.7 ETHICAL CONSIDERATIONS

The study followed rigorous ethical protocols to safeguard participants and uphold research integrity. Before any data were collected, each respondent received a clear explanation of the project's purpose, procedures, and potential risks, and written or thumb-printed informed consent was obtained. Participation was entirely voluntary, and respondents could withdraw at any stage without penalty. To preserve anonymity, questionnaires and interview notes were coded; no personally identifying information appears in the dataset or subsequent reports. All records—digital files and hard copies—were stored on password-protected devices and in locked cabinets accessible only to the research team, and they will be destroyed after the retention period stipulated by the approving body. Ethical clearance was secured from the relevant university review board as well as from district authorities in Buhera, ensuring compliance with national regulations. Throughout fieldwork, the team observed local customs, sought permission from community leaders, and scheduled interviews at times and venues convenient to participants, thereby maintaining cultural sensitivity and mutual respect.

3.8 LIMITATIONS

The fieldwork faced three principal constraints that required adaptive responses. First, the most climate-stressed wards include hamlets that are difficult to reach, especially after seasonal rains. To overcome this logistical barrier, the research team hired local guides familiar with footpaths and deployed mobile-data collection devices, which reduced travel time and allowed questionnaires to be completed offline and uploaded later. Second, a degree of respondent fatigue and scepticism surfaced; some farmers had taken part in multiple surveys and doubted the value of "another questionnaire." Collaboration with ward-level agricultural extension officers proved critical here: their endorsement, coupled with community meetings where the study's aims were explained in the local language, helped rebuild trust and boost participation rates. Third, uneven literacy levels complicated the administration of structured instruments. To ensure that questions were understood and answers accurately recorded, all tools were translated into Shona, and trained enumerators—fluent in both English and the local dialect—conducted face-to-face interviews, reading questions aloud when necessary. While these challenges inevitably shaped the tempo and cost of data collection, the mitigation measures put in place safeguarded data quality and breadth, enabling the study to generate a reliable portrait of Climate-Smart Agriculture adoption in Buhera District.

3.9 CONCLUSION

Chapter Three detailed the research strategy used to evaluate the economics of Climate-Smart Agriculture (CSA) among smallholders in Buhera District, Zimbabwe. A descriptive-survey design was selected because it captures farming practices, adoption drivers, and economic outcomes as they occur on the ground. Primary data came from structured questionnaires and semi-structured interviews administered to purposively chosen farmers who actively engage in CSA, ensuring that respondents could speak from firsthand experience. Complementary secondary data were drawn from peer-reviewed literature, government documents, and institutional reports to situate field findings within broader policy and agronomic contexts. Sampling procedures balanced breadth and depth: wards with active CSA initiatives were purposively identified, and knowledgeable farmers within them were selected, producing a dataset rich in relevant insight. Throughout the study, strict ethical standards—voluntary informed consent, confidentiality, and cultural sensitivity—guided every interaction. Data were organised around the study's objectives and analysed with a mix of descriptive statistics, regression modelling, and cost–benefit analysis. This analytical blend not only quantified adoption patterns but also illuminated the financial merits of different CSA practices. Collectively, the chosen methodology provides a rigorous platform for the study's subsequent results and recommendations.

CHAPTER 4

RESULTS PRESENTATION AND DISCUSSION

4.1 INTRODUCTION

Chapter Four presents and discusses the study's empirical findings on the economics of Climate-Smart Agriculture (CSA) among smallholder farmers in Buhera District. It begins by profiling respondents' demographic characteristics—gender, age, formal education, farm size, and other quantitative indicators—to situate subsequent analyses in their socio-economic context. The chapter then details the suite of CSA practices currently in use, highlighting patterns of uptake across conservation tillage, drought-tolerant seed, mulching, agroforestry, and related techniques. Next, it explores the determinants of adoption, drawing on both descriptive statistics and regression results to show how factors such as access to extension, credit availability, land tenure security, and household labour shape farmers' decisions. Finally, a cost–benefit analysis compares the economic performance of CSA adopters with that of non-adopters, quantifying differences in production costs, gross margins, and benefit-cost ratios. The chapter closes with a concise summary that integrates the key demographic insights, adoption drivers, and profitability outcomes, thereby setting the stage for the conclusions and policy recommendations that follow.

4.2 DEMOGRAPHIC CHARACTERISTICS

4.2.1 AGE

Survey results show a young agricultural population in Buhera District. Over two-thirds of studied homes have prime working-age people. In particular, 36 percent of households are led by people aged 28–43, and 33.3 percent by those aged 44–60. A large 25.3% of responders are young people (18–27 years), whereas just 5.3% aged 61–90. According to this age structure, farmers who are physically active, have lengthy planning horizons, and have seen recent Climate-Smart Agriculture (CSA) extension messaging or media campaigns dominate decision-making. International study shows that younger and middle-aged farmers are more open to new technology. This is because they are more familiar with agronomic advice dissemination information and communication technologies and have a longer return period. Thus, Buhera's demographic profile is encouraging for CSA adoption if complementing services like loans, inputs, and focused training are available to leverage on this latent capacity to innovate.

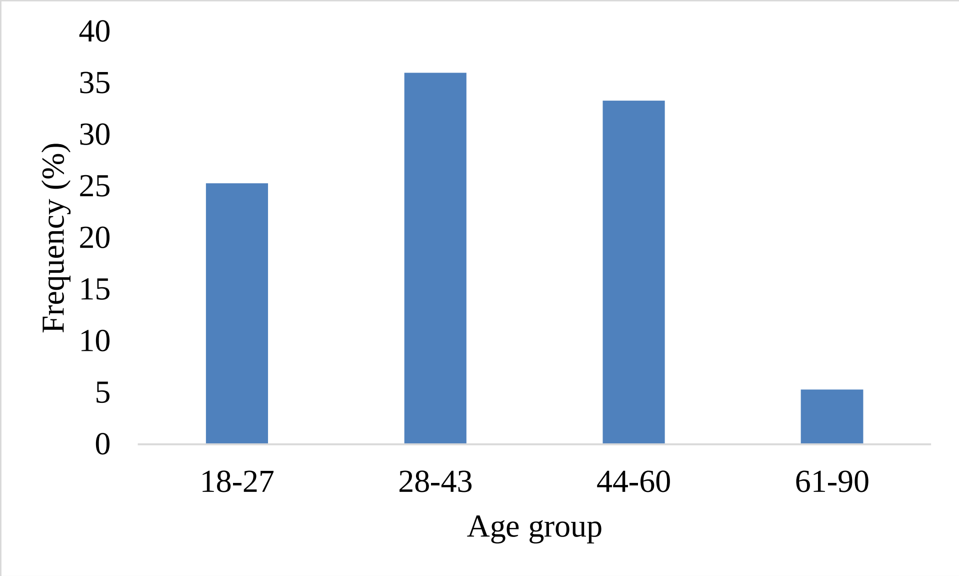

Figure 2: demographic characteristics farmers on gender

4.2.2 GENDER

The sample shows that 58.1% of agriculture responders are men and 41.9% are women. This imbalance shows that males dominate agricultural and animal production in Buhera, while the large number of female farmers underscores women's involvement in household food security and work. Their involvement in weeding, harvesting, and post-harvest processing affects Climate-Smart Agriculture (CSA) methods including residue retention and conservation tillage. The gender mix highlights the need for gender-responsive CSA solutions because men and women often have different resources and face different restrictions. Women have less land-tenure rights and credit resources. Customize training schedules, input packages, and extension messaging to guarantee that male and female farmers can embrace and benefit from climate-smart technologies.

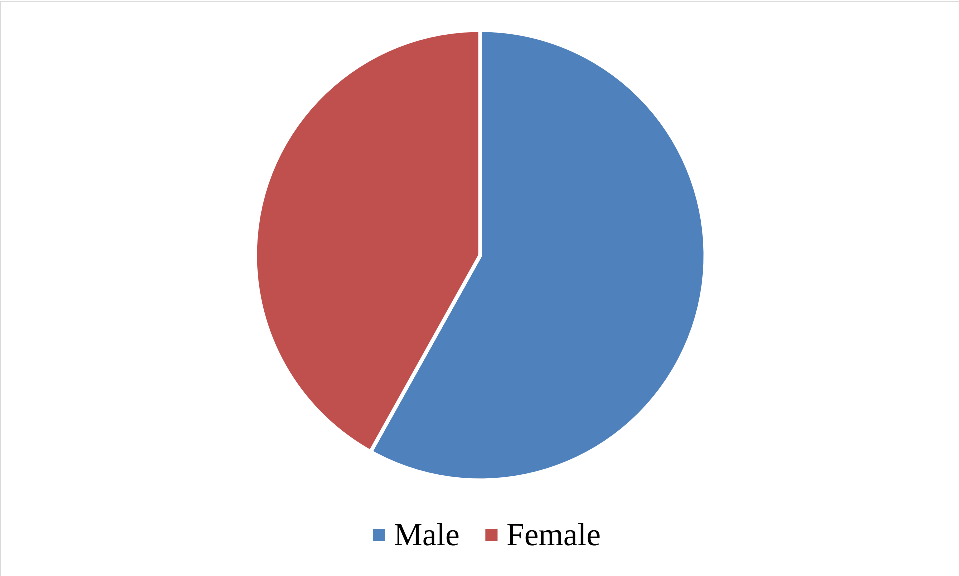

Figure 3: showing demographic for farmers on education

4.2.3 EDUCATION

In Buhera, 46% of smallholders have a secondary education, the cornerstone of their education. Another 33.3 percent have only finished basic school, while 14% have non-formal education, such as adult literacy classes or informal apprenticeships. The population has just 6.7% tertiary degrees, including agriculture certificates and university degrees. This profile suggests that most farmers have the literacy and numeracy skills to understand extension leaflets, document input–output data, and follow simple agronomic recommendations, which are necessary for Climate-Smart Agriculture (CSA) implementation. The lack of tertiary-educated manufacturers signifies a lack of critical thinking and sophisticated technical competence that may expedite innovation. The findings highlight the need for well-designed, easily understood training materials and hands-on demonstrations from extension services, farmer field schools, and radio programs to apply CSA concepts to most people who drop out of school.

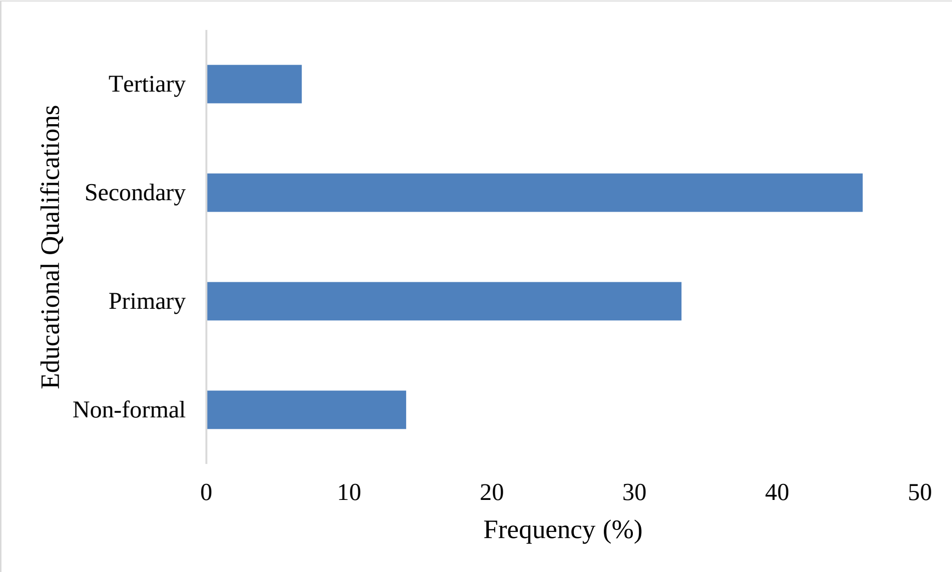

Figure 4: showing quantitative variables of respondents

4.2.4 QUANTITATIVE VARIABLES OF RESPONDENTS

Across the 91 sampled households, the mean annual income stands at US $99.41, accompanied by a standard deviation of US $9.54. Although modest in absolute terms, this spread signals pronounced economic heterogeneity: some farmers earn barely subsistence revenues, whereas a smaller group captures relatively higher cash flows, most likely through better market access, diversified enterprises, or earlier uptake of Climate-Smart Agriculture (CSA) technologies. Household size averages 5.61 members, a figure that translates into a sizable on-farm labour pool but also into commensurate food-security obligations; how each family balances labour supply and consumption needs is therefore central to its risk calculus in adopting new practices.

Respondents report an average of 9.21 years of farming experience (SD = 2.77), implying that the typical farmer has accumulated nearly a decade of location-specific knowledge about rainfall variability, soil behaviour, and input performance—assets that can either encourage experimentation with CSA or, conversely, entrench tried-and-tested routines. Landholdings are small even by Zimbabwean communal-area standards, averaging 1.41 ha but with a relatively large standard deviation of 1.87 ha, indicating that a minority of households command plots substantially above the mean while most work sub-hectare parcels. Such fragmentation underscores the importance of CSA options that intensify production per unit area—precision nutrient management, moisture-saving mulches, and drought-tolerant varieties—while safeguarding the fragile resource base on which livelihoods depend.

Table 4: showing 4 quantitative variables of respondents

Variable	Minimum	Maximum	Mean	St. Deviation
Income	20	535	99.41	9.54
Household size	2	14	5.61	2.41
Farming Experience	2	35	9.21	2.77
Size of land	0.5	5	1.41	1.87

4.3 CURRENT CSA PRACTICES BEING IMPLEMENTED BY SMALLHOLDER FARMERS

4.3.1 SOIL AND WATER MANAGEMENT PRACTICES

Evidence from the 91 sampled households shows a pronounced commitment to soil and water conservation techniques. Conservation agriculture tops the list, with 79.2 % of respondents practicing some combination of minimum tillage, residue retention, and crop rotation. This mirrors findings by Mutenje et al. (2019), who report similarly high uptake across Southern Africa owing to the practice's ability to improve soil structure, boost in-situ moisture, and ultimately lower labour requirements after the initial learning phase. Close behind are the low-cost fertility options of organic manure (73.3 %) and mulching (65.0 %), underscoring farmers' preference for inputs that are locally available, cash-saving, and compatible with mixed crop–livestock systems.

Water-centred measures are also well represented: 58.3 % of farmers harvest rainwater and 54.2 % employ contour ploughing. Both practices are vital in Buhera's drought-prone setting because they slow surface run-off and maximise infiltration—an outcome McCarthy et al. (2018) identify as pivotal for buffering yields against erratic rainfall. Terracing appears least common (45.0 %), a result consistent with Akinyi et al. (2022) who attribute muted adoption to the practice's heavy up-front labour and capital demands despite its long-term erosion control benefits.

Taken together, the pattern suggests that Buhera's smallholders are selectively embracing CSA options that strike an acceptable balance between resource requirements and perceived pay-offs, a behaviour Mogaka et al. (2022) describe as "pragmatic optimisation." The dominance of low-input, knowledge-intensive practices indicates both heightened awareness of climate risks and a willingness to invest labour—rather than scarce cash—in strategies that safeguard soil fertility and water availability over time.

Table 5: showing soil and water management practices

CSA Practices	Frequency	Percentage (%)
Conservation agriculture	95	79.2
Mulching	78	65.0
Contour ploughing	65	54.2
Use of organic manure	88	73.3
Terracing	54	45.0
Rainwater harvesting	70	58.3

4.3.2 CROP AND LAND MANAGEMENT CSA PRACTICES

Survey evidence indicates that Buhera's smallholders are actively integrating climate-resilient agronomic strategies into their production systems (Figure 4.2). Three practices top the adoption league table:

- drought-tolerant crop varieties – 76.5 %
- intercropping – 73.9 %

- conservation agriculture – 71.4 %

Together these measures form the district's first line of defence against erratic rainfall. Drought-tolerant varieties secure minimum harvests in dry years; intercropping spreads risk across species with different water requirements; and conservation-agriculture principles (minimum tillage, permanent soil cover, and rotations) improve infiltration and reduce evaporative losses. McCarthy, Lipper & Zilberman (2018) highlight exactly these attributes as pivotal for uninsured, cash-constrained farmers.

Risk-spreading and soil-building motives are also evident in the mid-tier practices: crop diversification (65.5 %) and organic-manure application (55.5 %). Their popularity echoes findings by Mutenje et al. (2019), who show that low-cash, knowledge-compatible options are the most readily embraced across Southern Africa's communal areas.

Soil-conservation techniques that require moderate behavioural change—minimum tillage (52.9 %) and mulching (48.7 %)—occupy a third stratum of uptake. Farmers recognise their importance for curbing erosion and conserving moisture on Buhera's sandy, nutrient-poor soils.

By contrast, practices with longer pay-off periods or higher labour and capital requirements lag behind:

- agroforestry – 43.7 %
- integrated soil-fertility management – 42.0 %
- rain-water harvesting structures – 39.5 %

Akinyi et al. (2022) report similar patterns, noting that these investments often stall without external incentives, specialised training, or start-up inputs.

The data portray a farming population that is progressively stacking CSA options, beginning with those that deliver quick, visible benefits and require minimal cash outlay. This "stepwise" adoption trajectory suggests that well-targeted extension, input-credit schemes, and results-demonstration plots could accelerate movement towards the more demanding (but potentially higher-impact) practices. Policy makers therefore have a clear entry point: bolster the existing foundation of widely adopted, low-cost practices while easing the labour, knowledge, and capital constraints that currently impede full CSA package uptake.

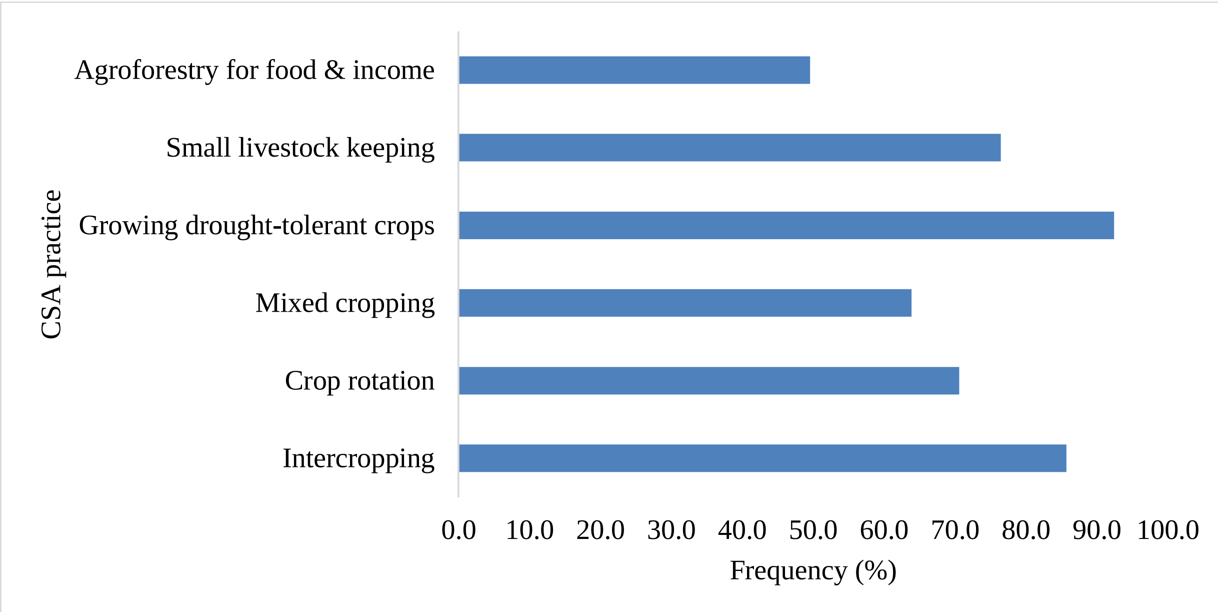

Figure 5: crop and land management CSA practices

4.3.3 INFORMATION AND RISK MANAGEMENT CSA STRATEGIES

The analysis of climate-information and risk-management practices shows that access to extension advice on climate risks is by far the most widespread intervention, reported by 80.8 percent of households. This confirms earlier work by Ajwang et al. (2024), which highlights frontline extension agents as the primary channel through which farmers translate abstract climate science into concrete management choices such as shifting planting dates or changing varieties. Seasonal weather forecasts are the next most common source of guidance, used by 73.3 percent of respondents, while 60.8 percent rely on short-lead early-warning alerts delivered through radio, SMS, or community notice systems; together these products enable farmers to fine-tune input purchases and stagger labour in anticipation of rainfall variability, corroborating McCarthy, Lipper and Zilberman's (2018) contention that timely climate information is a low-cost yet high-impact component of Climate-Smart Agriculture (CSA).

By contrast, what might be called "second-generation" learning and planning tools remain less prevalent. Just over half of the farmers (58.3 percent) participate in Farmer Field Schools, fewer than half (46.0 percent) receive mobile-based climate advisories, and only 40.9 percent engage in community-level risk mapping and contingency planning. Adoption of these more interactive or digital approaches is hampered by limited smartphone ownership, patchy network coverage, and unfamiliarity with participatory assessment methods, constraints also noted by Mutenje et al. (2019).

All in all, Buhera District therefore exhibits a two-tier information ecosystem: traditional extension visits and broadcast forecasts already enjoy broad reach, whereas the newer, more collaborative or technology-driven services have yet to secure comparable traction. Strengthening these latter channels—by subsidising data plans for advisory apps, integrating hazard-mapping modules into existing Farmer Field School curricula, and improving network infrastructure—would expand farmers' toolkits from basic awareness to proactive, locally led climate-risk planning.

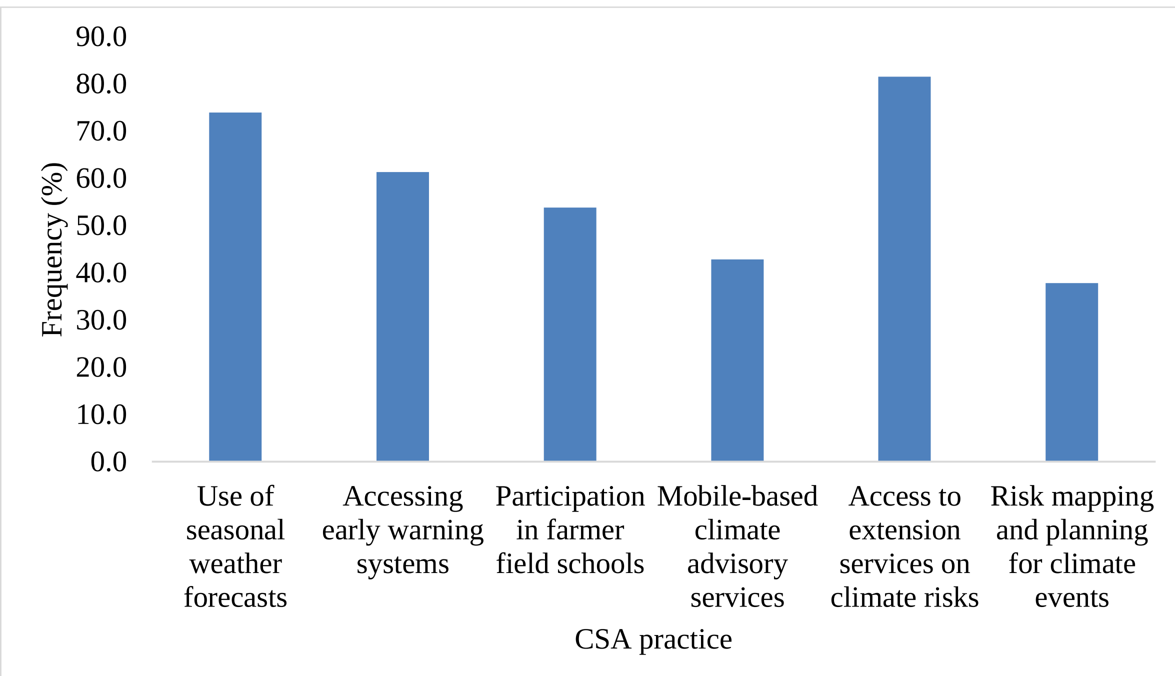

Figure 6: information and risk management CSA strategies

4.4 FACTORS INFLUENCING ADOPTION DECISIONS OF CSA PRACTICES AMONG SMALLHOLDER FARMERS

Membership in Farmer Clubs

Membership in farmer clubs exerts a strong, positive influence on the adoption of climate-smart agricultural (CSA) practices in Buhera District. Farmers who participate in these groups are 2.65 times more likely to adopt CSA than those who do not, largely because clubs operate as social hubs where members exchange information, attend joint training sessions, bulk-purchase inputs, and observe peers' on-farm demonstrations. The resulting peer validation reduces uncertainty surrounding new technologies, while collective action lowers individual transaction costs. In line with Ajwang et al. (2024), this finding underscores the role of social capital in accelerating the diffusion of climate-smart innovations and enhancing farmers' resilience to climate variability.

Income

Household income is another significant determinant of CSA uptake. Farmers with higher disposable incomes possess greater financial flexibility to invest in improved seed, organic amendments, micro-irrigation kits, or the labour required to implement more demanding practices. Adequate income also allows households to absorb the short-term risks that accompany experimentation and to buffer potential yield fluctuations during the transition period. This evidence supports McCarthy, Lipper and Zilberman's (2018) argument that financial capacity is often the decisive gateway through which smallholders move from awareness of sustainable practices to actual implementation.

Household Size

In contrast to income, household size shows a significant but negative relationship with CSA adoption. Although larger families imply a broader labour pool, they also generate higher food-consumption needs and greater competition for limited financial resources. These pressures can deter investment in new or unfamiliar technologies, especially if the perceived pay-off is uncertain or delayed. The result aligns with observations by Mujeyi and Mudhara (2020), who note that while labour availability is important, internal resource allocation within bigger households can constrain their ability to embrace innovation.

Years of Farming Experience

Years of farming experience positively affects CSA adoption by equipping farmers with a deeper understanding of local agro-ecological conditions and a historical perspective on weather patterns, soil behaviour, and crop performance. Experienced farmers are better positioned to evaluate the relative advantages of climate-smart options, manage associated risks, and fine-tune practices to their specific contexts. This experiential knowledge builds confidence in decision-making and corroborates findings by Mutenje et al. (2019) that accumulated practical know-how enhances adaptability and fosters innovation in response to climate challenges.

Size of Landholding

Landholding size also emerges as a significant positive predictor of CSA uptake. Larger plots afford farmers the flexibility to experiment with new practices on a portion of their land without jeopardising overall food security, and they facilitate spatial diversification that can spread production risk. In addition, larger holdings often correlate with better access to draft power and equipment, further easing implementation of labour-saving or mechanised techniques. Consistent with Akinyi et al. (2022), these findings suggest that land abundance provides both the physical space and economic rationale for investing in practices aimed at improving long-term productivity and resilience.

Table 6: 4 factors influencing adoption decisions of CSA practices among smallholder farmers

Variables in the Equation	B	S.E.	Wald	Exp(B)	Sig.
Accesstocredit	1.201	2.123	7.736	2.771	.052
Memberofclub	3.028	1.471	4.235	2.650	.002*
Age	1.086	1.317	0.681	2.964	.409

sex(1)	-0.093	.521	0.032	0.911	.858
Education	2.321	0.152	0.544	3.766	.053
Income	3.212	0.321	0.702	1.000	.040*
Householdsize	-0.750	0.194	5.029	2.110	.000*
yearsofexperience	0.395	0.120	1.943	1.485	.001*
Sizeofland	0.323	.112	8.280	0.720	.004*
Constant	-4.899	11.957	0.000	0.000	.998

*Significance at 0.05 significance level

4.5 COSTS AND BENEFITS OF ADOPTING CSA PRACTICES AMONGST SMALLHOLDER FARMERS REVENUES

REVENUES

Maize revenues under climate-smart agriculture (CSA) far outstrip those realised from conventional methods. The study shows that CSA farmers harvested 3 000 kg ha^{-1} and earned about US $900, whereas their conventional counterparts obtained only 2 000 kg ha^{-1} and US $600. This 50 percent yield premium reflects the productivity gains that accrue from practices such as minimum tillage, residue retention, organic nutrient management and improved soil-moisture conservation. Higher output translates directly into greater household food supplies and disposable income—critical benefits in a land-constrained setting like Buhera. The finding corroborates Mujeyi and Mudhara’s (2020) observations that CSA boosts yields among Southern African smallholders by enhancing soil fertility and water-use efficiency, and echoes McCarthy, Lipper and Zilberman’s (2018) argument that CSA offers economic as well as environmental dividends.

Costs

The cost comparison reveals that conventional maize production is almost twice as expensive as its CSA counterpart, with total outlays of roughly US $580 versus US $305 per hectare.

Conventional farmers spend heavily on synthetic fertiliser (US $240) and pesticides (US $60), while CSA farmers eliminate chemical fertiliser altogether and limit crop protection costs to about US $30 by relying on organic or integrated pest-management options. Although CSA entails slightly higher labour expenditures—US $50 for manure incorporation, mulching and field preparation compared with US $30 in the conventional system—the savings on external inputs more than compensate. This mirrors Akinyi et al.'s (2022) conclusion that CSA substitutes locally available resources and family labour for costly agro-chemicals, thereby reducing overall cash demands even if it raises the labour bill.

Net Benefits

When revenues and costs are combined, CSA delivers a striking net benefit of US $595 per hectare, compared with just US $20 under conventional management. The superior margin stems from the dual advantage of higher yields and lower cash expenditure on synthetic inputs, demonstrating that CSA is not only agronomically sound but also financially attractive. This surplus gives farmers room to reinvest in their operations, service debts, or cushion climate-related shocks, thereby strengthening livelihood resilience. In contrast, the slim profits from conventional farming—eroded by high fertiliser and pesticide costs—offer little incentive for long-term sustainability, especially in a context of rising input prices and increasing weather variability. Consistent with Mutenje et al. (2019), the results confirm that CSA simultaneously promotes environmental stewardship and generates higher economic returns for Buhera's smallholder farmers.

Table 7: costs and benefits of adopting CSA practices amongst smallholder farmer's revenues

Variables	CSA			Conventional		
Revenue	Quantity	$/Quantity	Total	Quantity	$/Quantity	Total
Maize yield kg/ha	3000	0.3	US$900.00	2000	0.3	US$600.00
Total Revenue			US$900.00			US$600.00

Expenditure						
Seed	10	3.5	US$35.00	10	3.5	US$35.00
Fertiliser/Compound D and Top			US$0.00	6	40	US$240.00
Manure and mulching (Labour days)	10	5	US$50.00			US$0.00
Planting (labour days)	10	5	US$50.00	10	5	US$50.00
Tillage	5	5	US$25.00	1	80	US$80.00
Weeding	5	5	US$25.00	1	60	US$60.00
Pesticide	2	15	US$30.00	2	30	US$60.00
Packaging	60	0.25	US$15.00	40	0.25	US$10.00
Transport costs	3	25	US$75.00	1.8	25	US$45.00
Total Costs			US$305.00			US$580.00
Net Benefits			US$595.00			US$20.00

4.5.2 NET PRESENT VALUE

The five-year Net Present Value calculation confirms that climate-smart agriculture (CSA) outperforms conventional maize production by a wide margin. In Year 1 the discounted cash flow from CSA stands at US $540.91, compared with only US $18.18 for the traditional system. Although both streams decline each year as future benefits are discounted, CSA maintains a commanding lead throughout the planning horizon: by Year 5 its NPV is still US $369.45, whereas the conventional approach has slipped to just US $12.42. When the annual figures are aggregated, the cumulative NPV for CSA reaches US $2 255.52, dwarfing the conventional total of US $75.82. This sustained advantage stems from the dual effect of higher, more stable revenues and lower cash outlays for synthetic inputs, which jointly generate larger positive cash flows that remain valuable even after discounting. The result reinforces earlier studies by Mujeyi and Mudhara (2020) and McCarthy et al. (2018), underscoring that CSA is not only environmentally prudent but also financially superior, offering smallholder farmers a robust pathway to improved livelihoods and greater resilience under mounting climate uncertainty.

Table 8: net present value

Year	CSA NPV (US$)	Conventional NPV (US$)
1	540.91	18.18
2	491.74	16.53
3	447.03	15.03
4	406.39	13.66
5	369.45	12.42
Total	2255.52	75.82

4.6 CHAPTER SUMMARY

In this chapter, the study shows that climate-smart agriculture is steadily taking hold in Buhera District, with most smallholders already practicing some mix of conservation tillage, mulching, drought-tolerant varieties, and rain-water harvesting, and those choices are shaped less by age or schooling than by social capital, disposable income, land size, household demands, and years of experience; membership in farmer clubs, in particular, emerges as a powerful catalyst because it opens doors to shared knowledge, inputs, and encouragement. The economic math is equally persuasive: CSA plots not only yield more grain but also slash spending on synthetic fertilisers and pesticides, so their net profits—and, when projected over five years, their net present values—tower over those of conventional fields. Put simply, the same practices that cushion farmers against erratic rainfall and soil degradation also fatten their bottom lines, making CSA both a practical and a profitable path for building resilient livelihoods in Buhera.

CHAPTER 5

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

5.1. INTRODUCTION

Chapter Five brings the study to its analytical close. It weaves together the core findings, answers the research questions, and translates the evidence into concrete guidance for action. The chapter opens with a concise recap of the results, linking each to the original objectives. It then situates these insights within the wider body of literature and relevant development frameworks, teasing out what the Buhera experience adds to current debates on smallholder climate resilience. Building on this discussion, the chapter distils the most salient conclusions about the reach, effectiveness, and economic pay-offs of Climate-Smart Agriculture (CSA) practices in the district. Finally, it puts forward practical recommendations for farmers, policymakers, and development partners aimed at accelerating the uptake and impact of CSA across Zimbabwe.

5.2 SUMMARY

The first objective was to take stock of the climate-smart practices already in the field. Survey results show that more than half of Buhera's smallholders now employ conservation agriculture, apply organic manure, spread mulch and harvest rainwater—interventions proven to improve soil structure and moisture retention in a warming, drying climate. By contrast, labour- and skill-intensive measures such as terracing and contour ploughing remain uncommon, signalling clear entry points for better-targeted extension and training.

The second objective probed what drives or hinders adoption. Logistic regression points to five decisive factors: membership in farmer groups, higher household income, smaller family size, longer farming experience and larger landholdings all raise the odds of taking up CSA. Access to credit and years of schooling hover at the margin of significance, while age and gender exert no measurable influence. These patterns echo earlier work showing that social capital, economic capacity and farm characteristics outweigh personal demographics in shaping technology choices.

The final objective tested whether CSA actually pays. A five-year cost–benefit and net-present-value comparison leaves little doubt: climate-smart plots generate markedly higher profits because they deliver bigger harvests while slashing fertiliser and pesticide bills. Conventional fields, by contrast, rack up high input costs for modest returns. The numbers reinforce the view that CSA is not only environmentally responsible but also a sound business decision for Zimbabwe's smallholder farmers.

5.3 CONCLUSIONS

Smallholder farmers in Buhera District have embraced the core pillars of Climate-Smart Agriculture—especially conservation tillage, organic-manure use and mulching—because these practices fit well with their need to safeguard soil moisture and fertility. Yet the low uptake of terracing and contour ploughing exposes persistent gaps in labour, equipment or practical know-how, pointing to an urgent need for more hands-on extension support and locally adapted demonstrations.

Adoption is not random; it rises sharply when farmers belong to organised groups, enjoy higher disposable income, manage smaller households, possess longer farming experience and cultivate larger plots. These findings underline the power of social networks, economic capacity and land endowment in driving technology choices, whereas personal traits such as age, gender and formal schooling matter far less. Programmes that strengthen farmer organisations and bolster household incomes are therefore likely to have the greatest impact on CSA uptake.

Finally, the numbers seal the case: climate-smart plots deliver markedly higher net profits and a far superior net present value over time than conventional fields, thanks to both bigger harvests and lower spending on synthetic inputs. CSA thus proves to be not only an environmentally sound strategy but also a financially rewarding one, offering a clear pathway for improving food security and climate resilience across similar smallholder systems.

5.4 RECOMMENDATIONS

For Smallholder Farmers

Adopt a mix of proven CSA options—conservation tillage, organic manure, mulching, rain-water harvesting, and drought-tolerant seed—to boost yields while protecting soils and moisture. Join or form farmer groups and cooperatives to pool labour, share knowledge, bulk-buy inputs, and improve bargaining power for credit and markets. Strengthen business skills (record-keeping, gross-margin analysis, side-income ventures) so the farm family can absorb climate shocks without selling productive assets.

For Extension Services and NGOs

Scale up hands-on training for the practices that remain rare—terracing, contour ploughing, integrated pest management, and on-farm water harvesting—using farmer field schools, lead-farmer demonstrations, and locally voiced radio slots. Design outreach packages around the factors that most shape uptake (group membership, income, land size, labour availability) and embed climate-risk modules, credit facilitation, and gender-responsive activities in every programme. Where labour is a constraint, introduce labour-saving variants or community work parties to spread workload peaks.

For Policymakers

Create an enabling environment by offering smart subsidies or low-interest credit lines for CSA inputs (e.g., cover-crop seed, composting tools, water-harvesting materials) and by piloting weather-indexed insurance that rewards climate-resilient farming. Invest in rural roads, produce aggregation centres, and real-time agrometeorological advisories so farmers can realise higher farm-gate prices and take time-critical decisions. Mainstream CSA objectives into national agricultural strategies, climate-adaptation plans, and budget allocations to ensure coherent, long-term support.

For Research Institutions

Co-design trials with farmers to fine-tune CSA technologies to local soils, rainfall patterns, and labour calendars; prioritise low-cost innovations such as improved composting techniques, micro-irrigation kits, and drought-resilient crop–livestock rotations. Establish a participatory monitoring system that tracks yield, profit, labour, and soil-health indicators so evidence feeds back quickly into policy and practice. Foster multidisciplinary partnerships—agronomy, socio-economics, climatology—to keep solutions both technically sound and socially acceptable.

5.4.1. RECOMMENDATIONS FOR FURTHER STUDY

Future work should look well beyond the short-term profit figures that dominate most CSA evaluations. Longitudinal studies are needed to track how conservation tillage, organic amendments, agro-forestry and similar practices shape soil structure, nutrient stocks, carbon sequestration and on-farm biodiversity over a decade or more, and to relate those biophysical changes to households' ability to bounce back from climate shocks. A second line of inquiry should examine how digital tools—smartphone apps, interactive voice response, WhatsApp groups and real-time weather dashboards—can speed up CSA adoption, fine-tune management decisions and reduce information gaps for remote farmers. Researchers should also unpack the gender and generational dimensions of climate-smart farming: How do decision-making power, labour burdens and benefit streams differ for women, men and rural youth, and what design tweaks would make CSA packages more inclusive? Finally, comparative studies that span Zimbabwe's major agro-ecological zones (and even neighbouring countries) would clarify which CSA combinations perform best under varying rainfall regimes, soil types and market access conditions, allowing policymakers to tailor interventions with far greater precision.

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APPENDICES

Questionnaire for household surveys

I am Natsai Munyoro, a final year student pursuing a Bachelor of Science Honours Degree in Agricultural Economics and Management at Bindura University of Science and Education. I am conducting research on "An Economic Analysis of Climate-Smart Agricultural Practices Among Smallholder Farmers in Buhera , Zimbabwe.Your participation in this survey is entirely voluntary, and all information provided will be treated with strict confidentiality and used solely for academic purposes. The questionnaire will take approximately 60 minutes to complete. Your honest responses will contribute significantly to understanding the economic factors influencing the adoption of climate-smart agricultural practices and help develop more effective strategies to support smallholder farmers in adapting to climate change.

SECTION A: DEMOGRAPHIC AND FARM CHARACTERISTICS

1. Respondent's Name (Optional): ________________________

2. Gender:

Male

Female

Prefer not to say

3. Age (years):

18-25

26-35

36-45

46-55

56-65

Above 65

4. Level of education:

No formal education

Primary education

Secondary education

Tertiary education

Other (Please specify): ________________________

5. How many years have you been farming?

Less than 5 years

5-10 years

11-20 years

More than 20 years

6. What is your primary source of income?

Farming only

Farming and off-farm employment

Farming and business

Remittances and farming

Other (Please specify): ________________________

7. What is your approximate monthly household income (in USD)?

Less than $50

$51-100

-$101-200

$201-300

Above $300

8. Location (ward in Buhera): ________________________

9. What agro-ecological zone is your farm located in?

Natural Region I

Natural Region II

Natural Region III

Natural Region IV

Natural Region V

10. Total farm size (hectares): ________________________

11. What is the land tenure system for your farm?

Communal land

A1 resettlement

A2 resettlement

Small-scale commercial

Other (Please specify): ________________________

12. How many people live in your household? ________________________

13. How many household members work on the farm? ________________________

SECTION B: CURRENT CLIMATE-SMART AGRICULTURAL PRACTICES

14. Are you familiar with the term "climate-smart agriculture"?

Yes

No

Somewhat

15. Which of the following climate-smart agricultural practices do you currently implement on your farm? (Check all that apply)

Conservation agriculture (minimum tillage, mulching, crop rotation)

Agroforestry (integrating trees with crops/livestock)

Water harvesting techniques (specify): ________________________

Drought-resistant crop varieties (specify): ________________________

Intercropping/mixed cropping

Improved irrigation methods (specify): ________________________

Integrated pest management

Improved livestock management

Use of climate information for planning

Diversification of crops

Organic farming practices

Other (Please specify): ________________________

None

16. For each practice you selected in question 15, please indicate when you started implementing it:

Practice

Year started

Still practicing

(Y/N)

17. For the practices you have discontinued, what were the main reasons? (Check all that apply)

Too expensive to maintain

Did not see expected benefits

Labor intensive

Lack of technical support

Conflicts with other farming methods

Other (Please specify): ________________________

SECTION C: FACTORS INFLUENCING ADOPTION DECISIONS

18 how frequently do you interact with agricultural extension officers?

Never

] Rarely (once a year or less)

Occasionally (2-3 times a year)

Regularly (4-6 times a year)

Frequently (monthly or more)

19.Have you received any training specifically on climate-smart agricultural practices in the past 3 years?

Yes (Please specify the number of trainings): ________________________

No

20.If you have access to credit, have you used it specifically for implementing climate-smart agricultural practices?

Yes (Please specify): ________________________

No

21.Do you have access to reliable climate information for planning your farming activities?

Yes, regularly

Yes, occasionally

No

SECTION D: COSTS AND BENEFITS OF CLIMATE-SMART AGRICULTURAL PRACTICES

22.Please estimate the initial implementation costs for each climate-smart practice you have adopted:

PRACTICE

INITIAL COST

(USD)

YEAR IMPLEMENTED

23.Have you observed any yield changes since adopting climate-smart agricultural practices?

Significant increase (more than 50%)

Moderate increase (25-50%)

Slight increase (less than 25%)

No change

Decrease in yield

24.Please provide yield information for your main crops before and after adopting climate-smart practices:

CROP

AVERAGE YIELD BEFORE CSA

(Kg/ha)

AVERAGE YIELD AFTER CSA

(Kg/ha)

YEAR ADOPTED CSA

25.Have you observed any changes in income since adopting climate-smart agricultural practices?

Significant increase (more than 50%)

Moderate increase (25-50%)

Slight increase (less than 25%)

No change

Decrease in income

26.Please provide specific examples of how your farm withstood climate-related stresses after adopting climate-smart practices:

____

____

____

SECTION E: CLIMATE PERCEPTIONS AND FUTURE PLANS

27.Have you noticed any changes in climate patterns in your area over the past 10 years?

Yes

No

Not sure

28. If yes to question 40, what changes have you observed? (Check all that apply)

Delayed onset of rainy season

Early cessation of rainy season

More frequent droughts

More intense rainfall events

Longer dry spells during growing season

Increased temperatures

More unpredictable weather patterns

Other (Please specify): ________________________

29. How concerned are you about the impact of climate change on your farming activities?

Very concerned

Somewhat concerned

Not concerned

Not sure

30. Any additional comments or information you would like to share about your experience with climate-smart agricultural practices:

____

____

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