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Environmental Policies and Performance of Agribusinesses Among Smallholder Farmers in Siaya County, Kenya

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ABSTRACT Despite existing environmental policies and government interventions, farmers continue to face low productivity, income instability, and environmental challenges such as soil degradation, water stress, climate variability, and improper agrochemical use. However, limited localized empirical evidence exists on how these environmental policy frameworks influence agribusiness performance. This study therefore examined the impact of environmental policies on agribusiness performance among smallholder farmers in Siaya County. The general objective was to examine the influence of environmental policies on agribusiness performance among smallholder farmers in Siaya County. Specifically, the study sought to determine the impact of land use policies; examine the relationship between water resource access and management practices and agribusiness performance; evaluate the effect of climate change resilience and adaptation practices; and assess the relationship between agrochemical use and agribusiness performance. The study was grounded in Institutional Theory, the Resource-Based View (RBV), the Sustainable Livelihoods Framework (SLF), and the Environmental Kuznets Curve (EKC) theory. Cross-sectional research design was employed to assess the relationship between independent variables and dependent variable. The target population comprised approximately 220,000 smallholder farming households in Siaya County. Using Yamane's (1967) formula, a sample size of 400 respondents was obtained. A stratified random sampling technique was used to ensure representation across all the sub-counties. Primary data were collected through structured questionnaires and analyzed using descriptive statistics and Multiple Linear Regression in SPSS Version 22. The findings revealed that all the independent variables had a positive and statistically significant effect. The study concluded that responsible agrochemical use enhances productivity when integrated with effective land management, sustainable water use, and adaptive climate strategies. The study identified a research gap in the limited county-level quantitative evidence linking specific environmental policy dimensions to agribusiness performance within a devolved governance structure. The study recommended the enforcement of land use regulations, improving equitable water access, scaling up climate-smart agriculture programs, promoting safe agrochemical use, and enhancing participatory policy implementation, farmer training, and improved extension services. It further recommended investment in irrigation and storage infrastructure, promotion of cooperatives, and support for diversification and value addition, with further research in comparative county studies and examination of gender and youth dimensions.

KEYWORDS: Smallholder Farmers, Agrochemicals, Land Use Policies, Agribusiness Performance, Climate Change, Resource Management, Land use policy.

INTRODUCTION

Agriculture is one of the most fundamental pillars of global economic and social development. Beyond its role in providing food for the world's population, agriculture supplies raw materials for industries, creates employment opportunities, and contributes to export earnings. According to the Food and Agriculture Organization (FAO, 2021), agriculture accounts for approximately 27% of global employment, with higher proportions in developing countries where the majority of people rely on farming as their primary livelihood. Despite its importance, agriculture faces unprecedented global challenges in the 21st century. Climate change, land degradation, biodiversity loss, deforestation, and water scarcity threaten the sustainability of food systems. The Intergovernmental Panel on Climate Change (IPCC, 2022) notes that global agricultural productivity growth has declined by an estimated 21% since 1961 due to climate change, with tropical regions experiencing the greatest impact. These trends are particularly concerning for smallholder farmers who depend directly on natural resources and rain-fed agriculture.

In response, governments and international organizations have increasingly emphasized the adoption of environmental policies to safeguard natural resources while maintaining agricultural productivity. Environmental policies encompass laws, regulations, and guidelines aimed at ensuring sustainable use of land, water, and biodiversity while promoting climate change adaptation and mitigation. At the global level, frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement (2015), and the Sustainable Development Goals (SDGs) provide the basis for policy formulation. The SDGs, for example, specifically emphasize agriculture and environment in multiple targets: Goal 2 (Zero Hunger) calls for sustainable food production systems and resilient agricultural practices; Goal 12 (Responsible Consumption and Production) promotes sustainable resource management; Goal 13 (Climate Action) demands urgent action to combat climate change and its impacts; and Goal 15 (Life on Land) seeks to protect, restore, and promote sustainable use of terrestrial ecosystems. Environmental policies at national and local levels are aligned with these goals to ensure that agriculture becomes both productive and sustainable Akinyi, M. (2020).

While the adoption of global frameworks is commendable, translating them into practice remains difficult. Many developing countries face institutional weaknesses, resource constraints, and lack of farmer awareness. Compliance with environmental regulations may be perceived as costly or bureaucratic, particularly for smallholder farmers. Consequently, while policies are formulated with the aim of balancing sustainability and productivity, their actual impact on agribusiness performance especially at the local level remains uncertain and context-specific. Agriculture is central to Africa's socio-economic transformation. It contributes between 20% and 60% of GDP in most countries and employs more than 60% of the continent's workforce (World Bank, 2022). The majority of agricultural production in Africa comes from smallholder farmers, who cultivate less than two hectares of land on average. These smallholder farmers produce nearly 80% of the continent's food supply, making them critical for food security and rural livelihoods.

However, African agriculture is characterized by low productivity compared to global averages. Crop yields remain far below potential due to limited access to modern inputs, poor infrastructure, market inefficiencies, and high vulnerability to environmental shocks. According to the United Nations Economic Commission for Africa (UNECA, 2020), land degradation affects more than 65% of Africa's land area, and 3% of GDP is lost annually due to soil erosion, desertification, and unsustainable farming practices. African governments have developed frameworks to promote environmental sustainability in agriculture. Key initiatives include the Comprehensive Africa Agriculture Development Programme (CAADP) under the New Partnership for Africa's Development (NEPAD), which emphasizes sustainable land and water management, and the African Union's Agenda 2063, which envisions a prosperous Africa based on inclusive growth and sustainable resource use. Countries have also committed to implementing climate-smart agriculture, conservation agriculture, and land restoration programs.

Kenya's economy is equally heavily reliant on agriculture, which contributes approximately 33% directly and 27% indirectly to GDP (KNBS, 2023). The sector also provides employment to more than 70% of the rural population and supplies about 65% of industrial raw materials. Kenya's main agricultural exports include tea, coffee, horticultural produce, and livestock products, which generate significant foreign exchange earnings. The sector is dominated by smallholder farmers who cultivate about 80% of agricultural land and produce more than 70% of the country's food requirements (MoA, 2022). These farmers typically practice mixed farming, growing crops such as maize, beans, sorghum, millet, and cassava while rearing livestock like cattle, goats, sheep, and poultry. Smallholders are therefore central to food security, poverty reduction, and rural development in Kenya.

To address environmental degradation, climate variability, and sustainability challenges, Kenya has enacted a comprehensive set of environmental policies and regulatory frameworks that guide natural resource management and agricultural development. The Environmental Management and Coordination Act (EMCA), 1999 (revised 2015) serves as the principal legal framework for environmental governance, providing mechanisms for sustainable resource management, environmental impact assessment, pollution control, and waste management. Complementing EMCA, the National Environmental Policy (2013) offers strategic direction on the sustainable use of natural resources, environmental conservation, and integration of environmental considerations into sectoral planning and development processes.

In response to climate-related risks, the Climate Change Act (2016) establishes an institutional and legal framework for climate change mitigation and adaptation, ensuring that climate action is mainstreamed across all sectors, including agriculture. This is operationalized through the National Climate Change Action Plan (NCCAP) 2018–2022, extended to 2030, which outlines concrete adaptation and mitigation measures aimed at enhancing resilience and reducing emissions. Additionally, the Agricultural Sector Transformation and Growth Strategy (ASTGS) 2019–2029 seeks to transform Kenya's agricultural sector by improving productivity, promoting commercialization, and strengthening climate resilience through the adoption of climate-smart agricultural practices.

The implementation of Kenya's environmental and agricultural policies is coordinated by the National Environment Management Authority (NEMA), the Ministry of Environment and Forestry, the Ministry of Agriculture, and county governments; however, despite this comprehensive institutional framework, the effectiveness of these policies in improving smallholder agribusiness performance remains unclear. Many smallholder farmers have limited awareness of environmental regulations, while weak enforcement capacity and resource constraints at both national and county levels hinder effective implementation. Consequently, some policies are perceived as restrictive rather than supportive, raising critical concerns about whether environmental policies are achieving their intended outcomes at the grassroots level.

Siaya County, located in western Kenya, has a population of approximately 993,000 people and 197,783 farm households (KNBS, 2019). The county is predominantly rural, and agriculture is the main source of livelihood for most households. Farming is typically small-scale and rain fed, with farmers cultivating maize, cassava, sorghum, groundnuts, and beans. Livestock rearing, particularly poultry, goats, and cattle, also plays a significant role in household economies. The county has favorable agroecological conditions but faces challenges that constrain agricultural performance. Declining soil fertility, deforestation, water pollution from Lake Victoria, and erratic rainfall patterns affect productivity. Environmental degradation is further exacerbated by population pressure, unsustainable farming practices, and limited adoption of soil and water conservation measures.

Siaya County has attempted to implement national environmental policies through its county government structures, supported by NEMA and agricultural extension services. However, enforcement is weak, and awareness among smallholder farmers remains low. Consequently, many farmers continue to use unsustainable practices that degrade the environment and limit long-term productivity. This makes Siaya County a particularly relevant case study for examining the relationship between environmental policies and the performance of smallholder agribusinesses.

By focusing on this county, the study will generate localized insights into how environmental governance shapes smallholder farming outcomes, highlighting gaps and opportunities for policy improvement.

Statement of the Problem

Agriculture in Siaya County, as in much of Kenya, is dominated by smallholder farmers who form the backbone of the local economy and food systems. Despite the county's favorable agro-ecological potential and continued government and donor interventions, smallholder farmers continue to experience persistently low productivity, unstable incomes, and increasing environmental degradation. Declining soil fertility, land fragmentation, inefficient water use, overreliance on agrochemicals, and increasing climate variability continue to undermine agricultural performance and threaten the sustainability of agribusiness enterprises in the county. This situation presents a paradox in which substantial policy effort and institutional investment in environmental governance coexist with continued poor agricultural outcomes at the grassroots level.

The Government of Kenya has introduced several environmental and agricultural policy frameworks, including the Environmental Management and Coordination Act (EMCA), the Climate Change Act (2016), the Agricultural Sector Transformation and Growth Strategy (ASTGS), and county-level climate change action plans. Institutions such as the National Environment Management Authority (NEMA), the Ministry of Agriculture, and county governments are mandated to enforce these policies and promote sustainable agricultural practices. In principle, these policy interventions are expected to enhance land use efficiency, improve water resource management, strengthen climate resilience, and regulate agrochemical use, thereby improving agribusiness productivity and environmental sustainability. However, the continued decline in farm performance despite these interventions reveals a disconnect between policy formulation and practical implementation at the farm level.

Conceptual gap exists in the way environmental policies are linked to agribusiness performance among smallholder farmers. Most existing studies treat environmental policies in a fragmented manner, focusing independently on land use, water management, climate resilience, or agrochemical regulation, without integrating these dimensions into a single explanatory framework. This creates limited understanding of how these policy components interact to influence overall agribusiness performance, including productivity, profitability, and sustainability. As a result, there is insufficient conceptual clarity on the combined effect of environmental policy instruments on smallholder farming systems, particularly within integrated rural economies such as Siaya County.

A contextual gap exists because much of the available empirical evidence is drawn from national-level or international studies that do not adequately reflect the unique socio-economic and ecological conditions of Siaya County. Smallholder farmers in the county operate under specific constraints such as land fragmentation, reliance on rain-fed agriculture, limited access to irrigation infrastructure, weak market linkages, and vulnerability to climate variability. These local realities influence how environmental policies are understood, adopted, and implemented. Consequently, findings from other regions may not accurately explain how environmental policies affect agribusiness performance in Siaya County, creating a need for localized evidence.

The methodological gap identified in previous studies is addressed through the use of a cross-sectional research design in this study. Unlike earlier studies that examined environmental policy variables in isolation, this design enables the simultaneous collection and analysis of data on land use policies, water resource management, climate change resilience practices, and agrochemical use within a single integrated framework, thereby capturing their combined and interactive effects on agribusiness performance. The design also allows data to be collected from a large and geographically diverse sample of smallholder farmers across Siaya County, improving representativeness and enabling county-wide generalization of findings. The cross-sectional design provides a realistic snapshot of actual farming conditions and institutional influences, thereby offering a more holistic, context-specific, and empirically robust understanding of how environmental policies collectively influence agribusiness performance among smallholder farmers.

Research Objectives

General Objective

To examine the influence of environmental policies on the performance of agribusinesses among smallholder farmers in Siaya County, Kenya.

Specific Objectives

1. To determine the impact of land use policies on agribusiness performance among smallholder farmers in Siaya County.
2. To examine the relationship between water resource access and management practices and the performance of agribusiness enterprises among smallholder farmers in Siaya County.
3. To evaluate how climate change resilience and adaptation practices affect the performance of agribusiness enterprises among smallholder farmers in Siaya County.
4. To assess the relationship between the use of agrochemicals and the performance of agribusiness enterprises among smallholder farmers in Siaya County.

Research Questions

1. How do land use policies affect agribusiness performance among smallholder farmers in Siaya County?
2. What is the relationship between water resource access and water resource management practices and agribusiness performance among smallholder farmers in Siaya County?
3. How do climate change resilience and adaptation practices influence agribusiness performance among smallholder farmers in Siaya County?
4. What is the relationship between the use of agrochemicals and agribusiness performance among smallholder farmers in Siaya County?

THEORETICAL FRAMEWORK

Institutional Theory emphasizes that institutions reduce transaction costs and coordinate economic activities through rules, standards, and support systems. Cooperatives and farmer associations help smallholder farmers access agricultural inputs, market information, extension services, and collective bargaining opportunities. In Siaya County, institutions such as the Anyiko Ujwanga Rice Growers Cooperative Society Ltd, Agricultural

Finance Corporation (AFC), county agricultural departments, and local community groups support farmers through financing, training, and environmental awareness programs. Informal institutions such as Rotating Savings and Credit Associations (ROSCAs), locally known as "Nyoluoro," also provide financial support and information-sharing platforms for farmers who cannot access formal banking systems. The study argues that effective institutional support enhances compliance with land use regulations and environmentally sustainable farming practices, thereby improving agribusiness performance. This theory is important in the present study because it helps explain how land use policies and agrochemical regulations influence farming practices and agribusiness outcomes among smallholder farmers.

The Resource-Based View (RBV) states that organizations achieve sustainable competitive advantage through effective utilization of valuable, rare, unique, and difficult-to-imitate resources. In agriculture, important resources include fertile land, water resources, farming knowledge, labor, technology, and social networks. RBV relates to this study because access to water resources, climate adaptation capacity, and environmental resource management directly influence agribusiness performance among smallholder farmers in Siaya County. From the RBV perspective, both tangible and intangible resources contribute significantly to agricultural productivity and sustainability. Tangible resources include land, livestock, irrigation infrastructure, farming equipment, rivers, and water bodies such as River Yala, River Nzoia, and Lake Victoria. Intangible resources include indigenous farming knowledge, cooperative membership, climate adaptation skills, farmer networks, and access to extension services. Environmental policies promoting water conservation, irrigation management, renewable energy technologies, and climate-smart agriculture strengthen farmers' ability to utilize these resources effectively.

The Sustainable Livelihoods Framework explains how environmental and economic vulnerabilities such as droughts, floods, climate change, diseases, and market instability affect rural livelihoods This study is primarily anchored on this theory because it provides a comprehensive and people-centered approach for examining how environmental management practices influence agribusiness performance among smallholder farmers. The framework integrates natural resource management, climate resilience, institutional support, and livelihood sustainability, which directly align with all the study objectives. SLF is important in this study because it explains how land use policies, water resource management, climate adaptation practices, and agrochemical use affect farmers' productivity, income, resilience, and sustainability. The study further argues that agribusiness performance cannot be understood solely from an economic perspective without considering social, environmental, and institutional factors affecting farmers' livelihoods.

The Environmental Kuznets Curve explains different stages of environmental and economic transformation within farming communities. In the early stages of agricultural development, smallholder farmers prioritize short-term survival and income generation, often leading to unsustainable practices such as overuse of agrochemicals, slash-and-burn farming, deforestation, and continuous cultivation. These practices contribute to soil degradation, biodiversity loss, water pollution, and climate vulnerability. As farmers gain access to financial resources, environmental awareness, extension services, and improved technologies, they begin adopting climate-smart agriculture, agroforestry, conservation farming, solar-powered irrigation, and environmentally friendly production systems. The theory supports the study in understanding how climate resilience practices and agrochemical management influence both environmental conservation and agribusiness performance.

EMPIRICAL REVIEW

Singh et al., 2020 conducted a study in India and found that soil conservation initiatives such as terracing and contour farming increased rice yields by 18%, demonstrating that land-use policies can significantly enhance agricultural productivity. Despite this positive outcome, the study is limited by the high implementation costs associated with conservation practices, which reduce participation among smallholder farmers. In addition, the study mainly focuses on yield improvement and does not consider broader agribusiness performance indicators such as profitability, market access, and enterprise sustainability, thereby creating a conceptual gap in understanding the full economic impact of land-use policies. Carvalho et al., 2019 in Brazil found that climate-smart land management practices increased soybean production by 25% while simultaneously reducing deforestation. While this study clearly demonstrates environmental and productivity benefits, it is limited in its failure to examine socio-economic and institutional constraints that influence adoption among smallholder farmers, creating a contextual gap in explaining how land-use policies operate in resource-constrained environments.

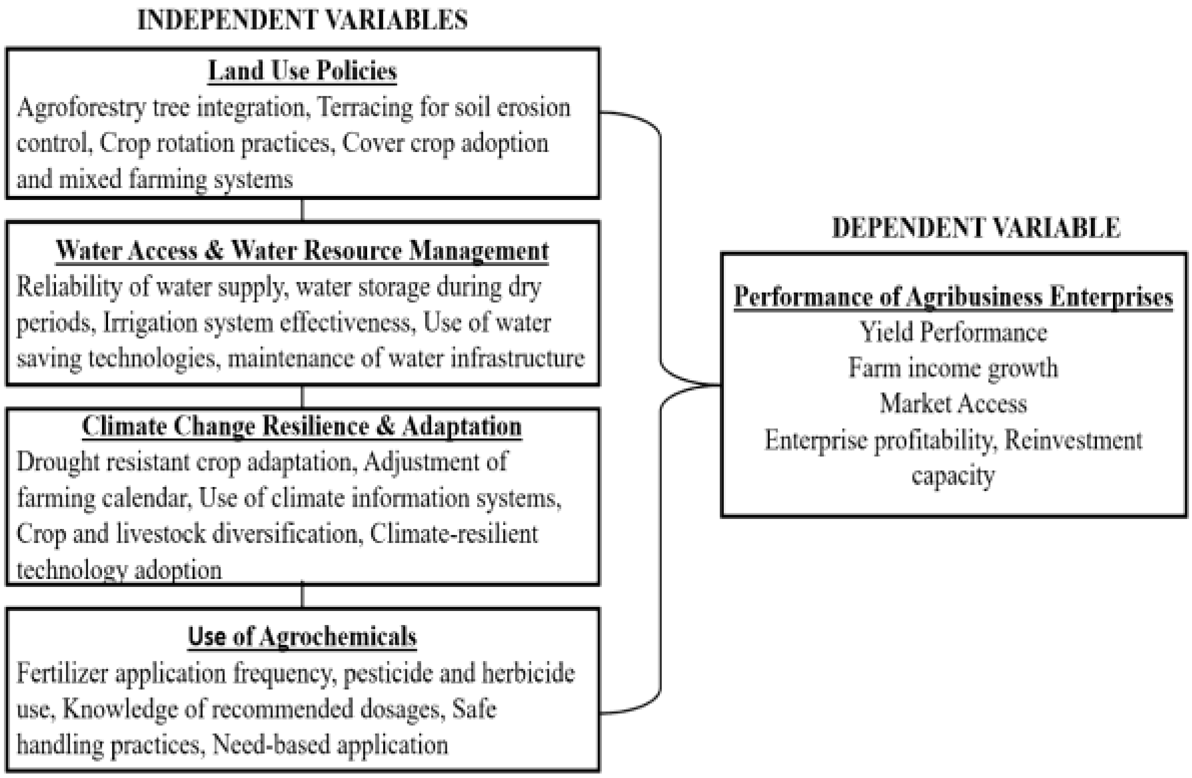
Li and Zhao (2021) in China found that strict water-use regulations and improved irrigation management increased irrigation efficiency and crop yields, although compliance costs temporarily reduced farmer income. While the study demonstrates strong productivity gains from improved water governance, it is limited by its short-term focus on income effects, creating a gap in understanding the long-term agribusiness performance implications of water resource management, particularly in relation to profitability, sustainability, and enterprise growth under regulated systems. Similarly, Kumar et al., 2019 in India reported that integrated watershed management programs improved water availability and soil moisture retention, leading to higher agricultural productivity. However, the study does not sufficiently examine how water resource management translates into broader agribusiness performance outcomes such as income stability, market participation, and enterprise resilience, especially among smallholder farmers operating under varying agro-ecological and institutional conditions.

Climate-smart agriculture and adaptation strategies have been widely shown to improve agricultural productivity and resilience. Carvalho et al., 2019 in Brazil found that the adoption of climate-smart practices such as improved crop varieties and soil conservation increased production while reducing environmental degradation. Although the study demonstrates strong agronomic and environmental benefits, it largely focuses on production outcomes and does not sufficiently examine agribusiness performance indicators such as profitability, income stability, and enterprise sustainability, creating a conceptual gap in linking adaptation practices to economic performance. Similarly, Tadesse et al., 2021 in Ethiopia found that wheat farmers implementing climate adaptation practices such as improved seeds and minimum tillage achieved higher yields and improved soil nutrient retention. However, the study does not adequately assess the long-term sustainability and economic viability of these practices among smallholder farmers, limiting its contribution to understanding resilience as a driver of agribusiness performance.

The use of agrochemicals has been widely studied in relation to agricultural productivity and environmental sustainability. Naab et al., 2017 in West Africa found that integrating organic inputs with reduced chemical fertilizers improved soil fertility and long-term productivity. While the study demonstrates positive environmental and yield outcomes, it largely emphasizes agronomic effects and does not adequately assess farm-level economic performance such as profitability, cost efficiency, and enterprise sustainability, creating a conceptual gap in linking agrochemical practices to agribusiness performance. Similarly, Li and Zhao (2021) in China reported that regulations limiting harmful pesticides enhanced environmental sustainability but required financial support to maintain farm profitability. However, the study is limited by its regulatory and policy focus, with insufficient attention to smallholder adaptive capacity and affordability constraints, creating a contextual gap in understanding how agrochemical regulations affect resource-constrained farmers.

CONCEPTUAL FRAMEWORK

The conceptual framework illustrates the relationship between environmental policies (independent variables) and performance of agribusinesses (dependent variable) as shown below;



(Source: Author, 2026)

Figure 1: Conceptual Framework

RESEARCH METHODOLOGY

A cross-sectional research design was employed. This design allowed the researcher to systematically describe the level of awareness, compliance, and adoption of environmental policies while examining their relationships with measurable agribusiness outcomes such as productivity, profitability, and sustainability. The choice of a cross-sectional research design was appropriate because the study did not manipulate the independent variable, environmental policies, but rather sought to understand naturally occurring relationships between these policies and the performance of smallholder agribusinesses. The total target population of the study comprised approximately 220,000 smallholder farming households as reported in the Siaya County Integrated Development Plan (2023–2027). Based on proportional distribution across the six sub-counties, the estimated number of smallholder households is 47,070 in Alego Usonga, 32,550 in Bondo, 32,110 in Gem, 31,450 in Rarieda, 44,660 in Ugenya, and 32,160 in Ugunja, summing to a total of 220,000 households.

A sample of 400 respondents was determined using the Yamane (1967) formula, and was proportionally distributed across the six sub-counties of Siaya. Stratified random sampling was used to capture variations across geographic areas, while primary data were collected through structured questionnaires administered to smallholder farmers across Siaya County to collect quantitative and qualitative data on factors influencing agribusiness performance. Data were analyzed using IBM SPSS Statistics Version 22 to generate descriptive and inferential statistics, enabling the study to establish meaningful patterns and relationships among the key variables.

RESULTS AND DISCUSSIONS

This chapter presents the results and discussions of the reliability tests, descriptive statistics, correlation analysis, regression analyses, and ANOVA test.

Reliability Test

A pilot study was conducted with 40 participants to test the reliability and internal consistency of the data.

Table 1: Reliability Statistics

Variable	Number of Items	Cronbach's Alpha
Land use policies and implementation	11	0.925
Access to and management of water resources	11	0.928
Climate change resilience and adaptation practices	10	0.935
Use of agrochemicals	10	0.932
Agribusiness performance	9	0.940

The table shows that the Cronbach's Alpha values for the variables ranged from 0.925 to 0.940, indicating excellent internal consistency. Based on commonly accepted thresholds, a Cronbach's Alpha value above 0.70 indicates acceptable reliability, while values above 0.90 reflect excellent internal consistency. Therefore, the results demonstrate that the questionnaire items consistently measured the intended study constructs.

Descriptive Statistics

The descriptive statistics were analyzed using the questionnaire items developed for all the variables included in the study, with each variable measured using several statements in the questionnaire. Respondents rated each statement using a five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree).

Table 2: Land Use Policies

	N	Minimum	Maximum	Mean	Std. Deviation
I use trees for shade, windbreaks, or boundary demarcation on my farm	3903		5	4.05	0.818
Agroforestry trees help reduce soil erosion on my land	3903		5	4.04	0.810
I practice crop rotation to maintain soil productivity	3903		5	4.02	0.798
I practice terracing on sloped land to reduce soil erosion	3903		5	3.97	0.820
I plant cover crops to protect soil and improve soil fertility	3903		5	3.94	0.826
I engage in mixed farming (crop and livestock integration)	3903		5	4.01	0.810
I practice terracing on sloped land to reduce soil erosion	3903		5	4.01	0.797
Adoption of soil conservation practices has reduced land degradation on my farm	3903		5	4.00	0.816
I have observed improved yields due to crop rotation practices	3903		5	3.99	0.821
I use drip irrigation method to avoid soil erosion	3903		5	3.99	0.835
I practice mulching to reduce water loss from the soil.	3903		5	4.04	0.801
Valid N (listwise)	390				

The table presents descriptive statistics for respondents' perceptions on land use policies and related practices. The mean scores for the items range from 3.94 to 4.05, which, on a 5-point Likert scale, indicates that respondents either agreed or strongly agreed with the statements. This suggests that farmers actively implement recommended land use practices such as tree planting, crop rotation, terracing, cover cropping, mixed farming, drip irrigation, and mulching. The standard deviations range from 0.797 to 0.835, showing relatively low variability in responses and suggesting consistent adherence to land use guidelines among the farmers. The findings reflect a high level of compliance with policies aimed at sustainable land management.

Table 3: Water Resource Management

	N	Minimum	Maximum	Mean	Std. Deviation
I have reliable access to water for farming activities	3903		5	3.97	0.825
I store water for use during dry periods	3903		5	3.99	0.824
I practice crop rotation to maintain soil productivity	3903		5	3.96	0.805
I use irrigation systems effectively to maximize production	3903		5	4.01	0.813
I monitor water use to avoid wastage	3903		5	3.91	0.832
Distance to water sources affects the efficiency of my farming activities	3903		5	4.05	0.818
Local water management arrangements support fair and sustainable water use among farmers	3903		5	4.00	0.830
I maintain water channels, pipes, or storage tanks to prevent leakages	3903		5	3.94	0.814
I reuse water where possible for farming activities	3903		5	4.04	0.821
I protect water sources from contamination through proper farm practices	3903		5	4.03	0.798
I apply water-saving technologies such as drip or sprinkler irrigation	3903		5	3.95	0.815
Valid N (listwise)	390				

The table presents descriptive statistics for respondents' perceptions on water resource management practices. The mean scores for the items range from 3.93 to 4.06, which, on a 5-point Likert scale, indicates that respondents either agreed or strongly agreed with the statements. This suggests that farmers actively implement recommended practices such as growing drought-resistant crops, adjusting planting schedules, using early warning systems, attending climate adaptation trainings, adopting soil and water conservation measures, diversifying crops or livestock, using drip irrigation, and adopting new technologies like solar-powered irrigation. The standard deviations range from 0.798 to 0.832, showing relatively low variability in responses and suggesting consistent engagement in water management practices among the farmers. The findings reflect a high level of adoption of strategies aimed at enhancing farm resilience and sustainability.

Table 4: Climate change Resilience

	N	Minimum	Maximum	Mean	Std. Deviation
I grow drought-resistant or climate-smart crop varieties	390	3	5	4.03	0.820
I adjust planting and harvesting schedules due to climate changes	390	3	5	3.96	0.832
I use weather or early warning systems for farming decisions	390	3	5	3.93	0.824
I attend training or workshops on climate adaptation practices	390	3	5	3.96	0.807
I implement soil and water conservation measures to reduce climate risks	390	3	5	4.03	0.823
I diversify crops or livestock to reduce climate-related losses	390	3	5	3.98	0.812
I adopt new technologies like solar for irrigation to cope with climate variability	390	3	5	4.06	0.816
I reinvest part of my farm income to expand my business	390	3	5	3.96	0.814
My farm generates profits after accounting for expenses	390	3	5	3.99	0.821
I use drip irrigation method to maximize on available water	390	3	5	3.97	0.825
Valid N (listwise)	390				

The table presents descriptive statistics on respondents' adoption of water resource management practices. The mean scores range from 3.93 to 4.06 on a 5-point Likert scale, indicating that farmers generally agreed or strongly agreed with the statements. This demonstrates active implementation of practices such as growing drought-resistant crops, adjusting planting schedules, using early warning systems, attending climate adaptation trainings, applying soil and water conservation measures, diversifying crops or livestock, employing drip irrigation, and adopting solar-powered irrigation technologies. The standard deviations, ranging from 0.807 to 0.832, suggest relatively low variation in responses, reflecting consistent adoption of water management strategies and a strong commitment to enhancing farm resilience and sustainability

Table 4: Use of Agrochemicals

	N	Minimum	Maximum	Mean	Std. Deviation
I regularly use fertilizers on my farm	3903		5	3.92	0.822
I regularly use pesticides or herbicides	3903		5	3.96	0.809
I know the recommended type and quantity of agrochemicals to apply	3903		5	4.06	0.816
I follow safe handling procedures when applying agrochemicals	3903		5	4.05	0.815
I believe agrochemicals improve my crop/livestock yields.	3903		5	4.05	0.805
I receive advice or training on agrochemical application	3903		5	4.02	0.824
Agrochemical use has increased my farm income	3903		5	3.96	0.817
I apply agrochemicals based on soil and crop needs	3903		5	3.98	0.828
I believe careful agrochemical use contributes to sustainable farming	3903		5	3.97	0.796
I monitor the effects of agrochemicals on soil health	3903		5	3.93	0.811
Valid N (listwise)	390				

The table presents descriptive statistics on respondents' use of agrochemicals. The mean scores for the items range from 3.92 to 4.06 on a 5-point Likert scale, indicating that respondents generally agreed or strongly agreed with the statements. This shows that farmers actively use agrochemicals in their farming practices, including applying fertilizers, pesticides, and herbicides, following safe handling procedures, using recommended types and quantities, receiving training, monitoring soil effects, and applying agrochemicals based on crop and soil needs. The standard deviations, ranging from 0.796 to 0.828, indicate relatively low variability in responses, reflecting consistent and responsible use of agrochemicals among the respondents, which contributes to productivity and sustainable farming practices.

Table 5: Performance of Agribusiness Enterprisers

	N	Minimum	Maximum	Mean	Std. Deviation
My farm produces the expected yield per season	3903		5	4.08	0.814
My farm income has increased over the past three years	3903		5	3.93	0.800
I have access to local markets for selling my products	3903		5	4.01	0.810
I experience high demand for my farm products	3903		5	3.94	0.803
I receive advice or training on agrochemical application	3903		5	4.04	0.818
I can meet household needs from farm income	3903		5	4.00	0.808
My farm performance has improved due to good management practices	3903		5	4.04	0.826

I reinvest part of my farm income to expand my business	3903	5	4.04	0.817
My farm generates profits after accounting for expenses	3903	5	3.98	0.802
Valid N (listwise)	390			

The table presents descriptive statistics on respondents' perceptions of agribusiness performance. The mean scores range from 3.93 to 4.08 on a 5-point Likert scale, indicating that respondents generally agreed or strongly agreed with the statements. This suggests that farmers experience positive outcomes in terms of expected yields, farm income growth, access to markets, high demand for products, household needs fulfillment, adoption of good management practices, reinvestment of income, and profitability. The standard deviations, ranging from 0.800 to 0.826, show relatively low variability in responses, reflecting consistent performance outcomes among the respondents and highlighting the effectiveness of sustainable agribusiness practices.

Pearson Correlation Analysis

Table 6: Correlations

		Performance of Agribusiness Enterprises	Land Use Policies	Water Resource Management	Climate change Resilience	Use of Agro-chemicals
Performance of Agribusiness Enterprises	Pearson Correlation	1	.777**	.788**	.662**	.761**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	390	390	390	390	390
Land Use Policies	Pearson Correlation	.777**	1	.816**	.644**	.749**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	390	390	390	390	390
Water Resource Management	Pearson Correlation	.788**	.816**	1	.691**	.743**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	390	390	390	390	390
Climate change Resilience	Pearson Correlation	.662**	.644**	.691**	1	.648**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	390	390	390	390	390
Use of Agro-chemicals	Pearson Correlation	.761**	.749**	.743**	.648**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	390	390	390	390	390

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis shows that all the predictors have strong, positive, and statistically significant relationships with the performance of agribusiness enterprises at the 0.01 level. Performance of agribusiness enterprises is positively correlated with land use policies (r = 0.777), water resource management (r = 0.788), climate change resilience (r = 0.662), and use of agrochemicals (r = 0.761). Water resource management shows the strongest association, suggesting that enterprises that effectively manage and utilize water resources tend to achieve higher productivity and sustainability. Land use policies and the use of agrochemicals are also strongly associated with performance, indicating that well-planned land regulations and proper application of agrochemicals enhance agribusiness performance. Climate change resilience, while slightly lower, still demonstrates a meaningful positive effect, highlighting the importance of adaptive strategies for improving agribusiness performance.

Regression Analysis

The multiple regression analysis was conducted to examine the joint effect of land use policies, water resource management, climate change resilience, and use of agrochemicals on the performance of agribusiness enterprises (Table 19).

Table 7: Joint Regression Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.847ª	.717	.714	.38475	.717	244.045	4	385	.000

a. Predictors: (Constant), Use of Agro-chemicals, Climate change Resilience, Land Use Policies, Water Resource Management

The model shows a strong positive relationship between the predictors and agribusiness performance, with an R value of 0.847, indicating a high degree of association. The R square value of 0.717 suggests that approximately 71.7% of the variation in agribusiness performance is jointly explained by the four predictors. The adjusted R square of 0.714 confirms the robustness of the model, accounting for the number of predictors included. The high F value of 244.045, with a significance level of $p < 0.001$, indicates that the regression model is statistically significant. This demonstrates that land use policies, water resource management, climate change resilience, and use of agrochemicals jointly have a strong and meaningful effect on the performance of agribusiness enterprises. The results affirm that these predictors are key determinants of agribusiness productivity and sustainability.

Analysis of Variance (ANOVA)

Table 8: Analysis of Variance (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	144.504	4	36.126	244.045	.000[b]
	Residual	56.992	385	0.148		
	Total	201.496	389			

a. Dependent Variable: Performance of Agribusiness Enterprises

b. Predictors: (Constant), Use of Agro-chemicals, Climate change Resilience, Land Use Policies, Water Resource Management

ANOVA was conducted to determine whether the overall regression model is statistically significant and whether the independent variables collectively have a meaningful effect on the dependent variable. The regression sum of squares (SS = 144.504) is substantially higher than the residual sum of squares (SS = 56.992), indicating that the model explains a large portion of the variation in agribusiness performance. The high F value of 244.045, with a significance level of $p = 0.000$, confirms that the model is statistically significant. This demonstrates that land use policies, water resource management, climate change resilience, and use of agrochemicals jointly have a strong and significant effect on the performance of agribusiness enterprises, reflecting a good model fit.

CONCLUSIONS

The study concludes that effective land use policies play a central role in enhancing smallholder agribusiness performance in Siaya County. Farmers who adopt recommended practices such as agroforestry, crop rotation, terracing, and mulching achieve better soil conservation and higher productivity. This indicates that well-designed and enforced land management regulations create an enabling environment for sustainable farming and improved enterprise outcomes. Strengthening institutional support and clarifying policy frameworks can therefore significantly enhance the resilience and productivity of smallholder agribusinesses.

Water resource management emerged as a critical determinant of agribusiness success. Farmers who are able to access, store, and utilize water efficiently maintain more stable production even under changing climatic conditions. This suggests that investments in water infrastructure, promotion of efficient irrigation methods, and farmer training on water conservation can substantially improve agricultural productivity and stability. Effective water management is therefore essential for sustaining enterprise performance in smallholder farming systems.

Climate change resilience and adaptation strategies also significantly influence agribusiness outcomes. Farmers who diversify crops, adopt climate-smart techniques, and adjust farming practices to environmental variability are better equipped to mitigate the risks posed by climate stressors. This highlights that integrating adaptive strategies into farming systems is key to maintaining consistent production and ensuring long-term sustainability. Building resilience into smallholder enterprises is thus critical for coping with climate-related challenges.

The study further demonstrates that responsible and strategic use of agrochemicals contributes positively to agribusiness productivity. Proper fertilization and pest management improve crop growth and overall performance, particularly when combined with sound land and water management practices. These findings underscore the importance of farmer education and guidance on safe and effective agrochemical application, which maximizes productivity while preserving environmental sustainability.

RECOMMENDATIONS

The study recommends that national and county governments develop and enforce environmental and agricultural policies that support sustainable agribusiness practices. This includes strengthening land use regulations, ensuring equitable access to water resources, and promoting climate-smart agriculture. Policies should provide clear guidance on the safe and effective use of agrochemicals and encourage participatory approaches where smallholder farmers are actively involved in decision-making processes. Policies should also incorporate measures that build farmers' adaptive capacity, such as facilitating access to credit, insurance schemes, training programs, and social protection. By combining regulatory enforcement with support for livelihood diversification and climate resilience, policymakers can enhance both environmental sustainability and the economic well-being of smallholder farmers.

Agricultural managers, extension officers, and community institutions should focus on building farmers' capacity to implement sustainable agribusiness practices. This includes providing training and awareness programs on effective land use planning, proper water resource management, climate-smart farming techniques, and safe and efficient agrochemical application. Managers should also facilitate access to resources that enhance productivity, such as irrigation systems, storage facilities, and market infrastructure, ensuring that farmers can optimize their outputs. Support for diversification of farming activities through microfinance, value addition, and small-scale enterprise development can strengthen resilience and reduce vulnerability to environmental and market shocks. Promoting cooperative societies, savings groups, and skills development programs can further enhance household adaptive capacity, enabling smallholder farmers to maintain stable agribusiness performance under changing climatic and resource conditions.

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