AGROECOLOGICAL PRACTICES AS DETERMINANTS OF SOCIO-ECONOMIC DEVELOPMENT OF FARMERS IN MAKUENI COUNTY, KENYA

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DECLARATION

Declaration by Student

This thesis is my original work and has not been presented for examination in any other university.

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DEDICATION

This thesis is dedicated to my parents, Holiness and Wiltone Mwasezi, for their unwavering moral support. To my friend, Mary Mutula for encouraging me, and to my three sons, Fredrick, Mali and Jabari, may this work serve as a source of inspiration for your academic journey and future careers

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ABBREVIATIONS AND ACRONYMS

AGP	Agro-ecological practices
ASAL	Arid and Semi-Arid Land
CBO	Community based Organizations
EMS	Environmental management systems
NGO	Non-governmental organizations
SED	Socioeconomic development
IPC	Integrated Food Security Phase Classification

ABSTRACT

Small-scale farmers worldwide are struggling to produce enough food to feed a growing population. Farmers are increasingly being asked to produce in huge quantities while still being ecologically friendly, economically profitable, and socially equitable. Although agroecological practices are increasingly being recognized as sustainable solutions to food insecurity and climate solutions, their adoption in Makueni County remains underexplored in relation to socio-economic development of farmers. Furthermore, financial constraints, weak policy support and inaccessibility to information limits adoption, making it difficult to understand how specific agroecological interventions influence resilience, livelihoods and productivity. Thus, the purpose of this study was to investigate agro-ecological practices as determinants of socio- economic development of farmers in Makueni County, Kenya. Specifically, the study determined the prevalence of agro-ecological practices adopted by farmers, assessed the factors influencing adoption of specific agro-ecological practices and determined the relationship between agro-ecological practices and socio-economic development of farmers. Anchored on Mellor's Theory of Agricultural Development and the Resource Exploitation Theory, a quantitative research approach and a descriptive cross-sectional design were adopted to explore the study's objectives. The target population consisted of crop-growing farmers affiliated with 30 self-help groups. To ensure representative sampling, stratification and proportionate sampling techniques were applied to draw participants from a total of 280 farmers. The sample size was determined using a formula provided by Select Statistical Services, resulting in a final selection of 163 respondents. These participants were chosen through proportionate sampling to accurately reflect the broader population under study. To identify the types of agro-ecological practices adopted by farmers, the frequency per item of observed variables was computed while a simple binary logistic regression and simple linear regression was used to examine the factors influencing adoption of specific agro-ecological practices and the influence of agro-ecological practices on socio-economic development of farmers, respectively. A total of 87.2% of farmers reported adopting at least one agro-ecological practice, with crop rotation (70.7%) commonly adopted, followed by zero/minimum tillage (51.2%) and agroforestry (43.9%). Whereas, agro-ecological practices such as crop residue incorporation (17.7%), legume intercropping (21.3%), compost/manure use (36.6%), cover cropping (23.2%), seed saving (14.6%), planting pest repellant plants (11%), and applying natural pesticides (11.6%) were less widely embraced. Enablers (motivation, accelerator, access to information) and barrier (financial constraints, inadequate extension support, market limitations, cultural and social norms, policy and institutional gaps) factors had a significant effect on the adoption of agro-ecological practices, with motivation showing the strongest positive effect and barriers exerting a strong negative impact. The overall model indicated good fit and moderate to strong predictive power. After regressing the determined agro-ecological practices against socio-economic development variable, the study found that agro-ecological practices influence farmers' socio-economic development by around 15.5%. Therefore, agro-ecological practices contribute to socio-economic development of famers by enhancing their livelihoods, improving sustainability and productivity. Motivation, access to information and barriers influence adoption of agro-ecological practices, indicating the need to capacity-build and offer targeted support to encourage sustainable agriculture and foster resilient among farmers.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

It is estimated that the global population will reach 9.1 billion people by 2050 (United Nations, 2009), indicating the need to increase food production. Despite increased food waste, overproduction, and allocation difficulties associated with increase of the population this world population would require an additional 30% of food and thus farmers throughout the world ought to work harder amidst these challenges to produce this extra food (Kinnunen, et al., 2020). For example, there is an increasing demand for farmers to produce not only in large quantities, but also in environmentally friendly, economically beneficial, and socially equitable ways (Lajoie-O'Malley, 2020). Climate change effects are also visible, as evidenced by prolonged droughts and flooding.

The decline in socio-economic status of people in arid and semi-arid land (ASAL) areas is worse in comparison to other areas, as these areas are naturally disadvantaged (Hag Husein, et al., 2021). Although social development has been defined differently in many contexts, in this context, socio-economic development refers to the capacity to ensure market accessibility, enhance inclusivity in crop production, improve security, education, health, and welfare, and ensure that all of these are provided equally regardless of social class or gender of the farmer as well as the farmer's ability to generate income, employment opportunities, develop agri-infrastructure and increase crop yields for the population's long-term survival. ASAL areas can make significant contributions to development despite their contribution being overlooked (Hag Husein et al., 2021). Climate change, food insecurity, droughts, and floods are the most severe threats to the success of development initiatives in ASAL areas (Kogo, et al., 2021).

Agriculture industry is increasingly expected to operate responsibly by implementing food production practices that reduce environmental impact, promote social equity, and economically benefit the community.

Agro-ecological practices (AGP), according to researchers Bezner-Kerr (2011), Chable (2020), González-Chang et al. (2020), Schoonhoven and Runhaar (2018), are farming systems that aim to improve ecosystem sustainability while also providing economic, social, and environmental benefits to farmers and communities. The adoption of AGP in agriculture has recently increased (González-Chang et al, 2020). However, there is little literature on the incorporation of AGP in farming, particularly in semi-arid and arid areas. Famine has been identified as a major cause of death in ASAL areas, and various research studies have indicated that if nothing is done, many people are likely to continue dying from hunger (Mansoor, et al., 2022; Muthamilarasan & Prasad, 2021).

Developed and developing countries are both facing famine. According to FAO et al. (2018), 821 million people are facing hunger in the world. In 2024, an approximate of 307 million people in Africa were reported to be chronically undernourished (Food and Agriculture Organization, 2025; Musvanhiri, 2025; World Health Organization, 2025). In Kenya, an approximate of 2.8 million people are encountering high levels of acute food insecurity (Integrated Food Security Phase Classification [IPC], 2025). According to Government of Makueni (2025), an approximate of 25.23% of households in Makueni County are experiencing hunger with 20% encountering moderate famine and 5.23% encountering severe famine. This indicates that the food systems and agricultural activities in the world are not able to achieve food demands. Furthermore,

contemporary food systems have had a significant impact on nutrition and food security through their health and economic implications (Myers et al., 2017). For example, many food producers are struggling to make ends meet due to poor income, and small and medium-sized food businesses are experiencing economic insecurity.

AGP are intended to increase food productivity while reducing environmental impact and promoting social equity. Adopting AGP may allow a farmer to save money, recycle some materials, and use less water (Shah, 2022). According to Reynaud and Paché (2019), an agro-ecology strategy can improve farmers' and communities' social and economic development. Farmers may also receive government incentives and free marketing benefits from pro-environment non-governmental organizations (NGO). Agro-ecological practices are gaining global momentum, with above 70 countries developing national strategies to entrench agro-ecology into food systems transformation and climate resilience efforts (Agroecology Coalition, 2025; FAO, 2025; UNDP, 2025). This increase reflects awareness of agro-ecology's role in solving interconnected challenges like food insecurity, climate change and biodiversity.

In Kenya, the government, through its national environment policy and National Agroecological Strategy (2024–2032), provides incentives to farmers to encourage them to participate in environmental and social justice initiatives to ensure climate resilience and sustainable livelihoods (Karuri, 2020; Ministry of Agriculture and Livestock Development, 2024). On the other hand, the majority of consumers have become environmentally conscious due to the impact of their purchasing habits have on the environment (Khan, 2020). Consumers are now willing to pay more for farm produce that is environmentally friendly (Connor, 2022). As a result, AGP adoption or

lack thereof may have an impact on the social and economic development of farmers and communities. However, the high initial costs of implementing specific AGP have led farmers to view agro-ecology as a costly venture that may reduce their profits (Ekers, 2019).

Farmers in semi-arid and arid areas such as Makueni county and other parts of the country are aware of the existence of AGP, but their integration into agricultural farming is minimal, according to researchers Autio (2021), Beinah (2020), Ntawuruhunga (2020), and Phiri et al. (2022). The extent to which agro-ecological farming practices have been adopted in Makueni County is not well documented in the literature, as current studies cover the entire country. Although the recently drafted Makueni County Agroecology Policy (2025) attempts to outline transformative framework to enhance sustainable farming, climate resilience and biodiversity via agro-ecological practices, there exists limited study on the effect of agro-ecological practices on socio-economic development of farmers.

Agro-ecological principles like recycling of nutrients, integration of indigenous knowledge, diversification and soil management are especially transformative in ASALs, where farmers encounter limited rainfall, fragile ecosystems and water scarcity (Ministry of Agriculture and Livestock Development, 2024). These practices minimize overreliance of external inputs that are costly and embrace climate resilience, making it viable for farmers to maintain productivity even under difficult climate conditions. The utilization of agroforestry and drought-tolerant crops, for instance, enhances food security while conserving soil and water. Agroecology empowers communities by fostering local value chains, enhances inclusivity in decision-making and ensures

equitable sharing of resources that promotes livelihoods and reduces poverty (Ministry of Agriculture and Livestock Development, 2024). Furthermore, agroecological interventions such as organic farming and community-based seed systems in Elgeyo Marakwet County have resulted in greater social cohesion, higher incomes and enhanced nutrition among smallholder farmers (Harris, 2024).

Agro-ecology is gaining momentum in Kenya, particularly among smallholder farmers. Group membership, farmer education, perceptions of agro-ecology's economic benefits, and access to information regarding extension services have been linked to agro-ecology adoption in Kenya (Kithinji et al., 2025; Nabiswa et al., 2024). However, other factors such as climate vulnerability, lack of market access, and resistance to change are yet to be explored and their relative effect on agro-ecological practices in semi-arid and arid regions like Makueni County, Kenya. Although the National Agro-ecology Strategy of 2024 to 2033 aims at addressing these challenges through the promotion of ecological farming, biodiversity restoration, and support of agro-ecological businesses (Ministry of Agriculture and Livestock Development, 2024), there still exist gaps in transiting policy into practice, particularly in semi-arid and arid areas where infrastructure and institutional support are weak. Makueni County is one of such regions in Kenya that encounters challenges such as soil degradation, food insecurity, and erratic rainfall. Although Makueni County government has made efforts to outline a framework to promote sustainable practices like ecosystem restoration, agroforestry, and organic farming (Makueni County Government, 2023), there still exist limitations in the implementation of agro-ecological practices.

Many scholars have conducted agro-ecological research. For example, Bellocchi et al. developed a model evaluation method in 2015, Robert Sroufe developed environmental management systems (EMS) in 2003, and Nicholls and Altieri developed agro-ecological approaches in 2012. Even though farmers are under pressure from a variety of sources to adopt environmentally friendly practices (Baur, 2022), few empirical studies have examined the impact of AGP on farmers' social and economic development. Those that exist discuss the contribution of AGP to agricultural sustainability. In their study, Wezel et al. (2014) classified agroecological cropping practices in terms of substitution, redesign, and efficiency, but left out the relationship between AGP and farmer social and economic development. Furthermore, Ndirangu (2017) sought to assess the impact of AGP adopted by farmers in agro-ecological zones on food security in Kenya in his study. In this context, this study sought to determine not only whether farmers in Makueni County have adopted AGP, but also the extent to which AGP impact social and economic development of farmers.

1.2 Problem Statement

In semi-arid and arid land areas, agroecology has become a major factor in transforming food systems and mitigating the effects of climate change. Agroecology enables farmers, particularly in ASAL areas, to adapt and develop resilience to many challenges posed by climate change, while also making nutritious food available to the region's entire population (Bryan, et al., 2013). AGP ensure that food is produced and consumed in an environmentally friendly manner (Reddy, 2017). AGP make significant contributions to biodiversity conservation, land degradation reversal, and farming system resilience to the effects of climate change (Reddy, 2017). AGP are not new in ASAL areas such as Kenya's Makueni County. These practices are ingrained in

traditional practices such as traditional water-harvesting systems, small-scale and family farming, and so on (Githunguri and Njiru, 2020).

Makueni County has developed critical experiences in sustainable farming that are aimed at assisting the community's low-income earners. Agroecology is being expanded in this region to help with climate change adaptation and food security. Climate change concerns, on the other hand, are on the rise. Despite farmers in Makueni County embracing sustainable farming, poverty and food insecurity continue to be a challenge (Mungai, 2014). Women are the most vulnerable to the effects of climate change. These women are impoverished and rely on their subsistence farming activities to feed their families.

Water scarcity, frequent drought, extreme heat, erosive rain, and wind all have had a significant impact on farming in Makueni County. These factors have reduced crop yields, exacerbated food insecurity, and increased poverty in the county (Omulo, 2022). Furthermore, soil fertility has declined, and there is no longer enough food to feed the families. Although much research has been conducted on how AGP influence farmers' socio-economic development, the resulting factors from these studies are mostly biased towards wetlands, leaving dryland areas such as Makueni County in Kenya without a proper guide to adopting agro-ecological practices. The models that have been proposed by researchers' lean towards fish farming and make it too wide for crop farming in dryland to fit because these practices differ from one farming practice to another.

Consequently, crop farming in drylands has been purely driven by culture. The recent private and non-governmental organization's crop farming initiatives have not been able to fully improve the situation, as they are inadequate. Also, the proposed initiatives

overlook water limitation and crop complete chain processes, which are the key components and linkages in enhancing food security. Currently, climate change is posing several challenges to the Makueni population regarding the use of land. Poverty, family conflicts and recurrent food insecurity are just few symptoms of the major problem. The type of mitigation required in this case should be able to respond to scientific research and agricultural practices that improve optimal crop yields and community members' living standards.

Although agroecological practices are increasingly being recognized as sustainable solutions to food insecurity and climate solutions, their adoption in Makueni County remains underexplored in relation to socio-economic development of farmers. Furthermore, financial constraints, weak policy support and inaccessibility to information limits adoption, making it difficult to understand how specific agroecological interventions affect resilience, livelihoods and productivity. It is against this background that this research was conducted. The goal of this research was to investigate the influence of agro-ecological practices on the socio-economic development of farmers in Makueni County, Kenya. The study attempted to suggest intervention measures that would help optimize crop yields and improve the living standards of the local community.

1.3 Objectives of the Study

The main objective of this study was to investigate agro-ecological practices as determinants of socio- economic development of farmers in Makueni County, Kenya. The specific objectives of the study were:

i. To determine the types of agro-ecological practices adopted by farmers in Makueni County, Kenya
ii. To examine the factors influencing adoption of specific agro-ecological practices in Makueni County, Kenya
iii. To determine the relationship between agro-ecological practices and socio-economic development of farmers in Makueni County, Kenya

1.4 Research Questions

The following research questions guided the study.

1. What are the types of agro-ecological practices adopted by farmers in Makueni County, Kenya?
2. What are the factors influencing the adoption of specific agro-ecological practices in Makueni County, Kenya?
3. Is there a relationship between agro-ecological practices and socio-economic development in Makueni County, Kenya?

1.5 Justification of the Study

Agro-ecology provides a transformative framework for Arid and semi-arid land (ASAL) areas that encounter persistent threats from food insecurity, drought and land degradation. Agro-ecological practices soil regeneration, indigenous knowledge, diversified cropping systems and water conservation minimize vulnerability and improve productivity in fragile ecosystems (Neondo, 2024). These practices provide a direct support to sustainable development goals like zero hunger (SDG 2), climate action (SDG 13) and life on land (SDG 15) by enhancing food availability, mitigating climate effects and restoring degraded landscapes (United Nations, n.d). Kenya's

National Agroecology Strategy for Food System Transformation (2024–2033) emphasizes agro-ecology as a main factor of inclusivity and climate-resilient food systems, especially in ASAL counties (Ministry of Agriculture and Livestock Development, 2024). Agro-ecology emphasizes on reduction of external inputs reliance, strengthening of local markets and farmer-led innovation, which are important in the sustainable development of marginalized areas. The recently drafted agro-ecology policy of 2025 in Makueni County aims to build farmer capacity, enhance ecological farming and integrate agro-ecology into county planning and budgeting (Government of Makueni County, 2025). This policy recognizes agro-ecology as a tool for reversing environmental degradation and empowering communities.

Food insecurity is increasingly becoming a great concern in the current world. According to FAO et al. (2018), 821 million people are facing hunger in the world. This indicates that the food systems and agricultural activities in the world are not able to achieve food demands. Population growth, climate change, rural-urban mobility, and growing demand on natural resources are all ongoing concerns that will have a significant impact on food systems (Willet et al., 2019). Furthermore, contemporary food systems have had a significant impact on nutrition and food security through their health and economic implications (Myers et al., 2017). For example, many food producers are struggling to make ends meet due to poor income, and small and medium-sized food businesses are experiencing economic insecurity.

Empirical research data supports the existence of a link between agro-ecology and farmer development. While studies on agro-ecology have been conducted in Makueni County, more research is needed to determine agro-ecological practices and their

impact on the social and economic development of crop growing farmers. Furthermore, the studies conducted focused only on a few agro-ecological practices while leaving out others, which does not fully authenticate the findings. Because the empirical data available does not show the time frame for which the study was conducted, verifying the research results is difficult. Because the empirical data only focuses on a few households, the results from these households are insufficient to draw conclusions about the findings. As a result, there was a need to conduct research that takes all these factors into account.

Adopting agro-ecological practices in ASAL areas will ensure food security and raise living standards for local communities as well as the entire country. As a result, the purpose of this research was to determine how prevalent agro-ecological practices are in ASAL areas such as Makueni County and whether they influence the SED of farmers in any way. The Makueni County was chosen for the study because it has a high level of geographic and natural diversity in terms of natural resources. With rising climate change awareness in the agricultural sector and modern farms in the region being relatively new, it was assumed that farmers had incorporated agro-ecological practices into their design and operations.

1.6 Scope of the Study

This study aimed to investigate the influence of Agroecological Practices (AGP) on socio-economic development among small-scale farmers, with a focus on Makueni County, the Eastern region of Kenya. The study focused on examining how various agroecological practices, such as crop choice and rotation, intercropping, agroforestry, organic fertilization, and soil and water conservation, are utilized in the county and their

contribution to enhancing socio-economic development of farmers. The sample size for this study consisted small-scale farmers from Makueni County who were selected to represent a diverse range of farming practices and experiences. Also, the analysis did not consider variations in farm size, socio-economic factors or access to resources that may affect the adoption rates. The use of factor scores oversimplified complex relationships between individual agro-ecological practices and socio-economic development of farmers. The research explored the relationships between the adoption of AGP techniques and their influence on the socio-economic development of farmers in the region, aiming to provide valuable insights into sustainable agricultural practices and their potential for improving livelihoods and food security in the study area.

1.7 Operational Definition of Terms

Agro-Ecological Practices	Farming systems that aim to improve ecosystem sustainability while also providing economic, social, and environmental benefits to farmers and communities.
Crop Choice	It is the decision to select the best crop for a given set of circumstances, most notably climate.
Crop Rotation	The process of sequentially planting different crops on the same plot of land to optimize nutrients and improve soil health.
Inter-Cropping	Growing more than one crop on the same farm at the same time.
Agroforestry	It is the practice of combining trees with crops or pasture
Organic Fertilization	It is using plant or animal materials that are either a byproduct or an end product of a naturally occurring process.

Soil And Water Conservation	It refers to activities carried out within ASAL areas to protect soil and enhance water availability.
Social Development	It is the capacity to ensure market accessibility, enhance inclusivity in crop production, improve security, education, health, and welfare, and ensure that all of these are provided equally regardless of social class or gender of the farmer
Economic Development	It refers to farmer's ability to generate income, employment opportunities, develop agri-infrastructure and increase crop yields for the population's long-term survival.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains the reviews of literature presented by various authors and scholars based on the study objectives. This literature review explains the theoretical framework, theoretical literature, empirical literature and how the findings relate to the dependent variable.

2.2 Theoretical Framework

This section shows a framework of the literature review. The literature is organized in accordance to the variables of the study which include; crop choice and rotation practices, inter-cropping practices, agroforestry practices.

2.2.1 Mellor's Theory of Agricultural Development

Mellor et al. (1966) proposed some analyses in their theory of agricultural development in which agro-ecological practices can aid in achieving social and economic development. Mellor defined agro-ecology as practices such as crop rotation, intercropping, agroforestry, soil and water conservation, and organic fertilization. Russian agronomist Basil et al. (1928) coined the term agro ecology. Over the years, the term agro-ecology has evolved and expanded to include other aspects of the food supply chain, recognizing the value of connecting farmers and consumers. This theory was supported by Hawes et al (2021), who argued that food crops must be managed in a sustainable manner to ensure long-term ecological functioning such as primary productivity, pest and pathogen regulation, carbon, water, and nutrient cycling. They went on to say that these processes can be influenced by agro-economic practices and

should be sustained by the abundance of plants and microbes in the existing ecosystem. However, according to Dumont et al (2021), the lack of consistency in the application of agro-ecology due to different definitions and a lack of standardized methodologies to recognize agro-ecological systems has proven to be problematic.

Makueni County is located in an ASAL region with a variable climate system. Because of the county's reliance on agricultural products, climate variability is expected to have a greater impact on the agricultural economy. Farmers in the county are thus negatively impacted by climate variability, which limits their potential produce. As a result, adopting Agro-ecological practices will aid in mitigating the negative effects of climate change in Makueni County. Mellor's Theory of Agricultural development was utilized to justify this study's findings.

2.2.2 The Resource Exploitation Theory

Plourde et al (1970) proposed the resource exploitation theory, which states that areas in which agricultural practices are to be undertaken require expansion for agricultural produce to increase, thereby increasing returns. This implies that society's living standard will rise, resulting in social and economic development. Tatum et al (2022) define social economic developments as procedures aimed at recognizing the social and economic needs of a community and attempting to find solutions that address those needs in a practical and accepted manner within society. Their general idea is to find a way to improve the standard of living within the community while also ensuring that the local economy is stable and capable of supporting the community. Kriegler et al. (2012) had similar arguments as Tatum (2022) whereby they argued that social economic development entails critical tools for exploring long-term solutions to

society's economic crisis. They also contended that a more consistent application of social and economic developments would result in a more integrated view of mitigation, adaptation, and climate change. As a result, adequate coverage of relevant social and economic developments can be achieved by identifying the pathways within the mitigation and adaptation dimensions.

Several institutional and socioeconomic factors, according to Maddison et al (2006), influence the ability and decision to adopt a specific adaptation strategy. In the face of climatic variability, farmers may choose to implement multiple strategies rather than rely on a single strategy to exploit complementary or sustainable among alternatives (Ojo et al., 2018). The current study aimed to investigate the influence of agro-ecological practices on social and economic development of crop growing farmers. McLoyd et al (1998) also stated that social economic developments may result in a high rate of perinatal complications, fewer home-based cognitive simulations, and increased lead exposure. Although some authors see the resource exploitation theory as having flaws in explaining social and economic development, it still stands out as a tool that can be used to measure living standards of community members when agro-ecological practices are applied in farming.

2.2.3 Diffusion of Innovations Theory

Diffusion of Innovations Theory was proposed by Everett Rogers in 1962 and it states that innovations spread through a population in stages; knowledge, persuasion, decision, implementation and confirmation and also through communication channels over a period of time. This theory groups adopters into innovators, early adopters, early majority, late majority and laggards, enabling policymakers and extension agents to

customize strategies to different farmer groups. This framework has successfully explained adoption of technologies in agriculture such as drought-resistant seeds and precision farming tools. For instance, previous studies have reported that early adopters have an influence on their peers, and accelerate diffusion in rural communities (Riverola & Dalmau, 2017). Nevertheless, some authors have argued that the theory overlooks structural barriers like education, access to credit, land tenure that can be hindrances to adoption regardless of communication efforts (Goss, 1979; Mbatha, 2024). Also, it has been criticized for its assumption of linearity and rational decision-making, failing to consider cultural and emotional factors that affect farmer behavior (Crofton, 2024).

Although the theory has these limitations, it has remained valuable in promotion of agro-ecological practices as drivers of sustainable community development. Identification of influential early adopters and taking advantage of local networks, development initiatives can embrace community-led transitions to sustainable farming. For instance, organic composting and agroforestry techniques can be introduced via pilot projects with progressive farmers who will then demonstrate the gain of sustainable farming to other farmers. This peer-based diffusion can improve income stability, food security and ensure environmental resilience. Furthermore, integration of the theory with participatory approaches and socio-economic metrics enables for more inclusive innovation strategies that takes into account of diverse contexts of farmers (Prihadyanti et al., 2024). Therefore, diffusion of innovations theory, though not exhaustive, provides a practical lens for scaling agro-ecological practices and enhancing livelihoods.

2.3 Theoretical Literature

This section examines the relevant theoretical literature on the relationship between agro-ecological practices and farmers' social and economic development in Makueni County.

2.3.1 Crop Choice and Rotation Practices

Crop selection is the decision to select the best crop for a given set of circumstances, most notably climate (Seo et al., 2008). Models that entail crop choice and rotation practices include type of crops included in the rotation, soil testing, crop maturity and growth stage as well as rooting patterns (Dury et al., 2012). Makueni farmers are not unique in their efforts to adapt to climate change by changing crops. Temperature and precipitation have an impact on the crops chosen by Makueni farmers. Fruits and vegetables are the primary crops grown due to the region's warm climate. Scholarly research demonstrates that understanding farmers' crop selection decisions is critical (Yuan et al., 2021). Yuan et al. (2021) further claim that farmers are more sensitive to climate change, which influences their crop selection decisions. Crop rotation, on the other hand, is seen as the process of sequentially planting different crops on the same plot of land to optimize nutrients and improve soil health (Pehlivan et al., 2021). Farmers have adapted crop rotation to reduce insect, weed, and pathogen pressure and increase crop diversity (Zhao et al., 2020).

However, while crop choice and rotation are beneficial to farmers, researchers Selim et al (2019) suggested that crop choice and rotation are risky, do not allow farmers to focus on a single crop for high yield, and require a lot of knowledge and skills that many farmers lack. Crop selection and rotation aid in minimizing food contamination,

increasing soil microbial structure, high land use efficiency, and superior yield. Farmers are thus encouraged to adopt this agro-ecological practice for the benefit of social and economic development.

2.3.2 Inter-cropping Practices

Growing more than one crop on the same farm at the same time is known as intercropping (Tashome et al, 2019). Inter-cropping also entails planting a deep-rooted crop with a shallow rooted crop or planting tall crop with a shorter crop. Mixed cropping increases the yield of the crops, ensure well utilization of the crops and enable farmers across the globe to harvest variety of crops at the same time (Aiyer et al., 1950). It allows farmers to use the same land while producing more diverse produce. According to Maitra et al. (2021), intercropping practices use relatively low input and improve agro-ecology quality. As a result, various benefits such as production sustainability, high yield, and environmental security will be ensured. According to Daryanto et al. (2020), achieving food security is difficult due to climate and soil quality challenges. The introduction of inter-cropping can help improve food security thus it is advisable to be adopted.

2.3.3 Agroforestry Practices

Agroforestry is the practice of combining trees with crops or pasture. This method aids in the reduction of water, soil, and nutrient losses in ASAL areas (Zhu et al., 2020). Furthermore, agroforestry is increasingly being recognized as a financially and environmentally sustainable land use system (Beyene et al., 2019). Agroforestry, on the other hand, is labor intensive because it necessitates regular maintenance work that requires years of dedication (Otter et al., 2020). Agroforestry aids in high yield within

a small area of land while also aiding in the preservation of soil, nutrients, and soil conservation.

2.3.4 Organic Fertilization Practices

Organic Fertilization Practices entail using plant or animal materials that are either a byproduct or an end product of a naturally occurring process (Lazcano et al., 2021). Animal manure or decomposed organic materials can be used. Organic fertilization, according to (Wailling et al., 2020), is critical to the global food supply chain and is required to sustain crop production for the growing population. However, while organic fertilization practices may be beneficial to product production, scholars Keel et al., (2019) argue that there is still a difference between organic and inorganic fertilizers and that organic fertilizers may not be environmentally friendly. Organic fertilization practices are pivotal contributors in increasing crop yields as they improve the soil aeration and microbial nature.

2.3.5 Soil and Water Conservation Practices

Soil and water conservation refers to activities carried out within ASAL areas to increase the productivity of the resource base (Mburia et al., 2021). These conservation efforts are critical because they aid in climate change adaptation, community livelihood improvement, and food security. Rainwater saturation on the ground can result from soil and water conservation practices, resulting in water overflowing during flooding. Also, if soil and water conservation practices such as terraces are not properly maintained, they can cause soil erosion and reduce soil quality (Deng et al., 2021). As Makueni farmers continue to exploit the county for Agricultural purposes, there has

been need for soil and water conservation to ensure there is food security and employment in the county.

2.4 Empirical Literature

2.4.1 Adoption of Agro-ecological Practices

Kiswii et al. (2022) conducted research on Agro-ecological practices and identified land size as a major barrier to agro-ecology adoption by farmers. The data was gathered through interviews and a total of 140 households were interviewed. The study also discovered a significant relationship between the AGP used by farmers and land size. Syomiti et al. (2022) conducted research on AGP and revealed that the constraints to dairy production were feed shortage, pests and diseases. The study further revealed that the main feed resources were grasses, crop residue which were being produced through crop rotation. Primary data was collected from 80 dairy farmers who were selected using random sampling.

Mutui et al. (2022) conducted research to determine the impact of agricultural technology on the livelihood of Makueni farmers. A descriptive survey was conducted, with a total of 300,000 people from the county serving as the target group. The sampling size for the study was determined using a random sampling technique. The study found that most farmers in the county had encountered changes in weather patterns while farming. Based on the findings of the three studies, it appears that farmers in Makueni use agro-ecological practices. As a result, it is prudent to conduct research in more than 140 households, target crop growers rather than 80 dairy farmers, and target crop farmers rather than entire farms. Furthermore, the study will investigate the extent to

which farmers' social and economic development is influenced by agro-ecological practices.

Akanmu et al. (2023) used mixed-methods to examine agro-ecological methods among smallholder farmers in Africa. They focused on sustainable intensification and found out that farmer training, access to extension services and local knowledge integration had a significant effect on adoption rates of agro-ecological techniques. They further noted that limited access to market incentives and credit hindered adoption of agro-ecological techniques. However, this study focused on a few chosen regions within Africa, which may fail to capture the full diversity of agro-ecological contexts across the continent. Furthermore, the study failed to analyze how market access and credit factors interact with farmer decision-making over time. Similarly, Manyanga et al. (2023) systematically reviewed 45 studies published between 2000 and 2022 to reveal adoption patterns, drivers and outcomes. They used a structured literature review and found out that practices such as intercropping, conservation agriculture and composting consistently enhanced crop productivity, food security and household income, particularly when supported by farmer education, secure land tenure and extension services. Nevertheless, this study had limitations on analysis of gender-specific adoption barriers, inadequate policy and institutional frameworks evaluation, lacks regionally customized approaches that considers ecological and socio-economic diversity.

Kithinji et al. (2025) used a mixed-method approach to conduct a case study on adoption of agro-ecological practices of smallholder farmers in semi-arid Kenya. They identified climate change awareness and perceived benefits such as enhanced soil

fertility and drought resilience as the key motivators, particularly when farmers can easily access extension services and training. The study further noted that gender disparities hindered adoption with women encountering limited access to credit, decision-making power and land. Nevertheless, this study had narrow geographic focus, relied on self-reported data and lacked long-term impact analysis, highlighting the need for further inclusive research.

Chimi et al. (2025) used co-word mapping and network visualization techniques to identify dominant themes, evolving research priorities and geographic concentrations of agro-ecological adoptions. A bibliographic review of 376 publications ranging between 1981 and 2024 was conducted and revealed that agro-ecological adoption is connected to climate change mitigation, sustainable food systems and biodiversity conservation with sub-Saharan Africa and Latin America emerging as research hotspots. Nevertheless, this study lacks interdisciplinary integration across ecological, social and economic domains, regions such as East Africa and Southeast Asia are underrepresented and its focus on policy impact and gender dynamics is limited. Thus, the need for an inclusive, regionally and cross-sectoral research that can enhance agro-ecological practices relevance and applicability at a global level.

CIFOR-ICRAF (2023) utilized mixed-method to explore agro-ecological adoption in Burkina Faso and found out that farmers with more financial resources, technical knowledge and labor adopted agro-ecological practices such as cover cropping, mulching and agroforestry in a wider range. Soil health and climate resilience were reported by farmers to be the major benefits and community networks played an important role in adopting these agro-ecological practices. Nevertheless, the study

lacked long-term impact analysis and gender-disaggregated data, hence limiting generalizability of this study findings across demographics and time. This study further failed to explore the effect of policy framework or market access on farmer decisions, which are important for accelerating adoption of agro-ecological practices.

2.4.2 Factors Influencing Adoption of Specific agro-ecological Practices

Agro-ecology has increasingly gained interest as an alternative form of agriculture to conventional agriculture, particularly in climate-vulnerable areas. A study by Fan et al. (2025) synthesized 34 global studies on cropping systems like organic soil amendments, agroforestry, and intercropping, and utilized statistical modeling as well as ecological indicators, and found that diversified systems promote soil fertility and climate resilience. This study recommended the need for more integrated ecological designs to better understand multi-trophic interactions and sustainable productivity balance. Similarly, a study in North Africa covering Egypt, Morocco, Tunisia, and Libya through field surveys and literature synthesis, identified crop diversification and direct seeding as practices being applied in wheat-based systems (Boutagayout et al., 2023). Although Egypt and Morocco reported moderate application, Libya indicated low application because of limited institutional support and inadequate support in research.

The study further reported on the exploration of allelopathic extracts and indigenous pest control, showing the need to localize experiments and share knowledge in local platforms. Embedment of agro-ecological principles into Kenyan national food systems through the National Agro-ecology Strategy (2024 to 20330) has seen farmers-led innovation and biodiversity conservation improve. This has positioned agro-

ecology as a major factor in promoting food security and driving climate adaptation. Nevertheless, implementation challenges are imminent, especially in coordinating efforts across the diverse agro-ecological regions of Kenya.

Lindemann et al. (2024) utilized ethnographic methods and longitudinal case studies to examine agro-ecological transitions in Latin America and found that community-based approaches promoted food security, yielded stability, and enhanced biodiversity. The study further noted that limited market access for agro-ecological products and weak institutional support made it difficult for agro-ecology to thrive. The study recommended strong policy frameworks and the creation of regional knowledge centers to support transitions, particularly in vulnerable communities. Similarly, an experimental study on microbial diversity and nutrient cycling found that agro-ecological inputs had a significant effect on microbial richness and nitrogen retention in semi-arid plots in India and Ethiopia (Han et al., 2025). Nevertheless, this study failed to explore crop productivity and carbon sequestration, hence the need for multi-season trials and deeper ecological monitoring. Collectively, studies report dimensions of agro-ecological practices and indicate persistent gaps in institutional support, scalability, and long-term impact assessment.

Access to information has been linked to the adoption of agro-ecological practices. Farmers who are able to access context-specific agricultural knowledge, particularly via extension services and farmer groups, are in a good position to apply sustainable methods like integrated pest management, crop rotation, and organic fertilization (Biovision Africa Trust, 2023). Farmers interacting with active group membership and agricultural officers influence them to adopt agro-ecology (Chatterjee et al., 2021).

Nevertheless, uneven dissemination of information, especially in rural areas, still remains a challenge. Limitations of digital access and under-resourced extension services have accelerated the challenge of uneven dissemination of information. Therefore, there is a need to examine inclusive communication channels that align with indigenous knowledge systems and their effects on agro-ecological practices.

Social networks, perceived economic benefits, and institutional support are some of the factors considered as accelerators (Kithinji et al., 2025). Application of UTAUT in Mali indicated that social influence and expected performance had a significant effect on the behavioral intentions of farmers to apply agro-ecological methods (Sidibé et al., 2024). Similarly, agricultural cooperatives and lead farmers as accelerators, facilitated peer learning and modelled successful practices (Nabiswa et al., 2024). Although market accessibility for agro-ecological products and accommodative policy environments act as accelerators, they are rarely applied in most regions. Coordination among NGOs, private actors, and government is needed to strengthen the accelerators and create an environment that is rewarding to ecological stewardship.

Motivation factors are linked to values, perceived risks, and experiences of farmers. In Mali, net benefit and expected effort had a positive effect on behavioral intention (Sidibé et al., 2024), implying that farmers feel motivated when they are convinced that agro-ecological practices are both rewarding and manageable. In Kenya, climate resilience, soil fertility, and reduced input costs have been reported as the key motivators (Biovision Africa Trust, 2023). Nevertheless, motivation wanes once the benefits are delayed or when high initial capital or intensive labor is required in applying agro-ecological practices (Khader, 2024). This, therefore, needs alignment of

interventions with the livelihood goals of farmers and provides short-term benefits together with long-term ecological benefits.

Land tenure, labor intensity, insecurity, inadequate financial incentives, and the abandonment of agro-ecological practices once donor ends are among the major barrier factors reported in the adoption of agro-ecology (Biovision Africa Trust, 2023). In Mali, accessibility to tools and improved infrastructure were essential to use behavior, but many farmers were unable to get that support (Sidibé et al., 2024). Furthermore, cultural norms and skepticism about adopting non-conventional practices have become an obstacle (Biovision Africa Trust, 2023). To address some of these challenges, there is a need to understand the extent to which these barrier factors affect the adoption of agro-ecological practices.

In conclusion, few studies have hypothesized a relationship and effects between some determinant variables and the application of agro-ecological practices. Also, there is limited empirical evidence from the reviewed literature that has explored the effect of accelerators, motivation, access to information, and barrier factors on the application of agro-ecological practices.

Musila et al (2019) conducted research to determine the social and economic development of people in Makueni County. The snowball sampling technique was used to sample 300 respondents, 142 of whom were male and 158 of whom were female. To collect both qualitative and quantitative data, questionnaires, group discussions, and face-to-face interviews were used. The study revealed that farmers have financial, health and social problems. Study further found that inability of farmers to save and have a proper financial plan would lead to suffering during harsh climatic conditions

and will make them not able to conduct some agro-ecological practices which might be costly.

Kibicho et al. (2019) conducted research on the social and economic development of farmers in Makueni County. According to the study, Makueni farmers lack formal financial credit services and thus are unable to mitigate their farming activities. The study recommended that farmers should increase their participation in the banking sector by taking credits in order to boost their farming activities thus increasing yield. According to these studies, Makueni County has elements of social and economic development. However, it does not indicate the extent to which agro-ecological practices influence social and economic development. Furthermore, a study with more than 300 respondents and more than 1000 farmers is required to determine the extent of social and economic development because of implementing agro-ecological practices in Makueni County.

2.4.3 Agro-ecological Practices and Socio-Economic Development of Farmers

In ASAL areas, agroecology has become a major factor in transforming food systems and minimizing the effects of climate change. Agroecology enables farmers, particularly in ASAL areas, to adapt and develop resilience to many challenges posed by climate change, while also making nutritious food available to the region's entire population (Bryan, et al., 2013). Bryan et al. (2013) carried out a compelling randomized controlled trial in all 100 villages of northern Bangladesh to determine how financial challenges influence seasonal migration decisions. They provided small cash or credit incentives to households selected randomly to test if easing liquidity obstacles would encourage temporary migration during lean season. The study found out that

migration rates increased significantly among treated households and individuals who migrated experienced enhanced food security and consumption. The study discovered that many families were willing to migrate but had no initial resources to do so, indicating persistence of poverty because of financial inaccessibility. Nevertheless, this study theoretical model failed to capture the forward-looking behavior of households, especially in relation to savings and planning. Furthermore, the study findings are limited in generalizability beyond rural Bangladesh socio-economic context.

Agro-ecological practices are ingrained in traditional practices such as traditional water-harvesting systems, small-scale and family farming, and so on (Githunguri & Njiru, 2020). Githunguri and Njiru (2020) carried out a mixed-methods study in rural Kenya to examine the socio-economic and cultural factors affecting agro-ecological adoption among smallholder farmers. These study findings indicated that secure land tenure, education level and access to extension services were important in influencing the adoption of agro-ecological practices like composting, integrated pest management and intercropping. Farmers who were in organized groups or had gained training indicated higher adoption rates and cited enhanced soil fertility and reduction of input costs as key benefits. Nevertheless, the study is limited in the geographic scope, limiting its generalizability to other regions. Agro-ecological practices (AGP), according to researchers Bezner-Kerr (2011), Chable (2020), González-Chang et al. (2020), Schoonhoven and Runhaar (2018), are farming systems that aim to improve ecosystem sustainability while also providing economic, social, and environmental benefits to farmers and communities. The adoption of AGP in agriculture has recently increased (González-Chang et al, 2020). However, there is little literature in Kenya on the incorporation of AGP in farming, particularly in semi-arid and arid areas.

Although previous research has supported the existence of a link between agro-ecology and farmer development (Bellocchi et al., 2015; Nicholls & Altieri, 2012; Sroufe, 2003), few empirical studies have examined the impact of AGP on farmers' social and economic development. Most of the previous studies on this subject have focused more on the contribution of AGP to agricultural sustainability. For instance, Wezel et al. (2014) classified agroecological cropping practices in terms of substitution, redesign, and efficiency, but left out the relationship between AGP and farmer social and economic development. Furthermore, Maitra et al. (2021) suggested that intercropping practices use relatively low input and improve agro-ecology quality. It is against this background that this research sought to fill the gaps and add information to the literature by providing empirical data regarding the influence of agro-ecological practices on the social-economic development of farmers in Makueni County, Kenya.

Water scarcity, frequent drought, extreme heat, erosive rain, and wind all have a significant impact on farming in Makueni County. These factors have reduced crop yields, exacerbated food insecurity, and increased poverty in the county (Mdemu, 2021). Furthermore, soil fertility has declined, and there is no longer enough food to feed the families. Although much research has been conducted on how AGP influence farmers' social-economic development, the resulting factors from these studies are mostly biased towards wetlands, leaving dryland areas such as Makueni County in Kenya without a proper guide to adopting agro-ecological practices (Bey, 2021; Rettberg et al., 2017). The models that have been proposed by researchers' lean towards fish farming and make it too wide for crop farming in dryland to fit because these practices differ from one farming practice to another (Ahmad et al.2022). Consequently, crop farming in drylands has been purely driven by culture. The recent

private and non-governmental organization’s crop farming initiatives have not been able to fully improve the situation, as they are inadequate. Also, the proposed initiatives overlook water limitation and crop complete chain processes, which are the key components and linkages in enhancing food security. Currently, climate change is posing several challenges to the Makueni population regarding the use of land. Poverty, family conflicts and recurrent food insecurity are just few symptoms of the major problem. The type of mitigation required in this case should be able to respond to scientific research and agricultural practices that improve optimal crop yields and community members' living standards.

Syano et al. (2022) conducted research on agro-ecology in Makueni County. Data from 200 households were gathered using a structured questionnaire. The data was analyzed using a binomial logistic regression model, which allows the relationship between agro-ecology and development to be determined. The model revealed that agro-ecology has a significant impact on development. The study recommended that agro-ecology be promoted in arid areas to increase farmers' financial worth in the face of climate change effects.

Kiswii et al. (2022) conducted a study in Makueni County to determine how land sizes affect agricultural produce produced by farmers. The study found that there was a small difference in land size between households that were food secure and those that were food insecure, so $p=0.021$ is less than $a=0.05$. Furthermore, there is a link between household land size and livelihood security. According to the study, culture, farm income, topography, and land quality are some of the major factors influencing household land sizes. The study also suggests that farmers be educated on the effects

of additional land subdivisions, land curb selling, and land consolidation. The minimum land size proposed for sustainable food production was 10 acres. That size was perfect for agricultural diversification, large-scale farming, and family requirements. These studies imply that agro-ecology has impact on the lives of farmers. However, they do not give the extent to which agro-ecology influence social and economic development of farmers. Therefore, it is prudent to conduct additional studies to determine the extent to which agro-ecological practices influence the social and economic development of farmers in Makueni County.

Fiore et al. (2024) used PRISMA-ScR framework to carry out a scoping review on the role of agro-ecology in socio-economic development and found out that many studies lacked integration of policy analysis and economic incentives despite agro-ecology increasingly being framed as a tool for sustainable development. Also, most studies failed to address regional disparities, especially in Central Africa and Southeast Asia. This study failed to examine how power dynamics between farmers and researchers might affect the collaborative effectiveness and equity among the collaborators despite it emphasizing knowledge co-creation. Thus, there is need for policy-aware and geographically inclusive research that considers transformative potential of agro-ecology. On similar note, Vikas Rajiv Ranjan (2024) reviewed sustainable food systems and highlighted agro-ecological practices' such as agroforestry, integrated pest management and polyculture influence on socio-economic development. This study frames agro-ecology anchored on local knowledge and participatory governance as a holistic solution to world challenges like environmental degradation and rural poverty. Nevertheless, this study review depends on secondary sources, limiting its empirical depth. Also, the study fails to address economic trade-offs, policy integration and

gender dynamics, which are important areas for expanding agro-ecological transformations.

2.5 Conceptual Framework

A conceptual framework is a visual representation that aids in the illustration of the expected relationship between the dependent and independent variables. Given prior knowledge of other researchers' points of view and observations on the subject of research, it represents the researcher's synthesis of the literature on how to explain a phenomenon, outlining the actions required during the study (Varpio et al., 2020). Anchored in Mellor's Theory of Agricultural Development, which states that agricultural transformation acts as a tool for broad-based economic growth via increased employment, rural incomes and productivity, figure 1 conceptual framework shows how AGPs act as catalysts for socio-economic development among farmers. Mellor emphasize stimulation of rural economies through sustainable agricultural intensification, particularly among smallholder farmers who gain support of appropriate technologies and institutional enablers.

Figure 1 shows AGPs like crop rotation, intercropping, agroforestry, and organic fertilization, which represent eco-friendly innovations that improve productivity while conserving resources. The study's first objective examines the prevalence of these practices, aligning with Mellor's perspective that increased adoption of improved techniques is the basis for agricultural-led development. Similarly, second and third objectives of assessing factors influencing AGP adoption and determining their socio-economic impact are directly supported by Mellor's emphasis on enabling conditions and outcomes. The below conceptual framework shows enables like access to training,

extension services and secure land tenure and barriers like credit constraints and gender disparities that influence adoption behavior, reflecting Mellor's assertion that equitable access and institutional support are essential for inclusive growth. Additionally, the socio-economic benefits like employment, improved quality of life, increased income and market access echo the prediction of Mellor that agricultural innovation, when adopted, result in rural transformation. Therefore, the conceptual framework operationalizes Mellor's theory by indicating how AGPs combined with adoption factors lead to tangible development outcomes for farming communities.

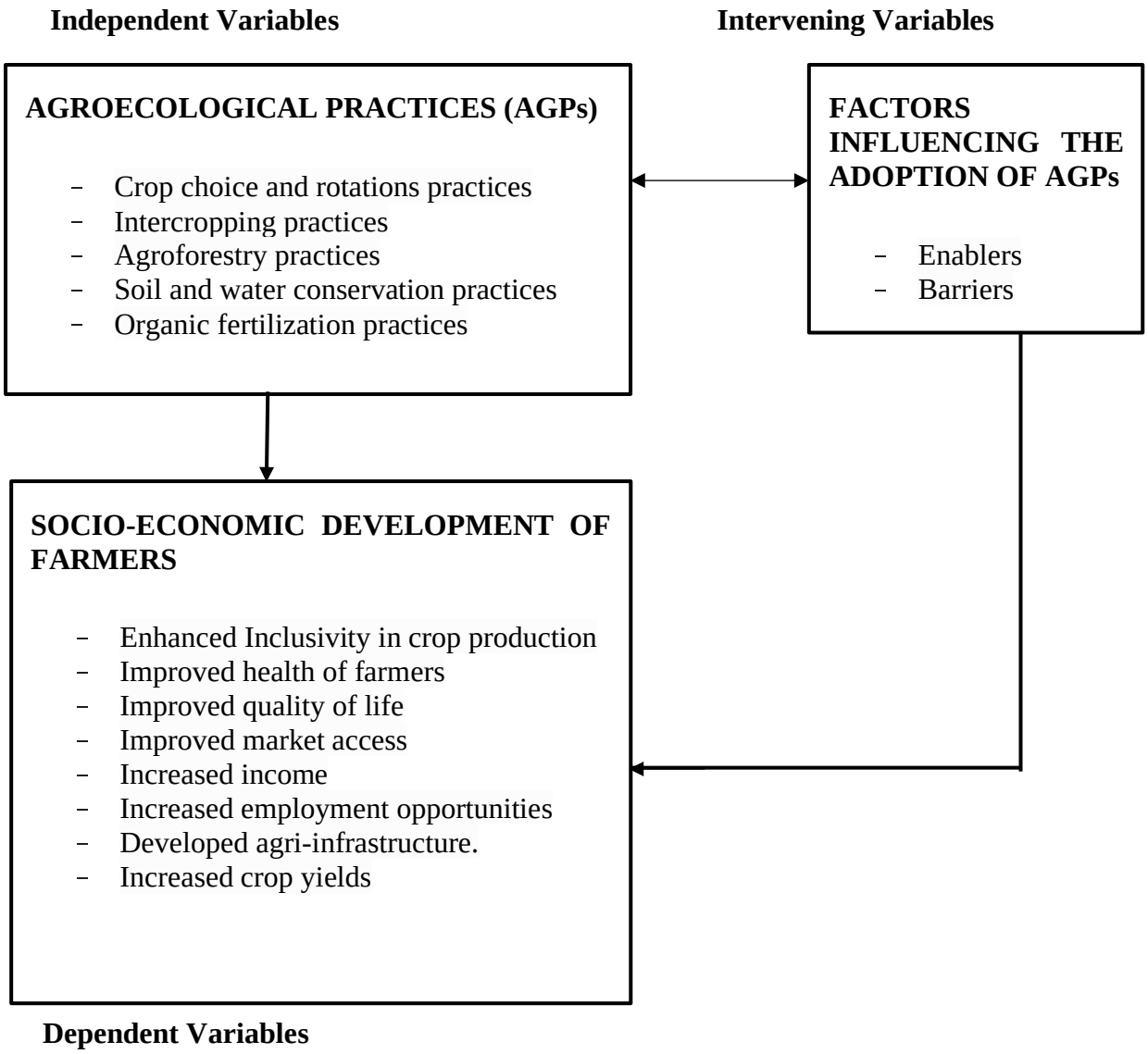

Figure 2.1: Influence of Agroecological Practices on Socio-economic Development of Farmers

Source: *Adopted from Mellor et al. (1966) and modified by the Author (2025)*

2.6 Research Gaps

The literature review in this chapter indicates that agro-ecology and development of famers has not been comprehensively explored in all ASAL areas in the Makueni County. There are limited empirical studies on AGP applications. Regardless of the contribution of agro-ecological practices to the development of farmers, a lot of agro-ecology factors are still left out hence more factors are still lacking. Finally, most of the studies were carried out in Makueni county, without considering uniqueness of specific sub-counties and their application of agro-ecology in production of crops. This study sought to find out the extent to which AGP influence social and economic development of farmers in Makueni County, Kenya.

2.6.1 Gaps in Research on Agro-ecological Practices Adopted by Farmers

Even though farmers rely heavily on agro ecological practices to improve their lives, some agro-ecological practices are not fully implemented and thus remain ambiguous in the literature. Furthermore, the existing literature does not fully identify whether and which agro-ecological practices can be implemented to fully influence the social and economic development of farmers in Makueni County.

2.6.2 Social and Economic Development of Farmers

Data from empirical research shows how AGP affect farmers' lives in Makueni County. While it is true that AGP have had some influence on the lives of farmers in Makueni County, the studies do not explain the extent to which agro-ecological practices influence the social and economic development of farmers, particularly in ASAL areas such as Makueni and Kibwezi East sub-counties.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The researcher, in this chapter describes process of research by highlighting research design, study area, population of study, sample size of the target population and sampling procedures. The data collection process from development of instrument to collection of data procedures are described in this chapter. Procedures of analyzing collected data are also enumerated.

3.2 Research Approach and Design

The study utilized quantitative research approach and descriptive cross-sectional design. The design was selected because it enables data collection on a sample of cases at a single point in time (Bryman, 2016; Bell et al., 2019). This enables variables to maintain their characteristics within the short period of collection of data, hence allowing suggestions to be made regarding relationships between variables as per the data collected via the survey (Saunders et al., 2009). A quantitative approach allowed numerical data to be collected and analyzed to identify patterns, test hypotheses and determine relationships among the variables under study. This approach ensured objectivity and replicability, enabling generalizability of the study findings to larger populations.

3.3 Study Area

The study targeted crop growing farmers operating within Makueni County, Kenya. Makueni County has six sub-counties. According to 2019 census, the population for Makueni County is 987,653 consisting of 497, 942 females and 489,691 males (KNBS,

2019). The terrain lies low from 600m above sea level. The area is great in terms of its natural diversity and geography and a good representation of semi-arid and arid areas and thus its selection for this study. Also, with rising agro-ecology awareness in the agriculture sector and farmers in the agro-ecology being relatively new to the farming practice, it was assumed that farmers had mainstreamed AGP in their farming. Makueni County was chosen for the study of agro-ecological practices and their effects on socio-economic development of farmers because of its pioneering Agro-ecology Policy and active participation in the in the CGIAR Agroecology Initiative. This county provides a dynamic policy environment and real-world testing grounds via agro-ecological living landscapes. This county has a semi-arid climate and frequented with droughts, making sustainable farming important. Also, it has dominance in diverse smallholder farming systems that made it possible to collect data on agro-ecology's contribution to food security, income generation and improved resilience. Makueni County is one of the counties in Kenya that emphasizes on young people involvement, gender equity and farmer-led innovation, making it a vibrant area for examining how agro-ecology can change livelihoods and empower communities.

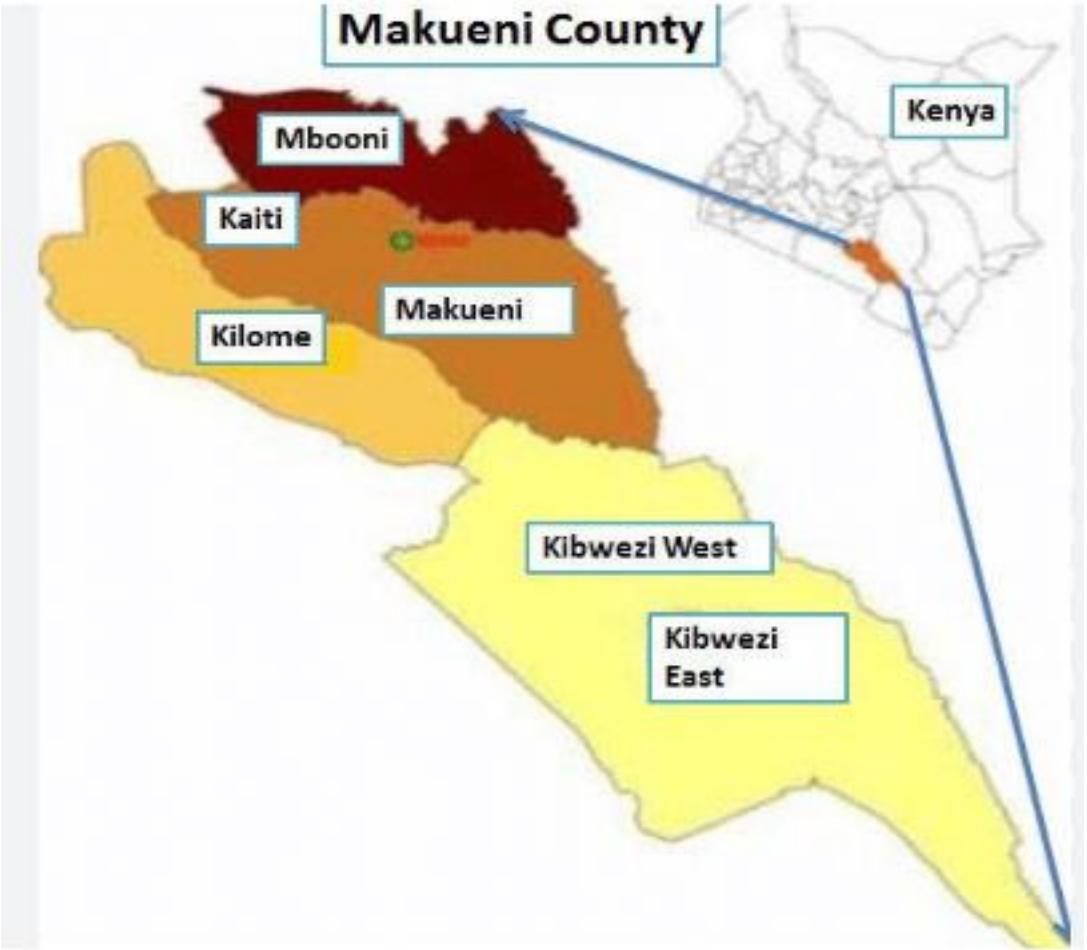

Figure 3.1: Makueni County Sub-counties

Source; *Adopted from Country maps of Kenya (2010)*

3.4 Population of Study

The population of study consisted crop growing farmers of 30 self-help group, with approximately 280 farmers in total to be selected based on list of groups by the Makueni Department of Social Development as at January 2023. These farmers from self-help groups were selected because they greatly get engaged in farming practices.

3.5 Sampling Procedure and Sample Size

The study selected a sample size of 163 farmers from 280 farmers belonging to self-help groups, using a statistical formula for calculating the sample from a larger population. The farmers were stratified based on their sub-county locations, and a proportionate sampling technique was employed to determine the number of respondents from each sub-county. The selection of sample size from 280 farmers of self-help groups was done through select statistical services' formula. This is a key scientific method for calculating sample from a larger population (Trench, 2013). The following formula was used.

$$n = \frac{N}{1 + N(e)^2}$$

The below procedure was followed.

Where,

n = required sample size

N = total population size

e = margin of error (expressed as a decimal, e.g., 0.05 for 5%)

MOE = 5% (Margin of error)

N= 280 (Population size)

Hence, n = 163

Therefore, the study sample size was 163. The 163 farmers from the 30 self-help groups were reached and asked to take part in the survey. Van Dalen's formula was used to draw proportionate samples from each stratum as indicated in the table below.

Population Strata = Total number of members in a strata/Total number of members in the population

Actual sample size = (Population strata / Estimate population of study) X Minimum sample size for the study

Where;

Population strata = Respondents' number from each sub-county

Estimated study population = 280

Sample size for the study = 163

Table 3.1: Determination of Sample Size

Sub-county	Population Strata	Population Estimate	Sample size
Makueni	167	280	97
Kibwezi East	113	280	66

3.6 Data Collection

3.6.1 Data Collection Tools

A questionnaire with both open and closed-ended questions and researcher-guided questions was used as a data collection instrument to enable collection of quantitative data. It was developed as per the study variables and informed by literature. The respondents were guided in filling in the questionnaire to enable in-depth insights. Using a 5-point Likert scales, questions addressing objectives were quantified. Likert scales was utilized to enable data be collected from large respondents' number and allow establishment of interpretation validity through numerous means (Nemoto & Beglar, 2014). Likert scale questions enabled quantification of subjective perceptions, attitudes and behaviors, and facilitated statistical analysis of trends and correlations. These variables were measured as per number of items indicated in the below tables.

For enablers and barriers, respondents were asked to complete a structured questionnaire with a 5-point Likert scale to measure the effect of enablers (motivation, access to information, accelerator) and barrier (financial constraints, inadequate extension support, market limitations, cultural and social norms, policy and institutional gaps) factors on agro-ecological practices in Makueni County, Kenya. The measurement continuum was as follows; 1 ‘totally disagree’ to 5 ‘strongly agree’.

Enablers and Barriers	**Measurement Items**
Enablers	
Motivation	Awareness of environmental degradation and climate
	Perceived economic benefits
	Access to Knowledge and Training
	Social influence and peer Networks
	Personal values and beliefs
Access to information	Access to Extension Services
	Participation in Farmer Groups or Cooperatives
	Exposure to Training and Workshops
	Access to Media and ICT Tools
	Availability of Demonstration Farms
Accelerator	Access to Financial Support
	Supportive Policies and Government Programs
	Market Incentives and Demand for Organic Produce
	Availability of Inputs and Infrastructure
	Institutional and NGO Partnerships
Barriers	Financial constraints
	Inadequate extension support
	Market limitations
	Cultural and social norms
	Policy and institutional gaps

For AGP, the respondents were required to score on a 5-point Likert scale the prevalence of the AGP in their farms as per the measurement items. The measurement continuum was as follows.

1 -less than 20% prevalence; 2-between 21% - 40% prevalence; 3 -between 41% - 60% prevalence; 4 - between 61% - 80% prevalence 5 – between 81% - 100% prevalence

Table 3.2: Agro-ecological Practices Measurement items

Agro-ecological practices	Measurement items
	Crop rotation
	Crop residue incorporation
	Legume intercropping
	Compost/Manure
	zero/minimum tillage
	Planting cover crops
	Seed saving
	Agro-forestry
	Planting pest repellant plants
	Natural pesticides

For socio-economic development, the respondents were needed to mark on a 5-point Likert scale the socio-economic development indicators linked with AGP. The measurement continuum was as indicated below; 1 – less than 20% linked with AGP;2 – 21% - 40% linked with AGP;3 – 41% - 60% linked with AGP; 4 – 61% - 80% linked with AGP;5 – 81% - 100% linked with AGP.

Table 3.3 Socio-economic Development Measurement Items

Socio-economic Development	Measurement items
	Enhanced inclusivity in crop production
	Improved health of farmers
	Improved quality of life
	Increased income
	Improved market access
	Increased employment opportunities
	Developed agri-infrastructure
	Increased crop yields

3.6.2 Validity and Reliability

A pilot study was conducted involving 20 respondents, which is 10 percent of the main sample size (Connelly, 2008). The primary objective of the pilot study was to test the validity and reliability of the questionnaires. Validity refers to measurement items of an instrument and the best method of measuring them, while Reliability refers to trust developed in the data generated from utilizing a particular instrument (Mohajan, 2017). Feedback from the respondents was sought to assess the clarity and comprehensibility of the questionnaire's content. Any errors or issues identified were corrected based on the findings from the piloting study. The questionnaires were distributed to the pilot respondents, and their filled responses were collected for analysis. The data collected during the piloting phase was carefully analyzed, and necessary adjustments was made to ensure the effectiveness and accuracy of the questionnaires for the main study.

3.7 Data Analysis

The data analysis involved quantitative analysis of the collected data. The data was edited, coded, and entered in IBM SPSS 22. Data screening whose intention is to detect and correct any data abnormalities (Broeck, Cunningham, Eeckels, & Herbst, 2005) was done by computing frequencies for each item and checks made for missing values. Further, normality of the data was checked by computing its skewness and kurtosis

using SPSS. According to Kim H.-Y., (2013) and Cisar & Cisar, (2010) skewness is a measure of asymmetry while kurtosis is a measure of 'data peakedness' of a distribution. According to researchers Kim H.-Y., (2013) and Darren & Mallery, (2010) for medium sized data samples of $50 > n < 300$, data distribution is considered abnormal if its skewness or kurtosis z statistic value is beyond ± 3.29 which corresponds to the alpha level 0.05. Descriptive statistics consisting of frequencies and means were used to describe the demographic composition of the study sample.

To determine the types of agro-ecological practices adopted by farmers, respondents were asked to rate on a Likert scale of 1 to 5 the prevalence of the types of agro-ecological practices. Descriptive statistics was used to obtain and rank the means of the various types of agro-ecological practices under study as being practiced by farmers in Makueni County, Kenya. Mean score of each types of agro-ecological practices i.e agroforestry, intercropping, crop rotation, soil and fertility management were then computed for comparison.

To determine the factors influencing the adoption of specific agro-ecological practices, the study utilized a simple binary logistic regression model to predict the binary outcome of adopting agro-ecological practices – 1 for adoption of agro-ecological practices and 0 for absence as per the independent variables of enablers and barriers factors.

To determine the influence of agro-ecological practices on socio-economic development, simple Linear regression was conducted to determine whether the agro-ecological practices have effect on socio-economic development of farmers participating in the study. Agro-ecological practices under study were transformed to

reduce the variables into one construct and the factor score was saved as a variable for subsequent regression analysis. The resulting factor score for agro-ecological practices was regressed against socio-economic development factor, which resulted from transforming indicators of socio-economic development to answer the question. The regression equation was expressed as follows:

i. $$Y = \alpha + \beta_1 X_1 + \cdots + \beta_n X_n + \varepsilon$$

Where, Y was the dependent variable (socio-economic development of farmers), X_n were the independent variables (different AGPs).

3.8 Ethical Considerations

The researcher sought authority to conduct the study from National Commission for Science, Technology and Innovation (NACOSTI) (see appendix II). There was no coercion in providing answers to survey questions. Respondents' confidentiality was kept, as information obtained was only accessible to the researcher and no third party had it before it was coded to enhance anonymity. Consent was sought from respondents to take part in the study as the study was voluntary. There were no questions touching on the respondents' private lives in the study. This ensured that the respondents' privacy was well taken care of. This also avoided discriminating individuals according to their age, sex or race.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

The findings of the study are introduced in this chapter and discussions made under many sections including response rate, data screening, reliability, demographic characteristics, types of agro-ecological practices adopted by farmers, factors influencing adoption of specific agro-ecological practices and the influence of agro-ecological practices on socio-economic development of farmers.

4.2 Response Rate

The study sample consisted of 163 crop-growing farmers from 30 self-help groups. All 163 questionnaires sent out to farmers and administered by research assistants were received back translating into a 100% response rate.

4.3 Data screening

The data screening process confirmed the presence of all values, hence there were no missing values. There was a fairly normal distribution of the data set with values of between 0.025 and 0.417 for skewness and -1.108 and -0.108 for kurtosis.

4.4 Reliability

All sets of measures for both piloting and the main study were computed in SPSS and generated Cronbach alpha coefficients of above 0.7 in each case (see Table 4.1), hence they were considered reliable.

Table 4.1: Cronbach Alpha Coefficients

Variables	Pilot Study		Main Survey	
	A	**No of Items**	**α**	**No of Items**
Agro-ecological practices	0.739	5	0.706	5
Socio-economic development indicators	0.850	8	0.902	8

4.5 Demographic Characteristics of the Respondents

The study demographic information is summarized in table 4.2.

Table 4.2: Demographic Information of the Respondents

Variables			Frequency	Percent
Gender	Male		84	51.5
	Female		79	48.5
	Total		**163**	**100.0**
Age (years) of respondent		18-35;	48	29.4
		35-60;	95	58.3
		Above 60	20	12.3
		Total	**163**	**100.0**
Sub-county		Kaiti	1	.6
		Kibwezi East	59	36.2
		Kibwezi West	7	4.3
		Makueni	96	58.9
		Total	**163**	**100.0**
Household head		No	37	22.7
		Yes	126	77.3
		Total	**163**	**100.0**
The relationship with Household Head				
		Child	8	4.9
		Grandchild	1	.6
		Parent	3	1.8
		Spouse	25	15.3
		Total	**37**	**22.7**
Current marital status of the HH head		Married	128	78.5
		Single	15	9.2
		Widowed	20	12.3
		Total	**163**	**100.0**
Household head born in Makueni		No	27	16.6
		Yes	136	83.4
		Total	**163**	**100.0**
Highest educational level of Household head		No formal education	5	3.1
		Primary School	36	22.1
		Secondary School	71	43.6
		Tertiary education	38	23.3
		University level	13	8.0
		Total	**163**	**100.0**
Main economic activity of the HH		Daily labour	6	3.7
		Farming	108	66.3
		Formal employment	16	9.8
		Other,	4	2.5
		Trading	29	17.8

	Total	**163**	**100.0**
Number of HH members	1.0	4	2.5
	2.0	13	8.0
	3.0	39	23.9
	4.0	28	17.2
	5.0	38	23.3
	6.0	25	15.3
	7.0	5	3.1
	8.0	5	3.1
	9.0	2	1.2
	10.0	3	1.8
	23.0	1	.6
	Total	**163**	**100.0**
HH own any livestock	No	26	16.0
	Yes	137	84.0
	Total	**163**	**100.0**
Nature of land tenure	Not owned	20	12.3
	Owned	143	87.7
	Total	**163**	**100.0**
The farm is fertile	No	47	28.8
	Yes	116	71.2
	Total	**163**	**100.0**
Labor shortage for farm activities	No	25	15.3
	Yes	138	84.7
	Total	**163**	**100.0**
Familiar with the concept of agro-ecological farming	No	22	13.5
	Yes	141	86.5
	Total	**163**	**100.0**
Adopted any agro-ecological practices in the farm	No	21	12.9
	Yes	142	87.1
	Total	**163**	**100.0**

The results in Table 4.2 indicate that 51.5% of the respondents were male while 48.5% were female with 12.3% being above 60 years old, 29.4% being between 18 and 35 years, and 58.3% being between 35 and 60 years old. 58.9% of crop-growing farmers came from Makueni sub-county while 0.6% came from Kaiti Sub-county in Makueni county. 77.3% of these crop-growing farmers were the household head while 22.7% had a relationship with the household head. 78.5% of the crop-growing farmers were

married while 9.2% of the farmers were single. 83.4% of the respondents indicated that they were born in Makueni County. 43.6% of these farmers held secondary school education while 66.3% of them reported farming as their main economic activity in the household. 23.9% of these farmers had three members in the household while only one household had a maximum of twenty-three members. 84% of the farmers owned livestock while 87.7% reported owning the land. 71.2% of the farmers indicated that the farm was fertile while 84.7% reported having labor shortage for farm activities. 86.5% of farmers indicated to be familiar with the concept of agro-ecological farming and 87.1% indicated to have adopted at least one or more agro-ecological practices in the farm. Low response rates were noted among farmers from Kaiti and Kibwezi West Sub counties of Makueni county. This can be attributed to few crop-growing activities conducted in these Sub counties due to prolonged drought seasons.

4.6 Agro-ecological Practices Adopted by Farmers

The study's first objective sought to determine the types of agro-ecological practices adopted by farmers in Makueni County, Kenya. In Table 4.3, the frequency per item of observed variables is computed to determine the types of agro-ecological practices adopted by farmers.

Table 4.3: Agro-Ecological Practices Adopted by Farmers

AGP practice	Frequency	% of adoption (yes)
Overall adoption of at least 1 AGP practice	143	87.2
Crop rotation	116	70.7
Crop residue incorporation	29	17.7
Legume intercropping	35	21.3
Compost/Manure	60	36.6
zero/minimum tillage	84	51.2
Planting cover crops	38	23.2
Seed saving	24	14.6
Agro-forestry	72	43.9
Planting pest repellant plants	18	11.0
Natural pesticides	19	11.6

A total of 143 respondents representing 87.2 percent reported to be adopting at least one agro-ecological practice in their farms. Whereas, 21 respondents representing 12.8 percent reported not to be applying any agro-ecological practices. Out of the 143 respondents who reported to embrace agro-ecological practices, 116 respondents representing 70.7 percent reported to have adopted crop rotation while 48 respondents (29.3%) indicated not to be practicing crop rotation. 29 respondents representing 17.7 percent indicated to practice crop residue incorporation while 135 of the respondents representing 82.3 percent reported not be practicing crop residue incorporation. Majority of the respondents (78.7%) reported not to be practicing legume intercropping in their farms. It is only 35 respondents representing 21.3 percent that reported to be practicing legume intercropping in their farms. Majority of respondents (63.4%) indicated not to be embracing compost/manure in their farming activities. It is only 60 respondents representing 36.6 percent that reported to be embracing compost/manure in their farming activities. 84 of the respondents representing 51.2 percent reported to be practicing agro-ecological zero/minimum tillage while 80 respondents (48.8%)

indicated not to be practicing zero/minimum tillage. Majority of respondents 76.8 percent reported not to be embracing agro-ecological planting cover crops. It is only 38 respondents representing 23.2 percent that reported to practice planting cover crops. Majority of respondents (85.4%) reported not to practice seed saving while 24 respondents representing 14.6 percent reported to be practicing seed saving in their farms. 72 respondents representing 43.9 percent reported to practice agro-forestry in their farms while 92 respondents (56.1%) reported not to practice agro-forestry in their farms. Only 18 respondents representing 11 percent indicated to be planting pest repellants plants in their farms while 146 of the respondents representing 89 percent reported not to be planting pest repellant plants in their farms. Majority of the respondents (88.4%) reported not to be applying natural pesticides while only 19 respondents representing 11.6 percent indicated to apply natural practices.

Ideally, crop rotation forms the foundation for most if not all agro-ecological practices, especially in arid and semi-arid areas. crop rotation agro-ecological practice was the most preferred in the county. This may be attributed to the push to rotate crops like alfalfa and wheat to improve soil organic carbon and nitrogen levels (Li et al., 2023). Additionally, integrating drought-resistant crops to optimize water use and help reduce evaporation as well as retain soil moisture (Begizew, 2021). Organic fertilization being the second most preferred agro-ecological practice can be attributed to the numerous calls for farmers to use manure from animals to grow crops. Agriculture is a contributor to climate change. Fertilizer production and usage on farms result in emissions that have global warming effects. Rio Earth Summit of 1992 advocated for the use of organic manure, replacing manufactured fertilizers that are highly connected to global climate change. Consequently, there has been a deliberate effort to make the

agricultural sector more sustainable through the use of organic fertilizers. This has seen farmers implement organic fertilization programs and incorporate the use of animal manure in growing crops.

Soil and water conservation practices were determined as the third most preferred agro-ecological practices. This agro-ecological practice is not as popular as crop rotation and organic fertilization practices because most farmers perceive the construction of gabions and possession of storage tanks to be an expensive venture and thus consider it to be the responsibility of the governments. However, today's farmers are attempting to close the water conservation loops by digging dams to harvest rainwater. For instance, some farmers have dug dams that collect rainwater that they use during drought periods. This does not only conserve water for use in the farms during drought season but also conserves water for use by livestock.

Lastly, crop choice and rotations practices are the least preferred among the agro-ecological practices under study. Farmers look for crops that can survive in drought-stricken areas and be able to yield much produce. Quality seeds and crops in the farms are linked to the ability to yield more harvests. However, obtaining quality seeds and crops needs much investment both finance and human personnel. This explains why crop choice and rotations seem to be lowly preferred in Makueni County.

These findings corroborate those of other authors. For instance, Yuan et al. (2021) found out that farmers are more sensitive to climate change, which influences their crop selection decisions. Also, Beyene et al. (2019) found that agroforestry is increasingly being recognized as a financially and environmentally sustainable land use system. Organic fertilization is critical to the global food supply chain and is required to sustain

crop production for the growing population (Wailling et al., 2020). However, the results contradict Zhao et al. (2020) who found out that farmers preferred crop rotation majorly to reduce insect, weed, and pathogen pressure and increase crop diversity. The findings do not also corroborate with Keel et al., (2019) who argued that there is still a difference between organic and inorganic fertilizers and that organic fertilizers may not be environmentally friendly.

4.7 Factors influencing the Adoption of Specific Agro-Ecological Practices

The study sought to examine the factors influencing the adoption of specific agro-ecological practices in Makueni County, Kenya. The study utilized a simple binary logistic regression model to predict the binary outcome of adopting agro-ecological practices, whereby 1 for adoption of agro-ecological practices and 0 for absence as per the independent variables of access to information, motivation, accelerator, and barrier factors. Table 4.4 below indicates the binary logistic regression analysis to examine the influence of access to information (Ac), accelerator factors (CC), motivation (Mo), and barrier factors (Bo) on the application of agro-ecological practices (AGRO).

Table 4.4: Factors Influencing the Application of Agro-Ecological Practices

Variables not in the Equation			Score	df	Sig.
Step 0	Variables	Ac	7.183	1	.007
		Mo	51.770	1	.000
		Bo	34.151	1	.000
		CC	9.359	1	.002
	Overall Statistics		74.382	4	.000

Table 4.4 reveals that access to information, accelerator, motivation, and barrier (financial constraints, inadequate extension support, market limitations, cultural and social norms, policy and institutional gaps) factors have a significant effect on the application of agro-ecological practices when they are taken into account individually.

Motivation factors (Score = 51.770, $p < .001$) indicated a strong, significant effect on the application of agro-ecological practices, followed by barrier factors (Score = 34.151, $p < .001$). Access to information (Score = 7.183, $p = .007$) indicated the least effect on the application of agro-ecological practices among the farmers. Generally, the model (Chi-square = 74.382, df = 4, $p < .001$) had a highly significant effect, implying that predictors collectively contributed meaningfully to the application of agro-ecological practices.

Table 4.5 shows Omnibus Tests of Model Coefficients that confirm the significance of the full model with a Chi-square value of 89.979 (df = 4, $p < .001$). This implies that including all four predictors improved the model's fit significantly.

Table 4.5: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	89.979	4	.000
	Block	89.979	4	.000
	Model	89.979	4	.000

Table 4.6 shows a model summary with a -2 Log Likelihood of 121.026, and the pseudo R-squared values—Cox & Snell $R^2 = .424$ and Nagelkerke $R^2 = .584$. This implies that the model has a moderate to strong explanatory power in predicting the application of agro-ecological practices.

Table 4.6*:* Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	121.026[a]	.424	.584

a. *Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.*

Table 4.7 indicates the Hosmer and Lemeshow test with a Chi-square of 9.746 (df = 5, p = .083), which is above the .05 threshold. This implies that there is a good fit between the observed and predicted values. Table 5 supported this by indicating close alignment between observed and expected frequencies across subcategories.

Table 4.7*:* Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	9.746	5	.083

Table 4.8*:* Contingency Table for Hosmer and Lemeshow Test

		AGRO = Not applied		AGRO = Applied		
		Observed	Expected	Observed	Expected	Total
Step 1	1	14	16.269	3	.731	17
	2	14	13.757	3	3.243	17
	3	18	14.977	10	13.023	28
	4	8	7.768	17	17.232	25
	5	1	.878	4	4.122	5
	6	2	2.447	33	32.553	35
	7	0	.904	36	35.096	36

Table 4.9 shows that access to information, motivation, accelerator, and barriers are all statistically significant. Access to information (B = .978, SE = .437, Wald = 4.999, p = .025), positively predicts application of agro-ecological practices. The odds ratio (Exp(B)) of 2.659 implies that farmers with greater access to information are 2.7 times more likely to apply agro-ecological practices. Similarly, motivation (B = 2.728, SE = .525, Wald = 27.007, p < .001) and accelerator (B = 2.080, SE = .773, Wald = 7.240, p = .007) had a positive effect on agro-ecological practices, with both factors indicating odds ratios of 7.417 and 5.655, respectively. On the contrary, barrier factors (B = -2.752, SE = .732, Wald = 14.132, p < .001) had a negative effect on the application of agro-ecological practices, with an odds ratio of .064, implying that higher barriers reduce the chances of applying agro-ecological practices significantly. Generally, the

findings indicate that promoting access to information, motivation, and accelerator factors while reducing barriers would improve the application of agro-ecological practices among farmers.

Table 4.9: Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Ac	.978	.437	4.999	1	.025	2.659
	Mo	2.728	.525	27.007	1	.000	7.417
	Bo	-2.752	.732	14.132	1	.000	.064
	CC	2.080	.773	7.240	1	.007	5.655
	Constant	9.169	1.779	26.558	1	.000	9599.129

a. Variable(s) entered on step 1: Ac, Mo, Bo, CC.

Access to information, motivation, and accelerator factors have a significant and positive effect on the application of agro-ecological practices. On the other hand, barriers have a significant and negative effect on the application of agro-ecological practices. These findings corroborate with Rizzo et al. (2023), who reported that accessibility to information is a major driver for sustainable innovation application among farmers. Additionally, Ndaba et al. (2022) and Sachet et al. (2021) reported that farmers who were accessible to agro-ecological knowledge and extension services were in a better position to apply agro-ecological practices. Motivation is another essential factor, as indicated by the high odds ratio, and it corroborates with Newton et al. (2020) and Ferreira et al. (2022), who emphasized that intrinsic motivation, like long-term productivity goals and environmental concern, improves agro-ecological adoption. Furthermore, the present study findings agree with D'Amato et al. (2021), who reported that accelerators such as community networks and supportive policies enhance the application of agro-ecological practices.

Barriers become an impediment to the application of agro-ecological practices, as indicated by a negative coefficient and a very low odds ratio. The presence of barriers immensely reduces the chances of applying agro-ecological practices. This corroborates with Foguesatto et al. (2020), who found that innovation aversion, complexity, and lack of perceived control are the main obstacles to the application of agro-ecological practices. Similarly, Biovision Africa Trust (2023) reported that structural and individual barriers like inadequate capital, training, and limited access to land were the major challenges that hindered agro-ecology adoption. Collectively, these studies support the regression implications of the model that states that improving access to information, fostering motivation, and leveraging accelerators, while at the same time reducing barriers, would improve the application of agro-ecological practices.

The present study presents clarity of the statistical relationships between access to information, motivation, accelerator, barrier variables, and the application of agro-ecological practices. Although previous studies acknowledged the significance of access to information, motivation, accelerators, and barriers, the present model precisely quantifies their effect on the application of agro-ecological practices. High odds ratio displayed by predictor variables suggests a stronger predictive power compared to those reported in prior studies. In early studies, motivation was generally treated as a qualitative or secondary factor. Similarly, the barrier's negative effect on the application of agro-ecological practices is highly pronounced in the present study, implying a complete hindrance. This differs from previous studies, such as Foguesatto et al. (2020) and Biovision Africa Trust (2023), which described barriers broadly without providing specific statistical weight. Furthermore, including accelerators as a

unique variable with a significant positive effect on the application of agro-ecological practices shows a more nuanced understanding of enabling conditions. In previous studies, accelerators were categorized under community support or general institutional support, and now, with its specificity in the current model, it enables the provision of a rigorous, data-driven model that both confirms previous work and sharpens it.

4.8 Agro-ecological Practices Influence on Social-economic Development of Farmers

The study sought to determine the influence of agro-ecological practices on social-economic development of farmers in Makueni County, Kenya. The study's objective was achieved by regressing agro-ecological practices against the social-economic development factors. Agro-ecological practices and socio-economic development metrics under study were transformed to reduce the variables into two constructs and the factor scores was saved as variables for subsequent regression analysis. The resulting factor score for agro-ecological practices was regressed against socio-economic development factor to answer the question summarized below.

Is there a relationship between agro-ecological practices and social-economic development in Makueni County, Kenya?

Table 4.10 indicates the analysis of variance (ANOVA) for social-economic development regressed against agro-ecological practices.

Table 4.10: Analysis of Variance (ANOVA) for Social-economic Development Factors

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	21.664	1	21.664	29.430	.000[b]
	Residual	118.514	161	.736		
	Total	**140.178**	**162**			

a. *Dependent Variable: Social-economic development factors*

b. *Predictors: (Constant), Agro-ecological practices*

Regression findings in table 4.10 show that regression model with agro-ecological practices as the predictors and social-economic development factors as the dependent variable was fit with F value (1, 161) = 29.43, p=.001

Table 4.11: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.393[a]	.155	.149	.85797

a. *Predictors: (Constant), Agro-ecological practices*

The model results shown in Table 4.11 indicate that R^2 was 15.5%. This implied that agro-ecological practices (Crop choice and rotations practices, intercropping practices, Agroforestry practices, Organic fertilization practices, and Soil and water conservation practices) explain 15.5% of the variance in social-economic development. Agro-ecological practices emerged as significant influencers of social-economic development.

Existing literature reveals similar conclusions regarding the influence of agroecological practices on the social-economic development of farmers. For instance, Mutui et al. (2022) found out that applying agricultural technology in farming influenced the livelihood of farmers. Similarly, Chatterjee et al. (2021) revealed that agro-ecology has a significant effect on the development of farmers. Khan et al. (2024) in their study reported that organic fertilization was a critical factor in the global food supply chain and recommended that it should be embraced to sustain crop production for the growing population. Therefore, these results affirm and give further evidence that agro-ecological practices positively and significantly influence the social-economic development of farmers. However, these results contradict Keel et al. (2019) who argued that organic fertilizers may not be environmentally friendly, hence farmers do not utilize it as a sustainable practice. Farmers have applied many ways to increase their crop yields and enhance their social-economic development. These ways include using animal manure, agroforestry, and intercropping and thus this explains the effect of agro-ecological practices on the social-economic development of farmers under study. In Kenya, most of the current studies are inclined to the relationship between agricultural technology and firm yields and not agro-ecological practices for the social-economic development of farmers, hence this study will fill this gap both theoretically and practically.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The summary of findings, conclusion, policy recommendations, and limitations and areas for further research are discussed in this chaper.

5.2 Summary

Firstly, the study sought to determine the types of agro-ecological practices adopted by farmers in Makueni County, Kenya. The frequency of the collected data regarding this objective was determined to find out the types of the agro-ecological practices adopted by farmers. The findings indicated that at least one agro-ecological practice was adopted by farmers in Makueni County, Kenya, with crop rotation emerging as the most preferred practice. This could be attributed to its role in improving fertility of the soil and retaining the moisture, particularly in semi-arid and arid areas. Organic fertilization via compost or manure became the second most preferred practice, indicating enhanced awareness on sustainable farming and climate change mitigation among farmers. Findings further indicated moderate uptake of soil conservation techniques as zero or minimum tillage was practiced by farmers. Also, agroforestry and planting cover crops featured prominently while practices such as legume intercropping, crop residue incorporation, seed saving, pest repellant plants and natural pesticides indicated limited adoption. Despite the importance of water conservation practices, there adoption was low and it is attributed to the perceived costs and dependence on government support to uptake them. Nevertheless, some farmers had taken self-initiatives to construct rainwater harvesting dams. The findings for this objective show a preference for practices that provide immediate agronomic benefits and align with availability of

resources. Also, findings reveal gaps in adopting agro-ecological practices because of financial and infrastructural obstacles.

Secondly, the study used a binary logistic regression model to examine the factors influencing the adoption of agro-ecological practices in Makueni County, Kenya. The findings revealed that enablers (access to information, accelerator and motivation) and barrier factors had a significant effect on adoption outcomes. Motivation emerged as the strongest predictor, followed by accelerator factors and access to information, all positively influencing adoption. Whereas, barriers had strong negative effect on adoption, indicating the likelihood of reducing adoption of agro-ecological practices. The model indicated strong explanatory power and good fit, confirming the strength of the predictors. These findings indicate the need to improve farmer motivation, strengthen support systems, enhance access to agro-ecological knowledge and reduce structural and individual barriers to encourage adoption of sustainable farming practices in the area.

Finally, the study found out that agro-ecological practices had a statistical significant effect on socio-economic development of farmers in Makueni County. Regression analysis reported that agro-ecological practices explain 15.5% of the variance in socio-economic development of farmers. Agro-ecological practices like intercropping, crop rotation, agroforestry, organic fertilization, soil and water conservation emerged as key factors that improved livelihoods. These present study findings corroborate with existing literature confirming the positive impact of sustainable farming on farmer welfare. However, the present study findings contrast with perspectives questioning

organic fertilizers' environmental viability. The present study gives both theoretical and practical information on improving rural development via sustainable agriculture.

5.3 Conclusion

The study in objective one concluded that majority of farmers in Makueni County have embraced at least one agro-ecological practice with crop rotation becoming the most adopted because of its soil-enhancing benefits and adaptability to semi-arid and arid conditions. Also, organic fertilization and zero/minimum tillage indicate moderate adoption, which is driven by climate resilience and sustainability efforts. Nevertheless, agro-ecological practices such as seed saving, water conservation and natural pest control are underutilized because of dependence on external support and financial constraints. These adoption patterns call for targeted interventions, resource support and capacity building to improve adoption of diverse agro-ecological practices and promote sustainability farming practices in the area.

The study in objective two concluded that access to information, motivation, accelerator factors, and barriers influence the adoption of agro-ecological practices in Makueni County. Motivation as an enabler being the strongest positive predictor and barriers having a substantial negative impact. The logistic regression model indicated strong explanatory power and a good fit. This confirmed the reliability of the predictors. The findings call for the need of utilizing targeted strategies that improve farmer motivation, leverage supportive networks and policies, enhance accessibility of agro-ecological knowledge and systematically address barriers to adoption. This will foster a more resilient and sustainable agricultural system in the area.

Finally, the study concluded that agro-ecological practices significantly contribute to the socio-economic development of farmers in Makueni County. Regression analysis confirmed a positive relationship and explained the variance in socio-economic development of farmers. Agro-ecological practices like crop rotation, agroforestry, intercropping, organic fertilization, and soil and water conservation were reported to improve livelihoods through enhanced productivity and sustainability. These findings enable transformation from conventional agricultural technologies to agro-ecological practices that could promote sustainable rural development.

5.4 Policy Recommendations

To improve the adoption of agro-ecological practices in Makueni County, there is need for policy interventions to prioritize educating and capacity-building farmers via extension services that show the benefits and practices of sustainable agriculture. Also, there is need to introduce financial incentives or subsidies to support resource-intensive practices like organic manure production and water conservation infrastructure. Policies ought to encourage accessibility of quality seeds and drought-resistant crop varieties. This could be achieved via strengthening local seed systems and minimizing input costs. Furthermore, there is need to integrate agro-ecology into county development plans and encourage community-based initiatives such as farmer cooperatives to foster shared learning and resource pooling.

To foster adoption of agro-ecological practices in Makueni County, government and development partners ought to invest in farmer motivation programs that shows long-term productivity and environmental benefits such as training on sustainable farming and recognition schemes. Expansion of community networks, supportive local

regulations and farmer cooperatives to create an enabling environment for farmers. Also, there is need for targeted interventions aimed at reducing key barriers like financial constraints, inaccessibility to land and inputs. There would be need to simplify agro-ecological technologies to minimize complexity and perceived risk.

To use agro-ecological practices to improve socio-economic development of farmers in Makueni County, agro-ecology ought to be integrated into county agricultural strategies and extension programs. Government agencies and development partners need to provide targeted training and subsidies for agro-ecological practices like organic fertilization, agroforestry, and water conservation. Also, policies ought to promote participatory research and innovation to customize agro-ecological solutions to local conditions. This will ensure inclusive rural development and long-term sustainability.

5.5 Limitations and Areas for Further Research.

Although the study gives essential information on agro-ecological practices as determinants of socio- economic development of farmers, it has limitations as highlighted below:

Firstly, the study relies on self-reported data that may be biased or inaccurate in responses of farmers in relation to adoption of agro-ecological practices. Also, the analysis does not consider variations in farm size, socio-economic factors or access to resources that may affect the adoption rates. The study is limited to Makueni County, limiting the generalizability of findings to other areas with different agro-climatic conditions. Further research need to investigate the role of policy, extension services and market access in increasing transformation of agro-ecological practices.

Longitudinal research could give deeper information regarding the long-term benefits accrued from agro-ecological practices.

Secondly, although the study quantified the influence of access to information, motivation, accelerator, and barrier factors on the adoption of agro-ecological practices effectively, it relied on self-reported data and cross-sectional design, which may bring biasness and fail to capture long-term behavioral changes. Hence, there is need for longitudinal study to investigate long-term impacts of information, motivation, accelerator, and barrier factors on agro-ecological practices' adoption, integrate spatial and economic dimensions and evaluate specific policy effectiveness. Investigation of young people participation, role of gender and digital tools in agro-ecological practices adoption would provide detailed information regarding inclusivity and scalable solutions.

Finally, the low explanatory power of the regression model limits the findings of the study. It indicates that while agro-ecological practices influence socio-economic development of farmers, other unexamined factors may also influence socio-economic development of farmers substantially. Also, the use of factor scores may oversimplify complex relationships between individual agro-ecological practices and socio-economic development of farmers. The narrow geographical scope, the sole focus on Makueni County may limit the generalizability of the findings to other areas with diverse agro-ecological and socio-economic development contexts. Further study need to be conducted with inclusion of additional variables like education levels, institutional support, and adopt mixed-method design to capture full information regarding agro-

ecological practices' impacts on socio-economic development of farmers across diverse farming communities.

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APPENDICES

Appendix I: Research Questionnaire

SECTION A

Respondents' Demographic Information

In question 1 to 4 below, please tick your response appropriately.

1. Gender

□ Male □ Female

2. Educational level

□ Secondary □ Certificate □Diploma □ Bachelor's degree

□ Master's degree □Other..... (Please indicate)

3. How long have you been working in this farm?

□ Less than 1 year □1 - 5 years □ 5 – 10 years □ More than 10 years

4. In your farm, do you have family members working with you?

Father and/or Mother……
Brother/s or Sister/s……..
Son/s or daughter/s…….
Other family member……..

5. Please, indicate how informed you are regarding the following agro-ecological practices:

	Not informed at all				**Very informed**
Agro-ecological Practises	**1**	**2**	**3**	**4**	**5**
Crop choice and rotations practices					
Intercropping practices					
Agroforestry practices					
Organic fertilization practices					
Soil and water conservation practices					

About the farm and agro-ecological practices in use

In question 6 to 9 below, please tick your response appropriately.

6. What is the type of farming?

   □ Commercial farming □ shifting cultivation □ Subsistence farming □Intensive farming

7. How many acres is the farm?

<2 acres…….
3 to 5 acres……
6 to 10 acres……
11 to 15 acres……..
>15 acres…….

8. How long has the farm been operated?

□ Less than 1 year □ 1 – 5 years □ 5 -–10 years □ More than 10 years

9. How would you describe the ownership of the farm?

□ Concession □ Purchased (owned by you) □ Rental

□ Family owned □ Other…… (Please indicate)

SECTION B

Agro-ecological Practices

Answer the following by ticking the appropriate box:

10. On a scale of 1 to 5, score the prevalence of the following agro-ecological practices in your farm. (1 -less than 20% prevalence; 2-between 21% - 40% prevalence; 3 -between 41% - 60% prevalence; 4 - between 61% - 80% prevalence 5 – between 81% - 100% prevalence)

Crop choice and rotations practices	1	2	3	4	5
Intercropping practices	1	2	3	4	5
Agroforestry practices	1	2	3	4	5
Organic fertilization practices	1	2	3	4	5
Soil and water conservation practices	1	2	3	4	5

From the previous question, what additional/other agroecological practices are you willing to adopt in the future?

Barriers and accelerators

11. Using the scale from 1 ‘totally disagree’ to 5 ‘strongly agree’, which are the barriers that you consider for the adoption (or not) of agro-ecological practices

	1	2	3	4	5
Lack of awareness, Knowledge and training (of Agro-ecological practices and the potential benefits)					
Short term economic tradeoffs (some AGP may have a longer payback period and farmers need immediate returns)					
Low yields of agro-ecological practices					
Access to resources (limited access to land, water, and other essential resources)					
Institutional and policy constraints as well as support from agricultural institutions (lack of supportive policies can discourage farmers from adopting AGP)					
Lack of technical support and extension services					
Market demand (no market for agroecological products or low prices from consumers)					

12. From the previous question, what other barrier (s) that have not been mentioned above?

Using the scale from 1 ‘totally disagree’ to 5 ‘strongly agree’, how important are the following factors when adopting agroecological practices.

	1	2	3	4	5
To learn about other farmers' experiences - (including through demonstration farms - recommendations and experiences shared by fellow farmers who have successfully adopted agroecological practices)					
Information on the health impact on the farmers and their families lives					

Climate change resilience (knowing how AGP can build my resilience to climate change and extreme weather events)					
High (market) demand of sustainable products					
Respect for nature and the value on sustainable agriculture (Environmental sustainability)					
Government Policies and Incentives - Supportive policies, subsidies, or financial incentives from the government that make agroecological practices more attractive					
Knowledge and Training - Access to information, training, and technical support					
Economic Viability - of agroecological practices; potential cost savings, increased yields, and profitability compared to conventional methods					

From the previous question, what other factor (s) that have not been mentioned above, would you like to add?

Different sources of information on agroecological practices

13. How reliable do you think these sources are? (1 = Not trustworthy at all; 5 = Extremely trustworthy)

Factors	1	2	3	4	5
Media - Radio and Television programmes on sustainable farming methods					
The Government					
Social Media - agricultural groups on social media platforms					
Mobile applications - designed to provide farmers with information on best practices, weather forecasts, and market trends relevant to agroecology					
Neighbor farmers, friends and family					
Government - Agricultural Fairs, Exhibitions, workshops and training programmes					

Local organizations and NGOs - Workshops and Training Programs organized by					

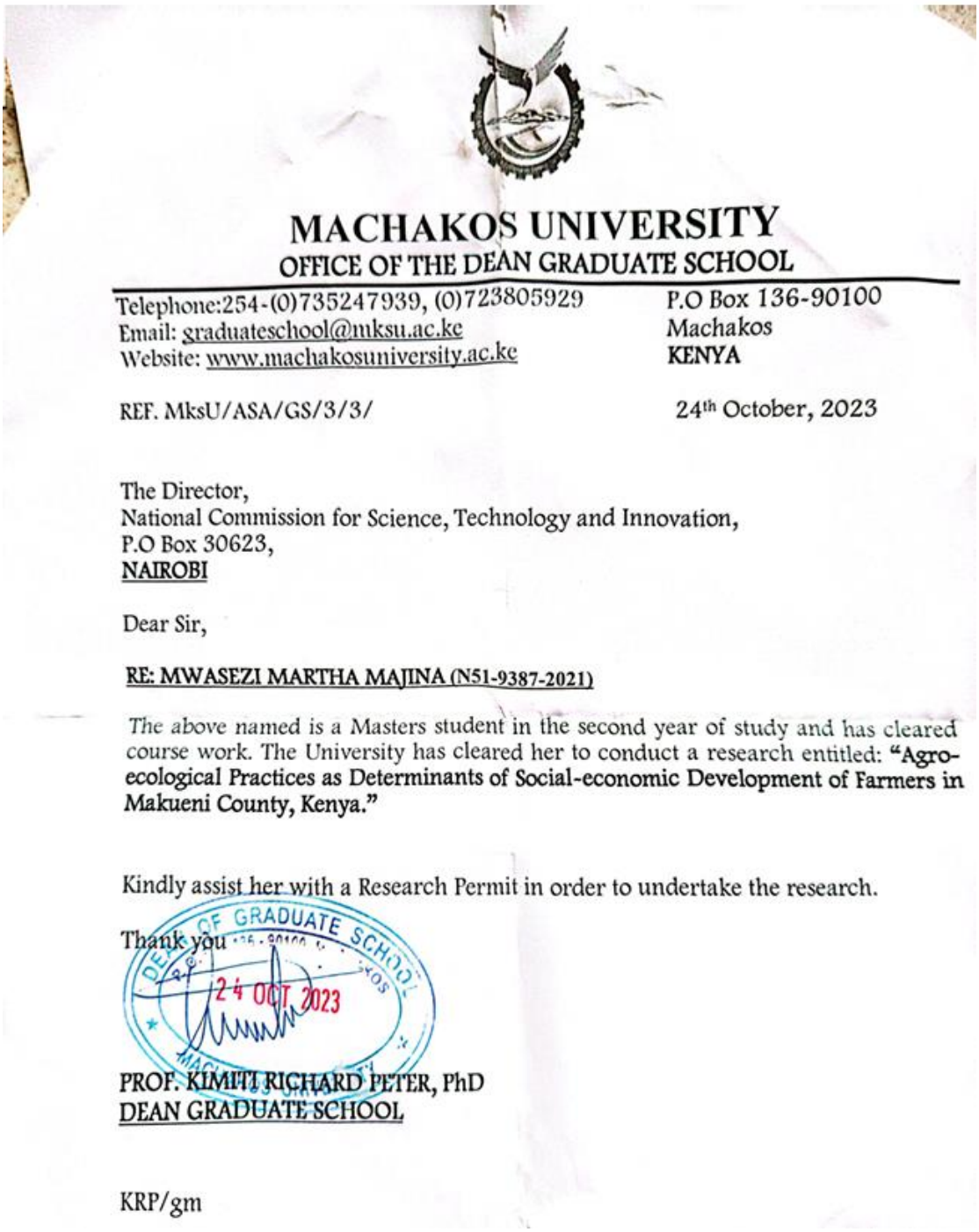
SECTION C

Social and Economic Development

14. On a scale of 1 to 5 score the following as social and economic indicators in your farm. (1 = less than 20% indication, 2 = between 21% – 40% indication, 3 = between 41 – 60% indication, 4 = between 61 – 80% indication and 5 = between 81% – 100% indication).

For the last five years you have enhanced inclusivity in crop production	1	2	3	4	5
For the last five years you have experienced improved health	1	2	3	4	5
For the last five years your quality of life has improved (Social relationships, emotional wellbeing, Quality of environment, belonging)	1	2	3	4	5
For the last five years market access to your farm produce has enhanced	1	2	3	4	5
For the last five years your income from the farm has increased	1	2	3	4	5
For the last five years your farm has increased employment opportunities	1	2	3	4	5
For the last five years you have experienced agri-infrastructural development	1	2	3	4	5
For the last five years you have experienced increased crop yields	1	2	3	4	5

Appendix II: Letter from Institution



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REF. MksU/ASA/GS/3/3/

24th October, 2023

The Director,
National Commission for Science, Technology and Innovation,
P.O Box 30623,
NAIROBI

Dear Sir,

RE: MWASEZI MARTHA MAJINA (N51-9387-2021)

The above named is a Masters student in the second year of study and has cleared course work. The University has cleared her to conduct a research entitled: **"Agro-ecological Practices as Determinants of Social-economic Development of Farmers in Makueni County, Kenya."**

Kindly assist her with a Research Permit in order to undertake the research.

Thank you

DEAN OF GRADUATE SCHOOL
24 OCT 2023

PROF. KIMITI RICHARD PETER, PhD
DEAN GRADUATE SCHOOL

KRP/gm

Appendix III: NACOSTI Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **983416**

Date of Issue: **12/December/2023**

RESEARCH LICENSE

This is to Certify that Miss.. Martha Majina Mwasezi of Machakos University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Makueni on the topic: AGROECOLOGICAL PRACTICES AS DETERMINANTS OF SOCIAL-ECONOMIC DEVELOPMENT OF FARMERS IN MAKUENI COUNTY, KENYA for the period ending : 12/December/2024.

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