FACTORS DRIVING ADOPTION OF AGRO-ECOLOGICAL PRACTICES AMONG SMALLHOLDER FARMERS IN KANGUNDO SUB-COUNTY, KENYA

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ABSTRACT

Agroecology is a key component of Climate-Smart Agriculture technologies advocated for among smallholder farmers by various agricultural programs. However, many farmers abandon these practices after the end of agricultural projects. This study aimed to investigate the drivers of agroecology agriculture adoption among smallholder farmers in Kangundo Sub-County. Utilizing a combination of purposive and snowball sampling, 41 agroecology smallholder farmers were selected. Primary data was collected using interview guides developed through the Kobo Collect App. Descriptive statistics and quantitative analysis, including simple linear regression, was employed to analyse the collected data. The findings of this study underscore the multifaceted nature of factors influencing the adoption of agroecological practices. Statistically significant evidence (p > .05) identified several key drivers positively affecting the adoption of agroecological practices. These drivers include the type of group (agricultural or non-agricultural), farmer category (lead or follower farmer), interaction with agricultural officers, level of involvement in a group (active or passive members), and group membership. These findings highlight the importance of social networks, group dynamics, and access to support services in facilitating the adoption of agroecological practices among smallholder farmers. In addition, the study also revealed land size, abandonment of other farming practices, household formal employment, and labour requirements as some of the factors hindering the adoption of agroecological practices in the area. Addressing these barriers is crucial for promoting the widespread adoption of sustainable agricultural practices and enhancing agricultural productivity and resilience.

Keywords: Agro-ecological Practices, Smallholder farmers, Drivers of Adoption, Drivers of Dis- Adoption

I. INTRODUCTION

Agroecology is increasingly recognized as a cornerstone of Climate-Smart Agriculture (CSA) strategies aimed at enhancing agricultural productivity, improving food security, and preserving natural resources and ecosystems. Rooted in ecological principles, agroecology seeks to manage agro-ecosystems in a sustainable and holistic manner to achieve long-term resilience and productivity (Ewert et al. 2023). Unlike conventional agriculture, which often relies on intensive tillage practices and chemical inputs, agroecology emphasizes the integration of ecological processes and biodiversity into farming systems (Wezel et al., 2020). Furthermore, agro ecological practices minimize water use; lower pollution levels on the farm, and ensures economic profitability for the farmers (Akanmu et al., 2023). Thus, application of agroecology techniques among the smallholder farmers is strategic to ensuring food security.

Agroecology encompasses a range of practices and techniques tailored to specific agro-ecological, socio-economic, and cultural contexts (Wezel et al. 2020). At its core, agroecology emphasizes three main principles: enhancing biodiversity, promoting synergies and interactions between different components of agro-ecosystems, and reducing reliance on external inputs (Barrios et al., 2020). By fostering ecological resilience and enhancing natural ecosystem services, agroecological farming systems can contribute to climate change adaptation and mitigation while promoting sustainable livelihoods for farming communities (Kliem, 2024).

Despite its potential benefits, the adoption of agroecology remains limited in many parts of Africa, including Kenya, where agro-ecological conditions are conducive to its implementation (Place et al., 2022). Studies have shown that farmers may be hesitant to embrace agroecological practices without adequate technical and financial support (Polonio Punzano et al., 2018). However, recent evidence suggests a growing interest in agroecology among farmers,

driven by recognition of its potential to improve soil fertility, increase crop yields, and enhance resilience to climate change (Carolina et al., 2024).

In Kenya, agroecology has gained traction through initiatives such as the Kenya Agroforestry Project and various farmer field schools promoting sustainable farming practices (Wanjira & Muriuki, 2020). Maize-legume rotations, intercropping, and agroforestry are among the agroecological practices increasingly adopted by farmers in Kenya's diverse agro-ecological zones (Akanmu et al., 2023). Evidence of agroecology's impact can be seen in regions where agroecology projects and trainings have been implemented, such as Machakos, Makueni, Murang'a, Kirinyaga, Laikipia, Nyandarua and Taita Taveta counties (Nyawira et al.2023).

In light of the growing recognition of agroecology's potential to address the challenges of climate change, food insecurity, and environmental degradation, there is a need for further research and investment to support its widespread adoption and implementation. This study seeks to contribute to this effort by examining the drivers of adoption of agroecology among smallholder farmers in Kangundo Sub-County, Kenya.

II. LITERATURE REVIEW

In examining the literature, it becomes evident that the agroecological zones have a significant impact on the uptake of agroecological practices, as different soil, hydrological, topographic, and climatic factors shape the acceptability and effectiveness of different methods (Altieri et al., 2015; Masere, & Worth, 2022; Belay et al., 2023). Techniques such as agroforestry and cover cropping may be more important in dry regions where soil preservation and moisture conservation are critical, while terracing and contour farming become essential in places with rough terrain to reduce the risk of erosion (Gairola & Nithinkumar, 2023; Muriithi, et al., 2021; Ricart et al., 2023). Moreover, the viability and adaption of techniques like irrigation and intercropping are determined by the availability of water resources as well as the dominant crop and animal systems (Maitra et al., 2021).

Household heads wield considerable influence over the adoption of agroecological practices due to their decision-making authority within the household. Research, such as that conducted by Gebre et al. (2019), indicates that the gender of the household head can significantly impact the acceptance of new agricultural technologies. In many societies, male-headed families tend to be more open to adopting new technology due to entrenched social and cultural norms that prioritize men's decision-making authority in agricultural matters. Conversely, female-headed households may face additional barriers to adopting new agricultural technologies (Theis et al. 2018). These barriers can include limited access to land, financial resources, extension services, and decision-making power within the household. As a result, female household heads may be more cautious or hesitant about adopting agroecological practices, even if they recognize their potential benefits.

The size of the household significantly influences the availability of labor for farm operations, thus impacting the adoption of agroecological practices. Tufa et al. (2023) emphasize on the role of household size in determining labor availability and subsequently, the adoption of agroecological practices. Moreover, empirical evidence suggests a correlation between household size and the likelihood of adopting agroecological practices, with larger households exhibiting a greater propensity for adoption (Zulu, 2017). This underscores the importance of considering household dynamics, including gender roles and size, when designing strategies to promote the uptake of sustainable agricultural practices.

Plot size, individual traits, and land tenure are important factors that influence whether or not agroecological practices are adopted. According to Makate (2019), small land sizes may encourage the adoption of innovations requiring a lot of work, but they may also impede the deployment of some agroecological practices because of space limitations.

The viability and uptake of agroecological practices are further influenced by a number of land and plot variables, including fertility, slope, soil type, and management techniques. Research conducted by Ahmed et al. (2024) emphasizes how critical it is to take these variables into account when determining if agroecological practices are appropriate for a given agricultural setting.

Furthermore, the adoption of agroecological practices is made much more problematic by the problem of land ownership. Leasing is a possibility for farmers who have insufficient land for farming, but it frequently offers little in the way of long-term investment incentives. Particularly with agroecological practices, farmers may need some time to fully reap its benefits before signing short-term leases. Long-term investment considerations are further complicated by the possibility of landowners reclaiming leased land if fertility improves (Adenuga et al., 2021). Given this, it becomes clear that one of the main reasons that influence smallholder farmers to adopt agroecological practices is the security of their land tenure. Farmers that have secure land tenure are better equipped to invest in sustainable agriculture techniques over the long term because they feel stable and confident. Therefore, in order to guarantee long-term uptake and acceptance among smallholder farmers, policies and initiatives meant to encourage the use of

sustainable practices should address land tenure problems (Bwalya, Mutandwa & Chiluba, 2023).

In order to provide farmers with agricultural information, extension is quite important. According to Xu et al., (2022), farmers who interact with extension agents on a regular basis are more likely to adopt new technology and carry out agroecological practices more skillfully. According to various studies, field days and other activities provide farmers with opportunities to practically learn new technology, which speeds up the adoption process (Sjakir et al., 2015; Emerick & Dar, 2020). In addition to extension services, it has been discovered that the adoption of agroecological practices is positively impacted by exposure to mass media and a range of information and technologies through smartphone, radio, and television ownership (Gao et al., 2020).

The adoption of agroecological practices has been linked to household income and availability of credit and lending facilities. High family income has been associated with the capacity to adopt technology, but the adoption of agroecological practices has been found to be negatively impacted by limited access to loans and other sources of income (Masca, Kyule & Bor, 2022). Credit availability affects both the ability to embrace new technology and household incomes. Because of this, excessive interest rates on credit facilities may subsequently contribute to the disuse of agroecological practices.

The ability of household members to make decisions about the farm is a key factor in the adoption of new technologies. While members of the household are welcome to attend meetings where choices are made, their ability to contribute to and impact the implementation of those decisions may be restricted due to a variety of factors, including age, gender, and whether or not they are the head of the family (Masere, 2022). Furthermore, research indicates that younger farmers are more open to adopting new technologies than their more senior counterparts (Olum et al., 2019). This is a result of farmers' reluctance to adopt unfamiliar technologies as they get older.

Farming systems such as mixed farming involving animal rearing and cultivation of crops can influence adoption of agroecological practices among smallholder farmers. Studies indicate divergent perspectives on how livestock ownership impacts agroecological practices adoption. Taruvinga et al. (2022) suggest that households engaged in livestock rearing are less inclined to adopt agroecological practices compared to those primarily focused on crop cultivation. This reluctance is attributed to the competition between the need for soil cover essential for agroecological practices and the demand for fodder to sustain livestock, creating adoption barrier for agroecological practices. However, contrasting viewpoints exist, with some studies highlighting the positive role of livestock in promoting agroecological practices adoption. Livestock ownership can serve as a source of capital, labor, and income for smallholder farmers, as well as manure thereby facilitating their ability to invest in and adopt agroecological practices (Mutyasira et al., 2018). By providing additional resources and diversifying income streams, livestock ownership may enhance farmers' capacity to implement agroecological practices and other sustainable agricultural practices. Therefore, understanding the specific dynamics of each farming system is essential for designing targeted interventions to promote agroecological practices adoption among smallholder farmers engaged in mixed farming practices (Eshetae et al., 2024).

For smallholder farmers, joining farmer groups provides several benefits, such as learning new technologies and agricultural methods. Increased member contact promotes knowledge sharing on best agricultural practices, which is one of the main advantages of joining a farmer organization (Adamaagashi et al., 2023). Farmer groupings enable discussions among farmers and sometimes with experts thus enabling farmers to improve their comprehension and uptake of agroecological practices through exchanging ideas, experiences, and innovations which prevail during talks, demonstrations, and group learning exercises. Furthermore, farmer groups frequently act as hubs for group action, giving members access to financing, a way to pool resources, and a way to influence other stakeholders and government bodies. Farmers can overcome their own obstacles and realize economies of scale by working together on cooperative initiatives, which can facilitate adoption and application of agroecological practices.

The degree of education can influence a farmer's decision to embrace or reject agroecological practices. More farmers have access to formal education, which improves their knowledge of and capacity for sustainable agriculture methods (Ghali et al., 2022). Increased knowledge of agroecology strategies and, consequently, a higher uptake of agroecological practices are linked to higher education levels. For instance, research shows that farmers' knowledge of soil degradation and its impact on the adoption of agroecological practices are related (Odendo et al., 2010); farmers who are less informed of the reduction in soil fertility are less likely to use agroecological practices.

III. METHODOLOGY

The study was conducted in Kangundo, a sub-county in Machakos County, with a population of 97,917 people over 172.7 square kilometres. The area is predominantly rural with smallholder farms engaged in maize, beans, vegetables, and dairy farming, facing challenges due to semi-arid conditions and irregular rainfall.

A descriptive research design was used, employing purposive and snowball sampling to select 41 smallholder

farmers, including 24 adopters and 17 dis-adopters of agroecological practices. Data were collected through online questionnaires using Kobo Collect and smartphones, featuring both open-ended and close-ended questions. Data analysis involved coding in MS Excel and using IBM SPSS software for descriptive statistics, correlation, and regression analysis to explore factors influencing the adoption or dis-adoption of agroecological practices. The study utilized Pearson's Correlation coefficient and regression models to determine significant variables and the extent of their influence, supported by one-way ANOVA for hypothesis testing.

IV. FINDINGS & DISCUSSION

4.1. Demographic Data

4.1.1 Farmer category

The finding show that the majority (71%) of the smallholder farmers interviewed were follower farmers while a minority (29%) were lead and model farmers. Lead farmers are the farmers who have been trained on agro ecological practices and they host demo plots. Follower farmers are all the other group members who learn from the demo plots as shown in Figure 1.

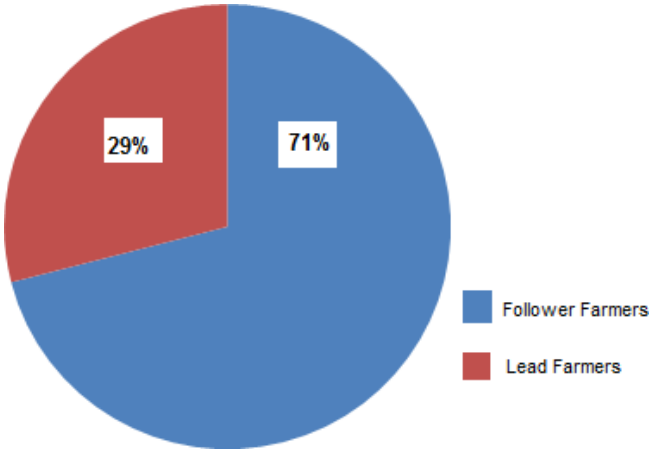

Figure 1: *Farmer Category*

4.1.2 Agroecology Practitioners by Gender

The study found that the majority of agroecology practitioners were females, making up 78% of the total, while males constituted the remaining 22%. This gender distribution was linked to prevailing household gender roles, where women were often assigned primary responsibility for agricultural activities compared to men. Additionally, the study observed that a larger proportion of participants in agricultural practices training sessions were women. The findings are presented in Figure 2 below.

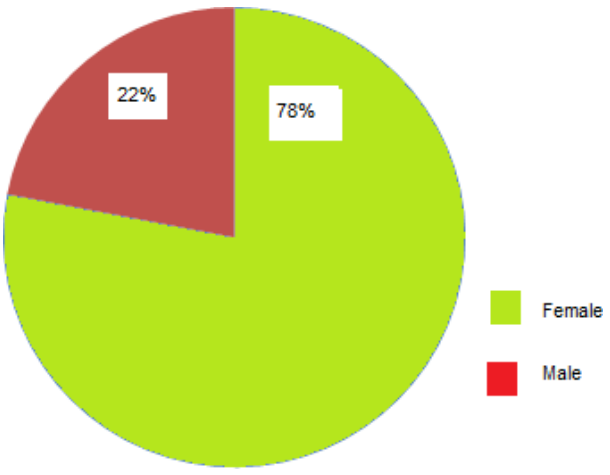

Figure 2: *Agroecology Practitioners by Gender*

4.1.2 Agroecology Practitioners by Age

Among the farmers practicing agroecology, the study found that a substantial portion, 46%, was aged between 46 and 55 years. Youths aged 35 years and below constituted a smaller proportion, accounting for only 19% of agroecology farmers. Additionally, a minority, 15%, of agroecology farmers were aged above 55 years as shown in Figure 3.

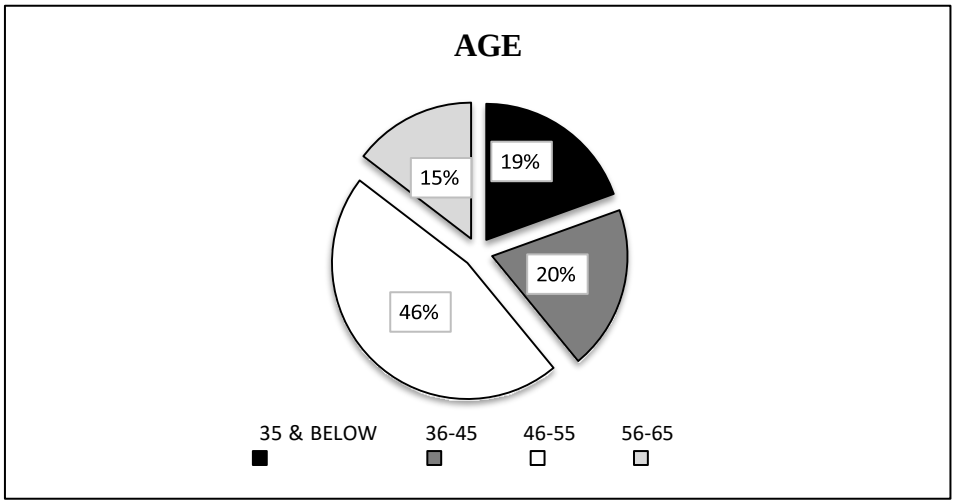

Figure 3: *Agroecology Farmers by Age*

4.1.3 Level of Education

The study revealed that a majority, comprising 54%, of the farmers had attained a primary level of education. A larger minority, accounting for 37% of the farmers, had completed secondary education. Additionally, a smaller percentage, 7%, of the farmers had achieved tertiary education. Only 2% of the farmers reported having no formal education. The results are presented in Figure 4.

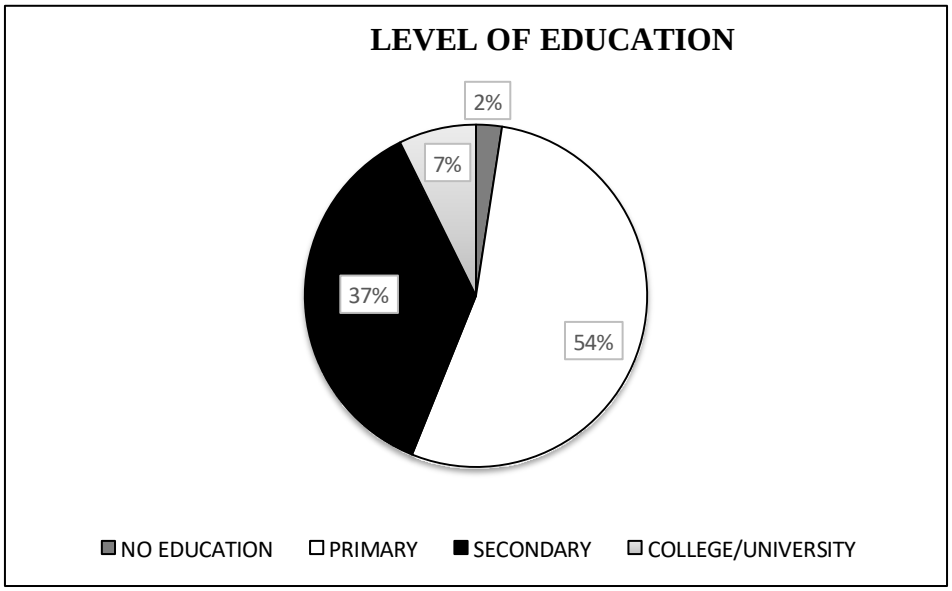

Figure 4: *Farmers Education Levels*

4.1.4 Land Ownership

The study established that a majority of the farmers (90%) owned the land, 7% had been granted the rights to farm the land and 3 % had leased the land. This may be attributed to the risks associated with investing in leased lands and the confidence the farmers have in investing in the lands they own. The results are presented in Figure 5.

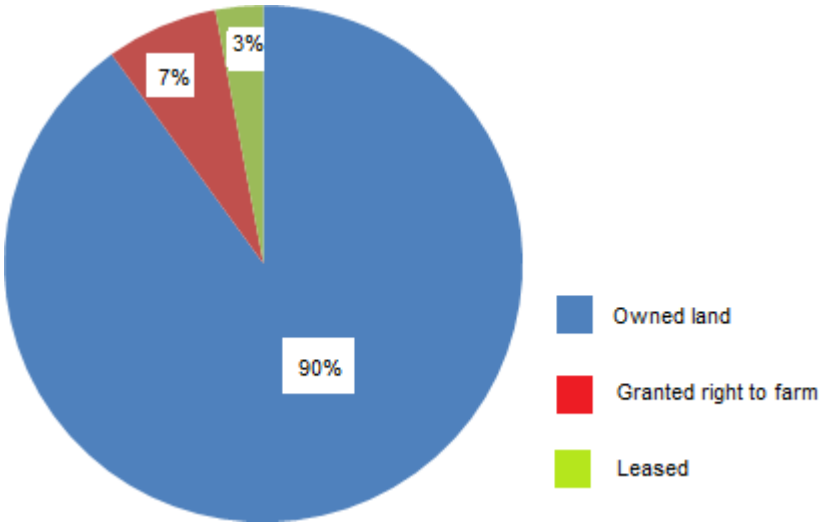

Figure 5: *Farmers Land Ownership*

4.1.5 Land Size

The majority (95%) of the agroecology farmers had two acres and below while 5% had land above two acres. The results are presented in Figure 6.

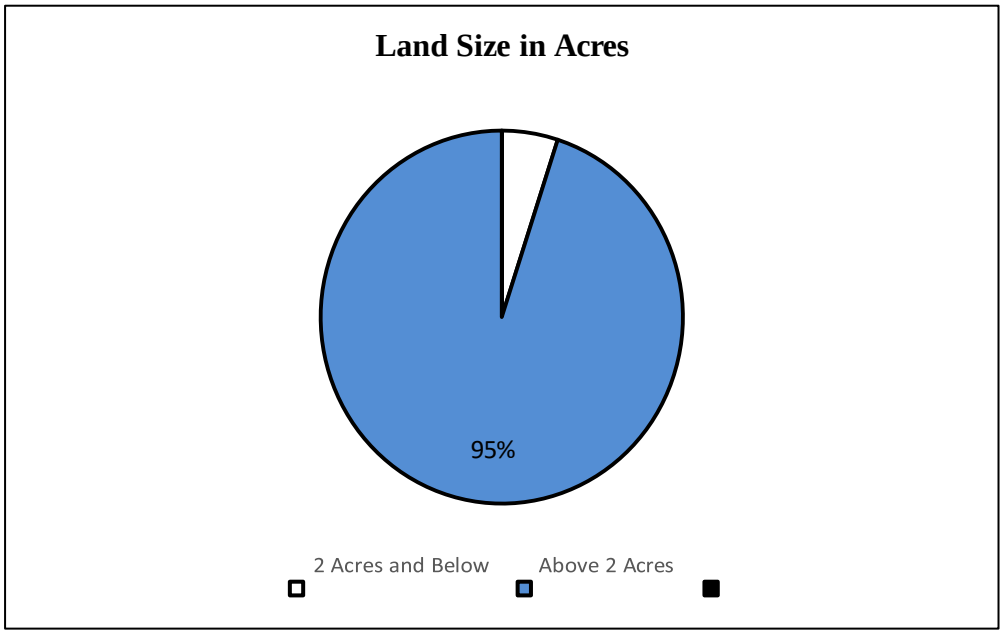

Figure 6: *Farmers Land Size*

4.1.6 Income level (Monthly)

The study findings indicate that a significant proportion, 63%, of smallholder farmers earns less than KES 10,000 per month. In contrast, only a small fraction, comprising 2% of the farmers, reported earning over KES 20,000 per month. This disparity in income levels among smallholder farmers may contribute to constraints in agricultural investment and adoption of new agricultural technologies. Limited financial resources may pose challenges for farmers in accessing inputs, such as improved seeds, fertilizers, and equipment, as well as in investing in training and adopting innovative farming practices. Understanding the economic context of smallholder farmers is crucial for developing targeted interventions and policies aimed at addressing the challenges they face in enhancing agricultural productivity and livelihoods. The results are presented in Figure 7.

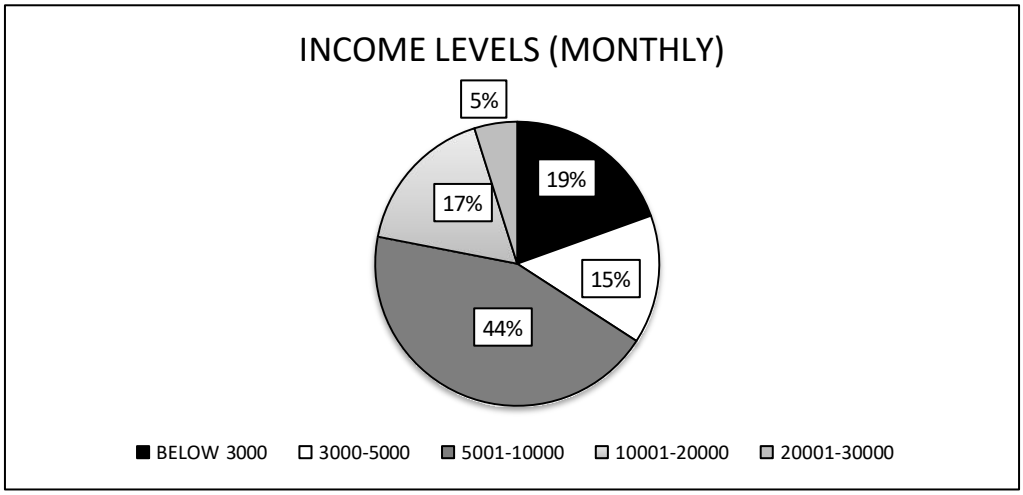

Figure 7: *Farmers Income Levels (Monthly)*

4.1.7 Access to Credit

The study also revealed that a significant majority, accounting for 85% of the farmers, lacked access to credit for agricultural purposes. This lack of access to credit can be attributed to the farmers' low incomes and the limited availability of credit facilities in the study area, which is primarily rural in nature. Insufficient financial resources and a lack of formal banking infrastructure in rural settings often pose significant challenges for smallholder farmers in accessing credit for agricultural investment, purchasing inputs, and adopting new technologies. Addressing these barriers to credit access is essential for promoting sustainable agricultural development and improving the livelihoods of smallholder farmers in rural areas. The results are presented in Figure 8.

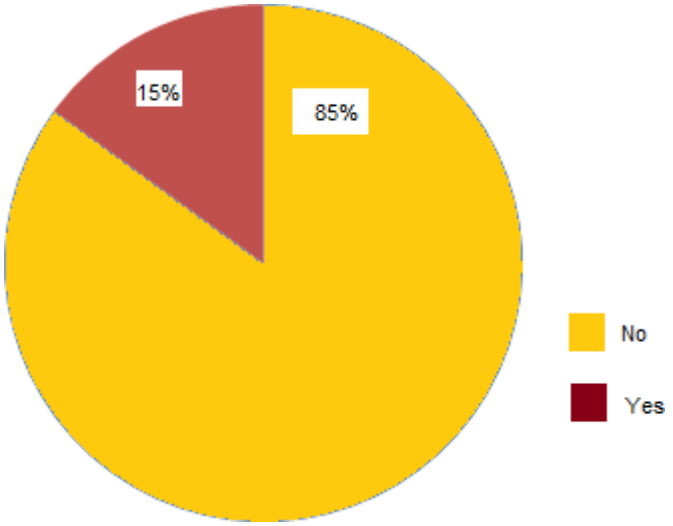

Figure 8: *Farmers Access to Credit*

4.2 Drivers of Adoption of Agroecology Practices

The study investigated the factors driving the adoption of agroecology practices among small-scale farmers. The findings of this analysis are illustrated in Figure 9.

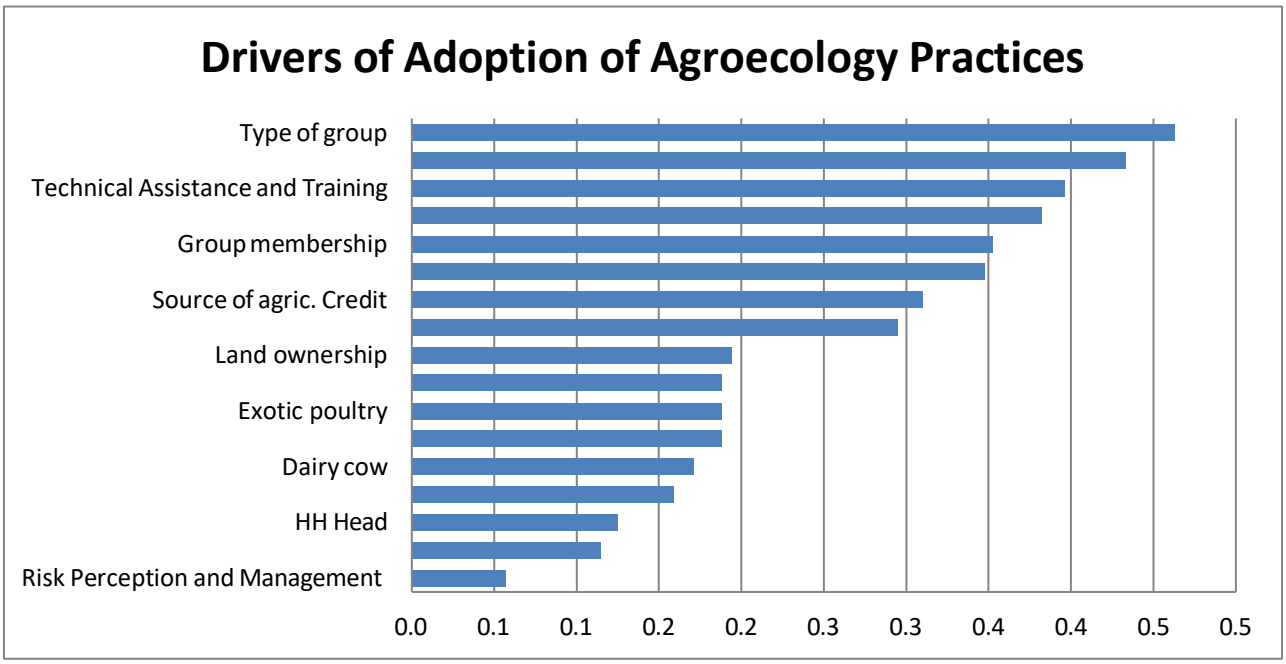

Figure 9: *Drivers of Adoption of Agroecology Practices*

The results in Figure 9 highlight the factors influencing the adoption of agroecology practices among small-scale farmers. The analysis reveals a spectrum of variables, each demonstrating a varying degree of positive relationship with the adoption of agroecology practices. Factors such as risk perception and management, social and cultural factors, market opportunities and incentives, income level, and household head exhibit relatively minor positive relationships, suggesting they have a modest influence on adoption. Income sources diversification, including employment, remittances, and business ownership, hold a slightly stronger positive relationship, indicating that farmers with diversified income streams may be more inclined to adopt agroecology practices. Moderate positive relationships are observed for factors like leadership position, ownership of livestock such as dairy cows and exotic poultry, knowledge and awareness of agroecology, local agroecological conditions, land ownership, and presence of mango trees. These findings suggest that possessing certain assets, knowledge, or environmental conditions may moderately enhance the likelihood of adoption. Factors such as owning crossbreed cows, farm size and type, access to agricultural credit, and the source of agricultural credit display a relatively strong positive relationship with adoption, indicating that these variables significantly influence farmers' decisions to adopt agroecology practices. Notably, the strongest positive relationships are observed for variables related to group membership, involvement in group activities, receiving technical assistance and training, and belonging to specific farmer categories, such as lead farmers. These findings underscore the critical role of social networks, group dynamics, and access to support services in facilitating agroecology adoption among smallholder farmers. The findings demonstrate the complex interplay of social, economic, environmental, and institutional factors shaping farmers' decisions to adopt agroecology practices, underscoring the importance of tailored interventions and supportive policies to promote sustainable agriculture (Ereziet al.2023).

4.3 Drivers of Dis-Adoption

The study investigated the factors that drive dis-adoption of agroecology practices among small-scale farmers. The findings of this analysis are illustrated in Figure 10. The results presented in Figure 10 show factors that exhibit a negative relationship with agroecology agriculture, thereby driving dis-adoption among farmers. Specifically, variables with scores above 0.4, including land size allocated to agroecological practices, the duration of practicing agroecological techniques, cessation of other farming practices, labor-intensive requirements, participation in merry-go-round groups, reliance on local cow breeds as the primary livestock, cultivation of beans as the primary crop, and farmers engaged in formal employment, demonstrated a strong negative relationship (-0.4 to -1) with the adoption of agroecological practices. Consequently, these variables were selected for further analysis in regression to delve deeper into their impact on the dis-adoption of agroecological practices.

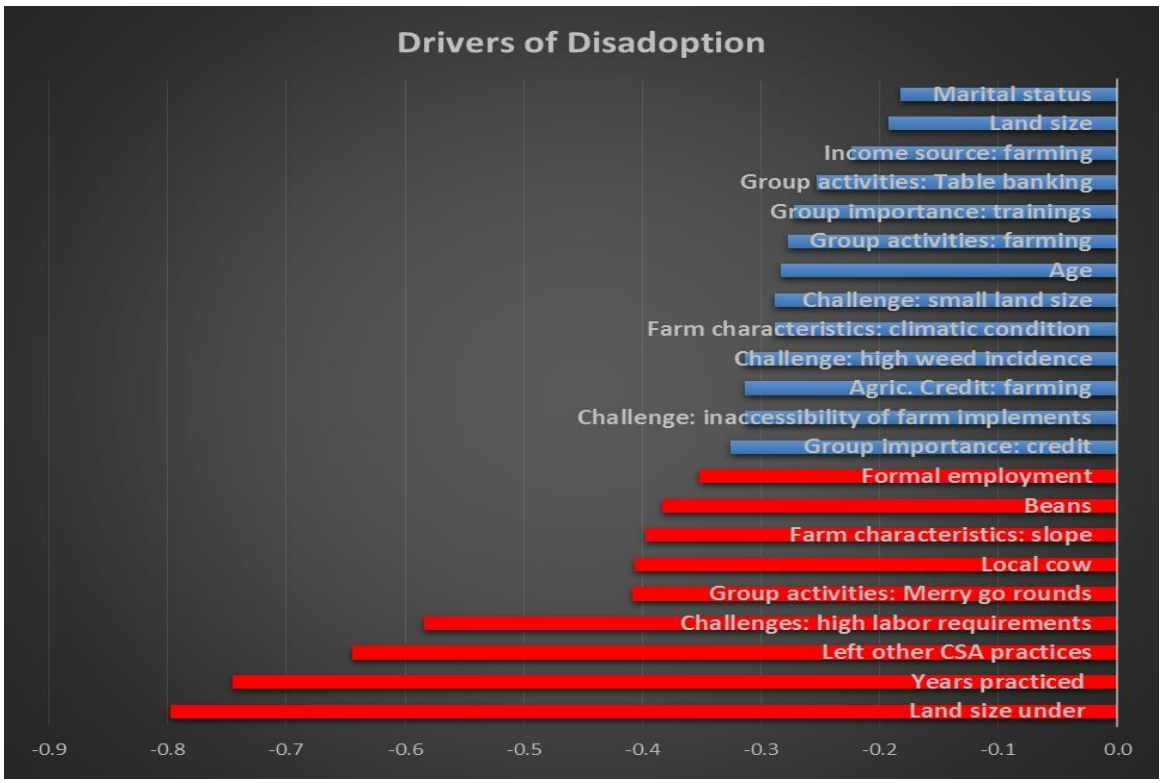

Figure 10: *Drivers of Dis-adoption*

4.3 Regression Analysis Results

To ascertain if the connection between the study's dependent variable and independent variables was linear, regression analysis was used. The following subsections include a tabulation and discussion of the results.

4.3.1 Model Summary Results

The study aimed at determining the regression relationship between the dependent variable and independent variables. The results are presented in Table 1.

Table 1

Model Summary Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.942a	.888	.834	.203

a. Dependent Variable: Adoption of Agro-Ecological Practices (Y)

b. Predictors: (Constant) Farmer Category, Agroforestry, Main Livestock Types Reared, Labor Requirements, Number of Years Practicing Agroecology, Land Size, Abandoned Farming Practices, Employment Status, Interaction with Agricultural Officers, Level of Group Involvement, Group Membership, Group Type, Group Activities/Merry Go Rounds (X_1).

Table 1 displays the Adjusted R-square value of 0.888, which indicates that the model accounts for 88.8% of the variance in adoption of agroecological practices. This indicates that the model is unable to account for 11.2% of the variance in adoption of agroecological practices. Therefore, the findings show that adoption of agroecological practices is influenced by the independent variables (farmer category, agroforestry, main livestock types reared, labor requirements, number of years practicing agroecology, land size, abandoned farming practices, employment status, interaction with agricultural officers, level of group involvement, group membership, group type, group activities/merry go rounds). This suggests that these factors play a crucial role in determining adoption of agroecological practices among farmers in Kangundo Sub-County.

4.5.2 Analysis of Variance Results

The regression model explains a substantial portion of the variance in the adoption of agro ecological practices, as indicated by the high regression sum of squares (8.837) relative to the residual sum of squares (1.114). The typical multiple linear regressions' ANOVA findings are shown in Table 2.

Table 2

ANOVA[a] Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.837	13	.680	16.470	.000[b]
Residual	1.114	27	.041		
Total	9.951	40			

a. Dependent Variable: Adoption of Agro ecological Practices

b. Predictors: (Constant), Farmer Category, Agroforestry, Main Livestock Types Reared, Labor Requirements, Number of Years Practicing Agroecology, Land Size, Abandoned Farming Practices, Employment Status, Interaction with Agricultural Officers, Level of Group Involvement, Group Membership, Group Type, Group Activities/Merry Go Rounds

The ANOVA results in Table 2 further support the notion that the predictors significantly influence adoption of agroecological practices. The significant F-statistic ($F = 16.470$, $p < 0.001$) indicates that the regression model significantly predicts the adoption of agroecological practices among the farmers.

5.5.3 Regression Coefficients Results

The analysis yielded the regression model's coefficient as shown in Table 3.

Table 3

Regression Coefficients[a] Results

Model	Unstandardized Coefficients		Standardized Coefficients		
1	B	Std. Error	Beta	t	Sig.
(Constant)	1.713	0.344		4.985	0
Farmer Category	0.103	0.084	0.095	1.219	0.233
Agroforestry	-0.238	0.097	-0.214	-2.45	0.021
Main livestock types reared/Local cow	-0.087	0.077	-0.087	-1.125	0.271
Labor Requirements	0.107	0.112	0.109	0.957	0.347
No. years practicing Agro ecology Agriculture	-0.196	0.07	-0.26	-2.775	0.01
Land size	-0.401	0.094	-0.477	-4.29	0
Abandoned Farming Practices	-0.17	0.107	-0.172	-1.587	0.124
Employment Status	0.12	0.121	0.086	0.987	0.333
Interaction with Agricultural Officer (s)	0.008	0.03	0.027	0.275	0.786
Level of Group Involvement	0.025	0.08	0.077	0.319	0.752
Group Membership	-0.381	0.518	-0.273	-0.735	0.469
Group Type	0.368	0.168	0.542	2.191	0.037
Group Activities/Merry Go Rounds	0.041	0.09	0.042	0.462	0.647

a. Dependent Variable: Adoption of Agroecological Practices (Y)

The regression coefficients presented in Table 3 reveal factors influencing the adoption of agro-ecological practices among smallholder farmers in Kangundo Sub-County. Significant predictors include agroforestry, years practicing agro-ecology, land size, and group type. Agroforestry ($B = -0.238$, $p = 0.021$) and years of agro-ecology practice ($B = -0.196$, $p = 0.010$) show significant negative relationships, indicating that farmers engaged in agroforestry or with more years in agro-ecology are less likely to adopt new practices. Land size ($B = -0.401$, $p < 0.001$) also negatively influences adoption, with larger land sizes associated with lower adoption rates. Conversely, group type ($B = 0.368$, $p = 0.037$) positively influences adoption, suggesting that certain group memberships encourage adopting agro-ecological practices. Other factors, such as farmer category, livestock types, labor

requirements, employment status, interactions with agricultural officers, group involvement, group membership, and group activities, do not significantly impact adoption. These findings highlight the importance of specific agricultural practices and group dynamics in promoting agro-ecological adoption in the region. These findings corroborate the findings of previous research by Wezel et al. (2020) and Coulibaly et al. (2019), which highlighted similar factors to adopt ecological farming practices.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusion

This study aimed to investigate the drivers of agroecology agriculture adoption among smallholder farmers in Kangundo Sub-County. The findings of this study underscore the multifaceted nature of factors influencing the adoption of agroecological practices. Statistically significant evidence ($p > .05$) identified several key drivers positively affecting the adoption of agroecological practices in Kangundo Sub-County. These drivers include the type of group (agricultural or non-agricultural), farmer category (lead or follower farmer), interaction with agricultural officers, level of involvement in a group (active or passive members), and group membership. These findings highlight the importance of social networks, group dynamics, and access to support services in facilitating the adoption of agroecological practices among smallholder farmers. However, the study also revealed several factors that may hinder the adoption of agroecological practices in the area. These factors include land size, abandonment of other farming practices, household formal employment, and labor requirements, among others. Addressing these barriers is crucial for promoting the widespread adoption of agroecological practices and enhancing agricultural productivity and resilience in Kangundo Sub-County.

5.2 Implications for Policy and Practice

The findings underscore the importance of focusing on specific agricultural practices and group dynamics to promote the adoption of agro-ecological practices. Policies aimed at supporting agroforestry and long-term practitioners may need to consider providing incentives or reducing barriers to encourage further adoption. Additionally, strengthening group-based approaches and fostering supportive group environments could enhance the adoption rates of sustainable practices. Targeted interventions that address the unique challenges faced by larger landowners could also be beneficial. Providing technical assistance, financial incentives, and tailored support to these farmers might help overcome the hurdles associated with large-scale implementation of agro-ecological practices.

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