Strathmore UNIVERSITY

SU+ @ Strathmore University Library

Electronic Theses and Dissertations

2026

Determinants of the adoption of regenerative agriculture practices in Embu and Tharaka Nithi Counties, Kenya.

Ngari, Peter Murimi
Strathmore Business School
Strathmore University

Recommended Citation

Ngari, P. M. (2026). *Determinants of the adoption of regenerative agriculture practices in Embu and Tharaka Nithi Counties, Kenya* [Strathmore University]. https://hdl.handle.net/11071/16867

Follow this and additional works at: https://hdl.handle.net/11071/16867

This work is availed for free and open access by Strathmore University Library.
It has been accepted for digital distribution by an authorized administrator of SU+ @Strathmore University.
For more information, please contact library@strathmore.edu

DETERMINANTS OF THE ADOPTION OF REGENERATIVE AGRICULTURE PRACTICES IN EMBU AND THARAKA NITHI COUNTIES, KENYA

PETER M. NGARI

ADM. NO: 13633

A DISSERTATION SUBMITTED TO STRATHMORE BUSINESS SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN DEVELOPMENT FINANCE OF STRATHMORE UNIVERSITY

JUNE 2026

DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

© No part of this dissertation may be reproduced without the permission of the author and Strathmore University

Name: Peter M. Ngari

Approval

The dissertation of Peter M. Ngari was approved by the following:

Name of Supervisor: Dr. Farida Abdul

School/Institute/Faculty: Strathmore University Business School

Dr. Ceaser Mwangi

Executive Dean

Strathmore University Business School.

Prof. Bernard Shibwabo

Director, Office of Graduate Studies

ACKNOWLEDGEMENTS

I thank my supervisor, Dr. Farida Abdul, for valuable guidance, support, and constructive feedback throughout this study's proposal development. Appreciation also goes to my lecturers, Dr. David Mathuva and Dr. Muli Maingi, for insightful comments and suggestions, which greatly contributed to improving the quality of the dissertation. To my tutors at Strathmore University, thank you for the dedication and for equipping me with the knowledge and skills that laid the foundation for this study. Special thanks go to my classmates for their collaboration, encouragement, and the stimulating discussions that enriched my academic experience. Deep appreciation is also extended to my family and friends for continuous encouragement and understanding throughout this journey. The support received has been truly meaningful.

VT OMNES VNVM SINT

ABSTRACT

Agriculture remains the backbone of Kenya's economy and a major source of livelihood for rural households. However, increasing climate variability, land degradation, declining soil fertility and unsustainable farming practices continue to threaten agricultural productivity and food security. Regenerative agriculture has emerged as a sustainable farming approach capable of restoring soil health, enhancing environmental resilience and improving long-term farm productivity. Despite its potential benefits, adoption among smallholder farmers remains limited. This study examined the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties, Kenya. Specifically, the study tested the hypotheses that socio-economic factors, environmental factors and payment for ecosystem services significantly influence adoption of regenerative agriculture practices. The study was guided by Innovation Resistance Theory and Protection Motivation Theory and employed a cross-sectional survey research design. Primary data was collected in December 2025 from 400 smallholder farmers selected through stratified and simple random sampling techniques. Data was collected using structured questionnaires and analyzed using descriptive statistics, correlation analysis, diagnostic tests, and multiple linear regression analysis based on composite indices constructed from weighted averages. The findings revealed that socio-economic factors significantly and positively influenced the adoption of regenerative agriculture practices. Payment for ecosystem services and market access also positively influenced adoption, indicating the importance of economic incentives and market integration in promoting sustainable farming practices. Conversely, environmental factors exhibited a negative influence on adoption, suggesting that adverse environmental conditions may constrain farmers' capacity to implement regenerative practices. Land tenure was found to have no significant influence on adoption decisions. The study concludes that adoption of regenerative agriculture is primarily driven by farmers' socio-economic capacity, access to incentives, and market opportunities. The study recommends strengthening farmer training programs, improving access to agricultural credit, expanding extension services, enhancing market linkages, and scaling up payment for ecosystem services initiatives to promote wider adoption of regenerative agriculture. A key limitation of the study is its cross-sectional design, which limits the ability to establish causal relationships over time.

Keywords: Regenerative agriculture, socio-economic factors, environmental factors, payment for ecosystem services, market access, land tenure, smallholder farmers, Kenya.

TABLE OF CONTENTS

DECLARATION ii

ACKNOWLEDGEMENTS iii

ABSTRACT iv

TABLE OF CONTENTS v

LIST OF TABLES ix

LIST OF FIGURES xi

LIST OF APPENDICES xii

ABBREVIATIONS AND ACRONYMS xiii

CHAPTER ONE: INTRODUCTION 1

1.1 Background of the Study 1

1.1.1 Adoption of Regenerative Agriculture 2

1.1.2 Determinants of the Adoption of Regenerative Agriculture 4

1.1.3 Regenerative Agriculture in Kenya 7

1.2 Statement of the Problem 8

1.3 Research Objectives 9

1.3.1 General Objective 10

1.3.2 Specific Objectives 10

1.4 Research Questions 10

1.5 Scope of the Study 10

1.6 Significance of the Study 10

1.6.1 Smallholder Farmers 11

1.6.2 Policy Makers and Development Partners 11

1.6.3 Academicians and Researchers 12

1.6.4 Theoretical Contribution 12

1.7 Chapter Summary 12

CHAPTER TWO: LITERATURE REVIEW 14

2.1 Introduction 14

2.2 Theoretical Review 14

2.2.1 Innovation Resistance Theory 14

2.2.2 Protection Motivation Theory 16

2.3 Empirical Review 19
2.3.1 Socio-economic Factors and Adoption of Regenerative Agriculture 19
2.3.2 Environmental Factors and Adoption of Regenerative Agriculture 21
2.3.3 Payment for Ecosystem Services and Adoption of Regenerative Agriculture 22
2.3.4 Control Variables – Land Tenure and Access to Markets 24
2.4 Summary of the Literature Research Gaps 25
2.5 Conceptual Framework 31
CHAPTER THREE: RESEARCH METHODOLOGY 40
3.1 Introduction 40
3.2 Research Philosophy 40
3.3 Research Design 41
3.4 Population and Sampling 41
3.4.1 Population of the Study 41
3.4.2 Sample Size Determination 43
3.5 Data Collection Methods 43
3.6 Data Analysis 44
3.7 Model Specification 45
3.8 Research Quality 48
3.8.1 Validity of the Research Instrument 48
3.8.2 Reliability of the Research Instrument 49
3.9 Ethical Issues in Research 51
CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION 52
4.1 Introduction 52
4.2 Response Rate 52
4.3 Demographic Characteristics 53
4.3.1 Gender Distribution 53
4.3.2 Exposure Distribution 54
4.4 Descriptive Statistics 55
4.4.1 Socio-economic Factors 56
4.4.2 Environmental Factors 67
4.4.3 Payment for Ecosystem Services 71

4.4.4 Adoption of Regenerative Agriculture Practices 74
4.4.5 Land Tenure 80
4.3.6 Access to Market 82
4.5 Correlation Analysis 83
4.6 Diagnostic Tests 86
4.6.1 Multi-collinearity Test 86
4.6.2 Homoscedasticity Test 87
4.6.3 Normality Test 88
4.6.4 Linearity Test 89
4.6.5 Influential Observations 91
4.7 Multiple Linear Regression Analysis 92
4.7.1 Parameter Estimates 93
4.7.2 ANOVA for the Model 95
4.7.3 Regression Model Summary 97
4.33: Regression Model Summary 97
4.8 Chapter Summary 99
CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATION 100
5.1 Introduction 100
5.2 Summary of Findings 100
5.3 Discussion 101
5.3.1 Effect of Socio-Economic Factors on the Adoption of Regenerative Agriculture Practices 101
5.3.2 Effect of Environmental Factors on the Adoption of Regenerative Agriculture Practices 102
5.3.3 Effect of Payment for Ecosystem Services on the Adoption of Regenerative Agriculture Practices 103
5.3.4 Effect of Control Variables on the Adoption of Regenerative Agriculture Practices 104
5.4 Conclusion 105
5.5 Recommendations 106
5.5.1 Policy Recommendations 106

5.5.2 Institutional and Extension Service Recommendations.....106
5.5.3 Farmer Capacity Development Recommendations 107
5.5.4 Financial and Incentive Mechanism Recommendations.....107
5.6 Limitations of the Study 107
5.7 Recommendations for Further Research 109
5.8 Chapter Summary.....110
REFERENCES 104

LIST OF TABLES

Table 2.1: Summary of Literature and Gaps 25
Table 2.2: Operationalization of Variables 34
Table 3.1: Population and Sample Distribution by County and Exposure Status…….. 43
Table 3.2: Validity of Research Instrument 48
Table 3.3: Reliability of the Research Instrument 50
Table 4.1: Response Rate 52
Table 4.2: Gender Distribution 54
Table 4.3: Exposure Distribution 55
Table 4.4: Age Distribution 56
Table 4.5: Size of the Household 57
Table 4.6: Education Level 58
Table 4.7: Agricultural Training 59
Table 4.8: Agricultural Extension Services 61
Table 4.9: Farming Experience 62
Table 4.10: Monthly Household Income 63
Table 4.11: Access to Credit 65
Table 4.12: Size of Land Under Cultivation 66
Table 4.13: Soil Fertility 67
Table 4.14: Rainfall Reliability 69
Table 4.15: Drought Frequency 70
Table 4.16: Awareness of PES Programs 71
Table 4.17: Participation in PES Programs 72
Table 4.18: Level of Incentives for Ecosystem 68
Table 4.19: Types of Regenerative Agriculture Adopted 75
Table 4.20: Percentage of Land Under Regenerative Agriculture 76
Table 4.21: Frequency of Applying Regenerative Agriculture Practices 78
Table 4.22: Consecutive Years of Practicing Regenerative Agriculture 79
Table 4.23: Land Ownership Status 81
Table 4.24: Access to the Market 82
Table 4.25: Correlation Analysis 84

Table 4.26: Multi-collinearity Test 86
Table 4.27: Homoscedasticity Test 87
Table 4.28: Normality Test 88
Table 4.29: Linearity Test 90
Table 4.31: Parameter Estimates 93
Table 4.32: ANOVA for the Model 95

LIST OF FIGURES

Figure 2.1: Conceptual Framework 33

VT OMNES VNVM SINT

LIST OF APPENDICES

APPENDIX I: QUESTIONNAIRE 117
APPENDIX II: INTERVIEW GUIDE 120
APPENDIX III: SIMILARITY REPORT 123
APPENDIX IV: ETHICAL APPROVAL LETTER 124
APPENDIX V: INTRODUCTORY LETTER TO NACOSTI 125
APPENDIX VI: RESEARCH PERMIT FROM NACOSTI 126

ABBREVIATIONS AND ACRONYMS

CGIAR: Consultative Group on International Agricultural Research

CRU: Carbon Removal Unit

FAO: Food and Agriculture Organization

GDP: Gross Domestic Product

IRT: Innovation Resistance Theory

ICT: Information and Communication Technology

KACP: Kenya Agricultural Carbon Project

KALRO: Kenya Agricultural and Livestock Research Organization

KCSAP: Kenya Climate Smart Agriculture Project

NGO: Non-Governmental Organization

OECD: The Organization for Economic Co-operation and Development

PES: Payments for Ecosystem Services

PMT: Protection Motivation Theory

RA: Regenerative Agriculture

SDGs: Sustainable Development Goals

VT OMNES VNVM SINT

DEFINITION OF TERMS

Adoption	The decision by a farmer to take up and consistently apply one or more regenerative agriculture practices such as no-till, cover cropping, crop rotation, stubble retention, agroforestry, and rotational grazing (Khangura et al., 2023).
Agroforestry	The integration of trees and shrubs with crops and livestock in farming systems to reduce erosion, improve soil fertility, increase carbon sequestration, and enhance farm resilience and productivity (Sollen-Norrlin et al., 2020).
Drought Exposure	The extent to which farmers experience prolonged dry periods that negatively affect crop and livestock production (Dabalen et al., 2024).
Extension Services	Government or NGO-supported advisory services aimed at training and equipping farmers with information and skills on improved agricultural practices (Pangapanga-Phiri et al., 2024).
Land Tenure	Legal or customary rights that individuals or groups hold to land, which influence their willingness to invest in long-term land improvements like agroforestry and composting (Neway & Zegeye, 2022).
Market Access	The ability of farmers to reach and sell produce in formal or informal markets, often influenced by distance, infrastructure, and availability of buyers (Otara et al., 2023; Dabalen et al., 2024).
Payments for Ecosystem Services	Financial or in-kind rewards offered to farmers who adopt land use practices that generate public environmental benefits such as soil health, biodiversity, and carbon sequestration (Dabalen et al., 2024; Nyongesa et al., 2016).

Regenerative Agriculture	A method of farming that uses natural processes to enhance soil health, biodiversity, and ecological function while improving productivity and Resilience. Practices include no-till, cover cropping, crop rotation, composting and agroforestry (Khangura et al., 2023).
Rotational Grazing	A livestock management practice where animals are moved among paddocks or pastures to allow vegetation to recover, improving soil health and forage production (Rehberger et al., 2023).
Smallholder Farmers	Farmers managing small parcels of land, typically less than 2 hectares, often for subsistence purposes but with some market participation (IFAD & UNEP, 2013).
Soil Quality	The capacity of soil to function as a vital ecosystem component, supporting plant growth, maintaining environmental quality, and promoting biological health (Alexanderson et al., 2024).

VT OMNES VNVM SINT

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Agriculture remains the backbone of Kenya's economy and a critical source of livelihood for rural households. The sector contributes approximately 33% directly to the national Gross Domestic Product (GDP) and a further 27% indirectly through linkages with manufacturing, trade, and other sectors (FAO, 2025). Agriculture employs more than 40% of the national labour force and supports over 80% of rural households, making it a central pillar of economic growth, food security, and poverty reduction in the country (Kenya Climate Smart Agriculture Strategy, 2017–2026; FAO, 2025). Despite its importance, the sector continues to face significant challenges including declining soil fertility, land degradation, erratic rainfall patterns, prolonged droughts, and increasing climate variability, all of which have contributed to declining agricultural productivity and heightened food insecurity among smallholder farming communities (Dabalen et al., 2024; Pangapanga-Phiri et al., 2024).

Smallholder farmers constitute the majority of agricultural producers in Kenya and are particularly vulnerable to environmental and climatic shocks due to their heavy reliance on rain-fed agriculture and limited access to financial, technical, and institutional resources (Wordofa et al., 2021; Massresha et al., 2021). Climate change has intensified production risks by increasing the frequency of droughts, rainfall variability, and soil degradation, thereby threatening household livelihoods and agricultural sustainability (Dabalen et al., 2024; Midamba et al., 2024). In response to these challenges, regenerative agriculture has gained increasing attention as a sustainable farming approach capable of restoring soil health, enhancing biodiversity, improving water retention, and strengthening resilience to climate change (Pangapanga-Phiri et al., 2024; Ntawuhiganayo et al., 2023). Practices such as agroforestry, cover cropping, mulching, crop rotation, and minimum tillage are increasingly being promoted as pathways towards sustainable agricultural production and environmental conservation (Midamba et al., 2024; Otara et al., 2023).

In Kenya, development organizations such as Farm Africa have been implementing regenerative agriculture initiatives aimed at enhancing sustainable land management, improving soil fertility, and strengthening climate resilience among smallholder farmers (Farm Africa, 2024). Embu and Tharaka Nithi Counties have emerged as important intervention areas because of their high dependence on agriculture, vulnerability to climate variability, increasing land degradation, and ongoing efforts to promote sustainable agricultural practices (Farm Africa, 2024; County Government of Embu, 2023; County Government of Tharaka Nithi, 2023). Despite these interventions, empirical evidence on the factors influencing adoption of regenerative agriculture practices among smallholder farmers in these counties remains limited and fragmented. Existing studies have predominantly focused on climate-smart agriculture, conservation agriculture, and sustainable land management practices in broader contexts, with limited attention given to the combined influence of socio-economic factors, environmental conditions, payment for ecosystem services, market access, and land tenure on the adoption of regenerative agriculture practices (Massresha et al., 2021; Wordofa et al., 2021; Midamba et al., 2024). This knowledge gap necessitated empirical investigation to generate evidence that can inform policy formulation, development interventions, and strategies aimed at scaling up regenerative agriculture among smallholder farmers in Kenya.

1.1.1 Adoption of Regenerative Agriculture

According to Khangura et al. (2023) Regenerative Agriculture (RA) is defined as a farming approach that uses natural processes to increase biological activity, enhance soil health, improve nutrient cycling, restore landscape function, and produce food while preserving or increasing farm profitability. It includes practices such as no-till or conservation tillage, stubble retention, cover cropping, diverse crop rotations, composting, rotational grazing, and agroforestry. RA differs from conventional agriculture, which is often reliant on synthetic inputs and tillage, by focusing on natural biological processes and reduced input systems. Globally, RA is gaining popularity as a response to soil degradation, rising input costs, and climate-related challenges. In the United States and Europe, large food companies like General Mills and Nestlé have adopted RA practices as part of their supply chain strategies (Wilson et al., 2023), while policy frameworks in Australia and the UK

support regenerative principles through subsidies and farmer education programs (Alexanderson et al., 2024; Khangura et al., 2023). However, the extent of adoption remains limited in many countries due to high transition costs, inconsistent definitions, and lack of long-term economic data.

In Africa, RA is still emerging but shows potential as a climate-smart, cost-effective approach to land restoration and food security. According to the World Bank (Dabalen et al., 2024), regenerative agriculture programs have reached over 100,000 farmers across Sub-Saharan Africa. For example, in Rwanda, RA is being integrated with farmer training and agroforestry interventions (Ntawuhiganayo et al., 2023), while South Africa has promoted elements of RA through conservation agriculture and pasture cropping systems (Lunn-Rockliffe et al., 2020). Despite this progress, adoption is hindered by limited institutional support, low awareness, and lack of access to tailored financial mechanisms.

In Kenya, RA is slowly being recognized as a strategy for climate adaptation and sustainable intensification. Initiatives such as Vi Agroforestry's Kenya Agricultural Carbon Project (KACP) and Farm Africa's Regenerative Agriculture Project in Embu and Tharaka Nithi counties have helped train farmers on RA practices. These projects also support farmers in carbon credit generation through partnerships like the World Bank's BioCarbon Fund and the Acorn carbon platform (Vi Agroforestry, 2020; Farm Africa, 2020). Recent policy developments have also sought to create an enabling environment for RA adoption. The Agricultural Soil Management Policy (2023) outlines institutional reforms, investment in extension services, and capacity building to guide sustainable soil practices. It emphasizes multi-sectoral coordination and targeted technical support as key drivers of improved land management (Kenya Ministry of Agriculture and Livestock Development, 2023). Similarly, Kenya's Climate Smart Agriculture Strategy (2017–2026) acknowledges agriculture as a major contributor to national greenhouse gas emissions and positions sustainable practices, including RA, as central to mitigation and resilience goals.

Despite these efforts, the adoption of RA in Kenya remains relatively low. A study by Otara et al. (2023) in the drylands areas of Embu County identified barriers such as high labour demands, lack of training, and financial constraints. Tittonell et al. (2022) highlighted those

policies are often fragmented and lack the coherence needed to support smallholder transitions to regenerative systems. Furthermore, challenges such as drought, limited access to reliable markets, and weak extension services undermine the scalability of RA programs in Kenya (Lunn-Rockliffe et al., 2020). The Climate Smart Agriculture Strategy further notes persistent financing gaps, limited private sector participation, and weak institutional coordination as ongoing barriers to implementation, contributing to duplication of efforts and low policy impact on the ground (Kenya Climate Smart Agriculture Strategy, 2017-2026).

1.1.2 Determinants of the Adoption of Regenerative Agriculture

Studies have identified a wide range of factors influencing the adoption of regenerative agriculture (RA) practices. These determinants cut across socio-economic factors, environmental factors, and incentives. Socio-economic factors include demographic factors (e.g gender, age, household size), education level, capacity building factors (e,g training, extension services), farming experience, and resource access factors (e.g access to credit, household income, farm size). Environmental factors include soil quality, rainfall patterns, and drought exposure, while incentives include Payment for Ecosystem Services (PES).

Socio-economic factors such as age, education, gender, and household structure affect farmers' willingness and capacity to adopt RA. For example, younger farmers are often more open to change and innovation, while education enhances understanding of sustainable techniques and access to information (Wordofa et al., 2021). Gender roles also play a significant role, particularly in smallholder contexts, where women may be more involved in labour-intensive tasks and less empowered to make resource decisions (Otara et al., 2023). However, findings are not consistent. While some studies in Ethiopia found male-headed households more likely to adopt (Massresha et al., 2021), others in Chile observed that women's participation, when supported by training, significantly improved adoption of ecological practices (Benitez-Altuna et al., 2021). Similarly, whereas Wordofa et al. (2021) report older farmers more likely to adopt, Udimal et al. (2017) found younger farmers were more likely to embrace innovations due to openness to risk-taking.

Access to financial resources, landholding size, and training opportunities are also frequently cited in literature. Farmers with higher incomes or larger farm sizes are more capable of absorbing risks associated with new practices (Hu et al., 2022). Training and extension services are equally critical, as they provide the technical knowledge, motivation, and confidence necessary for farmers to shift away from conventional methods. Ntawuhiganayo et al. (2023) found that targeted and continuous training improved the adoption of soil conservation practices, while Pangapanga-Phiri et al. (2024) observed that demonstration plots and peer-based learning enhanced uptake and sustained use of RA. Yet contradictions persist. While training and extension access in Rwanda improved adoption outcomes, studies in Uganda and Kenya highlight those barriers such as limited resources, cultural norms, and weak institutional support continue to hinder uptake despite training efforts (Ekepu & Tirivanhu, 2016). Likewise, although large farm size in China was positively associated with adoption (Hu et al., 2022), evidence from Ghana and Ethiopia shows that even smallholders adopt new technologies when contextual factors like extension access and awareness are supportive (Acheampong et al., 2022).

Environmental conditions such as climate variability, soil degradation, and water scarcity have also emerged as key drivers. As noted by Pirani (2024), farmers in ecologically fragile regions often adopt regenerative methods as climate adaptation tools. Wilson et al. (2023) found that in the United States, farmers exposed to drought and extreme weather were more likely to adopt regenerative strategies to build soil health and ecological resilience. Similarly, Kenny and Castilla-Rho (2022) highlight the role of worsening environmental conditions in Australia in driving adoption, especially when conventional systems become untenable. In the African context, however, the World Bank (Dabalen et al., 2024) says that adoption is constrained by inadequate climate information, limited access to inputs and extension, and insecure land tenure, which collectively hinder long-term decision-making.

Payments for Ecosystem Services (PES) have been identified as promising financial instruments to incentivize RA adoption by compensating farmers for their contribution to environmental conservation. Dabalen et al. (2024) underscore the value of PES in offsetting short-term financial losses, especially for smallholders. Wilson et al. (2023)

found that corporate PES initiatives by firms like Walmart and General Mills increased adoption through bundled financial and technical support. In Kenya, Nyongesa et al. (2016) demonstrated that farmers were willing to participate in PES schemes for watershed protection and showed strong commitment to continuing these practices with adequate incentives.

While the broader literature reveals multiple determinants of RA adoption, this study focused on three core categories: socioeconomic, environmental, and PES-related factors. These categories were selected because they consistently appear across prior studies, though often examined in isolation or in pairs. Very few studies have examined them simultaneously, particularly within the Sub-Saharan Africa smallholder context. For example, Wordofa et al. (2021), Otara et al. (2023), and Hu et al. (2023) looked at socio-economic factors, without considering environmental or incentive-related factors that could influence adoption. Similarly, Pirana (2024) and Wilson et al. (2023) focused on environmental factors and did not consider incentives or socio-economic factors, while Nyongesa et al. (2016) only looked at the role of PES schemes in influencing farmers' willingness to participate in sustainable practices. By adopting a multidimensional perspective, this study addresses this gap and provides a more comprehensive understanding of adoption behaviour in Kenya.

Socio-economic factors include gender, age, education, household size, and farming experience, which shape access to information, roles in decision-making, and openness to change, while factors such as farm size, household income, access to credit, access to training, and extension services determine whether a farmer has the financial and knowledge capacity to adopt new practices. Environmental factors such as drought occurrence, rainfall variability, and soil conditions influence the perceived urgency and relevance of RA. PES is included as a policy-linked economic instrument that can either incentivize or discourage adoption depending on its design and accessibility. The study also incorporated two control variables, land tenure and market access, which may influence adoption indirectly. Secure land rights are critical for farmers to invest in long-

term soil and land improvements, while reliable market access can increase the likelihood of adoption by reducing output risk and enhancing income predictability.

1.1.3 Regenerative Agriculture in Kenya

Kenya continues to experience increasing agricultural challenges arising from land degradation, declining soil fertility, climate variability, and unsustainable farming practices, which threaten agricultural productivity and food security (Kenya Climate Smart Agriculture Strategy, 2017–2026). Agriculture remains highly dependent on natural resources and contributes significantly to greenhouse gas emissions through land-use change and unsustainable farming systems. Consequently, regenerative agriculture (RA) has gained increasing policy and development attention as a sustainable approach for restoring soil health, enhancing biodiversity, improving water retention, and strengthening resilience to climate change (Agricultural Soil Management Policy, 2023; Vi Agroforestry, 2020). To promote sustainable agricultural transformation, government agencies, development partners, and non-governmental organizations have increasingly integrated regenerative agriculture practices such as agroforestry, cover cropping, mulching, crop rotation, minimum tillage, and organic soil management into farmer support programs (Farm Africa, 2022; Vi Agroforestry, 2020).

Among the ongoing regenerative agriculture initiatives in Kenya, Farm Africa's Regenerative Agriculture Project represents one of the most comprehensive interventions targeting smallholder farmers. The project is implemented in Embu and Tharaka Nithi Counties and combines farmer training, extension support, market linkages, institutional partnerships, and carbon financing mechanisms to promote sustainable agricultural practices (Farm Africa, 2022). These counties were selected because agriculture is the primary economic activity, yet farmers face persistent challenges including declining soil fertility, rainfall variability, recurrent droughts, land fragmentation, and limited access to agricultural services. Such conditions make the counties particularly suitable for examining factors influencing adoption of regenerative agriculture practices.

Despite increasing investments in regenerative agriculture promotion within Embu and Tharaka Nithi Counties, evidence on the factors influencing adoption among smallholder

farmers remains limited. Existing studies in Kenya have largely focused on climate-smart agriculture, conservation agriculture, and sustainable land management practices more broadly, with limited attention given specifically to regenerative agriculture and the institutional context created by Farm Africa's intervention (Midamba et al., 2024; Ntawuhiganayo et al., 2023; Pangapanga-Phiri et al., 2024). Furthermore, previous studies have tended to examine individual determinants of adoption in isolation, with limited consideration of the combined influence of socio-economic factors, environmental conditions, payment for ecosystem services, market access, and land tenure. Consequently, there remains insufficient empirical evidence on the relative importance of these factors in shaping adoption decisions among farmers participating in regenerative agriculture initiatives. This study sought to address this knowledge gap by examining the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties within the context of Farm Africa's regenerative agriculture intervention.

1.2 Statement of the Problem

Agriculture is the primary source of livelihood for most rural households in Kenya and plays a critical role in national food security and economic development. However, agricultural productivity continues to be constrained by declining soil fertility, land degradation, erratic rainfall patterns, recurrent droughts, and increasing climate variability (Kenya Climate Smart Agriculture Strategy, 2017–2026; Dabalen et al., 2024). These challenges are particularly severe among smallholder farmers, who depend largely on rain-fed agriculture and often have limited access to financial resources, agricultural technologies, extension services, and markets. Consequently, many farming households continue to experience low productivity, reduced resilience to climate shocks, and increasing vulnerability to food insecurity. Regenerative agriculture has been promoted as a sustainable approach for restoring soil health, improving water retention, enhancing biodiversity, and strengthening climate resilience among smallholder farmers (Pirani, 2024; Kenny & Castilla-Rho, 2022).

In Kenya, organizations such as Farm Africa have invested in promoting regenerative agriculture practices in Embu and Tharaka Nithi Counties through farmer training, institutional partnerships, and market-based incentives. Despite these interventions, evidence suggests that adoption of regenerative agriculture practices remains uneven among smallholder farmers, limiting the realization of anticipated environmental and productivity benefits (Farm Africa, 2022; Otara et al., 2023). Although previous studies have examined factors influencing adoption of agricultural innovations, most have focused on specific determinants such as socio-economic characteristics, extension services, or institutional support in isolation (Otara et al., 2023; Ntawuhiganayo et al., 2023; Wordofa et al., 2021). Limited empirical evidence exists on the combined influence of socio-economic factors, environmental conditions, payment for ecosystem services, market access, and land tenure on the adoption of regenerative agriculture practices within the Kenyan context.

Furthermore, few studies have specifically examined these relationships within areas where regenerative agriculture interventions are actively being implemented. Embu and Tharaka Nithi Counties provide an appropriate context for addressing this gap because they are among the counties targeted by Farm Africa's regenerative agriculture programme and are characterized by high dependence on agriculture, increasing climate-related risks, and widespread soil degradation. Understanding the factors associated with adoption of regenerative agriculture practices in these counties is therefore important for informing policy, improving intervention design, and supporting the scaling up of regenerative agriculture among smallholder farmers in Kenya. Consequently, this study sought to examine the relationship between socio-economic factors, environmental factors, payment for ecosystem services, market access, land tenure, and adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties.

1.3 Research Objectives

The study was guided by the following general and specific objectives:

1.3.1 General Objective

The main objective of the study was to establish the determinants of the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties in Kenya.

1.3.2 Specific Objectives

The specific objectives of the study were:

i. To find out the effect of socio-economic factors on the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties.
ii. To examine the effect of environmental factors on smallholder farmers' decision to adopt regenerative agriculture practices in Embu and Tharaka Nithi counties.
iii. To evaluate the role of payment for ecosystem services (PES) on the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties.

1.4 Research Questions

The research aimed to respond to the following questions:

i. What is the association between socio-economic factors and the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties?
ii. What is the association between environmental factors and the decision of smallholder farmers to adopt regenerative agriculture practices in Embu and Tharaka Nithi Counties?
iii. What is the association between payment for ecosystem services and the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties?

1.5 Scope of the Study

This study examined the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties, Kenya. Conceptually, the study focused on the relationship between socio-economic factors, environmental

factors, payment for ecosystem services, market access, land tenure, and adoption of regenerative agriculture practices. Geographically, the study was limited to selected sub-counties in Embu and Tharaka Nithi Counties, where Farm Africa has been implementing regenerative agriculture interventions and where farming households face significant climate and land degradation challenges. The target population comprised smallholder farmers with varying levels of exposure to regenerative agriculture initiatives, including both beneficiaries and non-beneficiaries of Farm Africa's programme, to facilitate comparison of adoption patterns across different farmer groups. The study was cross-sectional in nature, and primary data was collected from respondents between 1 December 2025 and 22 December 2025. The findings are therefore interpreted within the context of the study area and the period during which the data were collected.

1.6 Significance of the Study

The results of this research provide practical insights to several key stakeholders on sustainable farming in Kenya.

1.6.1 Smallholder Farmers

The study provides evidence-based insights into the benefits and challenges of adopting regenerative practices. This can inform farmers' decision-making and help them understand how social, economic, environmental, and incentive-related factors may affect adoption outcomes such as income, productivity, and cost of production.

1.6.2 Policy Makers and Development Partners

The study offers empirical data to support more effective policy and program design at both county and national levels. It is particularly useful to government departments, NGOs, and development agencies aiming to promote sustainable agriculture under frameworks such as the Agricultural Soil Management Policy (2023) and the Kenya Climate-Smart Agriculture Strategy (2017–2026). In addition, the findings help in assessing the effectiveness of ongoing initiatives such as the Farm Africa RA project, and provide basis for improving policy coherence, institutional coordination, and incentive design to improve adoption.

1.6.3 Academicians and Researchers

This research contributes to the growing body of knowledge on sustainable agriculture in Sub-Saharan Africa, specifically focusing on regenerative agriculture in the Kenyan context. Few studies have analysed the specific adoption patterns of RA within a multi-dimensional framework that includes social, economic, environmental, and policy factors. The study helps to address this gap and provides a foundation for future academic inquiry into farmer decision-making, sustainability transitions, and evidence-based climate adaptation strategies in the smallholder context.

1.6.4 Theoretical Contribution

This study makes a theoretical contribution by testing the applicability of two behavioural theories, Innovation Resistance Theory (IRT) and Protection Motivation Theory (PMT), in the context of smallholder agriculture in Sub-Saharan Africa. While these theories have been widely applied in consumer behaviour, health, and technology adoption studies, their use in agriculture, and specifically in regenerative farming systems, remains limited. By integrating IRT and PMT, the study evaluates how functional and psychological barriers, perceptions of climate risks, and coping appraisals jointly influence adoption decisions. In doing so, the research contributes to theory in three ways. First, it extends IRT to a rural agricultural setting where structural and contextual barriers may interact with individual resistance factors. Second, it applies PMT to link environmental stressors such as drought and soil degradation with adaptive behavioural responses. Third, it demonstrates how incentive mechanisms such as Payment for Ecosystem Services can reduce resistance and enhance coping efficacy, thereby enriching both theories.

1.7 Chapter Summary

This chapter introduced the study on the determinants of adoption of regenerative agriculture practices in Embu and Tharaka Nithi counties, Kenya. While regenerative agriculture is promoted as a pathway to resilience and sustainability, adoption among smallholder farmers remains low and uneven. Existing studies often treat determinants in isolation and rarely integrate incentive-based factors such as Payment for Ecosystem Services (PES), while at the same time, most studies are based on the development world.

These limitations highlight conceptual gap and conceptual gaps in understanding adoption dynamics in African smallholder systems. To address these gaps, the study applied a multidimensional adoption index and examined how social, economic, environmental, and PES factors interact to influence farmer behaviour in Sub-Saharan Africa context. Anchored on Innovation Resistance Theory (IRT) and Protection Motivation Theory (PMT), the study tested the applicability of these behavioural frameworks in an agricultural setting. The expected contribution is threefold including advancing theory by contextualizing IRT and PMT in smallholder agriculture, generating policy-relevant insights for sustainable farming, and providing practical guidance to farmers and development actors on pathways to scale up regenerative practices.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews the key determinants that influence the adoption of RA practices among smallholder farmers. It covers relevant theoretical and empirical literature to examine how social, economic, environmental, and incentive-related factors shape adoption behaviour. The chapter also identifies conceptual and contextual gaps in previous studies and presents a conceptual framework that visually maps the study's key variables and hypothesized relationships.

2.2 Theoretical Review

This study is anchored on two complementary theoretical frameworks: Innovation Resistance Theory (IRT) and Protection Motivation Theory (PMT). IRT offers a behavioral perspective that explains why smallholder farmers may resist adopting regenerative agriculture (RA) practices, even when such innovations are well-promoted and potentially beneficial. It highlights both functional and psychological barriers that influence adoption decisions. PMT, on the other hand, provides an environmental and cognitive lens, emphasizing how farmers respond to climate-related threats based on their perceived vulnerability, efficacy, and capacity to cope. Together, these theories offer a holistic understanding of the behavioural and contextual dynamics that shape adoption of RA among smallholder farmers in Kenya, particularly in Embu and Tharaka Nithi counties.

2.2.1 Innovation Resistance Theory

Innovation Resistance Theory (IRT) was originally proposed by Sheth (1981) and subsequently developed and formalized by Ram (1987) and Ram and Sheth (1989) to explain why individuals resist adopting innovations despite their potential benefits. The theory emerged as a response to traditional innovation diffusion models, which largely focused on factors promoting adoption while paying limited attention to the reasons individuals reject, delay, or resist innovations. Innovation Resistance Theory defines resistance as a natural and rational response that occurs when an innovation challenges existing beliefs, routines, practices, or resource allocations. According to the theory,

resistance does not necessarily imply permanent rejection but may manifest as postponement, opposition, reluctance, or selective adoption of an innovation (Ram & Sheth, 1989).

The theory identifies two broad categories of barriers that influence resistance to innovation: functional barriers and psychological barriers. Functional barriers include usage barriers, value barriers, and risk barriers. Usage barriers arise when an innovation is perceived as complex or difficult to implement. Value barriers occur when the perceived benefits of the innovation do not justify the costs or effort required for adoption. Risk barriers emerge when individuals perceive uncertainty regarding the outcomes of adopting the innovation. Psychological barriers comprise tradition barriers and image barriers. Tradition barriers occur when innovations conflict with existing cultural practices, habits, or beliefs, while image barriers arise when innovations are associated with negative perceptions or social stigma (Ram, 1987; Ram & Sheth, 1989).

Since its development, IRT has been widely applied across various disciplines, including technology adoption, renewable energy, financial innovation, and agricultural development. Kaur et al. (2020) found that usage, value, and risk barriers significantly reduced consumers' intentions to adopt mobile payment systems. Similarly, Xue et al. (2024) applied IRT in the context of electric vehicle adoption and reported that functional barriers exerted significant negative effects on adoption intentions, although supportive policy interventions reduced resistance. Within agriculture, Jin et al. (2022) demonstrated that communication and awareness campaigns reduced resistance to regenerative farming by improving familiarity with sustainable agricultural practices and lowering perceived risks associated with adoption. These studies illustrate the utility of IRT in explaining why potentially beneficial innovations often experience slow uptake despite demonstrated advantages.

Despite its contributions, IRT has been criticized for placing excessive emphasis on individual perceptions and behavioural responses while giving limited attention to broader socio-economic, institutional, and environmental factors that shape adoption decisions. Claudy et al. (2015) argue that innovation resistance is often influenced by contextual

constraints such as resource availability, market access, policy support, and institutional capacity, factors that are not adequately incorporated within the original theory. Similarly, Szmigin and Foxall (1998) note that resistance may result from temporary situational constraints rather than deeply rooted psychological opposition. Kleijnen et al. (2009) further observed that some barriers identified by the theory may diminish over time as users gain experience or as supporting infrastructure improves. In agricultural settings, these limitations are particularly important because farmers' decisions are often influenced by financial resources, climatic conditions, land tenure arrangements, extension services, and market opportunities in addition to psychological perceptions.

Notwithstanding these limitations, Innovation Resistance Theory provides an important theoretical foundation for understanding the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties. Regenerative agriculture often requires changes in farming practices, resource allocation, labour organization, and production planning, all of which may generate resistance among farmers. Functional barriers may arise from perceived labour requirements, implementation costs, limited technical knowledge, and uncertainty regarding economic returns. Psychological barriers may emerge where regenerative agriculture practices conflict with traditional farming methods or where farmers question their effectiveness. Evidence from Kenya indicates that labour demands, financial constraints, weak extension systems, and limited awareness continue to hinder adoption of regenerative agriculture practices (Otara et al., 2023; Farm Africa, 2022). Consequently, IRT provides a useful framework for explaining how farmers' perceptions of risks, costs, complexity, and compatibility influence their willingness to adopt regenerative agriculture practices. The theory is therefore relevant to this study because it helps explain the behavioural mechanisms through which socio-economic factors, environmental conditions, and payment for ecosystem services influence adoption decisions among smallholder farmers.

2.2.2 Protection Motivation Theory

Protection Motivation Theory (PMT) was originally developed by Rogers (1975) to explain how individuals respond to perceived threats and the factors that motivate them to adopt

protective behaviours. The theory emerged from health psychology research and was initially designed to explain behavioural responses to health-related risks. Rogers later refined the theory by incorporating cognitive processes that influence behavioural intentions, while Prentice-Dunn and Rogers (1997) further expanded its explanatory framework. PMT posits that individuals are motivated to adopt protective actions when they perceive a threat to be serious and believe that effective coping responses are available. The theory therefore explains behavioural change as a function of both threat perception and coping capacity.

The development of PMT led to the identification of two major cognitive appraisal processes: threat appraisal and coping appraisal (Rogers & Prentice-Dunn, 1997). Threat appraisal consists of perceived severity and perceived vulnerability. Perceived severity refers to the extent to which an individual believes that a threat can cause serious harm, while perceived vulnerability refers to the likelihood of personally experiencing that threat. Coping appraisal comprises self-efficacy, response efficacy, and response costs. Self-efficacy reflects an individual's confidence in their ability to implement a protective behaviour, response efficacy refers to the belief that the proposed action will effectively reduce the threat, and response costs represent the financial, social, or physical sacrifices associated with taking protective action. According to PMT, individuals are more likely to adopt adaptive behaviours when they perceive a threat as serious and believe they possess the ability and resources necessary to implement effective responses.

Over time, PMT has been widely applied beyond health behaviour research to environmental management, climate change adaptation, disaster risk reduction, and sustainable agriculture. In agricultural contexts, the theory has been used to explain farmers' adoption of climate-smart agriculture, conservation agriculture, drought adaptation measures, and environmental conservation practices. Bazrafkan et al. (2022) found that perceived severity, vulnerability, self-efficacy, and response efficacy significantly influenced farmers' adoption of conservation agriculture practices in Iran. Similarly, Bagagnan et al. (2019) reported that protection motivation mediated the relationship between climate risk perceptions and adaptation behaviour among farmers in

The Gambia. Badsar et al. (2023) further established that threat appraisal and coping appraisal significantly predicted sustainable agricultural behaviour, while Mosavian et al. (2023) found that drought perception, response efficacy, and household income influenced intentions to adopt water conservation measures. These studies demonstrate the usefulness of PMT in explaining farmers' responses to environmental and climate-related challenges.

Despite its extensive application, PMT has been criticized for several limitations, particularly within agricultural contexts. First, the theory places considerable emphasis on individual cognitive processes while paying limited attention to structural, institutional, and socio-economic constraints that often influence farmers' decisions. Smallholder farmers may perceive climate risks and understand the benefits of adaptive practices, yet still fail to adopt them because of inadequate financial resources, weak extension systems, insecure land tenure, or poor market access. Such contextual factors are not explicitly incorporated within the original PMT framework (Floyd et al., 2000). Second, the theory assumes that individuals make rational decisions based on threat and coping assessments, whereas agricultural decisions are often influenced by cultural norms, social networks, peer influence, and community expectations (Chen, 2020). Third, PMT does not adequately account for collective action and institutional support mechanisms that are critical in agricultural innovation systems. Researchers such as Oakley et al. (2020) have therefore argued for the inclusion of ownership appraisal and social responsibility dimensions, while Chen (2020) proposed incorporating moral obligation to improve the explanatory power of the theory in environmental and climate adaptation contexts.

Notwithstanding these limitations, PMT provides a valuable theoretical framework for understanding adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties. The study area experiences environmental challenges including declining soil fertility, rainfall variability, and recurrent droughts, which increase farmers' perceptions of environmental threats and therefore correspond to the threat appraisal component of PMT. At the same time, adoption of regenerative agriculture practices depends on farmers' confidence in their ability to implement such practices, their perceptions of the effectiveness of regenerative agriculture in addressing environmental

challenges, and the costs associated with adoption. Factors examined in this study, including socio-economic characteristics, environmental conditions, and payment for ecosystem services, directly influence self-efficacy, response efficacy, and perceived response costs. For example, access to training, extension services, and PES incentives can enhance farmers' confidence and reduce adoption costs, thereby strengthening protection motivation. Consequently, PMT is relevant to this study because it provides a framework for explaining how environmental risk perceptions and coping capacities influence farmers' decisions to adopt regenerative agriculture practices.

2.3 Empirical Review

2.3.1 Socio-economic Factors and Adoption of Regenerative Agriculture

Empirical evidence shows that factors such as age, gender, education level, farming experience, and household characteristics play a significant role in shaping smallholder farmers' adoption of RA practices. Wordofa et al. (2021), using propensity score matching in Eastern Ethiopia, found that farmers with more years of schooling and extensive farming experience were more likely to adopt improved agricultural technologies. Their findings also revealed that most adopters were male, indicating a gender gap in access to or willingness to adopt innovations. In contrast, Otara et al. (2023), studying 400 households in Embu County, Kenya, observed that while farming experience was positively associated with RA adoption, higher levels of education had a negative influence, with educated farmers more inclined to seek off-farm employment. These contrasting results suggest that education may play a different role depending on regional context.

Gender was also found to influence the type of RA practices adopted. Otara et al. (2023) reported that women were more involved in labor-intensive practices such as composting and intercropping, while men tended to adopt capital-intensive techniques. Neway and Zegeye (2022) also found that households led by men were more likely than those headed by women to adopt agricultural technologies. Age appears as another variable with mixed findings across studies. While Wordofa et al. (2021) and Massresha et al. (2021) reported a positive influence of older age on adoption, attributing it to experience and farm stability, Hawas and Degaga (2023) found age not to be statistically significant. Udimal et al. (2017),

in a study on improved rice varieties in Ghana, similarly found that younger and large-scale farmers were more inclined to adopt, suggesting that age may interact with farm scale or innovation type.

Household characteristics such as family size and social participation also emerge as relevant factors. Ekepu and Tirivanhu (2016) found that larger family size negatively influenced adoption of sorghum-legume intercropping. Meanwhile, Massresha et al. (2021) and Neway and Zegeye (2022) showed that membership in agricultural cooperatives and social networks positively influenced adoption, pointing to the role of social capital in disseminating knowledge and encouraging peer learning. The empirical findings reveal that social factors influence both the likelihood and type of RA practices adopted. However, contradictions in the role of education, gender and age suggest that the social context and livelihood alternatives must be considered when designing RA interventions. This study investigates how these factors influence RA adoption among smallholder farmers in Embu and Tharaka Nithi counties, contributing to the ongoing effort to reconcile inconsistent empirical findings with local realities. Other socio-economic factors such as farm size, household income, access to extension services and training, and credit access have consistently been identified as key determinants in the adoption of regenerative agriculture practices. Several studies show that these variables influence farmers' ability to invest in new practices, absorb short-term costs, and access needed information and technologies.

Hu et al. (2022), in a study on agricultural technology adoption in China, found that farmers with larger farms were more willing to adopt innovations because they could spread risk and had more flexibility to allocate financial resources. A similar observation was made by Otara et al. (2023), who reported that larger farm sizes in Kenya were positively associated with the adoption of capital-intensive RA practices such as minimum tillage and rotational grazing, while smaller farms favoured intercropping and composting. These findings suggest that landholding size directly impacts the capacity to adopt resource-demanding practices. Access to extension services and training also emerged as a significant predictor of RA adoption. Ntawuhiganayo et al. (2023) found that farmers who received practical,

hands-on training were more likely to adopt and maintain RA practices, owing to increased knowledge and confidence. Similarly, Pangapanga-Phiri et al. (2024) emphasized the importance of farmer-centred learning approaches, such as demonstration plots and peer-to-peer learning, in maintaining long-term adoption of conservation agriculture in Malawi. Midamba et al. (2024) echoed these findings, noting that maize farmers in Northern Uganda who had access to both ICT-based agricultural information and extension visits were significantly more likely to adopt sustainable practices.

Credit availability and household income levels further determine adoption outcomes. According to Hawas and Degaga (2023), households with higher or diversified income sources were more capable of absorbing short-term risks associated with adopting new agricultural techniques. Udimal et al. (2017) also established that access to credit and ownership of productive assets such as tractors and labour had a statistically significant effect on the adoption of improved rice technologies in Ghana. These inputs helped farmers overcome cost-related barriers that often deter low-income households from adopting innovations. Similarly, Massresha et al. (2021) found that households engaged in non-farm income-generating activities and with access to credit were more likely to adopt improved seed and irrigation practices. The literature also highlights that training interventions and knowledge-sharing mechanisms are not only economic enablers but also essential for enhancing farmer confidence and reducing uncertainty during the transition to RA. Frankel-Goldwater et al. (2024) pointed out that knowledge systems and access to trusted information play a vital role in influencing farmer decisions. These studies suggest that economic resources, both financial and informational, are central to enabling adoption of regenerative practices. This study therefore includes farm size, household income, credit access, training, and extension services as key economic variables when examining the adoption of RA among smallholder farmers in Embu and Tharaka Nithi counties.

2.3.2 Environmental Factors and Adoption of Regenerative Agriculture

Environmental factors such as climate variability, soil degradation, and water scarcity play a pivotal role in shaping farmers' decisions to adopt regenerative agriculture (RA) practices. In many agroecological contexts, RA is increasingly seen not just as a sustainable

alternative but as a necessary adaptation strategy in the face of worsening environmental stressors. Pirani (2024) emphasized that farmers in drought-prone regions or areas with declining soil fertility often adopt regenerative techniques as essential tools for climate resilience, particularly when interventions are locally adapted to environmental realities. Wilson et al. (2023), in their study on U.S. farmers, found that adoption of RA practices like cover cropping and reduced tillage was strongly linked to extreme weather events. Farmers adopted these strategies to restore soil health, improve water retention, and enhance on-farm biodiversity, viewing RA as a form of climate risk mitigation. Similarly, in Australia, Kenny and Castilla-Rho (2022) reported that the worsening climate crisis and environmental degradation were primary motivators for farmers transitioning to regenerative systems, as conventional models became increasingly unsustainable.

In the African context, however, environmental motivations for RA adoption are often constrained by structural barriers. A World Bank study by Dabalen et al. (2024) highlighted that the success of regenerative practices such as carbon sequestration and soil fertility improvement is highly contingent on local climatic and soil conditions. Yet, many African farmers face limitations such as poor access to localized climate information, weak extension systems, and insecure land tenure, which undermine their capacity to adopt or scale RA, even when ecological motivations are strong. The literature suggests that while environmental degradation is a strong motivator for RA adoption, actual uptake is moderated by farmers' access to timely information, technical support, and land security. This study incorporates environmental variables such as drought frequency, rainfall variability, and perceived soil degradation to better understand how ecological realities drive the adoption of RA in Kenya's Embu and Tharaka Nithi counties.

2.3.3 Payment for Ecosystem Services and Adoption of Regenerative Agriculture

Payments for Ecosystem Services (PES) have gained increasing attention as a promising strategy to incentivize the adoption of regenerative agriculture (RA), especially among smallholder farmers. PES schemes provide financial or in-kind rewards to farmers who engage in sustainable land management practices that generate public environmental benefits such as improved soil health, biodiversity, and carbon sequestration. However,

smallholder farmers often face trade-offs between short-term costs and long-term ecological gains. To address this challenge, Dabalen et al. (2024) argue that PES mechanisms can help offset the initial costs of adopting RA, although such systems remain underdeveloped across many regions due to limited institutional capacity and funding.

In Kenya, Nyongesa et al. (2016) examined a PES scheme in the Lake Naivasha watershed and found that most farmers were willing to accept compensation to implement sustainable farm practices and showed strong willingness to continue participating. The study concluded that PES offers a viable tool for restoring degraded agro-ecosystems while enhancing rural livelihoods and advancing conservation goals. In a broader conceptual analysis, Engel and Müller (2016) highlighted the policy potential of PES to promote climate-smart agriculture (CSA) where intrinsic motivation is low and adoption risks are high. Although not focused on a single country, their study suggested that PES is especially promising for smallholder systems in low-income regions where agricultural sustainability goals intersect with climate adaptation needs.

Other studies from Sub-Saharan Africa further reinforce the value of PES schemes in agricultural sustainability. For instance, in Uganda, Geussens et al. (2019) found that most farmers were willing to participate in PES contracts, with a preference for individual rather than communal compensation. In-kind support such as tools or labour assistance also increased acceptance. These findings underline the importance of designing PES schemes that are context-sensitive and farmer-centred. Further afield, studies in Latin America and Europe show similar results. In Ecuador, Raes et al. (2017) found that while financial incentives attracted farmer participation in silvopastoral PES programs, trust in institutions and prior experiences with regulation played a critical role in shaping long-term commitment. Canessa et al. (2023), studying biodiversity payments in Germany, observed that farmers preferred hybrid PES models and valued technical support, achievability of outcomes, and scheme compatibility with existing farming systems. Informed by these insights, this study includes PES as a key determinant of regenerative agriculture adoption. By investigating how PES schemes influence adoption decisions among smallholder farmers in Embu and Tharaka Nithi counties, the study aims to provide empirical evidence

on the potential for PES to catalyse sustainable land management practices in Kenya's agricultural systems.

2.3.4 Control Variables – Land Tenure and Access to Markets

Land tenure security is widely recognized as a foundational enabler of sustainable agricultural investment. Farmers who have secure rights over their land, either through formal title deeds or long-term customary claims, are more likely to adopt long-term soil-enhancing practices, such as composting, mulching, and agroforestry. As noted by Neway and Zegeye (2022), secure land tenure improves farmers' confidence in investing in regenerative practices by lowering the risk of land loss and enabling intergenerational planning. Conversely, insecure, or communal tenure systems may discourage adoption due to uncertainty about future returns or land access.

Access to markets also plays a crucial role in the adoption of RA. Farmers who are located closer to aggregation centres, roads, or consistent buyers have more incentive to improve the quality and quantity of their produce through sustainable practices. Better market access increases the likelihood of receiving higher prices, diversifying income sources, and obtaining inputs or technical support. According to Massresha et al. (2021), proximity to markets was significantly associated with higher uptake of improved farming techniques. In the context of regenerative agriculture, markets that value sustainably produced crops or link to carbon credit schemes may create additional economic incentive for adoption.

2.4 Summary of the Literature Research Gaps

Table 2.1: Summary of Literature and Gaps

Author(s) & Year	Purpose of the Study	Key Findings	Research Gaps Identified	Type of Gap	How Present Study Will Fill the Gaps
Otara et al. (2023)	To evaluate socioeconomic factors influencing the uptake of regenerative agriculture technologies in the dry lands of Embu County, Kenya.	Farming experience, farm size, main occupation, off-farm activities, age, gender, marital status, and education level influenced uptake.	The study did not investigate the influence of environmental factors, incentives such PES, or land tenure.	Conceptual	This study incorporated additional factors such as climate conditions, land tenure, and incentive structures to build a more multidimensional framework
Ntawuhiganayo et al. (2023)	To understand how circular economy principles are applied in agriculture and drivers of adoption of regenerative agriculture and household food security in Rwanda and Kenya	Adoption is low; farmers adopt low-capital regenerative practices such as intercropping and crop rotation; training increases likelihood of adoption	The study did not analyze the influence of climate conditions, land tenure systems, or market access, and focused primarily on socioeconomic and training factors	Conceptual	This study expanded the analysis by including drivers such as climate variability, land tenure security, and access to markets, and PES.
Neway & Zegeye (2022)	To analyze gender differences in the adoption of agricultural technology in	Gender significantly influences technology adoption, with	The study did not consider environmental factors, incentives such as PES, or wider socioeconomic factors	Conceptual	This study used a broader and multidimensional framework that includes incentives, extension

	North Shewa Zone, Ethiopia	male-headed households adopting more than female-headed ones due to differences in access and resources	of adoption and focused narrowly on gender-related economic and social factors.		service dynamics, and environmental conditions.
Wordofa et al. (2021)	To assess the impact of adoption of improved agricultural technologies on household income in Eastern Ethiopia	Users of improved technologies had significantly higher annual farm income; livestock ownership, land size, and soil conservation practices were key adoption drivers	The study focused on income impacts of conventional technologies and did not assess regenerative practices or broader socioeconomic or environmental drivers	Conceptual	This study focused specifically on regenerative agriculture practices and integrate socioeconomic, environmental, and incentive-related variables
Massresha et al. (2021)	To assess the perception and determinants of agricultural technology adoption in North Shoa Zone, Ethiopia	Adoption was influenced by age, education, farm size, livestock, off-farm income, extension access, credit access, and market distance	The study did not focus on regenerative agriculture and lacked analysis of climate conditions, land tenure security, or incentive-related factors	Conceptual	This study focused on regenerative agriculture and included environmental factors like climate variability, and issues of land tenure and incentive schemes
Hu et al. (2022)	To analyze the impact of farm size on agricultural technology progress in China from both micro	Larger farm size was associated with higher adoption of new technologies and greater investment in knowledge acquisition; higher	The study focused on farm size and did not assess other socioeconomic factors, environmental conditions, or incentive-related drivers of adoption,	Conceptual	This study went beyond structural factors like farm size to examine socioeconomic, incentive-related, and environmental factors influencing adoption in

	and macro perspectives	rates of technology progress in large-scale areas	especially in smallholder settings		African smallholder contexts
Midamba et al. (2024)	To determine the intensity and determinants of adoption of sustainable agricultural practices (SAPs) among maize producers in Northern Uganda	Education, farm size, ICT use, market information, extension access, and credit access increased adoption; household size negatively affected adoption	The study focused on SAPs broadly and did not examine regenerative practices or examine effects of incentives and climate conditions	Conceptual	This study focuses on regenerative agriculture and included incentive-related factors, climatic conditions variables that influence adoption
Kenny & Castilla-Rho (2022)	To explore barriers to adoption of regenerative agriculture in Australia through participatory modelling	Barriers are deeply rooted in values, beliefs, and systems; change requires coordinated long-term action at institutional, social, and individual levels	The study used participatory modelling to explore narratives but did not use empirical data or test actual adoption behavior of smallholder farmers	Conceptual	This study uses empirical data to identify drivers of regenerative agriculture adoption among smallholders in an African context
Dabalen et al. (2024)	To review empirical evidence on the impact of regenerative agriculture on productivity, resilience, and climate mitigation	Regenerative agriculture has potential to achieve triple wins, but empirical evidence is limited; adoption barriers include profitability concerns and lack of incentives	The study did not conduct empirical research or test variables on the ground; highlights need for causal empirical studies in African smallholder contexts	Conceptual	This study uses primary data to test specific socioeconomic, environmental, and incentive-related factors influencing adoption of regenerative agriculture by smallholder farmers

Frankel-Goldwater et al. (2024)	To uncover primary drivers in the adoption of regenerative agriculture among farmers and ranchers in the United States	Adoption is driven by the desire to improve health of people, soils, and ecosystems; relative economic privilege influences adoption	Study focused primarily on relational values and philosophical drivers in the U.S. context and did not analyze smallholder farmer constraints	Contextual	This study provides insights from a smallholder African context, incorporating variables like market access, land tenure, and localized barriers to regenerative agriculture adoption
Alexanderson et al. (2024)	To identify motivators, barriers, and farmer perceptions on regenerative agriculture in Australia	Regenerative agriculture was adopted for profitability, soil health, resilience; barriers included lack of community support and knowledge	The study focused on Australian farmers and used an online survey; lacks analysis of socioeconomic and incentive-based drivers relevant to African smallholder contexts	Contextual	This study focuses on smallholder farmers in Kenyan context, examining incentive-related drivers, market access, and training as key enablers of adoption.
Pangapanga-Phiri et al. (2024)	To understand the sustained adoption of conservation agriculture (CA) in a sentinel site in Malawi	Long-term extension support and peer learning are critical for sustained adoption; adoption decays over time without continued support	The study focused only on CA in a single site and did not explore broader institutional, environmental, or market-related barriers to regenerative agriculture	Contextual	This study broadens the scope to other regenerative practices and multiple regions, and includes wider socioeconomic and market access variables in the analysis
Nyongesa et al. (2016)	To estimate farmers' willingness to accept pay for ecosystem services and its socio-economic	Majority of farmers are willing to accept pay for sustainable land use practices; education, farm size, and income	The study was context-specific to ecosystem services, not focusing on regenerative agricultural practices or long-term behavioral factors	Contextual	This study assesses adoption of regenerative practices beyond PES and integrates socioeconomic, and environmental dimensions among smallholders' farmers.

	determinants in Lake Naivasha watershed	levels influence willingness			
Geussens et al. (2019)	To examine farmers' perspectives on PES design in Uganda using a choice experiment	Farmers showed strong willingness to participate in PES, with preference for individual over communal compensation and support for in-kind rewards	The study focused on PES design and farmer preferences, but not on actual adoption behavior of regenerative practices or long-term sustainability factors	Contextual	This study investigates actual adoption behavior of regenerative agriculture practices and includes socioeconomic, and environmental variables relevant to sustained adoption, beyond PES.
Canessa et al. (2023)	To examine farmers' preferences for different PES schemes (action-based, result-based, hybrid) and link them to biodiversity levels in Germany	Farmers with higher biodiversity were more likely to prefer result-based schemes; intensive farmers favored hybrid schemes; applicability and achievability of practices affected adoption decisions	The study focused on high-income contexts and grassland biodiversity, and did not assess applicability of PES or hybrid models in smallholder farming systems in low-income regions	Contextual	This study explores the feasibility and appeal of incentive models for regenerative agriculture in African smallholder systems.
Otara et al. (2023)	To evaluate socioeconomic factors influencing the uptake of regenerative agriculture technologies in the dry lands of Embu County, Kenya.	Farming experience, farm size, main occupation, off-farm activities, age, gender, marital status, and education level influenced uptake.	Applied binary adoption measures ("adopted/not adopted") without assessing intensity or diversity	Methodological	This study measures adoption across multiple RA practices, capturing both extent and intensity, not just yes/no adoption.

Wilson et al. (2023)	Investigated drought exposure and RA adoption in the US	Farmers facing drought more likely to adopt RA	Descriptive in nature, did not anchor analysis in behavioural theories	Methodological	This study anchors the analysis in IRT and PMT to test theory-based constructs empirically.

Source: (Author, 2025)

2.5 Conceptual Framework

The conceptual framework for this study was developed by integrating Innovation Resistance Theory (IRT) and Protection Motivation Theory (PMT) to explain the factors influencing adoption of regenerative agriculture (RA) practices among smallholder farmers in Embu and Tharaka Nithi Counties. The framework recognizes that adoption decisions are influenced by both resistance to change and motivation to respond to environmental threats. While IRT explains why farmers may resist adopting regenerative agriculture practices despite their potential benefits, PMT explains the factors that motivate farmers to adopt such practices as adaptive responses to environmental and climatic risks. Together, the two theories provide a more comprehensive explanation of adoption behaviour than either theory alone. Innovation Resistance Theory suggests that adoption may be hindered by perceived complexity, implementation costs, uncertainty regarding outcomes, and incompatibility with existing farming practices (Ram & Sheth, 1989). These barriers are reflected in the socio-economic characteristics examined in this study, including education level, farming experience, household income, access to credit, training, extension services, and farm size. Farmers with limited resources, knowledge, or institutional support are likely to perceive regenerative agriculture practices as costly, risky, or difficult to implement, thereby increasing resistance to adoption (Otara et al., 2023; Ntawuhiganayo et al., 2023).

Protection Motivation Theory complements this perspective by explaining how environmental threats influence adoption decisions. According to PMT, farmers are more likely to adopt protective behaviours when they perceive environmental risks as severe and believe that available responses are effective and feasible (Rogers & Prentice-Dunn, 1997). In this study, environmental factors such as declining soil fertility, rainfall variability, and drought occurrence represent threat appraisal components, while payment for ecosystem services, training, extension support, and access to resources strengthen coping appraisal through enhanced self-efficacy and response efficacy. Consequently, farmers who perceive greater environmental risks and possess adequate capacity to respond are expected to exhibit higher levels of regenerative agriculture adoption. The two theories complement each other by recognizing that adoption decisions involve both motivational and resistance

processes. PMT explains why farmers may be motivated to adopt regenerative agriculture due to environmental threats, whereas IRT explains why adoption may still be delayed or rejected despite such motivation because of perceived barriers and costs. However, the theories differ in their underlying assumptions. PMT assumes that perceived threats encourage adaptive behaviour, while IRT emphasizes that perceived complexity, risks, and incompatibility may discourage adoption even when benefits are recognized. The integration of these theories therefore allows the study to capture both the drivers and constraints of regenerative agriculture adoption.

Based on this theoretical integration, the study conceptualizes socio-economic factors, environmental factors, and payment for ecosystem services as the primary independent variables influencing adoption of regenerative agriculture practices. Market access and land tenure are included as control variables because they shape farmers' access to resources and incentives that may facilitate or constrain adoption. The dependent variable is adoption of regenerative agriculture practices, measured through the extent to which farmers implement regenerative practices such as agroforestry, cover cropping, mulching, crop rotation, minimum tillage, stubble retention, rotational grazing, organic manure application, and micro-dosing. The framework therefore proposes that socio-economic factors, environmental factors, and payment for ecosystem services influence adoption both directly and indirectly through their effects on farmers' perceptions of risk, capacity, costs, and expected benefits. This integrated theoretical perspective guided the formulation of the study hypotheses and the empirical analysis of factors associated with adoption of regenerative agriculture practices among smallholder farmers.

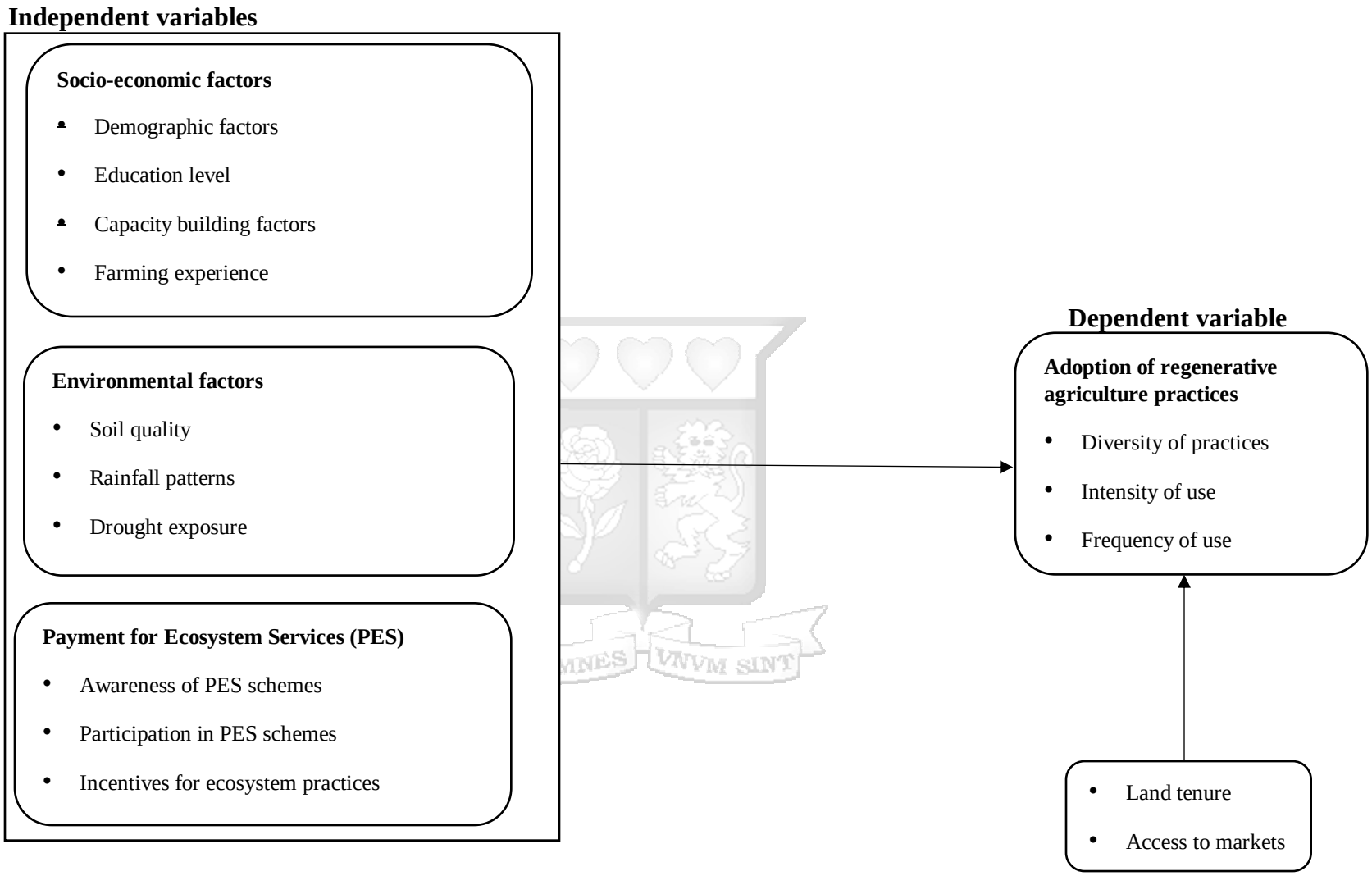


Figure 2.1: Conceptual Framework

Source: (Author, 2025)

2.6 Operationalization of the variables

Table 2.2: Operationalization of Variables

Variable	Type	Type of variable	Indicators	Measurement	Literature Source	Theory Supported
Dependent variable						
Adoption of regenerative agriculture practices	Dependent	Ordinal index component	Diversity (number of practices)	Number of regenerative agriculture practices adopted by the farmer	Pangapanga-Phiri et al. (2024); Frankel-Goldwater et al. (2024).	Innovation Resistance Theory Protection Motivation Theory
Adoption of regenerative agriculture practices	Dependent	Ordinal index component	Ordinal categories converted to index component	Percentage of farm area under RA practices	Pangapanga-Phiri et al. (2024); Frankel-Goldwater et al. (2024).	Innovation Resistance Theory Protection Motivation Theory
Adoption of regenerative agriculture practices	Dependent	Ordinal	Ordinal index component	5-point scale (1=Never to 5=Always)	Pangapanga-Phiri et al. (2024).	Innovation Resistance Theory Protection Motivation Theory

VT OMNES VNVM SINT

Adoption of regenerative agriculture practices	Dependent	Ordinal	Ordinal index component	Number of consecutive years using RA practices (ordinal ranges)	Pangapanga-Phiri et al. (2024).	Innovation Resistance Theory Protection Motivation Theory
Independent variables						
Socio-economic factors	Demographic factors	Ordinal	Gender	1=Male, 2=Female	Neway & Zegeye (2022).	Innovation Resistance Theory
Socio-economic factors	Demographic factors	Continuous	Age	Age in years or age ranges	Massresha et al. (2021).	Innovation Resistance Theory
Socio-economic factors	Demographic factors	Continuous	Household size	Household members (ranges, e.g., 1–3; 4–6; 7+)	Midamba et al. (2024).	Innovation Resistance Theory
Socio-economic factors	Education level	Ordinal	Highest level of education attained	Ordinal: 1=None, 2=Primary, 3=Secondary, 4=Tertiary	Midamba et al. (2024); Massresha et al. (2021).	Protection Motivation Theory
Socio-economic factors	Farming experience	Continuous	Years of farming experience	Years in farming (ranges: <5, 5–	Otara et al. (2023). Theory: IRT	Protection Motivation Theory

				10, 11–15, 16–20, >20)		
Socio-economic factors	Capacity building factors	Ordinal	Access to training	5-point Likert (1=None to 5=Very frequent)	Ntawuhiganayo et al. (2023).	Protection Motivation Theory
Socio-economic factors	Capacity building factors	Ordinal	Access to extension services	5-point Likert (1=None to 5=Very frequent)	Pangapanga-Phiri et al. (2024).	Protection Motivation Theory
Socio-economic factors	Resource access factors	Continuous	Household income	Household income range (KES)	Wordofa et al. (2021).	Protection Motivation Theory
Socio-economic factors	Resource access factors	Continuous	Access to credit	5-point Likert (1=Very difficult to 5=Very easy)	Midamba et al. (2024). Theory: PMT	Protection Motivation Theory
Socio-economic factors	Resource access factors	Continuous	Farm size	Ordinal: 1=Small (<2 acres), 2=Medium (2–5 acres), 3=Large (>5 acres)	Hu et al. (2022); Massresha et al. (2021).	Innovation Resistance Theory
Environmental factors	Soil quality	Ordinal	Perceived soil fertility	Perceived soil fertility	Alexanderson et al. (2024).	Innovation Resistance Theory

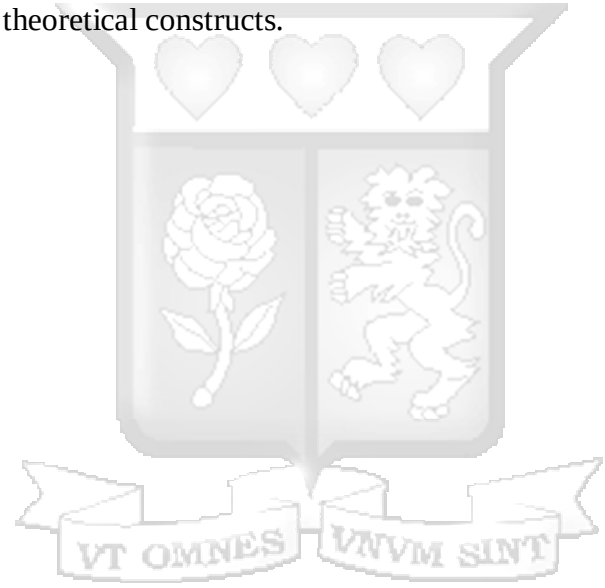
				(1=Very poor to 5=Very good)		Protection Motivation Theory
Environmental factors	Rainfall patterns	Ordinal	Perceived rainfall reliability	Perceived rainfall reliability (1=Very unreliable to 5=Very reliable)	Massresha et al. (2021).	Innovation Resistance Theory Protection Motivation Theory
Environmental factors	Drought exposure	Ordinal	Frequency of drought	Frequency in past 3 years (1=Never to 5=Very frequent)	Dabalen et al. (2024).	Protection Motivation Theory
Payment for Ecosystem Services (PES)	Awareness of PES schemes	Ordinal	Awareness of PES schemes	5-point scale (1=None to 5=Very high awareness)	Nyongesa et al. (2016); Geussens et al. (2019).	Protection Motivation Theory
Payment for Ecosystem Services (PES)	Participation in PES schemes	Ordinal	Degree of participation in PES schemes	Degree of participation (1=None to 5=Very active)	Nyongesa et al. (2016).	Protection Motivation Theory
Payment for Ecosystem Services (PES)	Incentives for ecosystem practices	Ordinal	Perceived strength of incentives	Perceived strength of incentives	Canessa et al. (2023).	Protection Motivation Theory

			(e.g., carbon credits)	(1=None to 5=Very strong)		
Land tenure	Control	Ordinal	Ownership status	Categories: Rented / Family-owned / Individually owned	Massresha et al. (2021); Wordofa et al. (2021).	Protection Motivation Theory
Access to markets	Control	Ordinal	Distance / ease of access	5-point Likert (1=Very difficult to 5=Very easy)	Massresha et al. (2021).	Protection Motivation Theory

Source (Author, 2025)

Several constructs in this study, namely socio-economic factors, environmental factors, payment for ecosystem services (PES), and adoption of regenerative agriculture practices, were multidimensional in nature and therefore could not be adequately represented by a single indicator. To address this, composite indices were constructed using multiple questionnaire items representing each construct. The selection of indicators was guided by the theoretical foundations of Innovation Resistance Theory (IRT) and Protection Motivation Theory (PMT), as well as empirical studies on regenerative agriculture adoption (Massresha et al., 2021; Pangapanga-Phiri et al., 2024; Wordofa et al., 2021). Responses measured on ordinal Likert-type scales were coded numerically and aggregated to form composite indices. Equal weighting was applied to all indicators within each construct. The choice of equal weighting was based on three considerations. First, literature does not provide a universally accepted theoretical basis for assigning differential weights to the selected indicators.

Second, equal weighting minimizes researcher subjectivity and has been widely used in composite index construction where indicators are considered equally important dimensions of a latent construct (OECD, 2008). Third, equal weighting provides transparency and ease of interpretation, particularly in exploratory studies examining relationships among multidimensional variables. To assess the robustness of the index construction procedure, sensitivity checks were performed by comparing the results obtained using composite indices with analyses based on individual indicators. The direction and significance of the key relationships remained broadly consistent across specifications, suggesting that the findings were not sensitive to the equal-weighting assumption. Therefore, the composite indices were considered appropriate representations of the underlying theoretical constructs.



CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used to investigate the determinants of the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties. It covers research philosophy, design, target population, sampling methods, data collection tools, data analysis techniques, and ethical considerations.

3.2 Research Philosophy

This study was guided by the positivist research philosophy, which is rooted in the belief that reality exists independently of human perception and can be objectively observed, measured, and analyzed (Cohen et al., 2007). Positivism emphasizes the use of empirical, quantifiable data and structured methodologies to test hypotheses and identify causal relationships. In the context of this research, which sought to examine the influence of social, economic, environmental, and incentive-based factors on the adoption of RA practices among smallholder farmers in Embu and Tharaka Nithi counties, positivism provides a systematic framework for gathering and analyzing measurable data. Using structured questionnaires and statistical analysis, the study aimed to generate generalizable findings that can inform evidence-based policy and programming across similar agricultural settings.

Nevertheless, alternative research philosophies such as interpretivism and pragmatism also offer relevant insights. Interpretivism, for instance, emphasizes subjective meanings and social interactions, which are important in understanding farmers' perceptions, values, and cultural influences on adoption (Cohen et al., 2018). Pragmatism, on the other hand, allows for combining qualitative and quantitative approaches to capture both measurable determinants and lived experiences (Saunders et al., 2019). While these paradigms are valuable, this study prioritized positivism because its primary aim was to test theory-driven hypotheses and quantify the effect of socioeconomic, environmental, and incentive-based variables on adoption. However, by acknowledging socio-cultural nuances highlighted in

interpretive traditions, the study remains aware of the contextual complexity of adoption behaviour, even if these are not the central focus of the chosen methodology.

3.3 Research Design

This study adopted a cross-sectional research design, which is appropriate for examining relationships among variables at a single point in time. According to Kumar (2019), a cross-sectional research design enables researchers to collect data from a target population simultaneously and analyse patterns, characteristics, and associations among study variables without manipulating the research environment. The design is particularly suitable for studies seeking to establish statistical relationships and identify factors associated with a particular phenomenon. The choice of a cross-sectional design was informed by the study objective of examining the association between socio-economic factors, environmental factors, payment for ecosystem services, market access, land tenure, and adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties. The design facilitated the collection of data from a large number of respondents within a relatively short period and at a lower cost compared to longitudinal approaches. Since data were collected at one point in time, the study does not establish causal relationships between the variables but rather identifies the extent and direction of associations among them. Consequently, the findings should be interpreted as evidence of statistical relationships rather than definitive cause-and-effect linkages.

3.4 Population and Sampling

3.4.1 Population of the Study

Saunders et al. (2009) define a population as the full set of cases from which a sample is drawn. For this study, the target population comprised smallholder farmers residing in Embu and Tharaka Nithi counties. According to the 2019 Agricultural Census (Ministry of Agriculture and Livestock Development, 2019), there was a total of 216,601 farming households in the two counties. Using Yamane's formula, a sample size of 399 farmers was determined. The sample has been rounded off to 400 farmers.

$n = N/1 + N(e)^2$ 3.1

Where:

N = 216,601 (total estimated farmers)

e = 0.05 (sampling error margin)

n = 216,601/1 + 216,601(0.05)^2 = 399 farmers

The study drew its sample from two distinct categories of smallholder farmers. The first group consisted of farmers who had some exposure to Farm Africa's regenerative agriculture project, including participation in field schools, training sessions, or demonstration activities. The second group comprised farmers from comparable areas within the same agroecological zones who had not had direct contact with Farm Africa interventions. This dual-sampling approach helped minimize potential bias and enabled comparison between project-influenced and independent adopters of RA practices.

Using Yamane's (1967) formula with a 5% level of precision, a total sample size of 400 farmers was determined from the combined agricultural population of 216,601 smallholder households across the two counties. To ensure proportional representation, 242 farmers were drawn from Embu County (130,925 farming households) and 158 from Tharaka Nithi County (85,676 farming households). Within each county, approximately half of the respondents were selected from areas exposed to Farm Africa's interventions, and the other half from non-project areas. This proportional stratification enhances representativeness and addresses the risk of overestimating adoption due to program-related influence.

VT OMNES VNVM SINT

Table 3.1: Population and Sample Distribution by County and Exposure Status

County	Exposure Status	Population (Farming Households)	Population (%)	Sample Size	Sample (%)
Embu	Exposed to Farm Africa Interventions	65,463	30.22	121	30.25
Embu	Non-Exposed	65,462	30.22	121	30.25
Subtotal Embu		**130,925**	**60.45**	**242**	**60.50**
Tharaka Nithi	Exposed to Farm Africa Interventions	42,838	19.78	79	19.75
Tharaka Nithi	Non-Exposed	42,838	19.78	79	19.75
Subtotal Tharaka Nithi		**85,676**	**39.55**	**158**	**39.50**
Total		**216,601**	**100.00**	**400**	**100.00**

Source: Ministry of Agriculture and Livestock Development (2019) and Author (2026).

3.4.2 Sample Size Determination

The sample size was 400 farmers calculated using Yamane's formula, suitable for large populations and aiming for a 5% margin of error and a 95% confidence level. Following determination of the sample size, a stratified random sampling approach was employed to select the respondents. The target population was first stratified by county (Embu and Tharaka Nithi) and further categorized according to farmers who had been exposed to Farm Africa's regenerative agriculture interventions and those who had not been exposed. The sample was then allocated proportionately across the strata based on the number of farming households in each category. Within each stratum, respondents were selected using simple random sampling to ensure that every eligible farmer had an equal chance of inclusion in the study. This procedure enhanced the representativeness of the sample and minimized sampling bias.

3.5 Data Collection Methods

This study employed a structured questionnaire as the primary data collection tool. The questionnaire was administered to smallholder farmers across selected sub-counties in Embu and Tharaka Nithi counties. The questionnaire was designed to capture both

quantitative and categorical data relevant to the independent variables and the dependent variable. The questionnaire was divided into thematic sections aligned with the conceptual framework and informed by validated tools used in similar studies. Questions were close-ended and structured on a Likert scale to allow for statistical analysis. A pilot study of 20 farmers was conducted in the same counties prior to the main survey to test the clarity, reliability, and internal consistency of the questionnaire.

Data was collected through face-to-face interviews, conducted by trained enumerators fluent in English, Swahili, and the local languages. This approach ensures accurate interpretation of responses, particularly for respondents with low literacy levels. To gain access to farmer groups and farmers, official permissions were sought from the Departments of Agriculture in the county governments of Embu and Tharaka Nithi. Additional coordination was done with Sub-County Agricultural Officers and community leaders to facilitate smooth mobilization of participants and logistical support.

3.6 Data Analysis

Data collected from the field survey was coded, entered and analyzed using Python in a Jupiter Notebook environment. The dataset was first subjected to data cleaning procedures, including removal of incomplete responses, consistency checks and recoding of categorical variables into numerical form. Likert-scale responses were transformed into ordered numerical values to facilitate quantitative analysis. Composite indices were then constructed using weighted averages to represent the major constructs of the study: socio-economic factors, environmental factors, payment for ecosystem services (PES), adoption of regenerative agriculture practices, land tenure and access to markets. This transformation enabled multidimensional concepts to be analyzed as continuous variables.

Prior to analysis, the validity of the research instrument was tested using the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy, while reliability was assessed using Cronbach's alpha coefficient. After confirming acceptable validity and reliability, descriptive statistics were computed, including frequencies and percentages for categorical variables and means and standard deviations for scale variables. Bivariate relationships were examined using Pearson correlation coefficients to establish preliminary associations

among the study variables. The main analysis employed multiple linear regression estimated using Ordinary Least Squares (OLS) to determine the determinants of adoption of regenerative agriculture practices.

Diagnostic tests were conducted to verify regression assumptions. Multicollinearity was assessed using the Variance Inflation Factor (VIF), heteroscedasticity using the Breusch–Pagan test, normality using the Shapiro–Wilk test, linearity using the Ramsey RESET test, and influential observations using Cook's Distance, leverage values, and studentized residuals. Where violations were detected, appropriate corrective measures were implemented. Specifically, heteroscedasticity-robust (HC1) standard errors were used, and nonlinear relationships were addressed by introducing quadratic terms after mean-centering relevant variables.

3.7 Model Specification

This study examined the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties, Kenya. The dependent variable was the adoption of regenerative agriculture practices index, measured as a composite indicator derived from four dimensions of adoption: diversity of regenerative agriculture practices adopted, proportion of land under regenerative agriculture, frequency of application, and duration of continuous use. The independent variables comprised socio-economic factors, environmental factors, and payment for ecosystem services (PES), while market access and land tenure were included as control variables. Given the multidimensional nature of the study constructs, composite indices were developed for socio-economic factors, environmental factors, PES and adoption of regenerative agriculture practices. The indices were constructed using equal weighting of validated indicators and aggregated using arithmetic means.

Equal weighting was adopted because no theoretical or empirical evidence existed to justify assigning greater importance to any individual indicator within a construct. Furthermore, equal weighting minimizes researcher subjectivity and is widely recommended where indicators represent complementary dimensions of a latent concept. Although alternative approaches such as factor analysis and structural equation modelling

can generate statistical weights, these methods are primarily appropriate when the objective is latent variable modelling or theory testing. Since the objective of this study was to examine relationships among multidimensional constructs rather than estimate latent factor structures, equal-weighted composite indices provided a transparent and easily interpretable approach. Construct validity was assessed using the Kaiser-Meyer-Olkin (KMO) measure and reliability was evaluated using Cronbach's alpha coefficients prior to index construction.

The composite indices were treated as approximately continuous variables because they were derived from multiple ordinal indicators aggregated into standardized composite scores. Previous methodological studies have demonstrated that composite indices generated from multiple Likert-type items can be analysed using linear regression techniques when they approximate continuous distributions and satisfy key regression assumptions. Accordingly, Ordinary Least Squares (OLS) regression was selected as the primary estimation technique. Alternative models such as ordered logit, ordered probit, Tobit, and fractional response models are typically appropriate when the dependent variable remains purely ordinal, censored, or fractional. However, because the adoption index combined several dimensions of adoption into a continuous composite measure, OLS was considered appropriate and provided coefficients that are readily interpretable. Nevertheless, the findings should be interpreted within the limitations of the chosen modelling framework.

Prior to model estimation, diagnostic tests for multicollinearity, heteroscedasticity, normality, and autocorrelation were conducted. The diagnostic results indicated the presence of heteroscedasticity in the residuals. Consequently, the model was estimated using Ordinary Least Squares with heteroscedasticity-robust standard errors (HC1) to obtain reliable parameter estimates and valid statistical inference. Robust standard errors help correct for non-constant error variance and improve the accuracy of hypothesis testing. Potential sources of endogeneity were also considered. For example, adoption of regenerative agriculture practices may itself improve household income, access to markets, or participation in PES programmes, creating the possibility of reverse causality.

In addition, unobserved factors such as farmer attitudes, entrepreneurial ability, and risk preferences may influence both the explanatory variables and adoption decisions. However, because the study relied on cross-sectional survey data and focused on identifying associations rather than establishing strict causal relationships, no instrumental variable approach was implemented. The findings should therefore be interpreted as evidence of statistical associations rather than definitive causal effects. The study was conducted at the household level, with each household represented by a single respondent. Consequently, intra-household correlation was not expected to pose a significant concern. The use of robust standard errors further enhanced the reliability of statistical inference by accounting for potential violations of classical regression assumptions.

The regression model was specified as follows:

Let:

AI_i = Adoption of regenerative agriculture practices index

SE_i = Socio-economic factors index

ENV_i = Environmental factors index

PES_i = Payment for ecosystem services index

Ma_i = Market access index

LT_i = Land tenure index

ε_i = Error term

The estimated model was expressed as:

$$AI_i = \beta_0 + \beta_1 SE_i + \beta_2 ENV_i + \beta_3 PES_i + \beta_4 LT_i + \beta_5 MA_i + \varepsilon_i \quad \text{..... 3.2}$$

Where:

β_0 = Intercept term

$\beta_1 - \beta_5$ = Regression coefficients measuring the effect of each explanatory variable on adoption of regenerative agriculture practices.

The parameters were estimated using the Ordinary Least Squares estimator:

$$\hat{\beta} = (X'X)^{-1} X'Y \quad \text{……3.3}$$

To address the violation of the homoscedasticity assumption, heteroscedasticity-robust (HC1) standard errors were used when computing test statistics and confidence intervals.

This approach ensured consistent standard error estimates and improved the reliability of hypothesis testing regarding the determinants of adoption of regenerative agriculture practices.

3.8 Research Quality

The quality of research refers to the extent to which the tools and procedures used in a study produce credible, consistent, and dependable results. As noted by Saunders et al. (2009), quality research should be capable of yielding similar results under consistent conditions. In this study, research quality was ensured through validity and reliability tests.

3.8.1 Validity of the Research Instrument

This subsection presents the assessment of the validity of the research instrument to ensure that the questionnaire adequately measured the intended study constructs. Construct validity was evaluated using the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy, which determines whether the variables share sufficient common variance to justify factor analysis. A higher KMO value indicates that the items are appropriate for measuring the underlying constructs. Table 3.2 reports the KMO statistics used to establish the validity of the research instrument.

Table 3.2: Validity of Research Instrument

Items/Scale	Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)	Sig.
Socio economic factors	0.465	0.000
Environmental factors	0.463	0.000
Payment for ecosystem services	0.643	0.000
Adoption of regenerative agriculture	0.543	0.000
Land tenure	0.401	0.000
Access to markets	0.512	0.000

Source (Author, 2026)

Table 3.2 presents the results of the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy used to assess the construct validity of the research instrument. The KMO statistic evaluates whether the observed variables share sufficient common variance to justify factor analysis, with values closer to 1 indicating stronger validity. Conventionally, KMO values above 0.5 are considered acceptable, values between 0.4–0.5 are considered

marginal but usable, and values below 0.4 indicate inadequate sampling adequacy. The socio-economic factors scale recorded a KMO value of 0.465, while environmental factors had a KMO of 0.463. These values fall within the marginal range, suggesting that the items moderately capture a common underlying construct but may contain some heterogeneity. Despite this, the significance level ($p = 0.000$) indicates that correlations among the items were sufficient to justify their inclusion in subsequent analysis.

The payment for ecosystem services (PES) scale achieved a KMO value of 0.643, indicating acceptable sampling adequacy and stronger construct validity relative to the other constructs. Similarly, the adoption of regenerative agriculture scale recorded a KMO value of 0.543, which meets the minimum acceptable threshold, implying that the indicators adequately represent the adoption construct. The control variables showed lower adequacy levels. Land tenure recorded a KMO value of 0.401, suggesting weak but still usable common variance among its indicators, while access to markets achieved a KMO of 0.512, indicating acceptable validity. In all cases, the significance levels ($p = 0.000$) confirm that the correlation matrices were appropriate for factor-based evaluation.

3.8.2 Reliability of the Research Instrument

This subsection presents the assessment of the reliability of the research instrument to determine the internal consistency of the questionnaire items used to measure the study constructs. Reliability was evaluated using Cronbach's alpha coefficient, which indicates the extent to which the items consistently measure the same underlying concept. Higher alpha values reflect greater internal consistency and stability of the measurement scale. Table 3.3 reports the Cronbach's alpha values used to establish the reliability of the research instrument.

Table 3.3: Reliability of the Research Instrument

Items	Cronbach's Alpha	No. of Items
All items on the questionnaire	0.862	32
Socio economic factors	0.734	10
Environmental factors	0.793	3
Payment for ecosystem services	0.795	3
Land tenure	0.801	3
Access to markets	0.823	1

Source (Author, 2026)

Table 3.3 presents the results of the reliability analysis conducted using Cronbach's alpha coefficient to assess the internal consistency of the questionnaire items measuring the study constructs. Cronbach's alpha values above 0.7 are generally considered acceptable, values above 0.8 good, and values above 0.9 excellent, indicating that the items consistently measure the intended constructs. The overall questionnaire achieved a Cronbach's alpha of 0.862 across 32 items, indicating high internal consistency and confirming that the instrument reliably captured the constructs under investigation. This suggests that the questionnaire items were well structured and suitable for statistical analysis.

The socio-economic factors scale recorded an alpha of 0.734 across 10 items, which falls within the acceptable reliability range. This indicates that the items measuring demographic characteristics, education, capacity building, farming experience and resource access consistently represented the socio-economic construct. The environmental factors scale achieved an alpha of 0.793 across 3 items, indicating good reliability, while the payment for ecosystem services (PES) scale recorded an alpha of 0.795, also demonstrating good internal consistency. For the control variables, land tenure recorded an alpha of 0.801 across 3 items, indicating good reliability. Access to markets recorded an alpha of 0.823 despite being measured with a single item; this reflects strong stability in responses and consistency across observations.

3.8.3 Pilot Test

A pilot study was conducted prior to the main survey to assess the clarity, relevance, and reliability of the questionnaire and to identify any ambiguities in the data collection

instrument. The pilot involved a sample of smallholder farmers drawn from Embu and Tharaka Nithi counties who possessed characteristics similar to those of the target population. Feedback obtained from the pilot study was used to refine the questionnaire, improve question sequencing, and enhance the overall quality of the instrument before the main data collection exercise.

Although the pilot study was conducted within the study counties, the pilot respondents were selected separately from those targeted for the main survey. The pilot exercise was undertaken solely for instrument testing and refinement and did not form part of the final study sample used for analysis.

3.9 Ethical Issues in Research

Ethical considerations were addressed during the study to ensure the protection of participants' rights and integrity of the research process. Before data collection began, approvals were sought from Strathmore University Institutional Scientific and Ethics Review Committee and a research permit was obtained from the National Commission for Science, Technology & Innovation (NACOSTI). Participants were asked for their informed permission, which included an explanation of the study's objectives, and the voluntary nature of their involvement. Measures were implemented to protect personal information throughout the research process.

VT OMNES VNVM SINT

CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents the analysis and interpretation of data on the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties. It begins with the response rate to establish the adequacy of the collected data, followed by demographic characteristics to provide context for the study population. Descriptive statistics are then used to summarize socio-economic factors, environmental conditions, payment for ecosystem services, and adoption indicators. Correlation analysis is conducted to examine preliminary relationships among the variables. Diagnostic tests are subsequently performed to assess the assumptions underlying regression analysis. Finally, regression results are presented and interpreted to determine the influence of the explanatory variables on the adoption of regenerative agriculture practices.

4.2 Response Rate

Table 4.1 presents the response rate of the administered questionnaires, which is used to assess the adequacy and reliability of the collected data for subsequent statistical analysis.

Table 4.1: Response Rate

Responses	Frequency	Response Rate (%)
Responded	393	98.25%
Not Responded	7	1.75%
Total	**400**	**100%**

Source (Author, 2026)

The study achieved a response rate of 98.25%, indicating that a substantial proportion of the targeted respondents successfully participated in the survey. This exceptionally high response rate was achieved through several deliberate strategies. First, the researcher worked closely with local agricultural extension officers, Village-Based Advisors (VBAs), farmer group leaders and community representatives who assisted in identifying and mobilizing eligible respondents prior to data collection. Second, questionnaires were administered through face-to-face interviews, which allowed immediate clarification of questions and reduced the likelihood of incomplete responses. Third, appointments were

scheduled at times convenient to farmers, taking into consideration farming activities and household responsibilities. In addition, the researcher conducted follow-up visits where initially selected respondents were unavailable during the first contact. A high response rate minimizes non-response bias and enhances the representativeness of the sample, thereby improving the validity and reliability of the study findings. According to Babbie (2016), a response rate above 50% is considered adequate for analysis, while rates exceeding 70% are regarded as very good. Similarly, Mugenda and Mugenda (2003) assert that a response rate of 60% and above is sufficient for drawing reliable conclusions in social science research. Therefore, the response rate achieved in this study is considered excellent and provides a strong basis for subsequent data analysis and interpretation of the findings.

4.3 Demographic Characteristics

The section presents the demographic characteristics of the respondents, focusing on gender and their exposure to regenerative agriculture practices. This section provides an overview of the sample composition, highlighting how respondents are distributed across gender categories and levels of exposure. Understanding these characteristics is essential for contextualizing subsequent analyses, as they may influence the adoption of regenerative agriculture practices and inform interpretation of the study's empirical findings.

4.3.1 Gender Distribution

This sub-section presents the gender distribution of the respondents, providing insight into the composition of the study sample in terms of male and female participants. This analysis is important for understanding the representativeness of the data and for examining potential gender-related differences in the adoption of regenerative agriculture practices. Table 4.2 summarizes the frequency and percentage distribution of respondents by gender, offering a clear depiction of the sample structure for subsequent analysis.

Table 4.2: Gender Distribution

Category	Frequency	Percentage (%)
Male	182	46.31
Female	211	53.69
Total	**393**	**100**

Source (Field data, 2026)

As presented in Table 4.2, female respondents constituted 53.69% (211) of the sample, while male respondents accounted for 46.31% (182). This indicates that women formed a slightly larger proportion of participants in the study, suggesting their active involvement in agricultural activities within the study area. The relatively balanced gender distribution enhances the credibility and representativeness of the findings, as it captures perspectives from both male and female farmers regarding the adoption of regenerative agriculture practices. The higher proportion of female respondents may reflect the significant role women play in smallholder farming systems, particularly in activities related to crop management and sustainable land-use practices. This is important in the context of regenerative agriculture, which often involves labour-intensive and management-oriented practices such as mulching, composting and crop diversification, areas where women's participation is typically pronounced. This finding is consistent with empirical literature which highlights that gender influences agricultural technology adoption, albeit in context-specific ways. While male farmers are often reported to have higher adoption rates of capital-intensive technologies due to greater access to resources such as land ownership, credit and extension services (Neway & Zegeye, 2022; Wordofa et al., 2021), women are increasingly recognized for their engagement in environmentally sustainable and regenerative practices (Otara et al., 2023).

4.3.2 Exposure Distribution

Section 4.3.2 presents the distribution of respondents based on their exposure to regenerative agriculture practices. This analysis provides insight into the extent to which farmers in the study area have interacted with or been influenced by regenerative agriculture initiatives. Understanding exposure levels is critical, as it often shapes awareness, knowledge acquisition, and eventual adoption of such practices. Table 4.3

summarizes the frequency and percentage distribution of respondents by exposure category, offering a clear basis for assessing its role in subsequent empirical analysis.

Table 4.3: Exposure Distribution

Exposure Category	Count	Percentage (%)
Exposed	197	50.13
Non-Exposed	196	49.87
Total	**393**	**100**

Source (Field data, 2026)

As presented in Table 4.3, respondents who had exposure to formal regenerative agriculture initiatives constituted 50.13% (197) of the sample, while those who were non-exposed accounted for 49.87% (196). This indicates a relatively balanced distribution between exposed and non-exposed farmers, with a slight majority having interacted with formal regenerative agriculture initiatives. The near parity in exposure levels is particularly important for the study, as it allows for meaningful comparison between farmers who have benefited from structured interventions and those who have not, thereby strengthening the analytical robustness of the findings. From empirical literature, Ntawuhiganayo et al. (2023) found that training and exposure to regenerative agriculture practices significantly enhance farmers' likelihood of adoption by improving technical knowledge and confidence. Similarly, Pangapanga-Phiri et al. (2024) emphasized that continuous extension support and hands-on learning approaches are essential for sustained adoption of conservation and regenerative practices. In the Kenyan context, Otara et al. (2023) reported that limited access to training and extension services remains a key barrier to widespread adoption, particularly among smallholder farmers in dryland regions.

4.4 Descriptive Statistics

This section presents descriptive statistics for the study variables to provide an overview of the characteristics and distribution of the data collected from smallholder farmers. The analysis summarizes the independent variables, including socio-economic factors, environmental factors and payment for ecosystem services, as well as the dependent variable representing the adoption of regenerative agriculture practices. In addition, the control variables; land tenure and access to markets are described. Measures such as

frequencies, percentages, means and standard deviations are used to illustrate patterns within the data and to establish a foundation for subsequent inferential analysis.

4.4.1 Socio-economic Factors

This subsection presents descriptive statistics for the socio-economic characteristics of the respondents. The analysis covers age distribution, household size, education level, capacity-building factors (training and extension services), farming experience and resource access factors such as income, farm size and access to credit. These variables are examined to provide insight into the economic and social conditions under which farmers operate and how they may influence the adoption of regenerative agriculture practices. Table 4.4 presents the age distribution of the respondents to provide insight into the generational composition of the sampled smallholder farmers.

Table 4.4: Age Distribution

Category	Frequency	Percentage (%)
Below 30	17	4.33
30–39	93	23.66
40–49	114	29.01
50–59	89	22.65
60 and above	80	20.36
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.4 indicate that the largest proportion of respondents were aged between 40–49 years, accounting for 29.01% (114) of the sample. This was followed by those aged 30–39 years at 23.66% (93) and 50–59 years at 22.65% (89), while respondents aged 60 years and above constituted 20.36% (80). In contrast, only 4.33% (17) of the respondents were below 30 years. This distribution suggests that farming activities in the study area are predominantly undertaken by middle-aged and older individuals, with relatively limited participation from younger farmers.

The dominance of farmers aged 40 years and above implies that agricultural decision-making is largely influenced by individuals with considerable farming experience and long-term engagement in agricultural activities. Such farmers are more likely to possess accumulated knowledge, established resource bases, and a deeper understanding of

environmental conditions, which can enhance their ability to evaluate and adopt regenerative agriculture practices. This observation aligns with empirical literature which identifies age as a key determinant of agricultural technology adoption. Studies have shown that middle-aged and older farmers are often more inclined to adopt sustainable and conservation-oriented practices due to their experience, resource stability, and familiarity with farming systems (Wordofa et al., 2021; Massresha et al., 2021).

Experience plays a critical role in shaping farmers' perceptions of risk and expected benefits associated with new technologies. Farmers with longer engagement in agriculture are better positioned to assess the long-term advantages of regenerative practices such as soil fertility improvement and resilience to climate variability. However, the relatively low proportion of younger farmers suggests potential challenges for the future sustainability and diffusion of regenerative agriculture, as younger individuals are typically more open to innovation and experimentation due to higher risk tolerance and greater exposure to modern information channels (Udimal et al., 2017).

Table 4.5 presents the distribution of respondents according to household size to provide an understanding of family labour availability among the sampled farmers.

Table 4.5: Size of the Household

Category	Frequency	Percentage (%)
1–3	140	35.62
4–6	218	55.47
7 and above	35	8.91
Total	**393**	**100**

Source (Field data, 2026)

The findings presented in Table 4.5 indicate that the majority of households comprised 4-6 members, accounting for 55.47% (218) of the sample. This was followed by smaller households of 1–3 members at 35.62% (140), while only 8.91% (35) of the respondents reported household sizes of seven or more members. This distribution suggests that most farmers in the study area operate within moderately sized households, which has important implications for labour availability and the adoption of regenerative agriculture practices.

Moderately sized households are often associated with an optimal balance between labour availability and consumption needs. In the context of regenerative agriculture, practices such as mulching, composting, crop rotation, and agroforestry require consistent labour input for implementation and maintenance. Households with 4-6 members are therefore better positioned to mobilize sufficient family labour without incurring excessive dependency burdens.

This finding is consistent with empirical studies that identify household size as a significant determinant of agricultural technology adoption. Larger households tend to benefit from increased labour supply, enabling them to adopt labour-intensive and management-driven practices more effectively (Midamba et al., 2024; Pangapanga-Phiri et al., 2024). However, the relatively lower proportion of households with seven or more members suggests that excessively large household sizes are less common in the study area. While larger households may provide more labour, they can also experience increased consumption pressure, which may limit the ability to invest in long-term sustainable practices such as soil restoration and ecosystem-based farming (Massresha et al., 2021). Conversely, smaller households with 1-3 members may face labour constraints, potentially hindering the adoption of practices that require continuous manual effort and monitoring.

Table 4.6 presents the distribution of respondents by level of formal education to illustrate the human capital characteristics of the sampled farmers.

Table 4.6: Education Level

Category	Frequency	Percentage (%)
No formal education	7	1.78
Primary	123	31.3
Secondary	157	39.95
Tertiary	106	26.97
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.6 indicate that the largest proportion of respondents had attained secondary education, accounting for 39.95% (157) of the sample. This was followed by those with primary education at 31.30% (123) and tertiary education at 26.97%

(106), while only 1.78% (7) of the respondents had no formal education. This distribution suggests that the majority of farmers in the study area possess at least basic levels of formal education, which is critical for understanding and applying agricultural innovations, including regenerative agriculture practices. The relatively high proportion of respondents with secondary and tertiary education implies that farmers are likely to have adequate literacy and numeracy skills necessary for interpreting extension messages, accessing agricultural information, and making informed farm management decisions. This finding aligns with empirical literature that identifies education as a key determinant of the adoption of improved and conservation agricultural technologies. Educated farmers are better equipped to evaluate the costs and benefits of new practices and are more capable of managing the risks associated with innovation (Massresha et al., 2021; Midamba et al., 2024).

Furthermore, higher levels of education enhance farmers' ability to understand complex concepts related to soil fertility management, climate change adaptation, and ecosystem-based farming approaches. This increases their likelihood of adopting regenerative agriculture practices, which often require a deeper understanding of ecological interactions and long-term productivity benefits (Ntawuhiganayo et al., 2023). In addition, education contributes to increased awareness of environmental conservation and sustainable resource use, as more educated farmers are generally more responsive to initiatives promoting sustainable land management (Pangapanga-Phiri et al., 2024).

Table 4.7 presents descriptive statistics on agricultural training. This helps to assess the level of knowledge acquisition, which is important determinants of the adoption of regenerative agriculture practices.

Table 4.7: Agricultural Training

Category	Frequency	Percentage (%)
Never	68	17.3
Rarely	98	24.94
Occasionally	100	25.45
Frequently	100	25.45
Very frequently	27	6.86
Total	**393**	**100**

Source (Field data, 2026)

The findings presented in Table 4.7 indicate that participation in agricultural training among respondents was generally moderate. Specifically, 17.30% (68) of the farmers reported that they had never attended any training sessions, while 24.94% (98) rarely attended. On the other hand, 25.45% (100) of the respondents attended training occasionally and an equal proportion of 25.45% (100) reported frequent participation, while only 6.86% (27) indicated that they attended training very frequently. This distribution suggests that although a considerable proportion of farmers have had some exposure to agricultural training, consistent and intensive participation remains relatively low. The pattern observed implies that most farmers engage with training programs on an intermittent basis rather than as a continuous learning process. Occasional and frequent participation by a combined 50.90% of respondents indicates that training opportunities exist within the study area, but the relatively low proportion of very frequent attendees suggests limitations in either accessibility, frequency of training programs, or farmers' ability to consistently participate. This moderate level of engagement may influence the depth of knowledge acquisition, particularly for regenerative agriculture practices, which often require sustained learning, experimentation, and behavioural change.

These findings are consistent with empirical literature which highlights the critical role of agricultural training in enhancing farmers' capacity to adopt improved and sustainable farming practices. Training programs have been shown to improve farmers' technical knowledge, strengthen understanding of soil management and ecosystem processes, and increase confidence in implementing new agricultural technologies (Ntawuhiganayo et al., 2023; Pangapanga-Phiri et al., 2024). However, irregular participation in training, as observed in this study, may lead to fragmented knowledge and limited practical application, thereby slowing the adoption of relatively complex practices such as regenerative agriculture (Midamba et al., 2024). Furthermore, the presence of a notable proportion of farmers who have never or rarely attended training (42.24%) underscores existing gaps in outreach and capacity-building efforts. This suggests that a significant segment of the farming population may lack adequate exposure to modern and sustainable agricultural practices, which could constrain overall adoption levels. Therefore, enhancing the frequency, accessibility, and inclusiveness of training programs is essential for

strengthening farmers' knowledge base and promoting wider adoption of regenerative agriculture practices within the study area.

Table 4.8 presents descriptive statistics on agricultural extension services. This helps to assess the level of technical support available to farmers, which is important determinants of the adoption of regenerative agriculture practices.

Table 4.8: Agricultural Extension Services

Category	Frequency	Percentage (%)
Never	53	13.49
Rarely	112	28.5
Occasionally	105	26.72
Frequently	100	25.45
Very frequently	23	5.85
Total	393	100

Source (Field data, 2026)

The findings presented in Table 4.8 indicate that access to agricultural extension services among respondents was generally moderate. Specifically, 13.49% (53) of the farmers reported that they had never received extension advice, while 28.50% (112) rarely accessed such services. In contrast, 26.72% (105) of the respondents received extension services occasionally and 25.45% (100) reported frequent access, while only 5.85% (23) indicated that they received extension support very frequently. This distribution suggests that although a substantial proportion of farmers have some level of contact with extension services, consistent and intensive engagement remains limited. The pattern observed implies that most farmers rely on intermittent extension support rather than continuous advisory services. The combined proportion of respondents who accessed extension services occasionally or frequently (52.17%) indicates the presence of extension outreach within the study area. However, the relatively low proportion of very frequent access highlights potential gaps in service delivery, such as inadequate staffing, logistical constraints, or limited coverage of extension programs. This moderate level of access may affect the quality and continuity of technical guidance provided to farmers, particularly for regenerative agriculture practices that require regular monitoring, timely interventions, and adaptive management.

These findings are consistent with empirical literature which underscores the critical role of extension services in promoting the adoption of sustainable agricultural practices. Extension agents provide essential technical knowledge, practical demonstrations, and follow-up support that help reduce uncertainty and build farmers' confidence in adopting new technologies (Massresha et al., 2021; Wordofa et al., 2021). Regular extension contact has been shown to enhance farmers' understanding of soil management, climate resilience, and ecosystem-based approaches, all of which are central to regenerative agriculture. However, the relatively high proportion of farmers who reported never or rarely accessing extension services (41.99%) points to significant limitations in outreach and accessibility. Infrequent interaction with extension agents may result in inadequate knowledge transfer and hinder effective implementation of regenerative practices, which often require continuous learning and technical support (Ntawuhiganayo et al., 2023; Pangapanga-Phiri et al., 2024).

Table 4.9 presents the distribution of respondents according to their years of farming experience to provide insight into their level of practical agricultural knowledge.

Table 4.9: Farming Experience

Category	Frequency	Percentage (%)
Less than 5 years	28	7.12
5–10 years	93	23.66
11–15 years	86	21.88
16–20 years	47	11.7
Over 20 years	139	35.37
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.9 indicate that a large proportion of respondents had over 20 years of farming experience, accounting for 35.37% (139) of the sample. This was followed by farmers with 5–10 years of experience at 23.66% (93) and those with 11–15 years at 21.88% (86). Respondents with 16–20 years of experience constituted 11.70% (47), while only 7.12% (28) had less than 5 years of farming experience. This distribution suggests that the majority of respondents are highly experienced farmers, implying that agricultural decision-making in the study area is largely influenced by accumulated

knowledge and long-term engagement in farming activities. The dominance of experienced farmers is particularly important in the context of regenerative agriculture, as such practices often require a deep understanding of soil dynamics, climate variability, and long-term productivity trends. Farmers with extensive experience are better positioned to assess the benefits of sustainable practices, including improved soil fertility, enhanced resilience to climatic shocks, and long-term yield stability.

This finding is consistent with empirical literature which identifies farming experience as a key determinant of adoption of sustainable agricultural practices. Experienced farmers tend to possess better knowledge of local agro-ecological conditions and are more capable of evaluating the effectiveness of conservation-oriented practices (Massresha et al., 2021; Otara et al., 2023). Furthermore, prolonged engagement in farming enables farmers to compare historical and current production outcomes, thereby strengthening their ability to recognize the advantages of regenerative agriculture practices over time. This enhances their willingness to adopt practices that promote environmental sustainability and long-term farm productivity (Pangapanga-Phiri et al., 2024). However, empirical evidence also suggests that farming experience may have mixed effects on adoption decisions. While experienced farmers are generally more informed and capable of evaluating innovations, they may also exhibit some degree of risk aversion, particularly when confronted with unfamiliar technologies or practices (Wordofa et al., 2021).

Table 4.10 presents the distribution of respondents according to monthly household income from farming to assess the economic capacity of farmers within the study area.

Table 4.10: Monthly Household Income

Category	Frequency	Percentage (%)
Below 10,000	41	10.43
10,001–20,000	82	20.87
20,001–30,000	85	21.63
30,001–50,000	63	16.03
Above 50,000	122	31.04
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.10 indicate considerable variation in monthly household income among the respondents. The largest proportion of farmers earned above KES 50,000, accounting for 31.04% (122) of the sample. This was followed by those earning between KES 20,001–30,000 at 21.63% (85) and KES 10,001–20,000 at 20.87% (82). Respondents earning between KES 30,001–50,000 constituted 16.03% (63), while only 10.43% (41) reported earnings below KES 10,000. This distribution suggests that a significant proportion of farmers fall within the middle to higher income categories, indicating moderate to relatively strong economic capacity within the study area. The dominance of higher income brackets implies that many farmers have the financial ability to invest in agricultural improvements, which is particularly relevant for the adoption of regenerative agriculture practices. Such practices often require upfront investments in inputs, labour, and farm management adjustments, as well as the ability to absorb short-term productivity fluctuations during the transition period. Farmers with higher income levels are therefore better positioned to adopt these practices, as they have greater financial flexibility and risk-bearing capacity.

This finding is consistent with empirical literature which identifies farm income as a key determinant of adoption of improved and conservation agricultural technologies. Higher income enhances farmers' ability to purchase necessary inputs, access credit, hire labour, and invest in long-term soil management strategies (Wordofa et al., 2021; Massresha et al., 2021). Additionally, regenerative agriculture practices often yield benefits gradually through improved soil health and ecosystem resilience, meaning that farmers with stronger financial resources are more likely to adopt them because they can withstand delayed returns (Pangapanga-Phiri et al., 2024). Conversely, the relatively smaller proportion of low-income farmers suggests that financial constraints may limit adoption among this group. Farmers earning below KES 10,000 are likely to prioritize immediate household consumption needs and may be less willing to adopt practices perceived to increase costs or reduce short-term yields (Midamba et al., 2024).

Table 4.11 presents the distribution of respondents according to their perceived ease of accessing agricultural credit, an important resource for financing farm investments and adoption of improved agricultural practices.

Table 4.11: Access to Credit

Category	Frequency	Percentage (%)
Very difficult	90	22.9
Difficult	130	33.08
Moderate	92	23.41
Easy	61	15.52
Very easy	20	5.09
Total	**393**	**100**

Source (Field data, 2026)

The findings presented in Table 4.11 indicate that a substantial proportion of farmers faced significant challenges in accessing credit. Specifically, 22.90% (90) of the respondents reported that access to credit was very difficult, while 33.08% (130) indicated it was difficult. This implies that more than half of the respondents (55.98%) experienced considerable barriers in obtaining financial support. In contrast, 23.41% (92) perceived access to credit as moderate, while only 15.52% (61) and 5.09% (20) reported that access was easy and very easy, respectively. These results suggest that limited access to credit remains a major constraint among smallholder farmers in the study area. The high proportion of farmers experiencing difficulty in accessing credit has important implications for the adoption of regenerative agriculture practices. Such practices often require initial investments in inputs, labour, and farm restructuring, as well as the capacity to absorb short-term risks associated with transitioning to sustainable systems. Therefore, inadequate access to credit can significantly hinder adoption, even in cases where farmers are aware of the benefits of regenerative agriculture.

These findings are consistent with empirical literature which identifies financial access as a critical determinant of adoption of improved and conservation agricultural technologies. Access to credit enables farmers to invest in productivity-enhancing inputs, implement soil improvement practices, and manage income variability during the transition period (Wordofa et al., 2021; Midamba et al., 2024). In situations where credit markets are inaccessible or underdeveloped, farmers tend to avoid innovations that involve upfront

costs or uncertain returns, despite their long-term benefits (Massresha et al., 2021). Furthermore, regenerative agriculture practices typically involve gradual returns through improved soil health, enhanced resilience, and ecosystem sustainability. This delayed payoff structure requires farmers to have sufficient financial buffers, which are often facilitated by access to credit. As such, farmers who lack reliable financial support are more likely to continue with conventional low-cost practices rather than adopt regenerative approaches (Pangapanga-Phiri et al., 2024).

Table 4.12 presents the distribution of respondents according to the size of land under cultivation in order to describe farm scale among the sampled smallholder farmers.

Table 4.12: Size of Land Under Cultivation

Category	Frequency	Percentage (%)
Less than 2 acres	171	43.51
2–5 acres	185	47.07
More than 5 acres	37	9.16
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.12 indicate that most farmers operated on relatively small parcels of land. The largest proportion of respondents cultivated between 2–5 acres, accounting for 47.07% (185) of the sample, followed closely by those cultivating less than 2 acres at 43.51% (171). Only a small proportion, 9.16% (37), reported cultivating more than 5 acres. This distribution clearly shows that the study population is predominantly composed of smallholder farmers with limited land resources. The dominance of small landholdings has important implications for agricultural decision-making and the adoption of regenerative agriculture practices. Farmers operating on small plots are often constrained in their ability to expand production through land acquisition and are therefore more likely to prioritize practices that enhance land productivity and sustainability. Regenerative agriculture practices, such as crop rotation, mulching, and soil fertility improvement, are particularly suited to such contexts because they focus on intensifying productivity while maintaining soil health over time.

This finding is consistent with empirical literature which identifies farm size as a significant determinant of adoption of improved and conservation agricultural practices. Smallholder farmers tend to adopt practices that enhance soil productivity and ensure long-term sustainability, as land scarcity limits their ability to increase output through expansion (Hu et al., 2022; Massresha et al., 2021). Sustainable land management practices are therefore more attractive to farmers with limited land, as maintaining soil fertility directly influences household food security and income stability (Pangapanga-Phiri et al., 2024). However, farm size may have mixed effects on adoption behavior. While larger farms often have greater financial resources and flexibility to experiment with new technologies, small farms are more inclined to adopt resource-conserving and productivity-enhancing practices to maximize output from existing land (Midamba et al., 2024). In this context, regenerative agriculture practices are particularly relevant, as they improve soil structure, nutrient cycling, and moisture retention, thereby enhancing yield stability without requiring land expansion.

4.4.2 Environmental Factors

This subsection presents descriptive statistics on environmental factors affecting farmers in the study area. The analysis focuses on farmers' perceptions of soil fertility, reliability of rainfall patterns, and frequency of drought occurrences. These factors provide insight into the environmental conditions under which agricultural activities are carried out and help to understand whether climatic and ecological pressures influence the adoption of regenerative agriculture practices. Table 4.13 summarizes the distribution of soil fertility.

Table 4.13: Soil Fertility

Category	Frequency	Percentage (%)
Very poor	1	0.25
Poor	21	5.33
Moderate	215	54.57
Good	120	30.46
Very good	36	9.14
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.13 indicate that the majority of farmers perceived their soil fertility to be moderate, accounting for 54.57% (215) of the respondents. This was followed by those who rated their soils as good at 30.46% (120) and very good at 9.14% (36). Only a small proportion of respondents reported poor soil fertility at 5.33% (21), while an insignificant share of 0.25% (1) indicated that their soils were very poor. Overall, this distribution suggests that most farmers consider their soils to be moderately fertile, with relatively few experiencing severe soil degradation. The predominance of moderate soil fertility implies that agricultural land in the study area is not critically degraded but also not optimally productive. This creates a context where farmers are likely to prioritize practices aimed at maintaining and gradually improving soil quality rather than undertaking costly restoration measures. Regenerative agriculture practices such as mulching, crop rotation, composting, and application of organic manure are therefore particularly relevant, as they enhance soil structure, nutrient cycling, and moisture retention over time.

This finding is consistent with empirical literature which indicates that farmers' perceptions of soil fertility play a critical role in influencing the adoption of conservation and regenerative agricultural practices. Farmers are more likely to adopt soil-enhancing technologies when they perceive declining or stagnant productivity, as this creates incentives for proactive soil management (Alexanderson et al., 2024; Pangapanga-Phiri et al., 2024). In cases of moderate fertility, farmers often engage in preventive strategies aimed at sustaining productivity and avoiding future degradation. Furthermore, the relatively small proportion of farmers reporting poor or very poor soil fertility suggests that extreme land degradation is not widespread in the study area. However, it also highlights the importance of maintaining current soil conditions to prevent further decline. Regenerative agriculture practices are particularly suited to such environments, as they focus on long-term soil health and ecosystem resilience rather than short-term yield maximization.

Table 4.14 presents respondents' perceptions of rainfall reliability, providing insights into climatic stability in the study area and its implications for agricultural decision-making and practice adoption.

Table 4.14: Rainfall Reliability

Category	Frequency	Percentage (%)
Very unreliable	18	4.57
Unreliable	150	38.07
Moderate	128	32.49
Reliable	96	24.37
Very reliable	1	0.25
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.14 indicate that rainfall reliability in the study area was generally perceived to be low. A substantial proportion of respondents reported rainfall as unreliable, accounting for 38.07% (150), while 32.49% (128) rated it as moderate. In contrast, 24.37% (96) of the respondents perceived rainfall as reliable, and only 0.25% (1) considered it to be very reliable. Additionally, 4.57% (18) reported rainfall as very unreliable. Overall, these findings suggest that the majority of farmers experience uncertainty in rainfall patterns, reflecting considerable climatic variability within the study area. The dominance of responses within the unreliable and moderate categories (70.56%) highlights the challenges farmers face in planning agricultural activities, as rainfall remains a critical determinant of crop production in rain-fed systems. Unpredictable rainfall patterns can lead to inconsistent planting seasons, reduced yields, and increased vulnerability to crop failure. This situation underscores the need for adaptive farming strategies that enhance resilience to climatic shocks. These findings are consistent with empirical literature which demonstrates that climate variability, particularly unreliable rainfall, is a major driver of adoption of climate-smart and regenerative agricultural practices. Farmers operating under uncertain weather conditions are more likely to adopt practices such as mulching, agroforestry, and soil moisture conservation techniques in order to mitigate the adverse effects of rainfall variability and stabilize production (Massresha et al., 2021; Dabalen et al., 2024). Regenerative agriculture practices, which improve soil water retention and enhance ecosystem resilience, are particularly suited to such environments.

Table 4.15 presents respondents' perceptions of drought frequency, highlighting the extent of climate-related stress and its potential influence on agricultural productivity and adoption of adaptive practices.

Table 4.15: Drought Frequency

Category	Frequency	Percentage (%)
Never	23	5.84
Rarely	184	46.7
Occasionally	157	39.85
Frequently	27	6.85
Very frequently	2	0.51
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.15 indicate that drought occurrence was a relatively common phenomenon in the study area, though largely experienced at lower frequencies. A substantial proportion of respondents, 46.70% (184), reported that drought occurred rarely, while 39.85% (157) indicated that it occurred occasionally. In contrast, only 6.85% (27) of the farmers experienced drought frequently and a minimal 0.51% (2) reported very frequent occurrences. Additionally, 5.84% (23) of respondents indicated that they had never experienced drought. Overall, these findings suggest that while drought is present in the study area, it is generally not experienced at extreme or persistent levels. The dominance of the "rarely" and "occasionally" categories (86.55%) implies that farmers are exposed to intermittent climatic stress rather than continuous drought conditions. Such sporadic exposure may still have significant implications for agricultural productivity, as even occasional drought events can disrupt planting cycles, reduce yields, and increase uncertainty in rain-fed farming systems. This level of exposure may encourage farmers to adopt precautionary and adaptive strategies aimed at mitigating the effects of moisture stress. These findings are consistent with empirical literature which indicates that exposure to drought, even at moderate levels, can influence the adoption of soil and water conservation practices. Farmers who experience periodic drought are more likely to adopt regenerative agriculture practices such as mulching, agroforestry, and crop rotation to improve soil moisture retention and enhance resilience to climatic variability (Pangapanga-

Phiri et al., 2024; Wordofa et al., 2021). Such practices help stabilize production and reduce vulnerability to rainfall fluctuations.

4.4.3 Payment for Ecosystem Services

This subsection presents descriptive statistics on Payment for Ecosystem Services (PES) related factors among the sampled farmers. The analysis examines farmers' awareness of PES programs, their level of participation, and their perception of incentives provided for ecosystem-friendly farming practices. These indicators help to assess the extent to which incentive-based environmental programs exist and whether they may influence the adoption of regenerative agriculture practices. The results for awareness of PES programs are summarized in Table 4.16.

Table 4.16: Awareness of PES Programs

Category	Frequency	Percentage (%)
Not at all aware	97	24.68
Slightly aware	143	36.39
Moderately aware	38	9.67
Aware	88	22.39
Very aware	27	6.87
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.16 indicate relatively low levels of awareness of Payment for Ecosystem Services (PES) programs among the respondents. A substantial proportion of farmers reported being either not at all aware (24.68%; 97) or only slightly aware (36.39%; 143) of such programs. Only 9.67% (38) indicated moderate awareness, while 22.39% (88) reported being aware and a small proportion of 6.87% (27) were very aware. Overall, this distribution shows that most farmers possess limited knowledge of PES initiatives, suggesting that information dissemination on such programs remains inadequate within the study area. The dominance of low-awareness categories (61.07%) implies that many farmers may not clearly understand the existence, objectives, or potential benefits associated with PES schemes. This has important implications for the adoption of regenerative agriculture practices, as PES programs are designed to provide financial incentives that encourage environmentally sustainable land-use practices. Without

adequate awareness, farmers are unlikely to participate in such programs or integrate conservation-oriented practices into their farming systems. These findings are consistent with empirical literature which identifies awareness as a critical prerequisite for participation in environmental incentive programs. Studies have shown that farmers who lack knowledge about PES mechanisms are less likely to adopt conservation practices linked to such schemes, regardless of the potential benefits (Nyongesa et al., 2016; Geussens et al., 2019). Awareness enhances farmers' understanding of how PES programs operate, the types of practices rewarded, and the long-term economic and environmental benefits associated with participation.

Table 4.17 presents the level of farmers' participation in PES programs, providing insight into engagement with incentive-based environmental initiatives and their potential influence on sustainable agricultural practices.

Table 4.17: Participation in PES Programs

Category	Frequency	Percentage (%)
Not at all	190	48.35
Slightly	88	22.39
Moderately	55	13.99
Actively	47	11.96
Very actively	13	3.31
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.17 indicate that participation in Payment for Ecosystem Services (PES) programs among respondents was generally low. A substantial proportion of farmers, 48.35% (190), reported that they had not participated at all in such initiatives. This was followed by 22.39% (88) who had participated slightly and 13.99% (55) who reported moderate participation. In contrast, only 11.96% (47) indicated active participation, while a minimal 3.31% (13) reported very active engagement. Overall, this distribution suggests that most farmers have had limited involvement in PES programs within the study area. The dominance of the "not at all" and "slightly" participation categories (70.74%) highlight the limited reach and uptake of PES initiatives among smallholder farmers in the study area. This low level of engagement may be attributed to

factors such as inadequate awareness, limited access to program information, or unclear implementation mechanisms. As a result, many farmers may be unable to benefit from the financial and technical incentives associated with PES schemes, which are intended to promote environmentally sustainable practices. These findings are consistent with empirical literature which indicates that participation in PES programs is often constrained by institutional and structural barriers. Studies have shown that farmers are less likely to engage in PES initiatives when programs are newly introduced, poorly communicated, or administratively complex (Nyongesa et al., 2016; Canessa et al., 2023). Effective participation typically requires clear guidelines, accessible enrolment processes, and consistent support mechanisms to encourage farmer involvement.

Table 4.18: Level of Incentives for Ecosystem Services

Category	Frequency	Percentage (%)
None	193	49.11
Very weak	87	22.14
Moderate	82	20.87
Strong	25	6.36
Very strong	6	1.53
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.18 indicate that the perceived level of ecosystem services incentives among respondents was generally low. Nearly half of the farmers, 49.11% (193), reported that no incentives were available, while 22.14% (87) perceived the incentives as very weak. A further 20.87% (82) rated the incentives as moderate, whereas only 6.36% (25) and 1.53% (6) considered them strong and very strong, respectively. Overall, this distribution suggests that the majority of farmers perceive ecosystem-related incentives as either absent or insufficiently attractive to motivate behavioural change. The dominance of the "none" and "very weak" categories (71.25%) highlights significant gaps in the provision and effectiveness of incentive-based environmental programs within the study area. This implies that many farmers are not receiving adequate financial or material support to encourage the adoption of regenerative agriculture practices. Given that such practices often require initial investments, labour adjustments, and a transition period with uncertain returns, the absence or weakness of incentives can act as a major barrier to

adoption. These findings are consistent with empirical literature which emphasizes that the strength and adequacy of incentives are critical determinants of farmers' willingness to adopt conservation and sustainable agricultural practices. Strong and well-structured incentives help offset opportunity costs associated with changing farming systems and provide motivation for long-term commitment to environmentally friendly practices (Canessa et al., 2023; Geussens et al., 2019). Conversely, modest or non-existent incentives are often insufficient to influence adoption decisions, particularly among smallholder farmers who face financial constraints and prioritize immediate household needs.

4.4.4 Adoption of Regenerative Agriculture Practices

This subsection presents descriptive statistics on the adoption of regenerative agriculture practices among the sampled farmers. The analysis examines the specific types of regenerative practices implemented, the proportion of land allocated to these practices, the frequency of their application, and the number of consecutive years farmers have practiced them. These indicators provide a comprehensive understanding of both the extent and intensity of adoption within the study area. Table 4.19 presents the types of regenerative practices adopted, Table 4.20 shows the percentage of land under regenerative agriculture, Table 4.21 reports the frequency of application, and Table 4.22 indicates the duration of practice among farmers.

Table 4.19 presents the distribution of the specific regenerative agriculture practices adopted by farmers in the study area. The table highlights the practices implemented and provides an indication of the diversity of regenerative approaches applied by smallholder farmers.

Table 4.19: Types of Regenerative Agriculture Adopted

Regenerative Agriculture Practice	Frequency	Percent of Respondents (%)
No till/Minimal tillage	391	99.49
Micro dosing	391	99.49
Use of Organic Manure	391	99.49
Mulching	391	99.49
Agro-forestry	391	99.49
Crop rotation	250	63.61
Cover cropping	160	40.71
Stubble retention	98	24.94
Rotational grazing	19	4.83

Source (Field data, 2026)

The results presented in Table 4.19 indicate a high level of reported adoption of several regenerative agriculture practices among the respondents. Notably, no-till/minimal tillage, micro dosing, use of organic manure, mulching, and agroforestry were each reported by 99.49% (391) of the respondents. Crop rotation was adopted by 63.61% (250) of the farmers, followed by cover cropping at 40.71% (160), stubble retention at 24.94% (98), and rotational grazing at 4.83% (19). These findings suggest that a substantial proportion of farmers in the study area reported implementing at least some regenerative agriculture practices. The exceptionally high adoption rates reported for no-till/minimal tillage, micro dosing, organic manure use, mulching, and agroforestry should, however, be interpreted with caution. First, the study was conducted in Embu and Tharaka Nithi Counties, where Farm Africa has been actively implementing regenerative agriculture interventions through farmer training, demonstration plots, extension support, and awareness programmes.

Consequently, the study population may have been more exposed to regenerative agriculture concepts and practices than the general farming population, contributing to higher reported adoption levels. Second, some of the reported practices, particularly organic manure application, mulching, and elements of minimum tillage, have traditionally been practiced by smallholder farmers as part of indigenous soil fertility management systems. Respondents may therefore have reported these practices irrespective of whether they were consciously implementing them as components of a regenerative agriculture framework. Furthermore, the possibility of social desirability bias cannot be entirely ruled out. Farmers who have participated in training programmes or interacted with extension

officers may be more inclined to report adoption of recommended practices because they perceive such responses to be desirable or expected. Similar concerns have been noted in agricultural adoption studies where self-reported adoption measures may overstate actual implementation levels (Wordofa et al., 2021; Massresha et al., 2021). The results should therefore be interpreted as reported adoption rather than independently verified adoption.

In contrast, crop rotation, cover cropping, stubble retention, and rotational grazing exhibited more moderate adoption levels. These practices generally require greater management adjustments, additional labour, land-use flexibility, or specialized technical knowledge. The relatively lower adoption rates are consistent with empirical studies indicating that more complex regenerative practices tend to diffuse more slowly because they involve higher implementation costs and greater behavioural change (Ntawuhiganayo et al., 2023; Pangapanga-Phiri et al., 2024). Rotational grazing, in particular, requires coordinated livestock and land management arrangements that may be difficult to implement under conditions of land fragmentation and limited grazing resources. Consequently, the variation in adoption rates across practices suggests that while farmers may readily adopt practices compatible with existing farming systems, adoption declines for practices requiring substantial changes in farm management and resource allocation.

Table 4.20 presents the proportion of farmland allocated to regenerative agriculture practices among the sampled farmers. The table provides insight into the intensity of adoption by showing how much of the cultivated land is managed using regenerative methods.

Table 4.20: Percentage of Land Under Regenerative Agriculture

Category	Frequency	Percentage (%)
Less than 20%	94	23.92
21–40%	97	24.68
41–60%	109	27.74
61–80%	61	15.27
Above 80%	32	7.89
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.20 indicate a moderate level of land allocation to regenerative agriculture practices among the respondents. The largest proportion of farmers, 27.74% (109), allocated between 41-60% of their land to regenerative practices. This was followed by 24.68% (97) who allocated 21-40% and 23.92% (94) who devoted less than 20% of their land. A smaller proportion, 15.27% (61), allocated between 61-80%, while only 7.89% (32) reported allocating more than 80% of their land to regenerative agriculture. These findings suggest that most farmers have partially integrated regenerative practices into their farming systems rather than fully transitioning to them. The distribution reflects a gradual and cautious adoption approach, where farmers allocate a portion of their land to regenerative agriculture while maintaining conventional practices on the remaining area. This strategy allows farmers to experiment with new techniques, assess their effectiveness under local conditions, and manage potential risks associated with yield variability and uncertain short-term returns. The relatively low proportion of farmers allocating more than 80% of their land to regenerative practices further supports the notion that full-scale adoption is still limited.

These findings are consistent with empirical literature on agricultural technology adoption, which indicates that farmers typically adopt innovations incrementally rather than undertaking immediate and complete transitions. Partial adoption enables farmers to test new practices while minimizing financial and production risks, especially in contexts characterized by resource constraints and climatic uncertainty (Massresha et al., 2021; Wordofa et al., 2021). Regenerative agriculture practices, which often involve gradual improvements in soil health and ecosystem resilience, are particularly suited to this phased adoption process. Furthermore, sustainable land management practices are often initially implemented on smaller portions of land to evaluate their performance before scaling up (Pangapanga-Phiri et al., 2024). This is especially important given that regenerative agriculture practices may require adjustments in farm management, learning new techniques, and coping with delayed economic benefits. As noted in previous studies, farmers tend to maintain a mix of conventional and regenerative practices during the transition period to hedge against production risks and ensure household food security (Midamba et al., 2024).

Table 4.21 presents the frequency with which farmers apply regenerative agriculture practices in their farming activities. The table provides insight into the consistency of adoption and helps distinguish between occasional experimentation and routine implementation of regenerative methods.

Table 4.21: Frequency of Applying Regenerative Agriculture Practices

Category	Frequency	Percentage (%)
Never	13	3.31
Rarely	94	23.92
Occasionally	104	26.46
Frequently	131	33.08
Always	51	12.72
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.21 indicate varying levels of consistency in the application of regenerative agriculture practices among the respondents. The largest proportion of farmers, 33.08% (131), reported applying these practices frequently, followed by 26.46% (104) who applied them occasionally and 23.92% (94) who applied them rarely. A smaller proportion, 12.72% (51), indicated that they always applied regenerative practices, while only 3.31% (13) reported that they never applied them. These findings suggest that most farmers have incorporated regenerative agriculture into their farming systems, although the level of consistency varies across respondents. The relatively high proportion of farmers applying practices frequently and always (45.80%) indicates growing acceptance and practical relevance of regenerative agriculture within the study area. This suggests that a significant number of farmers recognize the benefits associated with these practices and are integrating them into routine farm operations. However, the presence of farmers who apply these practices occasionally or rarely (50.38%) reflects a gradual and adaptive adoption process, where farmers continue to experiment and adjust their use based on experience, available resources, and perceived outcomes.

This pattern is consistent with empirical literature which characterizes agricultural technology adoption as a dynamic and learning-oriented process rather than a one-time decision. Farmers typically begin with intermittent application of new practices as they

evaluate their effectiveness, particularly when the benefits are realized over time (Pangapanga-Phiri et al., 2024; Massresha et al., 2021). Regenerative agriculture practices often require continuous management, behavioural change, and adaptation to local conditions, which can result in irregular application during the early stages of adoption (Midamba et al., 2024). Furthermore, variations in the frequency of application may be influenced by several factors, including labour availability, climatic variability, access to inputs, and financial capacity. For instance, practices such as mulching, composting, and crop rotation require sustained effort and timely implementation, which may not always be feasible for all farmers. Empirical studies indicate that such constraints can affect the consistency with which farmers apply sustainable agricultural practices (Wordofa et al., 2021).

Table 4.22 presents the number of consecutive years respondents have practiced regenerative agriculture. The table helps to assess the duration and continuity of adoption, indicating whether farmers are recent adopters or have long-term experience with regenerative practices.

Table 4.22: Consecutive Years of Practicing Regenerative Agriculture

Category	Frequency	Percentage (%)
1–2 years	121	30.79
3–4 years	113	28.75
5–6 years	80	20.36
More than 6 years	79	20.1
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.22 indicate that adoption of regenerative agriculture practices among respondents is relatively recent for a significant proportion of farmers, while a considerable number have sustained practice over longer periods. The largest proportion of respondents, 30.79% (121), reported practicing regenerative agriculture for 1-2 years, followed closely by 28.75% (113) who had practiced for 3-4 years. Meanwhile, 20.36% (80) indicated 5-6 years of continuous practice, and 20.10% (79) reported practicing for more than six years. This distribution suggests that while many farmers are recent adopters, there is also a substantial group with longer-term engagement, indicating

gradual diffusion and consolidation of regenerative agriculture practices within the study area. The relatively high proportion of farmers with 1-4 years of experience (59.54%) implies that regenerative agriculture is still in a growth phase, with increasing uptake in recent years. This may reflect the influence of training programs, extension services, and demonstration initiatives that have raised awareness and encouraged adoption. At the same time, the presence of farmers with over five years of experience (40.46%) suggests that regenerative practices are not only being adopted but also sustained over time, likely due to perceived benefits such as improved soil fertility, enhanced moisture retention, and increased resilience to climatic variability.

These findings are consistent with empirical literature which characterizes the adoption of sustainable agricultural practices as a gradual diffusion process rather than an instantaneous transition. Farmers often begin adoption after observing the outcomes experienced by early adopters and continue practicing when benefits become evident (Pangapanga-Phiri et al., 2024; Massresha et al., 2021). The coexistence of recent and long-term adopters in this study reflects different stages of the adoption lifecycle, where innovators and early adopters play a critical role in influencing wider community uptake through demonstration effects and knowledge sharing (Midamba et al., 2024). Furthermore, sustained adoption over several years indicates the importance of learning-by-doing in reinforcing farmers' commitment to regenerative practices. As farmers gain experience, they become more confident in managing these practices and are better able to appreciate their long-term benefits. Empirical studies suggest that continued engagement with sustainable practices is often driven by observable improvements in soil health, productivity stability, and resilience to environmental stress (Wordofa et al., 2021).

4.4.5 Land Tenure

This subsection presents descriptive statistics on land tenure, which is treated as a control variable in the study. Land ownership status may influence farmers' long-term investment decisions, including the willingness to implement regenerative agriculture practices that often yield benefits over time. Table 4.23 summarizes the distribution of respondents according to their land ownership status.

Table 4.23: Land Ownership Status

Land Tenure Category	Selected Frequency	Percent of Respondents (%)
Rented	65	16.54
Family owned	190	48.35
Individually owned	224	57

Source (Field data, 2026)

The results presented in Table 4.23 indicate that the majority of respondents cultivated land under relatively secure tenure arrangements. Individually owned land was the most prevalent, reported by 57.00% (224) of respondents, followed by family-owned land at 48.35% (190). In contrast, only 16.54% (65) of the respondents indicated that they operated on rented land. It is important to note that these categories are not mutually exclusive, as some farmers reported multiple forms of land tenure. Nonetheless, the findings clearly show that land ownership, whether individual or family-based, dominates in the study area. The predominance of individually and family-owned land suggests a high level of tenure security among farmers, which has important implications for the adoption of regenerative agriculture practices. Secure land tenure provides farmers with the confidence to invest in long-term soil fertility improvement and conservation practices, as they are more likely to benefit from the future returns of such investments. Regenerative agriculture practices, which often yield benefits gradually through improved soil health, moisture retention, and ecosystem stability, are particularly dependent on long-term commitment and therefore more attractive to farmers with secure land rights.

Conversely, the relatively low proportion of farmers operating on rented land indicates that short-term land use arrangements are less common. Farmers on rented land may be less willing to adopt regenerative practices due to uncertainty regarding continued access to the land and the inability to fully capture long-term benefits. As a result, farmers may prioritize short-term productivity over sustainability, limiting the adoption of practices that require sustained investment. These findings are consistent with empirical literature which identifies land tenure security as a key determinant of adoption of conservation and climate-smart agricultural practices. Farmers with secure ownership rights are more inclined to invest in practices that improve soil fertility and long-term productivity because

they expect to reap future benefits (Massresha et al., 2021; Wordofa et al., 2021). In contrast, insecure tenure arrangements often discourage investment in sustainable land management due to the risk of losing access before benefits are realized (Pangapanga-Phiri et al., 2024). Furthermore, sustainable agricultural practices such as regenerative agriculture typically involve delayed economic returns and require ongoing management. This makes tenure security particularly important, as it reduces uncertainty and encourages farmers to adopt practices that enhance long-term resilience and productivity (Midamba et al., 2024).

4.3.6 Access to Market

This subsection presents descriptive statistics on access to markets, which is included in the study as a control variable. Market accessibility influences farmers' ability to sell produce and obtain income, thereby affecting their capacity and motivation to adopt improved agricultural practices. Table 4.24 summarizes respondents' perceptions of their ease of accessing markets for selling farm produce.

Table 4.24: Access to the Market

Category	Frequency	Percentage (%)
Very difficult	10	2.54
Difficult	42	10.69
Moderate	87	21.88
Easy	155	39.44
Very easy	99	25.19
Total	**393**	**100**

Source (Field data, 2026)

The results presented in Table 4.24 indicate that most farmers had relatively favorable access to markets. A substantial proportion of respondents reported that accessing markets was easy, accounting for 39.44% (155), while 25.19% (99) indicated that it was very easy. Additionally, 21.88% (87) perceived market access as moderate. In contrast, only 10.69% (42) of respondents reported that access was difficult, and a small proportion of 2.54% (10) indicated that it was very difficult. Overall, these findings suggest that the majority of farmers in the study area operate within relatively functional market systems with minimal barriers to selling their produce. The predominance of favorable market access (64.63%

reporting easy or very easy access) implies that farmers have opportunities to commercialize their agricultural output, which can positively influence production decisions and investment in improved farming practices. Good market accessibility reduces uncertainty regarding returns from agricultural investments and provides incentives for farmers to adopt productivity-enhancing and sustainable practices, including regenerative agriculture. Farmers who can reliably access markets are more likely to invest in practices that improve yield stability and product quality, as they are assured of outlets for their produce.

These findings are consistent with empirical literature which identifies market access as a key determinant of the adoption of improved and sustainable agricultural technologies. Farmers with reliable access to output markets are more willing to invest in agricultural innovations because they can recover costs and generate income from increased production (Massresha et al., 2021; Wordofa et al., 2021). Furthermore, market access enhances farmers' exposure to information and input suppliers, thereby facilitating the adoption of conservation and climate-smart agricultural practices (Midamba et al., 2024). In addition, regenerative agriculture practices often lead to improvements in product quality, soil health, and long-term productivity, benefits that are more valuable when farmers have efficient market channels. Easy access to markets enables farmers to capitalize on these benefits, thereby reinforcing adoption decisions (Pangapanga-Phiri et al., 2024). Conversely, the relatively small proportion of farmers experiencing difficulty in accessing markets may face limitations in adopting such practices due to reduced economic incentives and increased transaction costs.

4.5 Correlation Analysis

This section presents the correlation analysis used to examine the preliminary relationships among the key study variables before conducting regression analysis. Table 4.25 reports the pairwise correlation coefficients between socio-economic factors, environmental factors, payment for ecosystem services, adoption of regenerative agriculture practices, and the control variables (land tenure and market access). To conduct the analysis, individual questionnaire items representing each construct were transformed into composite indices

through weighted averaging. Likert-scale responses were first coded numerically on ordinal scales and then averaged across items representing each construct. For instance, socio-economic factors combined indicators such as education, training, farming experience, income, and credit access to generate a composite weighted mean of 2.6046 (SD = 0.5068). Environmental factors produced a weighted mean of 2.8999 (SD = 0.3841), while payment for ecosystem services recorded 2.2235 (SD = 1.0497). Adoption of regenerative agriculture practices yielded a weighted mean of 2.7515 (SD = 0.9164). Similarly, market access and land tenure generated weighted means of 3.7423 (SD = 1.0327) and 2.0314 (SD = 0.7769), respectively. This transformation reduced dimensionality and enabled the constructs to be analyzed as continuous variables suitable for correlation and subsequent regression analysis.

Table 4.25: Correlation Analysis

	Socio-economic factors	**Environmental factors**	**Payment for Ecosystem Services**	**Adoption of regenerative agriculture practices**	**Market access**	**Land tenure**
Socio-economic factors	1	0.076	0.346	0.481	0.336	0.087
Environmental factors	0.076	1	0.226	0.092	0.023	0.018
Payment for Ecosystem	0.346	0.226	1	0.409	-0.021	0.097
Adoption of regenerative agriculture	0.481	0.092	0.409	1	0.240	0.045
Market access	0.336	0.023	-0.021	0.240	1	-0.048
Land tenure	0.087	0.018	0.097	0.045	-0.048	1

Source (Author, 2026)

The results presented in Table 4.25 indicate varying degrees of association among the study variables. The findings show that socio-economic factors had a moderate positive correlation with the adoption of regenerative agriculture practices (r = 0.481). This suggests that farmers with stronger socio-economic conditions, such as higher levels of education, better access to credit, greater farming experience, and increased participation in training and extension services, were more likely to adopt regenerative agriculture practices. The socio-economic index also exhibited a moderate positive relationship with payment for ecosystem services (PES) (r = 0.346) and market access (r = 0.336), implying that farmers with better socio-economic standing were more likely to access markets and engage with PES-related initiatives. These findings are consistent with empirical literature which

identifies human capital, financial capacity, and access to institutional support as critical drivers of adoption of sustainable agricultural technologies (Massresha et al., 2021; Wordofa et al., 2021). Farmers with stronger socio-economic resources are generally more capable of absorbing risks, accessing information, and investing in conservation-oriented farming practices (Midamba et al., 2024).

Environmental factors exhibited a weak positive relationship with the adoption of regenerative agriculture practices (r = 0.092). This suggests that environmental conditions such as soil fertility, rainfall reliability, and drought frequency had only a limited direct influence on adoption decisions. Environmental factors also showed weak positive correlations with socio-economic factors (r = 0.076) and PES (r = 0.226). These findings imply that although environmental stress may create awareness of the need for sustainable farming practices, it does not necessarily translate into adoption without complementary economic and institutional support mechanisms. This observation aligns with previous studies which argue that climate variability and environmental degradation alone are insufficient to drive behavioural change unless farmers have access to knowledge, incentives, and resources to respond effectively (Dabalen et al., 2024; Pangapanga-Phiri et al., 2024).

The PES index demonstrated a moderate positive relationship with adoption of regenerative agriculture practices (r = 0.409), indicating that higher awareness, participation, and perceived incentives associated with PES programs were linked to greater adoption of regenerative practices. This finding suggests that incentive-based environmental programs can play an important role in encouraging sustainable agricultural behavior. However, the relatively moderate strength of the relationship also indicates that the influence of PES may still be constrained by factors such as limited awareness, weak incentives, and low participation levels observed earlier in the study. Previous empirical literature supports this interpretation, noting that PES programs are more effective when incentives are substantial, accessible, and clearly understood by farmers (Nyongesa et al., 2016; Canessa et al., 2023).

The control variables displayed relatively weak associations with adoption. Market access showed a modest positive correlation with adoption (r = 0.240), implying that farmers with better access to markets were more likely to adopt regenerative agriculture practices. Improved market access may enhance economic incentives for sustainable production by providing reliable outlets for farm produce and increasing exposure to information and input suppliers. This finding is consistent with studies which identify market accessibility as an important enabling factor for adoption of improved agricultural technologies (Massresha et al., 2021; Wordofa et al., 2021). In contrast, land tenure exhibited a very weak positive relationship with adoption (r = 0.045), suggesting that land ownership arrangements alone did not strongly determine adoption behavior in the study area.

4.6 Diagnostic Tests

This section presents diagnostic tests conducted to verify whether the data satisfy the assumptions underlying multiple linear regression analysis. Ensuring that these assumptions hold is essential for obtaining reliable and unbiased parameter estimates. The study specifically evaluates multicollinearity among explanatory variables, homoscedasticity of the error terms, normality of residuals, and linearity of the relationship between the dependent and independent variables.

4.6.1 Multi-collinearity Test

Multi-collinearity test evaluates whether strong correlations exist among the explanatory variables, which could distort regression estimates and reduce the reliability of coefficient interpretations. Table 4.26 presents the results of the multicollinearity diagnostic test using the Variance Inflation Factor (VIF).

Table 4.26: Multi-collinearity Test

Variable	VIF
const	66.023
Socio Economic	1.509
Environmental	1.082
PES	1.378
Land Tenure	1.038
Market Access	1.174

Source (Author, 2026)

The results in Table 4.26 indicate that all explanatory variables have VIF values well below the commonly accepted threshold of 10 and even below the stricter threshold of 5. Specifically, the socio-economic index recorded a VIF of 1.509, the environmental index 1.082, the PES index 1.378, land tenure 1.038, and market access 1.174. These values suggest very low levels of correlation among the independent variables, implying that each variable contributes unique information to the regression model. The constant term shows a high VIF (66.023), which is expected and not problematic because multicollinearity concerns apply only to explanatory variables rather than the intercept. Therefore, it does not affect model estimation or interpretation. This outcome is consistent with empirical modelling practices in adoption studies, where socio-economic, environmental and institutional variables are theoretically distinct constructs that typically capture different dimensions of farmers' decision-making behavior (Massresha et al., 2021; Wordofa et al., 2021). Previous research on sustainable agricultural adoption emphasizes that factors such as resource capacity, climate conditions and incentive structures operate through separate mechanisms, and therefore should not be highly collinear when properly specified (Midamba et al., 2024). Low multicollinearity ensures stable coefficient estimates and reliable inference, which is essential in identifying the independent contribution of each determinant of adoption (Pangapanga-Phiri et al., 2024).

4.6.2 Homoscedasticity Test

This subsection presents the homoscedasticity test conducted to examine whether the variance of the regression residuals remains constant across different levels of the predicted values. Homoscedasticity is an important assumption of ordinary least squares regression, as violation of this assumption may lead to inefficient estimates and unreliable statistical inference. Table 4.27 reports the results of the statistical tests used to assess the presence of heteroscedasticity in the model.

Table 4.27: Homoscedasticity Test

Test	LM Statistic	LM p-value	F Statistic	F p-value
Breusch–Pagan	15.382	0.009	3.152	0.008

Source (Author, 2026)

The results in Table 4.27 show an LM statistic of 15.38173 with a corresponding p-value of 0.00885. Similarly, the F-statistic of 3.15217 has a p-value of 0.00839. Since both p-values are less than the conventional significance level of 0.05, the null hypothesis of homoscedasticity is rejected. This indicates that the variance of the residuals is not constant and that heteroscedasticity is present in the regression model. The presence of heteroscedasticity implies that although the Ordinary Least Squares (OLS) coefficient estimates remain unbiased, their standard errors may be inefficient and lead to unreliable hypothesis testing if not corrected. To address this issue, the study employed heteroscedasticity-robust standard errors (HC1) when estimating the regression model. The use of robust standard errors ensures valid statistical inference by providing consistent estimates of the variance–covariance matrix even when the homoscedasticity assumption is violated. This outcome is consistent with other studies in agricultural adoption, where cross-sectional farm-level data commonly exhibit heteroscedasticity due to variation in farm size, income levels, production systems and environmental conditions across households (Massresha et al., 2021; Wordofa et al., 2021). Such variability causes unequal dispersion of errors because farmers operate under heterogeneous economic and ecological circumstances. Previous studies examining sustainable and climate-smart agriculture adoption similarly report heteroscedastic disturbances and recommend the use of robust estimators to ensure reliable statistical inference (Midamba et al., 2024; Pangapanga-Phiri et al., 2024).

4.6.3 Normality Test

This subsection presents the normality test conducted to determine whether the regression residuals follow a normal distribution, an important assumption for valid statistical inference in regression analysis. The Shapiro–Wilk test was employed to evaluate the normality of the residuals. Table 4.28 reports the results of the test and indicates whether the normality assumption is satisfied in the model.

Table 4.28: Normality Test

Test	Statistic	p-value
Shapiro-Wilk	0.986	0.001

Source (Author, 2026)

The results in Table 4.28 produced a statistic of 0.98645 with a p-value of 0.00094. Since the p-value is less than the conventional significance level of 0.05, the null hypothesis of normality is rejected. This indicates that the regression residuals are not normally distributed. In cross-sectional data, such deviations from normality are common because of heterogeneity in farmer characteristics, behavioral differences and varying adoption intensities across households. Violation of the normality assumption does not bias the Ordinary Least Squares (OLS) coefficient estimates; however, it may affect the reliability of statistical inference when conventional standard errors are used. To address this limitation, the study employed heteroscedasticity-robust standard errors (HC1). Robust standard errors do not rely on the assumption of normally distributed residuals and therefore provide consistent and reliable estimates of statistical significance even when the normality assumption is violated. This outcome is consistent with empirical literature on agricultural adoption modelling, which frequently reports non-normal residual distributions due to diverse socio-economic conditions, uneven exposure to extension services and varying farm management strategies among smallholder farmers (Massresha et al., 2021; Wordofa et al., 2021). Adoption intensity often differs substantially across households, producing skewed distributions that violate classical regression assumptions (Midamba et al., 2024). Previous studies examining sustainable and climate-smart agriculture adoption therefore recommend the use of robust estimators to obtain valid inference under such conditions (Pangapanga-Phiri et al., 2024).

4.6.4 Linearity Test

This subsection presents the linearity test conducted to determine whether the relationship between the dependent variable and the independent variables is linear, as assumed in ordinary least squares regression. The Ramsey RESET test was employed to detect possible model misspecification arising from omitted nonlinear relationships. Table 4.29 reports the results of the linearity test and indicates whether the linear functional form of the regression model is appropriate.

Table 4.29: Linearity Test

Test	F Statistic	p-value
Ramsey RESET (power=2)	14.639	0.000
Ramsey RESET (power=3)	8.359	0.000

Source (Author, 2026)

The results presented in Table 4.29 indicate that the linearity assumption was not fully satisfied. The Ramsey RESET test yielded statistically significant F-statistics for both the squared term (power = 2) and cubic term (power = 3), with p-values below the 0.05 significance level. These results suggest the possibility of omitted nonlinear relationships or functional form misspecification in the original model. Consequently, the null hypothesis of correct linear functional form was rejected. To address this concern, the study examined the distribution and measurement properties of the study variables. Individual questionnaire items were transformed into composite indices representing socio-economic factors, environmental factors, payment for ecosystem services (PES), and adoption of regenerative agriculture practices. The transformation involved coding ordinal and Likert-scale responses numerically and aggregating them using equal-weighted arithmetic means.

This procedure converted multiple categorical indicators into approximately continuous composite measures, thereby reducing dimensionality and improving the linear representation of the underlying constructs. The use of composite indices is widely recommended when analysing multidimensional concepts because it minimizes measurement error associated with individual indicators and facilitates more stable estimation of relationships among variables. Although the linearity test suggested some departures from a strictly linear functional form, the transformed composite variables exhibited approximately linear relationships and were consistent with the theoretical framework underpinning the study. Furthermore, the primary objective of the analysis was to examine the direction and strength of associations among the key constructs rather than to model complex nonlinear behavioural responses. Consequently, the study retained a parsimonious linear specification and estimated the model using Ordinary Least Squares (OLS).

4.6.5 Influential Observations

This subsection presents the diagnostic test for influential observations, which assesses whether specific data points exert undue influence on the regression estimates. Identifying such observations is important to ensure that the model results are not driven by extreme cases. Cook's Distance, leverage values and studentized residuals were examined to detect potentially influential observations. Table 4.30 summarizes the results of these diagnostics and indicates whether any observations substantially affect the regression model.

Table 4.30: Influential Observations

Item	Value
N observations	393
k parameters (incl. intercept)	6
Cook's D threshold (4/n)	0.010
Leverage threshold (2k/n)	0.030
|Studentized residual| threshold	3
Count flagged by Cook's D > 4/n	21
Count flagged by Cook's D > 1	0
Count flagged by leverage > 2k/n	17
Count flagged by |stud resid| > 3	0
Count flagged by ANY rule	32

Source (Author, 2026)

The results presented in Table 4.30 indicate that 21 observations exceeded the Cook's Distance sensitivity threshold of 4/n, while none exceeded the conventional threshold of Cook's Distance greater than 1. Additionally, 17 observations exhibited leverage values above the recommended leverage threshold, suggesting that they possessed relatively unusual combinations of predictor values compared to the rest of the sample. However, no observation recorded a studentized residual exceeding ±3, indicating the absence of extreme outliers in the dependent variable. Overall, 32 observations were flagged by at least one diagnostic criterion. The diagnostic results suggest the presence of influential observations arising from natural variation within the sample rather than from data entry errors, measurement problems, or model misspecification. Such heterogeneity is common in cross-sectional agricultural surveys because farmers differ substantially in their socio-economic characteristics, environmental conditions, access to markets, participation in PES programmes, and adoption of regenerative agriculture practices (Massresha et al.,

2021; Wordofa et al., 2021). Consequently, observations with relatively high leverage are expected in farm-level datasets and do not necessarily invalidate the regression results.

To assess the robustness of the findings, a sensitivity analysis was conducted by re-estimating the regression model after excluding the observations flagged as potentially influential. The results were compared with those obtained from the full sample. The direction, magnitude, and statistical significance of the key coefficients remained largely unchanged, indicating that the substantive conclusions of the study were not driven by a small number of influential observations. Based on these findings, all observations were retained in the final analysis to preserve sample representativeness and avoid potential sample-selection bias. Furthermore, the final model was estimated using Ordinary Least Squares with heteroscedasticity-robust standard errors (HC1) to obtain reliable statistical inference in the presence of heteroscedasticity. The consistency of the results across the full-sample and sensitivity analyses provides additional evidence of the robustness of the study findings. This approach is consistent with recommendations in applied econometric research, which advocate retaining valid observations and evaluating the stability of results through sensitivity checks rather than automatically deleting observations that reflect genuine population heterogeneity (Gujarati & Porter, 2009).

4.7 Multiple Linear Regression Analysis

This section presents the results of the regression analysis conducted to examine the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties. The analysis evaluates the influence of socio-economic factors, environmental factors, payment for ecosystem services and control variables on the adoption index. The section begins with the presentation and interpretation of the parameter estimates to determine the direction, magnitude, and statistical significance of the effects of the explanatory variables on adoption of regenerative agriculture practices. This is followed by the ANOVA results, which assess the overall joint significance of the regression model. Finally, the regression model summary is presented to evaluate the overall goodness of fit and explanatory power of the model.

4.7.1 Parameter Estimates

This subsection presents the parameter estimates of the regression model to determine the direction and magnitude of the effects of each explanatory variable on the adoption of regenerative agriculture practices. The coefficients indicate whether each variable increases or decreases the adoption index and whether the effect is statistically significant. Table 4.31 reports the estimated coefficients, standard errors, t-statistics and corresponding significance levels used to evaluate the individual contribution of each predictor in the model.

Table 4.31: Parameter Estimates

Variable	Coefficient	Std. Error	t-value	p-value	Lower 95% CI	Upper 95% CI
const	0.305	0.069	4.441	0.000	0.170	0.439
Socio economic index	0.595	0.009	63.254	0.000	0.576	0.613
Environmental index	-0.033	0.016	-2.033	0.043	-0.065	-0.001
PES index	0.256	0.003	79.570	0.000	0.249	0.262
Market access index	0.119	0.004	29.383	0.000	0.111	0.127
Land tenure index	-0.008	0.014	-0.571	0.568	-0.035	0.019

Source (Author, 2026)

Table 4.31 presents the parameter estimates of the regression model examining the factors associated with the adoption of regenerative agriculture practices among smallholder farmers. The coefficients indicate the direction, magnitude, and statistical significance of the associations between socio-economic factors, environmental factors, payment for ecosystem services (PES), control variables, and the adoption index. The intercept term was positive and statistically significant ($\beta = 0.304871$, $p < 0.001$), representing the expected level of adoption when all explanatory variables are held constant. This finding suggests that a moderate level of regenerative agriculture adoption exists among farmers regardless of variation in the explanatory variables, possibly reflecting the presence of traditional conservation-oriented farming practices already embedded within local agricultural systems.

The socio-economic index exhibited a positive and highly significant association with adoption of regenerative agriculture practices ($\beta = 0.594742$, $p < 0.001$). This result indicates that farmers with higher levels of education, training, farming experience, income, and access to credit tended to report higher levels of adoption of regenerative agriculture practices. The magnitude of the coefficient suggests that socio-economic conditions were strongly associated with adoption behaviour within the study area. This finding is consistent with empirical literature which identifies human capital, financial capacity, and access to institutional resources as important correlates of adoption of sustainable agricultural technologies (Massresha et al., 2021; Midamba et al., 2024; Wordofa et al., 2021). Farmers possessing stronger socio-economic resources are generally better positioned to access information, manage risks, and engage with sustainable farming initiatives.

Environmental factors were negatively and significantly associated with adoption ($\beta = -0.033101$, $p = 0.042781$). This finding suggests that poorer environmental conditions, reflected by lower soil fertility, unreliable rainfall patterns, and greater drought exposure, were associated with lower levels of adoption of regenerative agriculture practices. Although regenerative agriculture is often promoted as a strategy for addressing environmental challenges, the observed negative association may indicate that farmers operating under severe environmental constraints face greater resource limitations and production uncertainties. This observation is consistent with studies reporting that environmental stress alone is not necessarily associated with higher adoption unless accompanied by adequate economic and institutional support (Dabalen et al., 2024; Pangapanga-Phiri et al., 2024).

The PES index exhibited a positive and highly significant association with adoption ($\beta = 0.255805$, $p < 0.001$). This result suggests that higher levels of awareness, participation, and perceived incentives relating to PES programmes were associated with higher levels of adoption of regenerative agriculture practices. Farmers who reported greater engagement with PES initiatives also tended to report greater adoption of sustainable farming practices. This finding aligns with empirical literature highlighting the role of

incentive-based environmental programmes in supporting conservation-oriented farming behaviour (Nyongesa et al., 2016; Canessa et al., 2023). Market access was also positively and significantly associated with adoption ($\beta = 0.119476$, $p < 0.001$). Farmers reporting easier access to output markets tended to exhibit higher levels of adoption of regenerative agriculture practices. This association may reflect the role of market participation in facilitating access to agricultural information, inputs, and economic opportunities.

Similar findings have been reported in previous studies which identify market integration as an important correlate of adoption of improved agricultural technologies (Massresha et al., 2021; Pangapanga-Phiri et al., 2024). In contrast, land tenure exhibited a negative but statistically insignificant association with adoption ($\beta = -0.007949$, $p = 0.568386$). This finding suggests that land ownership arrangements were not significantly associated with adoption levels after accounting for socio-economic factors, environmental factors, PES, and market access. Although land tenure security is often linked to long-term investment decisions in agriculture, the results indicate that within the study area, adoption was more strongly associated with socio-economic characteristics, participation in PES-related activities, and market accessibility than with land ownership status itself.

4.7.2 ANOVA for the Model

This subsection presents the Analysis of Variance (ANOVA) results for the estimated regression model. The ANOVA test evaluates the overall statistical significance of the model by examining whether the explanatory variables jointly contribute to explaining variations in the adoption of regenerative agriculture practices. Table 4.32 reports the sum of squares, degrees of freedom, F-statistics and significance levels used to assess whether the model provides a better fit than a model with no predictors.

Table 4.32: ANOVA for the Model

Source	SS	df	MS	F	Prob > F
Regression	99.968	5	19.994	34.204	0.000
Residual	225.630	386	0.585		
Total	329.060	391			

Source (Author, 2026)

The results presented in Table 4.32 show that the overall regression model was statistically significant in explaining adoption of regenerative agriculture practices among smallholder farmers. The regression sum of squares (SS = 99.96813) relative to the residual sum of squares (SS = 225.6298) indicates that the explanatory variables collectively accounted for a substantial proportion of the variation in the adoption index. The model produced an F-statistic of 34.20443 with a corresponding probability value of p = 0.000, which is far below the conventional significance level of 0.05. This implies that the null hypothesis that all regression coefficients are jointly equal to zero was rejected, confirming that the explanatory variables included in the model significantly influenced adoption of regenerative agriculture practices. The statistically significant ANOVA results demonstrate that the combined effects of socio-economic factors, environmental factors, payment for ecosystem services, market access, and land tenure provide meaningful explanatory power in predicting farmers' adoption behavior. This suggests that adoption of regenerative agriculture practices is not random, but rather influenced by identifiable economic, institutional, and environmental conditions within the farming context.

The relatively large regression mean square (MS = 19.99363) compared to the residual mean square (MS = 0.584533) further indicates that the model explains considerably more variation in adoption than would be expected by chance alone. In practical terms, this means that the selected explanatory variables collectively provide a reliable basis for understanding variations in farmers' adoption decisions across the study area. These findings are consistent with empirical literature which emphasizes that adoption of sustainable agricultural practices is multidimensional and influenced by a combination of socio-economic, institutional, and market-related factors rather than a single determinant (Massresha et al., 2021; Wordofa et al., 2021). Previous studies have similarly reported that factors such as access to training, financial resources, market opportunities, and incentive mechanisms jointly shape farmers' willingness and ability to adopt regenerative and climate-smart agricultural practices (Midamba et al., 2024; Pangapanga-Phiri et al., 2024).

4.7.3 Regression Model Summary

This subsection presents the regression model summary to evaluate the overall performance and goodness of fit of the estimated model. The summary statistics indicate how well the explanatory variables collectively explain variations in the adoption of regenerative agriculture practices. Table 4.33 reports key indicators including the coefficient of determination (R^2), adjusted R^2, F-statistic, and associated probability values used to assess the adequacy and statistical significance of the model.

4.33: Regression Model Summary

Statistic	**Value**
Number of observations	393
R-squared	0.787
Adjusted R-squared	0.787
F-statistic	5844.199
Prob (F-statistic)	0
Log-Likelihood	-234.730
AIC	481.460
BIC	505.287
Durbin-Watson	1.0710

Source (Author, 2026)

The regression model summary presented in Table 4.33 indicates that the model provides a strong explanation of the factors influencing adoption of regenerative agriculture practices among smallholder farmers. The analysis was based on 393 observations, providing an adequate sample size for reliable statistical estimation and inference. The coefficient of determination (R^2) was 0.78696, implying that approximately 78.70% of the variation in the adoption of regenerative agriculture practices was explained by the explanatory variables included in the model, namely socio-economic factors, environmental factors, payment for ecosystem services, market access, and land tenure. The adjusted R^2 of 0.78679 further confirms the robustness of the model, indicating that even after adjusting for the number of predictors, the model still explains about 78.68% of the variation in adoption behavior. The high explanatory power of the model suggests that the selected variables are highly relevant in explaining farmers' adoption decisions. This indicates that adoption of regenerative agriculture practices in the study area is strongly shaped by measurable socio-economic, institutional, and environmental factors. Such a

relatively high R^2 value is desirable in behavioural and agricultural adoption studies because it demonstrates that the model adequately captures the key determinants influencing farmers' decisions.

The overall significance of the model is confirmed by the F-statistic of 5844.1988 with a probability value of 0.000. This indicates that the explanatory variables jointly have a statistically significant effect on adoption of regenerative agriculture practices. Therefore, the null hypothesis that all slope coefficients are simultaneously equal to zero is rejected. The findings imply that the combined influence of socio-economic conditions, environmental factors, PES-related variables, market access, and land tenure significantly explains variations in adoption behavior among farmers. This observation is consistent with empirical literature which emphasizes that adoption of sustainable agricultural technologies results from the interaction of economic, institutional, and environmental factors rather than from isolated influences (Wordofa et al., 2021; Pangapanga-Phiri et al., 2024).

The Akaike Information Criterion (AIC = 481.4597) and Bayesian Information Criterion (BIC = 505.2873) further suggest that the model achieved a good balance between explanatory power and model parsimony. Lower values of these criteria generally indicate a better-fitting model relative to alternative specifications. In addition, the log-likelihood value of −234.7299 reflects the adequacy of the estimated model in fitting the observed data. The Durbin-Watson statistic of 1.07097 suggests the presence of some positive autocorrelation in the residuals, although this issue is generally less severe in cross-sectional data compared to time-series data. Nonetheless, the use of robust estimation techniques helped correct for potential heteroscedasticity and autocorrelation effects, thereby improving the reliability and efficiency of the estimated coefficients. Previous empirical studies examining adoption of agricultural technologies similarly employ robust estimation techniques to address violations of classical regression assumptions under heterogeneous farming conditions (Massresha et al., 2021; Midamba et al., 2024).

4.8 Chapter Summary

This chapter presented the analysis, presentation, and interpretation of data on the determinants of adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi counties. The chapter began by establishing the adequacy of the study data through the response rate analysis, which confirmed that the collected data were sufficient and reliable for statistical analysis. Descriptive statistics were then used to examine demographic characteristics, socio-economic factors, environmental factors, payment for ecosystem services, adoption of regenerative agriculture practices, land tenure, and market access. The findings revealed moderate to high adoption of several regenerative agriculture practices, with socio-economic conditions, market access, and PES-related factors playing important roles in shaping adoption behavior. Correlation analysis showed positive relationships between adoption and socio-economic factors, payment for ecosystem services, and market access, while environmental factors and land tenure exhibited relatively weak associations. Diagnostic tests confirmed the absence of multicollinearity but detected heteroscedasticity, necessitating the use of robust estimation techniques. Finally, regression analysis established that socio-economic factors, payment for ecosystem services, and market access significantly influenced adoption of regenerative agriculture practices, while environmental factors had a negative but significant effect and land tenure remained statistically insignificant.

VT OMNES VNVM SINT

CHAPTER FIVE
DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the discussion, conclusion and recommendations of the study based on the findings. The chapter interprets the empirical results in relation to the study objectives and existing empirical literature on adoption of regenerative agriculture practices among smallholder farmers. The discussion focuses on the influence of socio-economic factors, environmental factors, payment for ecosystem services (PES) and the control variables (market access and land tenure) on the adoption of regenerative agriculture practices. The chapter provides conclusions drawn from the findings, policy and practical recommendations, limitations of the study and suggestions for future research.

5.2 Summary of Findings

This study examined the factors associated with the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties, Kenya, focusing on socio-economic factors, environmental factors, payment for ecosystem services (PES), market access, and land tenure. The study achieved a high response rate, indicating strong participation by the targeted respondents and enhancing the reliability of the findings. The descriptive results revealed that farming activities in the study area were largely undertaken by middle-aged and older farmers operating on relatively small land holdings and within moderately sized households. Most respondents had attained formal education, possessed considerable farming experience, and had moderate access to agricultural training and extension services. However, access to agricultural credit remained a challenge for many farmers, despite generally favorable market access conditions. These findings suggest that farmers' socio-economic circumstances play an important role in shaping their engagement with regenerative agriculture practices.

The study further found that awareness, participation, and perceived benefits of payment for ecosystem services programs were generally low among the respondents. Although several regenerative agriculture practices were widely reported, adoption varied across

specific practices, with some requiring greater technical knowledge, labour input, or management adjustments than others. Most farmers had partially integrated regenerative agriculture practices into their farming systems rather than fully transitioning to them, indicating a gradual adoption process. The correlation analysis revealed positive associations between adoption of regenerative agriculture practices and socio-economic factors, payment for ecosystem services, and market access, while environmental factors and land tenure displayed relatively weaker relationships with adoption. The regression analysis further showed that socio-economic factors, payment for ecosystem services, and market access were significantly associated with adoption of regenerative agriculture practices. Environmental factors were negatively associated with adoption, whereas land tenure was not significantly associated with adoption.

5.3 Discussion of Findings

This section discusses the findings of the study in relation to the study objectives, theoretical foundations, and existing empirical literature. The discussion focuses on the extent to which the findings support or contradict the propositions of Innovation Resistance Theory (IRT) and Protection Motivation Theory (PMT), while also situating the results within the broader literature on adoption of regenerative agriculture practices among smallholder farmers.

5.3.1 Effect of Socio-Economic Factors on the Adoption of Regenerative Agriculture Practices

The study found that socio-economic factors were positively associated with adoption of regenerative agriculture practices among smallholder farmers. This finding suggests that farmers with higher levels of education, training, extension support, farming experience, income, access to credit, and productive resources tended to report higher levels of adoption. The finding is consistent with previous studies which identify socio-economic capacity as a critical factor associated with adoption of sustainable agricultural technologies (Massresha et al., 2021; Midamba et al., 2024; Wordofa et al., 2021). Several mechanisms may explain this relationship. Farmers with greater access to education and extension services are more likely to understand the long-term benefits of regenerative

agriculture and possess the technical knowledge required for implementation. Similarly, access to income and credit enables farmers to absorb transition costs, acquire inputs, and manage risks associated with adopting unfamiliar practices.

The findings suggest that resource-constrained farmers may face greater barriers to adoption because regenerative agriculture often requires investments in learning, labour, and farm management adjustments before benefits become fully realized. The results strongly support Innovation Resistance Theory. According to IRT, adoption is often hindered by perceived usage barriers, value barriers, and risk barriers. Farmers with stronger socio-economic capacity are better positioned to overcome these barriers because they possess the knowledge, financial resources, and institutional support necessary to reduce uncertainty and perceived risks. The findings also support Protection Motivation Theory, which posits that adoption is influenced by individuals' confidence in their ability to implement a response successfully. Education, training, and extension services enhance farmers' self-efficacy and response efficacy, thereby increasing their willingness to engage in regenerative agriculture practices.

5.3.2 Effect of Environmental Factors on the Adoption of Regenerative Agriculture Practices

The study found that environmental factors were negatively associated with adoption of regenerative agriculture practices. At first glance, this finding appears counterintuitive because regenerative agriculture is frequently promoted as a strategy for addressing soil degradation, drought, and climate variability. However, several plausible explanations may account for this relationship. Farmers operating under severe environmental stress often face immediate livelihood pressures that limit their ability to invest in practices whose benefits accrue gradually over time. Declining soil fertility, prolonged droughts, and unreliable rainfall may reduce farm income, increase production risks, and constrain access to resources required for implementing regenerative practices. Consequently, farmers facing the most severe environmental challenges may prioritize short-term survival strategies rather than long-term soil restoration investments. Similar observations have been reported by Dabalen et al. (2024) and Pangapanga-Phiri et al. (2024), who argue that

environmental stress does not automatically translate into adoption of sustainable practices unless accompanied by adequate financial, technical, and institutional support.

The findings partially support Protection Motivation Theory while also revealing its limitations. PMT suggests that perceived environmental threats should motivate protective action. However, the theory also recognizes that threat appraisal alone is insufficient. Farmers must believe they possess the capacity and resources necessary to respond effectively. The findings suggest that while environmental risks may increase awareness of agricultural challenges, limited coping capacity may prevent farmers from translating concern into action. This highlights the importance of combining environmental awareness initiatives with practical support mechanisms that strengthen farmers' ability to implement regenerative agriculture practices. The negative association may also reflect heterogeneity among farmers. Households with greater financial resources, access to extension services, or stronger social networks may be better positioned to respond to environmental challenges than poorer households facing similar ecological conditions. Consequently, environmental pressures may have different implications depending on farmers' socio-economic circumstances.

5.3.3 Effect of Payment for Ecosystem Services on the Adoption of Regenerative Agriculture Practices

The findings indicate that payment for ecosystem services was positively associated with adoption of regenerative agriculture practices. Farmers who reported greater awareness of PES programmes, stronger participation in incentive schemes, and more favourable perceptions of ecosystem-related incentives tended to exhibit higher levels of adoption. This finding suggests that incentive-based mechanisms may play an important role in encouraging farmers to engage in sustainable land management practices. The relationship can be explained by the ability of PES programmes to reduce the economic uncertainty associated with transitioning to regenerative agriculture. Many regenerative practices involve short-term costs and delayed benefits. Financial incentives, carbon payments, subsidies, or ecosystem rewards may therefore make adoption more attractive by compensating farmers for perceived risks and opportunity costs.

Similar conclusions have been reached by Nyongesa et al. (2016), Geussens et al. (2019), and Canessa et al. (2023), who found that environmental incentive programmes can encourage adoption when farmers understand the benefits and perceive the incentives as credible and accessible. The findings support both Protection Motivation Theory and Innovation Resistance Theory. From a PMT perspective, PES programmes increase response efficacy by demonstrating that sustainable practices can generate tangible benefits. At the same time, incentives reduce perceived response costs, making adoption more feasible. From an IRT perspective, PES mechanisms help reduce value barriers and risk barriers by increasing the perceived attractiveness and economic viability of regenerative agriculture practices.

5.3.4 Effect of Control Variables on the Adoption of Regenerative Agriculture Practices

Among the control variables, market access was positively associated with adoption of regenerative agriculture practices, whereas land tenure was not significantly associated with adoption. The positive association between market access and adoption suggests that farmers with easier access to markets are more likely to participate in sustainable farming systems. Market access may enhance adoption by providing opportunities to commercialize agricultural produce, access agricultural information, obtain inputs, and interact with extension providers and other market actors. Previous studies similarly identify market integration as an important factor associated with adoption of improved agricultural technologies because it strengthens economic incentives and reduces uncertainty regarding returns on agricultural investments (Massresha et al., 2021; Wordofa et al., 2021). The finding that land tenure was not significantly associated with adoption suggests that ownership status alone may not be sufficient to explain adoption behaviour.

While secure tenure arrangements are often considered important for encouraging long-term investments in land improvement, the results indicate that farmers' access to knowledge, financial resources, incentives, and markets may be more influential in shaping adoption decisions. This finding suggests that tenure security may operate indirectly through its interaction with other socio-economic and institutional factors rather than

exerting an independent association with adoption. From a theoretical perspective, the market access findings support both PMT and IRT by demonstrating the importance of reducing uncertainty and strengthening perceived benefits associated with adoption. Conversely, the insignificant association between land tenure and adoption suggests that the behavioural and institutional mechanisms emphasized by the two theories may be more relevant in explaining adoption decisions than ownership arrangements alone.

5.4 Conclusion

This study examined the factors associated with the adoption of regenerative agriculture practices among smallholder farmers in Embu and Tharaka Nithi Counties, Kenya. The findings indicate that adoption of regenerative agriculture practices is more closely associated with farmers' socio-economic characteristics, participation in payment for ecosystem services initiatives, and access to markets than with environmental conditions or land tenure arrangements. Farmers with higher levels of education, greater access to agricultural training and extension services, more farming experience, stronger income positions, and better access to credit generally reported higher levels of adoption of regenerative agriculture practices. Similarly, greater awareness of, participation in, and perceived benefits from payment for ecosystem services programmes were associated with higher reported adoption levels. The findings also suggest that farmers operating under more challenging environmental conditions tended to report lower levels of adoption, possibly reflecting the resource constraints and production risks associated with severe environmental stress.

In addition, farmers with better access to markets generally reported higher adoption levels, highlighting the importance of economic opportunities and access to agricultural information. In contrast, land tenure arrangements were not significantly associated with adoption after accounting for the other study variables. Overall, the study suggests that adoption of regenerative agriculture practices among smallholder farmers is associated with a combination of socio-economic, institutional, and market-related factors. However, these findings should be interpreted with caution because the study relied on cross-sectional data and self-reported measures of adoption, which may be subject to recall and

social desirability biases. Consequently, the results indicate statistical associations rather than definitive causal relationships. Nevertheless, the findings provide useful insights into the factors that appear to be linked to adoption of regenerative agriculture practices and offer an empirical basis for designing interventions aimed at promoting sustainable agricultural practices among smallholder farmers in similar contexts.

5.5 Recommendations

5.5.1 Policy Recommendations

The findings showed that socio-economic factors were strongly associated with adoption of regenerative agriculture practices. Therefore, national and county governments should prioritize targeted farmer capacity enhancement programmes rather than broad agricultural support initiatives. Specifically, county governments in Embu and Tharaka Nithi should integrate regenerative agriculture modules into existing extension programmes and develop farmer certification programmes focusing on soil health management, cover cropping, agroforestry, mulching, and organic nutrient management. Given the positive association between payment for ecosystem services (PES) and adoption, policymakers should establish county-level PES frameworks linked to carbon sequestration, watershed protection, and soil restoration. Existing initiatives such as Farm Africa's carbon market programme should be expanded to reach non-participating farmers through transparent enrollment mechanisms and simplified participation requirements.

5.5.2 Institutional and Extension Service Recommendations

Since market access was positively associated with adoption, county governments, producer organizations, and development partners should strengthen value chains for regenerative agriculture products. This can be achieved by developing aggregation centres, linking farmers to premium markets for sustainably produced products, and facilitating contractual arrangements between farmer groups and buyers. Agricultural extension services should also move beyond awareness creation and provide farm-level technical support through demonstration plots and peer-learning networks. Special emphasis should be placed on practices that recorded relatively lower adoption levels, including cover cropping, stubble retention, and rotational grazing.

5.5.3 Farmer Capacity Development Recommendations

Farmer groups and cooperatives should be strengthened as platforms for collective learning, input acquisition, and knowledge exchange. Since adoption was more common among farmers with greater access to training and information, farmer organizations should establish community-based learning systems where experienced adopters mentor new adopters. Particular attention should be given to resource-constrained households and farmers operating in environmentally stressed areas, as these groups may face greater challenges in implementing regenerative agriculture practices.

5.5.4 Financial and Incentive Mechanism Recommendations

Given the positive association between PES and adoption, financial institutions, development partners, and county governments should develop incentive mechanisms specifically linked to regenerative agriculture outcomes. Rather than providing general agricultural loans, financing products should support investments in regenerative practices such as agroforestry establishment, organic input production, water conservation infrastructure, and soil restoration activities. In addition, awareness campaigns should focus on improving farmers' understanding of carbon markets, ecosystem service payments, and other environmental incentive programmes. These interventions should prioritize farmers in drought-prone and environmentally vulnerable areas where environmental stress appears to constrain adoption despite the potential benefits of regenerative agriculture.

5.6 Limitations of the Study

Despite generating valuable insights into the factors associated with adoption of regenerative agriculture practices among smallholder farmers, several limitations should be considered when interpreting the findings. First, the study employed a cross-sectional research design in which data were collected at a single point in time. Consequently, the findings identify statistical associations rather than causal relationships. While socio-economic factors, payment for ecosystem services, and market access were found to be associated with adoption, the study design does not permit conclusions regarding the

direction of causality or how adoption behaviour evolves over time. Longitudinal studies would be required to establish temporal relationships and adoption dynamics.

Second, the study relied primarily on self-reported questionnaire data. Self-reported measures are susceptible to recall bias, particularly when respondents are required to report farming practices implemented over several years. In addition, social desirability bias may have influenced responses, especially regarding environmentally desirable practices such as agroforestry, mulching, and conservation-oriented farming. The very high reported adoption rates for some regenerative agriculture practices should therefore be interpreted cautiously, as they may partly reflect respondents' desire to provide socially acceptable answers. Third, the construction of composite indices using equal weighting may have introduced measurement limitations. Although equal weighting provided a transparent and practical approach for aggregating indicators, it implicitly assumes that all indicators contribute equally to the underlying construct. Alternative approaches such as factor analysis or structural equation modelling might yield different index structures and relationships.

Fourth, the study may be subject to omitted variable bias. Important behavioural and institutional factors, including farmers' attitudes toward innovation, risk preferences, social networks, peer influence, cultural norms, trust in institutions, and perceptions of regenerative agriculture benefits, were not explicitly incorporated into the regression model. The omission of these variables may partly explain the unexplained variation in adoption behaviour and suggests that the observed associations should not be interpreted as exhaustive explanations of adoption decisions. Fifth, although the study included both farmers exposed and not exposed to Farm Africa interventions, the possibility of selection effects cannot be completely ruled out. Farmers participating in regenerative agriculture programmes may differ systematically from non-participants in ways that were not fully observable or measurable. Such differences could influence reported adoption levels and associated factors.

Finally, the geographical scope of the study was limited to Embu and Tharaka Nithi Counties, which were selected because of their active regenerative agriculture interventions

and agroecological characteristics. Consequently, the findings may not be directly generalizable to other regions of Kenya with different farming systems, institutional environments, market structures, or climatic conditions. Therefore, caution should be exercised when extending the findings beyond the study area. Despite these limitations, the study provides important empirical evidence on regenerative agriculture adoption in Kenya and offers a useful foundation for future research employing longitudinal designs, objective field-based adoption measurements, and broader geographical coverage.

5.7 Recommendations for Further Research

This study contributes to the growing literature on regenerative agriculture in Kenya by simultaneously examining socio-economic factors, environmental factors, payment for ecosystem services (PES), market access, and land tenure within a single analytical framework. Unlike most previous studies that focused primarily on conservation agriculture or isolated determinants of technology adoption, this study integrated Innovation Resistance Theory and Protection Motivation Theory to explain adoption behaviour and empirically measured PES alongside conventional socio-economic and environmental factors. The study also developed multidimensional composite indices to capture adoption intensity and associated determinants. Nevertheless, several opportunities for further research remain. First, future studies should employ longitudinal or panel research designs to track adoption behaviour over time. A panel study following the same households for three to five years would provide deeper insights into adoption dynamics, persistence, dis-adoption, and the long-term effects of regenerative agriculture on farm productivity, income, and environmental outcomes. Such designs would also enable stronger causal inference than the cross-sectional approach used in this study.

Second, experimental and quasi-experimental studies should be conducted to evaluate the effectiveness of specific PES models. For example, researchers could compare farmers receiving carbon-payment incentives with similar farmers not receiving incentives using randomized controlled trials (RCTs), propensity score matching, or difference-in-differences approaches. Such studies would provide robust evidence on the extent to which PES programmes influence adoption decisions and environmental outcomes. Third, future

research should undertake cost-benefit and profitability analyses of individual regenerative agriculture practices. While this study examined adoption behaviour, it did not assess the economic returns associated with specific practices such as agroforestry, cover cropping, mulching, or minimum tillage. Understanding the financial viability of these practices would provide important information for farmers, policymakers, and development partners.

Fourth, mixed-methods studies combining quantitative surveys with qualitative interviews and focus group discussions should be conducted to explore behavioural factors not captured in the present study. Variables such as risk preferences, social norms, peer influence, trust in institutions, cultural beliefs, and perceptions of regenerative agriculture may provide deeper insights into why some farmers adopt while others resist adoption despite operating under similar conditions. Finally, future studies should expand the geographical scope to include different agroecological zones within Kenya and other East African countries. Comparative studies would help determine whether the relationships observed in Embu and Tharaka Nithi Counties are context-specific or applicable to broader smallholder farming systems. Such research would strengthen external validity and contribute to the development of location-specific policies and interventions for scaling regenerative agriculture.

5.8 Chapter Summary

This chapter presented the discussion, conclusion and recommendations of the study on the determinants of adoption of regenerative agriculture practices among smallholder farmers. The findings established that socio-economic factors, payment for ecosystem services and market access significantly influenced adoption of regenerative agriculture practices, while environmental factors had a significant negative effect and land tenure was statistically insignificant. The study concluded that adoption is primarily resource-driven and economically motivated, requiring adequate financial capacity, technical support and institutional incentives. The chapter further provided policy, institutional and farmer-level recommendations aimed at strengthening adoption of regenerative agriculture practices, while also highlighting the study limitations and suggesting areas for future research.

REFERENCES

Alexanderson, M. S., Luke, H., & Lloyd, D. J. (2024). Regenerative agriculture in Australia: The changing face of farming. *Frontiers in Sustainable Food Systems, 8*, 1402849.

Badsar, M., Moghim, M., & Ghasemi, M. (2023). Analysis of factors influencing farmers' sustainable environmental behavior in agriculture activities: Integration of the planned behavior and the protection motivation theories. *Environment, Development and Sustainability*, *25*(9), 9903-9934.

Bagagnan, A. R., Ouedraogo, I., M. Fonta, W., Sowe, M., & Wallis, A. (2019). Can protection motivation theory explain farmers' adaptation to climate change decision making in the Gambia? *Climate*, *7*(1), 13.

Bazrafkan, K., Valizadeh, N., Khannejad, S., Kianmehr, N., Bijani, M., & Hayati, D. (2022). What drives farmers to use conservation agriculture? Application of mediated protection motivation theory. *Frontiers in Psychology*, *13*, 991323.

Canessa, C., Venus, T. E., Wiesmeier, M., Mennig, P., & Sauer, J. (2023). Incentives, rewards or both in payments for ecosystem services: Drawing a link between farmers' preferences and biodiversity levels. *Ecological Economics, 213*, 107954.

Cereal Growers Association (CGA). (2020). *Development of pulse value chain through regenerative agriculture*. https://cga.co.ke

Chen, M. F. (2020). Moral extension of the protection motivation theory model to predict climate change mitigation behavioral intentions in Taiwan. *Environmental Science and Pollution Research*, *27*(12), 13714-13725.

Claudy, M. C., Garcia, R., & O'Driscoll, A. (2015). Consumer resistance to innovation—a behavioral reasoning perspective. *Journal of the Academy of Marketing Science, 43*(4), 528–544.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). Routledge.

Dabalen, A., Goyal, A., & Song, R. (2024). *Regenerative agriculture in practice*. World Bank.

Ekepu, D., & Tirivanhu, P. (2016). Assessing socio–economic factors influencing adoption of legume-based multiple cropping systems among smallholder sorghum farmers in Soroti, Uganda. *South African Journal of Agricultural Extension, 44*(2), 195–215.

Engel, S., & Müller, A. (2016). Payments for environmental services to promote "climate-smart agriculture"? Potential and challenges. *Agricultural Economics, 47*(S1), 173–184.

FAO. (2025). *Kenya country profile*. Food and Agriculture Organization of the United Nations.

Farm Africa. (2020). *Farm Africa's regenerative agriculture project*. https://www.farmafrica.org/

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of applied social psychology*, *30*(2), 407-429.

Frankel-Goldwater, L., Wojtynia, N., & Dueñas-Ocampo, S. (2024). Healthy people, soils, and ecosystems: Uncovering primary drivers in the adoption of regenerative agriculture by US farmers and ranchers. *Frontiers in Sustainable Food Systems, 7*, 1070518.

Geussens, K., Van den Broeck, G., Vanderhaegen, K., Verbist, B., & Maertens, M. (2019). Farmers' perspectives on payments for ecosystem services in Uganda. *Land Use Policy, 84*, 316–327.

Hawas, L. D., & Degaga, D. T. (2023). Factors affecting improved agricultural technologies adoption: Logistic model in study areas in East Shewa Zone, Ethiopia. *Journal of Sustainable Development in Africa, 25*(1), 119–137.

Hu, Y., Li, B., Zhang, Z., & Wang, J. (2022). Farm size and agricultural technology progress: Evidence from China. *Journal of Rural Studies, 93*, 417–429.

International Fund for Agricultural Development & United Nations Environment Programme. (2013). *Smallholders, food security and the environment*. International Fund for Agricultural Development. https://www.ifad.org/documents/38714170/39135645/smallholders_report.pdf/133e8903-0204-4e7d-a780-bca847933f2e

Jin, Q., Raza, S. H., Mahmood, N., Zaman, U., Saeed, I., Yousaf, M., & Aslam, S. (2022). Exploring influence of communication campaigns in promoting regenerative farming through diminishing farmers' resistance to innovation: An innovation resistance theory perspective from Global South. *Frontiers in Psychology, 13*, 924896.

Jinger, D., Kumar, R., Kakade, V., et al. (2022). Agroforestry for controlling soil erosion and enhancing system productivity in ravine lands of Western India under climate change scenario. *Environmental Monitoring and Assessment, 194*, 267.

Kaur, P., Dhir, A., Singh, N., Sahu, G., & Almotairi, M. (2020). An innovation resistance theory perspective on mobile payment solutions. *Journal of Retailing and Consumer Services, 55*, 102059.

Kenny, D. C., & Castilla-Rho, J. (2022). What prevents the adoption of regenerative agriculture and what can we do about it? Lessons and narratives from a participatory modelling exercise in Australia. *Land, 11*(9), 1383.

Khangura, R., Ferris, D., Wagg, C., & Bowyer, J. (2023). Regenerative agriculture A literature review on the practices and mechanisms used to improve soil health. *Sustainability, 15*(3), 2338.

Kleijnen, M., Lee, N., & Wetzels, M. (2009). An exploration of consumer resistance to innovation and its antecedents. *Journal of economic psychology*, *30*(3), 344-357.

Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners* (5th ed.). SAGE Publications.

Lemke, S., Smith, N., Thiim, C., & Stump, K. (2024). Drivers and barriers to adoption of regenerative agriculture: Case studies on lessons learned from organic. *International Journal of Agricultural Sustainability, 22*(1), 2324216.

Lunn-Rockliffe, S., Davies, M., Moore, H., Wilman, A., McGlade, J., & Bent, D. (2020). *Farmer-led regenerative agriculture for Africa*.

Massresha, S. E., Lema, T. Z., Neway, M. M., & Degu, W. A. (2021). Perception and determinants of agricultural technology adoption in North Shoa Zone, Amhara Regional State, Ethiopia. *Cogent Economics & Finance, 9*(1), 1956774.

Midamba, D. C., Kwesiga, M., & Ouko, K. O. (2024). Determinants of adoption of sustainable agricultural practices among maize producers in Northern Uganda. *Cogent Social Sciences, 10*(1), 2286034.

Ministry of Agriculture, Livestock & Fisheries and Cooperatives. (2023). *Agricultural Soil Management Policy 2023*. Government of Kenya. https://www.adaptation-undp.org/sites/default/files/resources/kenya_climate_smart_agriculture_strategy.pdf

Ministry of Agriculture, Livestock and Fisheries. (2017). *Kenya Climate Smart Agriculture Strategy 2017–2026*. United Nations Development Programme. http://www.adaptation-undp.org/sites/default/files/resources/kenya_climate_smart_agriculture_strategy.pdf

Mosavian, S. H., Rostami, F., & Tatar, M. (2023). Modeling farmers' intention to water protection behavior: A new extended version of the protection motivation theory. *Journal of Environmental Psychology, 90*, 102036.

Neway, M. M., & Zegeye, M. B. (2022). Gender differences in the adoption of agricultural technology in North Shewa Zone, Amhara Regional State, Ethiopia. *Cogent Social Sciences, 8*(1), 2069209.

Ntawuhiganayo, E. B., Nijman-Ross, E., Geme, T., Negesa, D., & Nahimana, S. (2023). Assessing the adoption of regenerative agricultural practices in Eastern Africa. *Frontiers in Sustainability, 4*, 1105846.

Nyongesa, J. M., Bett, H. K., Lagat, J. K., & Ayuya, O. I. (2016). Estimating farmers' stated willingness to accept pay for ecosystem services: Case of Lake Naivasha watershed Payment for Ecosystem Services scheme–Kenya. *Ecological Processes, 5*, 1–15.

Oakley, M., Mohun Himmelweit, S., Leinster, P., & Casado, M. R. (2020). Protection motivation theory: a proposed theoretical extension and moving beyond rationality the case of flooding. *Water, 12*(7), 1848.

OECD/FAO. (2016). *OECD-FAO agricultural outlook 2016–2025*. OECD Publishing.

Otara, E. N., Mogaka, H. R., Ndirangu, S. N., & Mugwe, J. N. (2023). Socioeconomic factors influencing uptake of regenerative agriculture technologies in the dry-lands of Embu County, Kenya. *Journal of Agricultural Extension, 27*(1), 1–12.

Pangapanga-Phiri, I., Ngoma, H., & Thierfelder, C. (2024). Understanding sustained adoption of conservation agriculture among smallholder farmers: Insights from a sentinel site in Malawi. *Renewable Agriculture and Food Systems, 39*, e10.

Pirani, E. (2024). *Regenerative agriculture and positive deviance among smallholder farmers in Taita-Taveta County, Kenya*.

Raes, L., Speelman, S., & Aguirre, N. (2017). Farmers' preferences for PES contracts to adopt silvopastoral systems in southern Ecuador, revealed through a choice experiment. *Environmental Management, 60*, 200–215.

Ram, S. (1987). A model of innovation resistance. *Advances in Consumer Research, 14*, 208–212.

Ram, S., & Sheth, J. N. (1989). Consumer resistance to innovations: The marketing problem and its solutions. *Journal of Consumer Marketing, 6*(2), 5–14.

Rehberger, E., West, P. C., Spillane, C., & McKeown, P. C. (2023). What climate and environmental benefits of regenerative agriculture practices? Evidence reviews. *Environmental Research Communications, 5*(5), 052001.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change1. *The journal of psychology*, *91*(1), 93-114.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.). Pearson.

Sheth, J. N., & Stellner, W. H. (1979). *Psychology of innovation resistance: The less developed concept (LDC) in diffusion research*. University of Illinois at Urbana-Champaign.

Sollen-Norrlin, M., Ghaley, B. B., & Rintoul, N. L. J. (2020). Agroforestry benefits and challenges for adoption in Europe and beyond. *Sustainability, 12*(17), 7001.

Szmigin, I., & Foxall, G. R. (1998). Three forms of innovation resistance: The case of retail payment methods. *Technovation, 18*(6–7), 459–468.

Tittonell, P., El Mujtar, V., Felix, G., Kebede, Y., Laborda, L., Luján Soto, R., & de Vente, J. (2022). Regenerative agriculture Agroecology without politics? *Frontiers in Sustainable Food Systems, 6*, 844261.

Udimal, T. B., Jincai, Z., Mensah, O. S., & Caesar, A. E. (2017). Factors influencing agricultural technology adoption: The case of improved rice varieties (NERICA) in the Northern Region, Ghana. *Journal of Economics and Sustainable Development, 8*(8), 141–148.

United Nations. (2025). *Population*. https://www.un.org/en/global-issues/population
Vi Agroforestry. (2020). *Kenya Agricultural Carbon Project (KACP)*. https://www.via.goforresty.org/projects/kacp/

Wilson, K., Mercier, S., & Myers, R. (2023). *Encouraging farmer adoption of regenerative agriculture practices in the United States*. The Chicago Council on Global Affairs.

Wordofa, M. G., Hassen, J. Y., Endris, G. S., Aweke, C. S., Moges, D. K., & Rorisa, D. T. (2021). Adoption of improved agricultural technology and its impact on household income: A propensity score matching estimation in eastern Ethiopia. *Agriculture & Food Security, 10*, 1–12.

World Bank. (2025). *Food security update*. https://www.worldbank.org/en/topic/agriculture/brief/food-security-update

World Food Programme. (2025). *WFP 2025 global outlook*. https://www.wfp.org/publications/wfp-2025-global-outlook

World Health Organization. (2024). *Hunger numbers stubbornly high for three consecutive years as global crises deepen – UN report*. https://www.who.int/news/item/24-07-2024-hunger-numbers-stubbornly-high

Xue, Y., Zhang, X., Zhang, Y., & Luo, E. (2024). Understanding the barriers to consumer purchasing of electric vehicles: The innovation resistance theory. *Sustainability*, *16*(6), 2420.

APPENDIX I: QUESTIONNAIRE

Instructions

This questionnaire seeks to collect information for academic research on the Determinants of the Adoption of Regenerative Agriculture Practices among Smallholder Farmers in Embu and Tharaka Nithi Counties, Kenya.

Your responses will be treated with utmost confidentiality and used solely for academic purposes.

Please respond by ticking (✓) or circling the most appropriate response.

SECTION A: SOCIO-ECONOMIC FACTORS

A1. Demographic Factors

1. 1. Gender of respondent: ☐ Male ☐ Female
2. 2. Age of respondent (years): ☐ Below 30 ☐ 30–39 ☐ 40–49 ☐ 50–59 ☐ 60 and above
3. 3. Household size (number of members): ☐ 1–3 ☐ 4–6 ☐ 7 and above

A2. Education Level

4. Highest level of formal education attained: ☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary

A3. Capacity-Building Factors

4. 5. How often have you attended agricultural training sessions in the last 3 years? ☐ Never ☐ Rarely ☐ Occasionally ☐ Frequently ☐ Very frequently
5. 6. How often do you receive agricultural extension services or advice? ☐ Never ☐ Rarely ☐ Occasionally ☐ Frequently ☐ Very frequently

A4. Farming Experience

7. Number of years you have been involved in farming: ☐ Less than 5 years ☐ 5–10 years ☐ 11–15 years ☐ 16–20 years ☐ Over 20 years

A5. Resource Access Factors

6. 8. Approximate monthly household income from farming (KES): ☐ Below 10,000 ☐ 10,001–20,000 ☐ 20,001–30,000 ☐ 30,001–50,000 ☐ Above 50,000
7. 9. How would you rate your ease of accessing agricultural credit? ☐ Very difficult ☐ Difficult ☐ Moderate ☐ Easy ☐ Very easy
8. 10. Approximate size of land under cultivation: ☐ Less than 2 acres ☐ 2–5 acres ☐ More than 5 acres

SECTION B: ENVIRONMENTAL FACTORS

9. 11. How would you rate the fertility of your soil? ☐ Very poor ☐ Poor ☐ Moderate ☐ Good ☐ Very good
10. 12. How reliable are rainfall patterns in your area for farming? ☐ Very unreliable ☐ Unreliable ☐ Moderate ☐ Reliable ☐ Very reliable
11. 13. How frequently do you experience droughts that affect your farming activities? ☐ Never ☐ Rarely ☐ Occasionally ☐ Frequently ☐ Very frequently

SECTION C: PAYMENT FOR ECOSYSTEM SERVICES

12. 14. How aware are you of Payment for Ecosystem Services (PES) programs or schemes in your area? ☐ Not at all aware ☐ Slightly aware ☐ Moderately aware ☐ Aware ☐ Very aware
13. 15. To what extent have you participated in PES programs or related initiatives? ☐ Not at all ☐ Slightly ☐ Moderately ☐ Actively ☐ Very actively
14. 16. How would you rate the level of incentives provided for practicing ecosystem-friendly farming (e.g., subsidies, inputs, rewards)? ☐ None ☐ Very weak ☐ Moderate ☐ Strong ☐ Very strong

SECTION D: ADOPTION OF REGENERATIVE AGRICULTURE PRACTICES

15. 17. Which regenerative agriculture practices do you currently use? (Tick all that apply) ☐ No-till/minimal tillage ☐ Cover cropping ☐ Crop rotation ☐ Stubble retention ☐ Rotational grazing ☐ Agroforestry
16. 19. Approximately what percentage of your land is under regenerative agriculture practices? ☐ Less than 20% ☐ 21–40% ☐ 41–60% ☐ 61–80% ☐ Above 80%
17. 20. How frequently do you apply regenerative agriculture practices each season? ☐ Never ☐ Rarely ☐ Occasionally ☐ Frequently ☐ Always
18. 21. For how many consecutive years have you consistently practiced regenerative agriculture? ☐ None ☐ 1–2 years ☐ 3–4 years ☐ 5–6 years ☐ More than 6 years

SECTION E: CONTROL VARIABLES

19. 22. Land tenure: Which statement best describes your land ownership status? ☐ Rented ☐ Family-owned ☐ Individually owned
20. 23. How would you rate your access to markets for selling farm produce? ☐ Very difficult ☐ Difficult ☐ Moderate ☐ Easy ☐ Very easy

VT OMNES VNVM SINT

APPENDIX II: DATA COLLECTION GUIDE FOR RESEARCH ASSISTANTS

This guide was used by research assistants to administer the questionnaire consistently, ensuring that respondents clearly understood each question and that all responses were accurately recorded according to the options provided.

General Instructions

Before starting the interview: Greet the respondent politely, introduce yourself, and explain the purpose of the study. Emphasize confidentiality and voluntary participation.

During the interview: Read each question exactly as written. Avoid paraphrasing, suggesting answers, or skipping questions. Tick or circle the response given by the respondent clearly.

After the interview: Review the questionnaire for completeness and thank the respondent for their time.

SECTION A: SOCIO-ECONOMIC FACTORS

A1. Demographic Factors

Q1. Gender: Ask, 'What is your gender?' Tick Male or Female as stated.

Q2. Age: Ask, 'What is your age group?' Read options one by one and tick the appropriate range.

Q3. Household size: Ask, 'How many people live in your household?' Record number and tick correct range.

A2. Education Level

Q4. Ask, 'What is the highest level of formal education you have completed?' Tick one option (None, Primary, Secondary, or Tertiary).

A3. Capacity-Building Factors (Training and Extension Services)

Q5. Ask, 'In the last three years, how often have you attended agricultural training sessions or workshops?' Tick from Never to Very frequently.

Q6. Ask, 'How often do agricultural officers or extension workers visit or assist you?' Tick response according to frequency (Never–Very frequently).

A4. Farming Experience

Q7. Ask, 'For approximately how many years have you been engaged in farming activities?' Record number and tick corresponding range.

A5. Resource Access Factors

Q8. Ask, 'On average, what is your monthly income from farming?' Tick the correct income range.

Q9. Ask, 'How would you rate your ease of accessing agricultural credit?' Tick from Very difficult to Very easy.

Q10. Ask, 'What is the approximate size of land you cultivate?' Tick the appropriate size category.

SECTION B: ENVIRONMENTAL FACTORS

Q11. Ask, 'How would you rate the fertility of your soil?' Tick from Very poor to Very good.

Q12. Ask, 'How reliable are rainfall patterns in your area for farming?' Tick from Very unreliable to Very reliable.

Q13. Ask, 'How often do droughts occur in your area and affect your farming?' Tick appropriate frequency.

SECTION C: PAYMENT FOR ECOSYSTEM SERVICES (PES)

Q14. Ask, 'How aware are you of programs that reward farmers for ecosystem-friendly practices such as tree planting, soil conservation, or regenerative agriculture?' Tick from Not at all aware to Very aware.

Q15. Ask, 'To what extent have you personally participated in such programs or activities?' Tick from Not at all to Very actively.

Q16. Ask, 'How strong or useful are the incentives provided to encourage such practices?' Tick from None to Very strong.

SECTION D: ADOPTION OF REGENERATIVE AGRICULTURE PRACTICES

Q17. Ask, 'Which of the following regenerative agriculture practices do you currently use?' Read each and tick all that apply.

Q18. Ask, 'How many of these practices do you currently apply on your farm?' Write the number given by respondent.

Q19. Ask, 'Approximately what percentage of your total land is under regenerative agriculture practices?' Tick the correct range.

Q20. Ask, 'How frequently do you apply these practices each farming season?' Tick from Never to Always.

Q21. Ask, 'For how many consecutive years have you practiced regenerative agriculture without interruption?' Tick the appropriate year range.

SECTION E: CONTROL VARIABLES

Q22. Ask, 'What is the ownership status of the land you are currently cultivating?' Tick Rented, Family-owned, or individually owned.

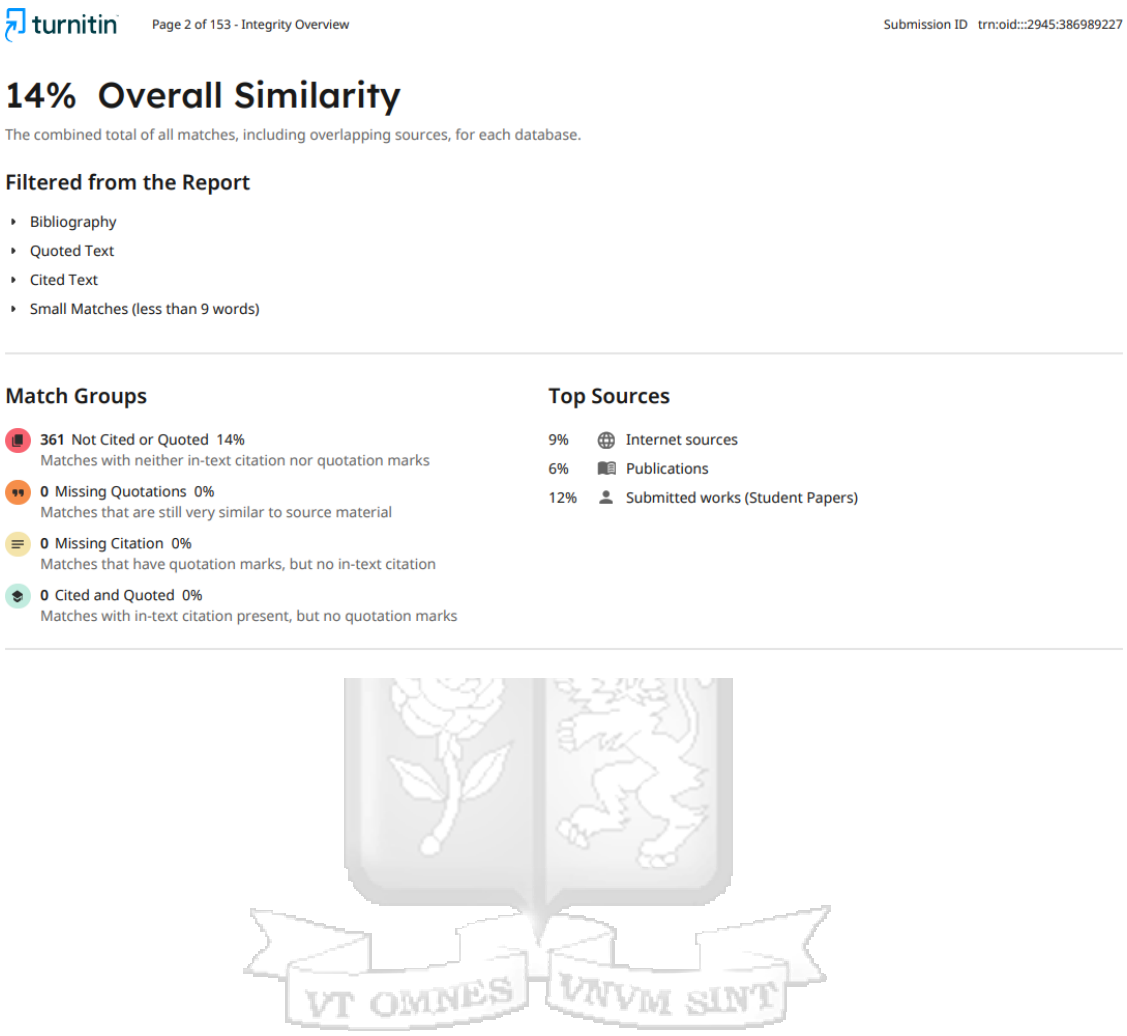
Q23. Ask, 'How would you rate your ease of accessing markets for selling your farm produce?' Tick from Very difficult to Very easy.

Closing the Interview

Thank the respondent sincerely for their time and input and review the questionnaire for completeness.

VT OMNES VNVM SINT

APPENDIX III: SIMILARITY REPORT



turnitin Page 2 of 153 - Integrity Overview Submission ID trn:oid:::2945:386989227

14% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography
- Quoted Text
- Cited Text
- Small Matches (less than 9 words)

Match Groups

361 Not Cited or Quoted 14%
Matches with neither in-text citation nor quotation marks

0 Missing Quotations 0%
Matches that are still very similar to source material

0 Missing Citation 0%
Matches that have quotation marks, but no in-text citation

0 Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

Top Sources

9% Internet sources
6% Publications
12% Submitted works (Student Papers)

APPENDIX IV: ETHICAL APPROVAL LETTER

Strathmore UNIVERSITY

28th October 2025

Mr Ngari Peter,
peter.ngari@strathmore.edu

Dear Mr Ngari,

RE: Determinants of the Adoption of Regenerative Agriculture Practices in Embu and Tharaka Nithi Counties, Kenya

This is to inform you that SU-ISERC has reviewed and **approved** your above **SU-masters** research proposal. Your application reference number is **SU-ISERC3100/25.** The approval period is from **28th October 2025 to 27th October 2026.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, and MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-ISERC.
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-ISERC within 72 hours of notification
iv. Any changes, anticipated or otherwise, that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-ISERC within 72 hours
v. Clearance for the export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to the expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days of completion of the study to SU-ISERC.

Before commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) https://research-portal.nacosti.go.ke/ and obtain other clearances needed.

Yours sincerely,

Mr Ambrose Rachier,
Chairperson; SU-ISERC

APPENDIX V: INTRODUCTORY LETTER TO NACOSTI

Ole Sangale Rd, Madaraka Estate
P. O Box 59857 - 00200, Nairobi, Kenya
Cell: +254 703 034 414/6/7
X/Twitter/Tiktok: @SBSKenya
Facebook/Linkedin: Strathmore University Business School

Email: **sbsinfo@strathmore.edu** or visit **www.sbs.strathmore.edu**

Strathmore UNIVERSITY BUSINESS SCHOOL

20 Years of Developing Great African Leaders

29th October 2025

Director General,
National Commission for Science Technology and Innovation,
P.O. Box 30623, 00100
Nairobi.

Dear Sir/Madam,

RE: FACILITATION OF RESEARCH – PETER NGARI

This is to introduce Peter Ngari, who is a Master of Science in Development Finance (MDF) Student at Strathmore University Business School, admission number MDF/ 13633/23. As part of our MDF Program, Peter is expected to do applied research and undertake a project. This is in partial fulfillment of the requirements of the MDF course.

Peter is undertaking a research paper on **" Determinants of the Adoption of Regenerative Agriculture Practices in Embu and Tharaka Nithi Counties, Kenya"** The information obtained shall be treated confidentially and shall be used for academic purposes only.

Our MDF seeks to establish links with industry, and one of these ways is by directing our research to areas that would be of direct use to industry. We would be glad to share our findings with you after the research.

We appreciate your support and shall be willing to provide any further information if required.

Yours sincerely,

Njoki Kiagiri

Manager - Graduate Programmes.

Strathmore University Business School is a Proud member of:

Association of African Business Schools AABS AACSB

APPENDIX VI: RESEARCH PERMIT FROM NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **116449**

Date of Issue: **10/November/2025**

RESEARCH LICENSE



This is to Certify that Mr.. Peter Murimi Ngari of Strathmore University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Embu, Tharaka-Nithi on the topic: DETERMINANTS OF THE ADOPTION OF REGENERATIVE AGRICULTURE PRACTICES IN EMBU AND THARAKA NITHI COUNTIES, KENYA for the period ending : 10/November/2026.

License No: **NACOSTI/P/25/4181770**

116449

Applicant Identification Number

Ag. Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions