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MONITORING AND EVALUATION PRACTICES ON SUSTAINABILITY OF BEEKEEPING PROJECTS IN MAKUENI COUNTY, KENYA

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Research submitted to the Faculty of Arts and Social Sciences in partial fulfillment of the requirements for a Master of Arts Degree in Project Planning and Management at the Catholic University of Eastern Africa, Kenya.

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DECLARATION

This research is my original work and has not been presented for a degree at any other university. No part of this work may be reproduced without the permission of the author and The Catholic University of Eastern Africa (CUEA).

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DEDICATION

I dedicate this research to my family and friends for their unwavering support, encouragement, and belief in my capabilities throughout my academic journey.

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ABBREVIATIONS AND ACRONYMS

ASALs– Arid and Semi-Arid Lands

FAO– Food and Agriculture Organization

M&E– Monitoring and Evaluation

NGO– Non-Governmental Organization

ROI – Return on Investment

SNV – Netherlands Development Organisation

UNDP– United Nations Development Programme

ABSTRACT

Beekeeping initiatives are currently being encouraged as climate resistant livelihood, particularly in dry and semi-arid areas such as Makueni County where bee keeping is helping to sustain livelihoods, food security and the environment. However, their sustainability is questionable in most areas of the county because they have poor monitoring, follow-up, and utilize less feedback and data. Nevertheless, there is scarcity of empirical studies that have engaged in systematic study of the impact of particular monitoring and evaluation practices on sustainability in beekeeping initiatives in Makueni County. The primary goal of the study was to investigate the impact of monitoring and evaluation practices, namely, data utilization, training follow-up, hive monitoring, and feedback action, on the sustainability of the beekeeping projects in the county. The research was informed by Systems Theory and Results-Based Management Theory and used qualitative research approach whereby the study involved beekeepers, extension officers, project coordinators, and monitoring and evaluation personnel who were involved in the donor- and government-sponsored beekeeping programs. Purposive sampling was used to identify 53 participants who included 4 focus group discussions and 32 participants that comprised of 21 key informant interviews. Key informant interviews and focus group discussions were used to collect data; they were thematically analyzed using the framework of Braun and Clarke. The results indicate that efficient monitoring and evaluation can boost hive productivity, retention of farmers, and household income, contributing to environmental, social, and economic sustainability. The research finds that the practice of a powerful monitoring and evaluation is essential in the process of supporting community-based bee keeping projects. The paper is valuable as it produces evidence that can be used by county policies, enhances the practice of project management, and deepens the theoretical debate on sustainability in community-based livelihood projects.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter provides the background and context of the study. It outlines the problem statement, purpose, objectives, and research questions. It also highlights the justification, significance, scope, constraints, conceptual framework, and key definitions.

1.1 Background to the Study

Beekeeping is the process of rearing bee colonies in order to obtain honey, beeswax, and other byproducts (Prodanović et al., 2024). The beekeeping industry is pervasive all over the world, including mass commercial activities of the developed nations, up to smallholder structures amongst the rural population of the developing nations (Fedoriak et al., 2021). It is becoming a popular decision by governments, NGOs, and international development agencies as an appropriate strategy for a sustainable livelihood. The practice is increasingly recognized as of value ecologically, economically, and socially worldwide. FAO (2021) observes that bees contribute to sustainable agricultural practices and a healthy approach to biodiversity balance due to their contribution as pollinators (Canton, 2021). According to Zalilova et al. (2021). It also brings opportunities to the marginalized people and local self-sustainability. Beekeeping is important in reducing poverty, which not only helps to benefit people economically in one way, but also promotes environmental resilience.

Successful beekeeping projects are marked by sustained farmer engagement, ecological balance, and long-term economic viability. Sustainability, in this case, refers to the long-term utilization of the hive, the uniform application of best standards, and the generation of income without external donor or government funding (El Agrebi et al., 2021). According to the FAO (2021), the sustainability of any rural project has three dimensions, including environmental, social, and economic ones. Environmental sustainability means hive colonization, pollination benefits, and reduced pesticide use. Farmer retention, community ownership, as well as empowerment of women and young people are components of social sustainability (Feketéné Ferenczi et al., 2023). Consistent honey production, a steady income stream, and the long-term viability of beekeeping are key indicators of economic sustainability. These pointers form the foundation for measuring the long-term effects of beekeeping programs.

Although it has its merits, many beekeeping projects do not be long-term sustainable. The projects funded by the donors are usually oriented towards hive distribution and initial training, but not on follow-up and capacity building later on. Canton (2021) states that the flaws can be hardly blamed on the beekeeping but the lack of systematic and long-term support. According to Tirok et al. (2024), more than two-thirds of all beekeeping projects in the developing world are funded by a donor at the beginning of the first two years. This has followed some major reasons which include, poor follow-up, poor involvement of farmers and lack of reinforcement training. The most common effects are the dumping of the hives, inadequate growth of the colony, decreased productivity, and deterioration of farmer interest (Danieli et al., 2023). Such problems highlight the need for better management that is far-sighted and not solely based on their start-up.

In Sub-Saharan Africa, beekeeping is an emerging livelihood practice. It is an alternative to traditional agriculture in semi-arid zones with poor rainfall, mixed land degradation, and drought. It needs a small amount of capital in rural territories, does not need arable land or irrigation, and has an ecological and economic purpose (Gakenia et al., 2024). Africa has a variety of indigenous flowering plants that provide a considerable habitat for the bees. Its advantages have made governments and NGOs popularize it as a rural development plan and a process of adapting to climate change (Chen et al., 2021). The use of beekeeping has been increasing steadily in the countries of Sub-Saharan Africa due to its flexibility in arid areas, low input needs, and its support for rural development concerns.

Sub-Saharan Africa has serious challenges in sustainability of beekeeping that are a serious challenge to its potential. The majority of donor-funded initiatives are likely to offer hives and start-up packages, but do not provide technical assistance and training to farmers in the long run (Gonzalez Pacheco & Barragan Ocana, 2023). This has contributed to poor hive colonization, poor management, and equipment left unattended after the project. This has led to low honey production and farmer participation because of a lack of routine monitoring and follow-ups and poor local extension services. Kijera (2025) explains that over 60 percent of beekeeping projects funded by donors fail within two years because of inappropriate participation of farmers and lack of proper monitoring. This is not a failure in beekeeping as such, but an issue in a greater failure in planning, implementation, and maintenance of projects.

Kenya is the other front-runner African nation to include in its development strategies. Beekeeping is also projected as an important aspect in Kenya Vision 2030 that has established a portion of the strategic goals of poverty reduction in the rural setting, food security, and environmental conservation (Harianja et al., 2023). Harianja et al. (2023) introduce an additional element that beekeeping in Kenya has enjoyed significant support through numerous counties, and its institutional support has been well supported by the national development plans and donor programs, which focus on uplifting the livelihoods of the rural communities. It also agrees with the Climate-Smart Agriculture Strategy, which explores the strategies of being more productive by aiming at reaching a climate-resilient future (Bazrafkan& Alipour, n.d.). The

Ministry of Agriculture, with the support of donors such as FAO, SNV Netherlands, and other non-governmental organizations (NGO), has come up with numerous beekeeping initiatives in arid and semi-arid lands (ASALs) (Haider et al., 2025). The practice has boosted the income of farmers, enhanced climate-resilient agriculture, and allowed community groups to access new markets and training prospects.

Beekeeping is also very appropriate in ASAL counties with low land pressure, abundant forage, and suitable adaptive species of bees that fit well in the region, including the ones used in Turkana, Kitui, Baringo, and Makueni (Pajarillo et al., 2022). This provides an easily scalable, realistic alternative to conventional farming among smallholder farmers in drought-affected regions. Kenya has more than 2 million untapped bee colonies, yet the commercial use is limited to a small percentage (Canton, 2021). Although the government and donors have been supportive of beekeeping through training, equipment, and cooperative support, sustainability is a significant concern. Most projects do not have effective Monitoring and Evaluation (M&E) systems that are paramount to tracking progress, accumulating farmers' knowledge, and achieving long-term success (Etxegarai-Legarreta & Sanchez-Famoso, 2022). This denotes the great degree of urgency in closing the separation between project implementation and long-term rural development, employing local evidence-based solutions.

Makueni County, located in Kenya, can be categorized as an arid and semi-arid (ASAL) area, which experiences poor weather and low agricultural production. It experiences irregular precipitation, extreme heat, and a predilection to drought; thus, rain-fed agriculture cannot be depended on (Kilonzo &Machibya, 2025). Mutua et al. (2023) argued that in Makueni, small-scale farming is a source of food and income for more than 80 percent of the population in the area. They are therefore exposed to food insecurity, poverty, and economic vulnerability.

Subsistence farming is also pressured by the unavailability of water, infertile soils, and unharvested crops, particularly during off-seasons (Kilonzo &Machibya, 2025). These have tested the government and its development partners to find other resilient sources of livelihood that match the ASAL situations.

In Makueni, beekeeping is a viable, low-cost, and eco-friendly means of livelihood. County Government, with its partners, including FAO, SNV Netherlands, and NGOs, has been a leader in a range of beekeeping projects (Mutua et al., 2023). These include hive distribution (Kenya Top Bar and Langstroth predominated), protective garments and equipment, farmer training, and connectivity to the market via cooperatives. It has been incorporated into wider systems of rural development, specifically as climate-smart agriculture, in select wards (Ntawuzumunsi et al., 2021). Beekeeping should be practiced as a means of conservation and as a buffer against climate shocks. This aims to increase incomes, help the environment, and reduce reliance on unsustainable farming practices.

Although some projects on beekeeping are initiated at an early stage, most of these projects fail after the donor's or the county's interest wanes. The lack of follow-up, training, and technical assistance has resulted in poor colony development, high hive abandonment, and low honey production, as reported (Chami et al., 2022). Farmers are not always skilled in managing pests, relocating hives, or harvesting crops. The result of this is dwindling interest and abandoned paraphernalia, as well as structurally failing structures. Chami et al. (2022) add that as most projects do not support a feedback mechanism or follow-up of hive distribution, farmers lose connection with implementers. Although beekeeping has potential in Makueni, implementation is weak, follow-ups are poor, and the farmers do not fully embrace it. These recurring shortcomings highlight the urgent need to understand the sustainability of beekeeping initiatives, focusing not only on their start-up but also on their long-term environmental, social, and economic viability.

In this study, sustainability is described as maintaining the use of hives, involving farmers on a constant basis, and generating frequent earnings without external support. Globally, sustainability in beekeeping promotes the sustainability of hives, sustaining the environment and income predictability beyond donor remittances. In Sub-Saharan Africa, sustainability is often hindered by poor follow-ups, monitoring, and project failures, whereas beekeeping, as a climate-resilient business, has considerable potential. In Kenya, sustainability issues include weak colonization in hives, losses to farmers, erratic honey harvests, and a lack of coherent monitoring and evaluation. Beekeeping is being strongly promoted in Makueni County as a form of sustainable rural livelihood in the face of the prolonged drought and reduced harvests (Burma, 2023). It is appealing because it has low input requirements, is easy to adapt to the local environment, and can generate income when producing honey. The decision as to which factors can lead to the long-term success or failure of beekeeping interventions is, therefore, an inseparable part of design and increased impact.

The sustainability of beekeeping projects can be evaluated along the lines of environmental, social, and economic capacities, each with its indicators that present the prospects for sustainability. Environmental sustainability relates to how closely beekeeping activities align with and support the ecology (Yang & Ou, 2023). The indicators are the rate of colonization; the number of occupied hives (as an indicator of colony health and suitability of the site); pollination of surrounding crops and plants (a measure of ecological value); and a decrease or absence of pesticide use near apiaries, as pesticide exposure has been linked to adverse effects on bees and the environment. All these indicators show whether beekeeping improves the ecological landscape or not.

Social sustainability considers the human and community aspects that may impact a project's sustainability (Alexander &Segbefia, n.d.). Perceived value and relevance are also evident in the retention rate, or the number of farmers trained and who continue with beekeeping. Collaboration by the farmers through organised groups or cooperatives increases the opportunity for collective ownership and support systems (Nganso et al., 2025). Social equity is achieved through gender inclusivity, which is determined by the percentage of women involved in and benefiting from the beekeeping activities. Collectively, these criteria help shed light on the degree to which the intervention is embedded, social, and equitable at the local level.

Economic sustainability is closely tied to economic viability as a way of life. A consistent monthly income from honey sales is both a consequence of a successful economic activity and proof of proper market engagement (Feketéné Ferenczi et al., 2023). The consistency of income needs to be through stable market channels, like retail outlet, cooperatives, value added processing. The economic benefit of continuing to operate and reinvest in hives, despite the intervention of outside assistance, is proven by the fact that the long-term use of hives continues (de Graaf et al., 2022).

Although an encouraging initial adoption pathway, a considerable percentage of the beekeeping projects in Makueni do not meet these sustainability standards. The desolation of the hive, the decline in honey production, and the inability to be interested in keeping bees is the indicator of sustainability (Manoj et al., 2023). These are normally blamed on poor technical support, follow-up training as well as poor monitoring systems. These gaps in the form of an ineffective Monitoring and Evaluation (M&E) frameworks have resulted in a loss of early detection of problems (Haider et al., 2025). In this case, key elements for sustainability include post-training follow-ups, hive inspections, and farmer feedback mechanisms. These support continuity, skills application, and adjustments over time. Therefore, sustainability in beekeeping is not only a product of ecological compatibility or economic output but also of strong follow-through, monitoring, and local ownership.

Monitoring and evaluation (M&E) are the routine procedures involved in the assessment of the activities, inputs, outputs and results of a project, which monitor the performance, support the learning process and enhance accountability (Kose, 2025). In the community-based programs of beekeeping, a good monitoring and evaluation (M & E) program can enable them to detect loopholes in their implementation, establish adaptive strategies, and establish performance reports within clear objectives. Mutua et al. (2023) further contribute to the fact that in an arid and semi-arid land (ASAL) environment, where environmental and social change is so fast, interventions run the risk of becoming detached from the reality on the ground without applied M&E. It is not only that a good M&E framework is the one that documents improvement, but also that it results in learning, timely action, and transparency by all parties (Gakenia et al., 2024). These three interlocking dimensions of M&E are important to the viability of beekeeping in the Makueni County context: capacity-building follow-up, hive monitoring, and feedback action.

Monitoring and evaluation (M&E) are important variables that define the sustainability of beekeeping interventions. Internationally, M&E enhances sustainability by increasing accountability and adaptive learning. In Sub-Saharan Africa, the poor M&E systems cripple the long-term results of donor-driven projects. In Kenya, insufficient follow-up and data utilization contribute to project unsustainability, and M&E is needed in environments like Makueni County.

Data utilization showcases the implementation of gathered information in beekeeping projects in decision-making, dissemination of knowledge, and enhanced results (Şengül & Saner, 2023). Şengül & Saner (2023) add that the decision-making process concerns whether the gathered information about farmers, the monitoring of the hives, and market trends is being used to act in an appropriate and timely manner to change the location of the hives or change the training program. Stakeholder sharing takes care of making sure the leading players are exposed to the project data so that areas of effort can overlap in the project, as well as duplication (Zalilova et al., 2021). According to Zalilova et al. (2021), lesson application leads to the incorporation of prior knowledge gains in the current strategy application, like the application of best hive designs or timeline adjustments given seasonal patterns.

Sustainability also relies on how well follow-up occurs after initial training. It encompasses the rate of farmers who were prepared initially and are still in operation, which is a dimension of the sustainability of the training or acceptance. The frequency of refresher sessions is an indicator of the level of ongoing capacity-building activities of a project, and projects that are committed to ensuring long-term skill retention will conduct refresher sessions frequently (Luo et al., 2021). The holding of techniques through the vital skills of the farmers to perform the necessary procedures, such as pest control, examination of the bee hives, and harvesting of honey, proves the responsibility of whether the training has captured reality and modification of conduct.

Hive monitoring is critical for the detection and correction of problems before they harm productivity. Volume of inspection per farmer is a simple indicator of the frequency of inspection of hives for pests, colony strength, and honey levels (Abrol, 2023). Abrol (2023) notes that observing the usage of records indicates whether or not these inspections are recorded and studied, and it will enable patterns to be monitored over the years. The issue must be identified on time so that the proper detection of colony collapse, infestations, or relocation requirements may help to exclude more significant losses and facilitate stable production results.

Feedback action is important as farmers and project implementers act on field-level insights. The count of the issues solved indicates the degree to which problems brought up during the monitoring or education are solved. Feedback utilized is a measure of input in feedback, which results in change, and this shows the level at which the project takes feedback from the farmers and frontline workers (Pocol et al., 2021). Pocol et al. (2021) believe that the changes in input or changes in the form of a hive type, placement strategy, or training content demonstrate the level to which the system responds to the local needs and challenges, cultivating sustainability.

Most beekeeping initiatives within Makueni use input-based measures, such as the distribution of hives or the number of farmers trained so far, and do not measure outcomes and behaviour change in an orderly method (Chen et al., 2021). Beekeeping in arid and semi-arid areas is heavily advocated as an arid-resistant livelihood. However, the majority of the literature concentrates on economic output and technical input. Little consideration is given to the management of projects on a temporal basis. There are only a few empirical experiments that would associate specific monitoring and evaluation (M&E) elements, such as training follow-up, hive inspection, data use, or feedback action, with long-term outcomes. These are hive colonization, retention of farmers, and stabilized income. M&E is frequently mentioned on a general level. There are a few attempts to disaggregate it at the functional or the sustainability dimension level. It causes difficulty in determining what practices are actually environmental, social, or economically sustainable.

Key components of monitoring and evaluation, like technique retention and regular checks, are hardly researched. In Makueni, most initiatives stall once donor funding ends, largely due to ineffective training, weak monitoring, poor feedback systems, and limited field support (Kijera, 2025). Although M&E has been touted as important in terms of sustainability, there is limited evidence at the field level on how or why it might guide or fail to guide beekeeping projects in Kenyan ASALs.

1.2 Problem statement

In the ideal scenario, sustainable beekeeping should be cheap, drought-tolerant, and able to support food security and incomes. However, this is not the case in Makueni, where results remain inconsistent. Nevertheless, the major beekeeping projects in Makueni County cannot be sustained in the long term , with over 40% of distributed hives becoming inactive within one year. Mutua et al. (2023) connect it to the poor follow-up, post-training support, and insufficient involvement of project staff, including a lack of routine hive monitoring, limited post-training visits, weak data utilization, and poor feedback action. Many beekeepers leave their hives months after investing heavily in hives and quality training, with more than 35% of trained beekeepers abandoning hives within six months, which can result in poor long-term prospects.

Consequently, farmers find it difficult to sustain colonies without constant advice from experts, which indicates that they need better support systems. When allocated hives are not maintained or when the production of honey ceases, the anticipated benefits on income, nutrition, and resilience are not realized. The poor and continued outcomes generate frustrations and lead to a loss of credibility in aid programs. Therefore, the monitoring and evaluation phase is critical to sustainable beekeeping.

However, existing studies on beekeeping in Makueni County have not examined how specific monitoring and evaluation practices (such as structured follow-up visits, systematic data utilization, routine hive monitoring, and actionable feedback mechanisms) influence project sustainability across economic, social, environmental, and institutional dimensions in donor-funded, government-led, and community-based projects. Interest in such internal factors is usually what determines the success of projects. Without M&E, any beekeeping initiative is unreliable and unsupportable, dissipating resources and ignoring the needs of the local people (Newman et al., 2021). This study explored how monitoring and evaluation practices influence hive productivity, farmer retention, and earnings in Makueni County in relation to sustainable climate-resilient practices, while addressing the methodological gap that prior studies used quantitative surveys that could not explain why specific M&E practices succeed or fail.

1.3 Purpose of the Study

The purpose of the study was to explore the influence of monitoring and evaluation practices on the sustainability of beekeeping projects in Makueni County, Kenya.

1.4 Objectives of the Study

1. To explore how hive monitoring contributes to sustainable beekeeping in Makueni County.
2. To explore the role of follow-up activities in supporting sustainable beekeeping practices.
3. To identify the significance of hive setup verification in promoting continuity in beekeeping.
4. To analyze how the use of monitoring data influences sustainable beekeeping practices in Makueni County.

1.5 Research Questions

1. How does hive monitoring contribute to sustainable beekeeping in Makueni County?
2. What role do follow-up activities play in supporting sustainable beekeeping practices?
3. How does hive setup verification influence the continuity and adaptive management of beekeeping practices in Makueni County?
4. How does the use of monitoring data influence the sustainability of beekeeping practices in Makueni County?

1.6 Justification of the Study

With skewed rainfall patterns, less rain, and the demand for alternative livelihoods in the rural community, beekeeping as a sustainable livelihood intervention has been promoted in Makueni County. Despite the widespread use of different development programs, many projects fail to survive once sponsorship ends. One issue is often neglected practices before hive distribution (structured training), during implementation (level of monitoring), and after distribution (feedback to the decision-making body). This has consequences of poor bee hive survival, low honey yields, and minimal long-term benefits. To improve project sustainability in the future, this focused on training, hive monitoring, and feedback action. The study attempted to generate evidence on these practical and observable elements of project implementation and apply it to support the redesign and strengthening of beekeeping programs implemented in semi-arid environments.

1.7 Significance of the Study

This work offered information on the operational elements that contributed to the sustainability of beekeeping projects in Makueni County. The study narrowed down the variables that project managers and field officers could control. This assisted development organizations and donor-funded programs in gaining insight into and improving their implementation methods through training, hive checking, and feedback response. The study also informed local government extension services and cooperative networks on how to serve beekeepers in a more efficient and responsive manner. In addition, the research provided information that supported sustainable beekeeping practices. It also bridged a literature gap concerning the impact of field-level practices on project outcomes, especially in arid and semi-arid environments where development projects are constrained by factors characteristic of such environments.

1.8 Scope and Delimitation of the Study

The research was only limited to the beekeeping projects that were taken by the nongovernment organizations in Makueni County within the last five years. It also considers the relationship of four independent factors, data utilization, training, hive monitoring, and feedback action, to the sustainability of these projects. Project implementation engaged with implementers, extension agents, and beekeepers who directly participated in training programs, hive usage, and project feedback mechanisms. The study excluded technical factors like hive engineering and bee species performance unless they impact that variable. Agricultural or environmental policies, as a broader look at the system, was not be included in the study unless they affect training delivery, monitoring frequency, and feedback responsiveness. The study derived specific, actionable, and realizable results from collating on these operational variables.

1.9 Limitations of the study

Incomplete documentation could become one of the constraints, particularly when project implementers or farmers lack consistency in recording activities. The study utilised triangulation of numerous data sources such as interviews, direct observations, and monitoring logs that are available. In cases where documentation does not exist, it was verified by means of cross-checking with the project staff, local leaders, and trained farmers to re-establish the sequence of activities and confirm the key occurrences.

The bias of self-reporting in interviews is another setback since the respondent might be giving the answer based on memory or giving unrealistic answers. Behavior and event-based questions to be used in the study minimize the dependence on general recall. They were also be supported, where feasible, by observational evidence and physical verification (e.g., inquiry on the state of the hive or training materials) to increase the validity of self-reported data.

The narrow geographic area, which is concentrated in Makueni County only, limits the applicability of the results to other counties that have diverse agro-ecological or socio-economic settings. This shortcoming was met by placing the results well in the local context and making procedural comparisons with the respective literature on similar arid or semi-arid areas. In the findings, the main recommendations was made with issues cited where more research is required to make them all-inclusive.

1.10 Conceptual framework

This framework was based on the understanding that the conceptual relationships leading to sustainability in beekeeping projects include preparation, oversight and adaptation. The independent variables include data utilization, Training Follow-up, Hive Monitoring, and Feedback Action have measurable indicators that reflect the workable practical field activity. Data Utilization supports sustainability by guiding better decisions. Projects are more responsive when the information is monitored to change and adjust strategies, share information with stakeholders, and implement lessons. This enhances management of the hives, builds teamwork and enhances performance in the long-term, environmental, social and economic levels. Follow-up Training will enable farmers to have more technical training and practice consistency. It is presumed that the retention of techniques was demonstrated by more percentages of educated farmers, refresh and improved hive management and production that would translate to the sustainability of project performance. Hive Monitoring is a daily inspection of the beehives and proper monitoring of the same and early detection of issues. Checking and actively working with monitoring record regularly will help to identify pest or weakness of the colony early which will make it easier to make better management decisions and improve environmental and economic sustainability. Feedback Action incorporates resolution of the issues that are found out, taking up of farmer feedback and subsequent changes to inputs. Appropriate and timely resolution of problems through timely action on be recordings of farmers will tend to boost the builder confidence and retention and the productivity of the same. Sustainability (the Dependent Variable) is used in three dimensions, including environmental (rate of hive colonization), social (farmer retention), and economic (monthly income in honey). It is expected that there is a positive relationship, and with better M&E practices, better results are realized in all aspects of sustainability (all three domains of sustainability).

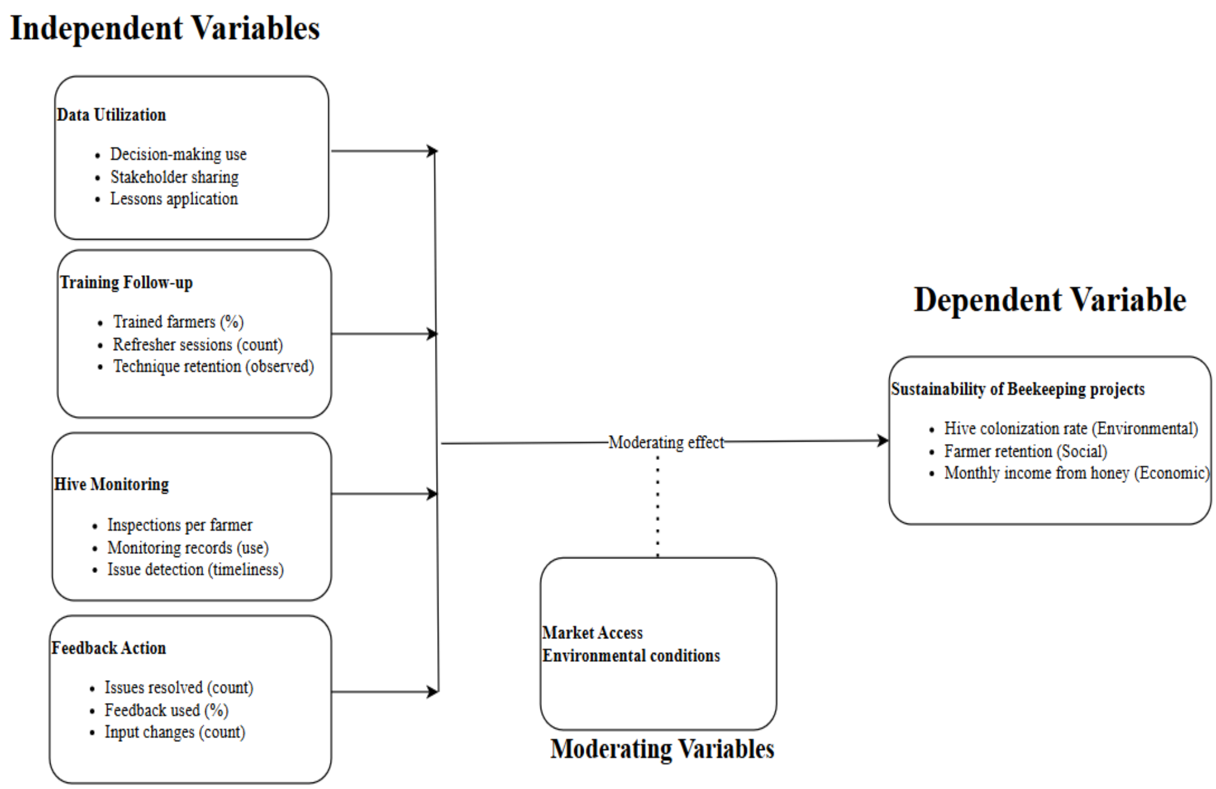

Figure 1.1: Conceptual framework

1.11 Operational Definition of Terms

1. **Monitoring and Evaluation (M&E):** Integrated process of systematically tracking, assessing, and using data related to beekeeping project activities, progress, and outcomes in Makueni County to inform decision-making, improve project performance, and ensure long-term sustainability.
2. **Data Utilization**: The application of M&E data by project stakeholders to guide actions, refine strategies, and support the continuous improvement of beekeeping initiatives.
3. **Decision-making Use**: The extent to which project implementers and stakeholders rely on M&E findings to make operational, managerial, or strategic decisions related to beekeeping.
4. **Feedback Action**: Responses or adjustments made by project teams or farmers based on insights from M&E data, aimed at correcting issues or enhancing outcomes.
5. **Lessons Application**: The integration of past M&E experiences or findings into current practices to improve the effectiveness and adaptability of beekeeping projects.
6. **Training Follow-up**: Ongoing support and supervision provided to trained beekeepers to reinforce skills, monitor knowledge application, and ensure quality practices.
7. **Technique Retention**: The consistent demonstration of correct beekeeping techniques by trained farmers during follow-up assessments or field visits.
8. **Sustainability of Beekeeping Projects**: The ability of beekeeping activities to continue generating environmental, social, and economic benefits over time without relying on continuous external support.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature related to the sustainability of beekeeping projects and the role of monitoring and evaluation practices. It discusses theoretical perspectives and empirical studies that explain how monitoring, follow-up activities, and data use influence sustainable outcomes. The review also identifies existing gaps that the current study seeks to address.

2.1 Theoretical framework

The theories used in this research are knowledgeable in explaining the circumstance of monitoring and evaluation practices relative to the sustainability of beekeeping projects. The theories can assist in the process of how different factors interplay and affect each other during projects and eventually define the long-term outcomes. Relevant theoretical discourses would facilitate the study in correlating the results in a more systematic way and draw useful inferences. The research is premised on the following theories as discussed in the subsections below.

2.1.1 System Theory

System Theory is one of the theories that can be used in this study. Ludwig von Bertalanffy invented it in the 1940s (Luhmann et al., 2013). It explains how the various components of a system are dependent and interdependent to each other to make them effective, sustainable, and responsive to changes over time. It has biological origins and has since been expanded into a cross-disciplinary system used in other fields including organizational studies, education. Systems theory has been used to study the interaction between different components of a system and how this influences the results, and it is therefore very applicable when understanding sustainability (Luhmann et al., 2013). It has been applied to studies analyzing the performance of health systems, programs of study delivery, and project results in agriculture, particularly where feedback loops, adaptation, and sustainability are of concern. It is a theory that posits a system is composed of all interdependent and interrelated parts that work together to achieve a goal. As soon as one of the components transforms, the other is also influenced, leading to a dynamic balance. The theory in this context helps explain the interaction and effects of monitoring and evaluation (independent variables) on the sustainability of beekeeping projects (dependent variable) in Makueni County. This aligns with the study's aim to investigate how M&E practices influence the sustainability of community-based projects.

The reasoning behind implementing System Theory is its logical nature with the focus on the significance of feedback, continual learning, and interrelations between the elements of the project (Hofkirchner&Schafranek, 2011). Such characteristics align with sustainability practices that cannot rely solely on singular acts of intervention but rather on ongoing changes and adjustments. One strength of the theory is that it is holistic, enabling the researcher to study the project as a whole, rather than examining it in parts (Hofkirchner&Schafranek, 2011). It supports more complicated relationships and feedback essential to the success of long-term projects. The problem is that it is too general; providing precise, predictive suggestions on what to do may not be helpful, and operationalizing it in empirical studies is even more problematic (Hofkirchner&Schafranek, 2011). Nonetheless, its capability to describe how components interact dynamically renders it appropriate in explaining how monitoring and evaluation structures contribute to the sustainability of the beekeeping projects, which may help transfer the insights into the sound implementation and policy.

2.1.2 Results-Based Management (RBM) Theory

Another theory was applied in the study is Results-Based Management (RBM) Theory. RBM was developed in the 1990s as a government and development agency reformation idea, where the focus of planning, implementation, and assessment of projects and programs is a clear direction towards attaining quantifiable outcomes (Alesani, 2023). It encourages monitoring and evaluation (M&E) to be considered at every phase of a project cycle to keep track of the progress, measure the performance, and utilize evidence to make decisions (Lainjo, 2019). It has been a popular application in development studies, humanitarian programs, as well as in administration to enhance accountability, learning, and sustainability of interventions. It has been applied to analyze the effectiveness of M&E systems in the connection between inputs and activities and outputs and the preferred results and impacts, especially in community-based and donor-funded projects (Lainjo, 2019). The RBM Theory suggests that efficient M&E does not merely consist of gathering information but also in making sure that the information gathered is analyzed, shared, and used to make projects more efficient and sustainable.

In this study, the theory was used to support the purpose in the area of integrating M&E in sustainability planning of beekeeping projects. It informed the study on the effects of data use, training follow-up, hive monitoring, and feedback action on the environmental, social, and economic sustainability outcomes (Vahamaki et al., 2011). The independent variables include the M&E related practices, which are data usage, training follow-up, hive monitoring, and feedback action, and the dependent variable is the sustainability of the beekeeping projects estimated by the hive colonization rates, the farmer retention, and the income provided by the honey (Alesani, 2023). The topicality of the theory is in the fact that it is aimed at constant utilization of the M&E outputs to enhance the quality of the decision-making and better the project strategies to be more impactful. It is powerful as it connects evidence to action and this increases accountability and learning. However, its weakness is that it is resource intensive, and can be opposed by other stakeholders who are new to data driven management methods (Vahamaki et al., 2011). Despite such limitations, the theory is still applicable because it offers a systematic approach to learning how systematic M & E practices can play a role in long term sustainability of development projects.

2.2 Sustainability of Beekeeping Projects

The rate of hive colonization is an environmental sustainability measure that quantifies the performances of bee colonies of successfully settling and proliferating in man-made dominated hives placed in specific ecological surroundings. According to Bertoni et al., (2025) successful colonization depends a lot on the pattern of adjacent land-use, flora, and the lack of pollutants, such as agrochemicals. Bertoni et al. (2025) report that the level of ecological balance is quite high, which results in the very high rate of colonization in the environment, i.e. semi-natural grasslands and in the environment with the high abundance of native vegetation. In the regions where pesticides had been widely spread, Bertoni et al. (2025) found that in most cases, the colonies failed to grow or they became of low vitality. Bertoni et al. (2025) also emphasize in their study that ecological corridors and hedges should be created in order to secure the continuous occupancy of the hives. Thus, environmental sustainability on beekeeping does not only mean the availability of physical hives alone, but the social protection of the natural bee environments.

Kouchner et al. (2019) also provide an additional European perspective, focusing on the development of an assessment framework for the environmental performance of French beekeeping systems. Kouchner et al. (2019) submit floral access, landscape diversity, and pesticide exposure as building blocks determining colonization exercise outcomes in hives. The framework by Kouchner et al. (2019) indicates that a well-organized beekeeping system also faces challenges with colonization when situated in an ecologically compromised region. Kouchner et al. (2019) show that when organic agricultural practices are combined with beekeeping, hive occupancy rates are more stable and consistent, even under conditions of climate change. Interestingly, Kouchner et al. (2019) also mention that hive colonization is vulnerable to microclimatic changes, especially regarding altitude and temperature fluctuations, and that the placement of hives should thus, depending on location, consider data on the local environment. Kouchner et al. (2019) found that policy-level interventions, including agri-environmental regimes and land conservation programs, are relevant to sustaining beekeeping practices on a long-term basis.

Harianja et al. (2023) analyze the effects of environmental outcomes in Indonesian beekeeping, that is, how the colonization of bee hives interacts with land use, deforestation, and agroforestry systems. In their research, Harianja et al. (2023) report that the application of hives within or in mixed agroforest ecosystems received significantly greater colonization than monoculture plantations or deforested areas. According to Harianja et al. (2023), this is likely associated with the constant access to various pollen and nectar resources of agroforestry crops, such as coffee, coconut, and fruit trees. Harianja et al. (2023) also indicate the traditional ecology knowledge of native tribes and that is what led to the strategic planting of hives thus increasing the success of colonization. However, Harianja et al. (2023) also caution that such environmental advantages are much hampered by the pessimism of transforming land to palm oil plantations.

Farmer retention is a major concept in the social sustainability of beekeeping projects because it implies a sense of commitment, the acquisition of knowledge, and the continuation and conservation of skills on a communal scale. Gring-Pemble and Perilla (2021) examined how the sustainable communities practiced beekeeping in the Latin American communities. Gring-Pemble and Perilla (2021) noted that programs that included social empowerment, locally based leadership, and capacity-building projects achieve much better farmer retention. In their case studies, Gring-Pemble and Perilla (2021) found it is evident that beekeepers remain more engaged in the long run when they are not only served as aid recipients but also stakeholders in a model co-designed with them. Gring-Pemble and Perilla (2021) also note that tri-sector partnerships between governments, NGOs, and businesses are important as they support farmers with post-training support. According to Gring-Pemble and Perilla (2021), understanding in social settings and models of cooperation increase motivation and resilience in the group, which leads to low attrition rates in beekeeping activities.

Nat Schouten and John Lloyd (2019) discuss the trends in success and failure in beekeeping initiatives in developing nations, which gives a more specific view of the conditions that encourage or dishearten farmers to join the initiatives in the long run. Schouten and Lloyd (2019) in their analysis discovered that the absence of follow-up assistance, inadequate training tailoring, and a lack of fit between the expectations of the farmers are significant causes of the disengagement of the farmers. Conversely, Schouten and Lloyd (2019) document that the ones that encourage peer-to-peer mentorship, give farmers the opportunity to experiment, and equip them with resources, which are not binding, are more likely to be retained in the long run. Schouten and Lloyd (2019) also note the psychological aspect of retention, then the fact that farmers who find it culturally acceptable and personally fulfilling to keep bees have a higher chance of continuing with it.

Schouten and Lloyd (2019) add that gender inclusion, access to decision-making platforms, and the inclusion of traditional knowledge also boost social cohesion and participation. Schouten and

Lloyd (2019) advise that the use of retention-oriented policies should be dynamic, culturally responsive, and integrated into the general rural development policies.

Popescu and Popescu (2019) assess the contribution of ecological beekeeping to enhancing the social fabric and identity in rural Romanian communities. The findings of Popescu and Popescu (2019) indicate that engagement with ecological beekeeping leads to the support of a sense of belonging and pride in their land to rural farmers, so that they feel like land guardians. Popescu and Popescu (2019) claim that the implementation of social sustainability is reinforced through the integration of beekeeping into the community's social and cultural story and intergenerational experiences. Popescu and Popescu (2019) discovered that where beekeeping is taught in schools and school ceremonies and local rituals are beekeeping-oriented, attrition levels among farmers are extremely low. Popescu and Popescu (2019) also highlight the robustness of locally based knowledge networks, which place veterans in the role of training apprentices, thereby creating a chain of generations and collective memory. Popescu and Popescu (2019) identify cooperative beekeeping models as a means to enhance community resilience in the face of economic hardships or environmental disturbances. Comprehensively, Popescu and Popescu (2019) demonstrate that farmer retention is neither a logistical nor a technical issue, but a highly social process that is deeply rooted in the realms of community life and the identity of the countryside.

The economic sustainability measure is the monthly profit earned by selling honey in a beekeeping operation, especially in a rural economy where there are only a limited number of livelihood custodians in the local economy. Gonzalez Pacheco and Barragan Ocana (2023) discuss sustainability in the post-COVID context through the lens of the economy, noting that innovations and digitalization are the main factors that can increase income within the apicultural industry. Gonzalez Pacheco and Barragan Ocana (2023) review cooperatives within Latin

America and reveal that beekeepers who migrated to engage in e-commerce, value-added products (such as propolis and royal jelly), and branding realized a more stable monthly income compared to those who continued to use conventional markets. According to Gonzalez Pacheco and Barragan Ocana (2023), through access to technological infrastructure and market intelligence, beekeeping has become a viable commercial activity, no longer a subsistence activity. Gonzalez Pacheco and Barragan Ocana (2023) warn that unless special training and access to capital are available, small-scale farmers was left behind in obtaining such gains, perpetuating income inequality. Gonzalez Pacheco and Barragan Ocana (2023) propose to provide subsidies and low-interest loans, along with training technical education that is specific to marginalized demographics, to enhance equal economic sustainability.

Patel et al. (2020) offer a systematic study of the effect of a set of more closely interconnected socio-ecological reasons and conditions on economic performances of beekeepers in developing-world countries. Patel et al. (2020) employ a social-ecological system, depicting the feedback mechanism linking market access, land use, climatic variability, and earnings in honey production. According to Patel et al. (2020), beekeepers who have access to strong supply chains, storage, and cooperative marketing outlets, among other resources, report increased and more consistent monthly incomes. Besides, Patel et al. (2020) note that the ability of the economy to remain sustainable is usually linked to infrastructure, such as rural roads, electricity, and communications, which dictate the expenses and frequency of transporting honey to urban markets. Patel et al. (2020) note that exogenous shocks, such as droughts or political instability, can abruptly reduce the flow of income, particularly for those whose income sources are not diverse. According to Patel et al. (2020), to establish economic resilience, they should implement interventions at several levels: training beekeepers on the financial aspects, ensuring they sell a variety of products (e.g., beeswax, pollen), and training them in cooperative improvement. Patel et al. (2020) show that this global perspective illustrates the monthly wage is not only a result but also an input, which sustains other facets e.g., retention and environmental reinvestment.

2.3 Data Utilization and Sustainability of Beekeeping Projects

One important pillar of sustainable beekeeping is the ability to use data to inform decisions, as it will have a direct impact on the management and adaptation of apicultural operations to new challenges. De Graaf et al. (2022) note that systems using computational assistance in decision-making have shown immense promise in enhancing the results of beekeeping in Europe. The B-GOOD project integrates as many data points as it can, such as environmental factors, hive health factors, and management practices in the apiaries, and transforms them into evidence-based guidelines on the part of beekeepers. According to De Graaf et al. (2022), the system has enabled the stakeholders to manage changes by making reactive decisions turn to proactive decisions to improve the health of the hive, as well as improve the survival and productivity of the colony. De Graaf et al. (2022) also point out that the use of near-real-time or real-time information could assist in creating sustainability by increasing the chances of reducing colony losses and helping beekeepers adjust their activities when the environmental factors are available. De Graaf et al. (2022) also observe that the usefulness of the platform has helped especially in regulating the climate changes, creating feeding time schedules, and developing disease treatment strategies that have served as the foundation of incentive to both environmental and economic sustainability. Also, De Graaf et al. (2022) explain that the project will support long-term resilience and strategic planning of beekeeping communities as it will help to structure the data in a manner that will allow taking actionable intelligence.

The further digitalization of tools makes the significance of data in decision-making even stronger. HiveLink system is an IoT Smart Bee Hive System Monitoring that was developed by Dsouza and Hegde (2023). According to Dsouza and Hegde (2023), the main idea of this innovation is that the surrounding and the hive should be constantly monitored to become successful in the management of apicultures. HiveLink employs temperature-humidity and sound to help the beekeepers to know the status of the colony without physically inspecting the colony because this may generate stress to the colony and create disruptions. According to Dsouza and Hegde (2023) this system is directly linked with decisions it makes, linked with hive longevity and productivity such as swarm risk detection, queen loss detection and low temperatures. Besides environmental awareness, Dsouza and Hegde (2023) observe that the technology provides the opportunity to optimally utilize time and resources, which is one of the determinants of economic sustainability. The fact that HiveLink can become an early warning system due to the automated warnings in place ensures that interventions are done in time, an advantage that could not be enjoyed under the old system of beekeeping. Dsouza and Hegde (2023) argue that such decisions, based on data, limit the loss in colony survival and enhance the productivity of beekeeping activities, thereby making beekeeping a more feasible and sustainable livelihood practice, particularly in areas where manual supervision is scarce.

Sharing information among stakeholders, including researchers, government agencies, NGOs, and beekeepers, is needed in order to enhance overall sustainability of beekeepers industry. According to Santos et al. (2025), capacity building in Ecuador and Bolivia through Copernicus Earth Observation data has further increased the level of collaboration between stakeholders in the sustainable agricultural development sector, including beekeeping. Santos et al. (2025) explain that these partnership structures facilitate access to environmental and apicultural information for each other, establish common platforms on which stakeholders can interpret trends, share information, and align efforts. In this respect, Santos et al. (2025) state that data was transformed into a public good, increasing its transparency, accountability, and enhancing mutual learning. Santos et al. (2025) find that the systematic exchange of satellite-derived and field data enables more informed local beekeepers about weather, vegetation, and disease outbreaks, allowing them to coordinate their criteria with ecological trends. Consequently, Santos et al. (2025) note that instead of being an initiative of the individual, sustainability is incorporated into the operations of the entire beekeeping value chain. Santos et al. (2025) emphasize that this integrated model of knowledge sharing fosters social and economic sustainability through enhanced networks between communities, as well as economic sustainability through the harmonization of production strategies and reduced losses.

Zacepins et al. (2013) also substantiate the utility of stakeholder-driven data sharing through profitability listings of precision farming technologies, including their accomplishments in beekeeping. Zacepins et al. (2013) state that the value of data increases significantly when measurement systems and monitoring data are transparent and accessible to all stakeholders involved in the activity. Zacepins et al. (2013) argue it is true in the context of beekeeping, where precision tools enable profitability per hive performance or environmental input, are transparent in decision-making, and facilitate the distribution of resources. When the dataset is shared, Zacepins et al. (2013) report that stakeholders, including funders, trainers, and farmers, are better equipped to prioritize investments in ensuring more sustainable practices. Zacepins et al. (2013) emphasize that it is through the mass application of performance metrics that alignment of economic objectives with environmental realities is promoted, especially when stakeholders collaborate to perfect best practices. Zacepins et al. (2013) maintain that data sharing can foster transparency and accountability in the design and assessment of the system, ensuring that all stakeholders in the beekeeping ecosystem work towards shared goals of its sustainability. Furthermore, Zacepins et al. (2013) note that such cooperation facilitates constant feedback, improvement, and capacity building at all levels, and stakeholder sharing emerges as one of the key mechanisms for long-term project sustainability.

Implementing the lessons gained based on previous data findings is also one of the key methods according to which the beekeeping practice can be made more sustainable. The system of modular sensory hardware and data processing capabilities by Komasilovs et al. (2019) is accurate to the precision requirements of beekeeping to meet its precision monitoring and longitudinal learning purposes. Kamasilovs et al. (2019) clarify that the system captures massive information about different parameters in the hives and stores it to enable analysis and comparison of the actual parameters with the previous trends. With the help of such, according to Komasilovs et al. (2019), one was able to recognize typical trends of problems and anticipate against them using countermeasures to limit them, including seasonal low productivity or environmental stress. Kamasilovs et al. (2019) sustain that such learning, which is obtained through the repetition is indeed crucial in enhancing adaptive capacity, which is a necessity to environmental sustainability. Kamasilovs et al. (2019) further elaborate that how the system manages and displays this data also leaves less technologically aware beekeepers to be capable of interpreting and taking action on the past trends.

Moreover, according to Komasilovs et al. (2019), the use of such insights also guarantees economic sustainability because the beekeepers was able to reduce resource waste and increase its use. Komasilovs et al. (2019) note that sensor-based feedback lessons are utilized in positioning the hives, inputting methods during various management seasons, and feeding, which can significantly contribute to honey production and hive health. Komasilovs et al. (2019) observe that patterns of social sustainability are also enhanced where lessons are institutionalized through peer learning and an extension program, whereby experienced beekeepers share their outcomes with new beekeepers. Komasilovs et al. (2019) conclude that based on these shared understandings, community standards and evidence-based training are grounded, and a culture of practice develops as a result of this knowledge. Komasilovs et al. (2019) highlight that, in fact, the data that is not only gathered but also analysed and used in systematic ways creates a cycle of constant improvement and is thus able to cause long-lasting and powerful beekeeping systems.

2.4 Training Follow-Up and Sustainability of Beekeeping Projects

The proportion of trained farmers in bee activities is indicative of the sustainability of apicultural practices, as capacity-building programs aim to develop the technical and management skills necessary to sustain productive and sound projects. Musaya (2018) suggests a critical assessment of a beekeeping training initiative in Manenberg Township, Cape Town, revealing the empowering impacts of the disciplined training on local farmers and their increased participation in sustainable development. As Musaya (2018) points out, the greater the percentage of trained beekeepers, the more successful bee hives was managed, the more the bee biology was understood, and the more honey was produced by the honey bees. According to Musaya (2018), the trained farmers were also more inclined to resort to environmentally friendly farming which included using organic pesticides and the introduction of better hive location ideas which led to a higher ecological viability. Additionally, according to Musaya (2018), the trained staff had the highest likelihood to implement knowledge and produce a community of practice that will facilitate social sustainability. Musaya (2018) highlights that training in terms of economics also served as a factor in gaining more certainty and confidence in beekeeping, which led to more honey production and the diversification of sources of income. It is worth noting that, according to Musaya (2018), the scale and popularity of the training activities are the key predictors of the success of any project in the long term because a bigger group of farmers is the evidence of the resilience and sustainability of the low-resource communities in terms of beekeeping.

Sharma et al. (2016) conducted a study on bee-keeping training programs provided by Krishi Vigyan Kendra in Sri Muktsar Sahib, India and concluded that the percentage of farmer-beneficiaries of the training has a positive relationship with increased adoption rates of apicultural practices. According to Sharma et al. (2016), the trained people showed appropriate knowledge of hive inspection, disease identification, and colony division, which are the main aspects of environmental and economic sustainability. According to Sharma et al. (2016), the added initial training of farmers was also related to the growth of knowledge transfer via communities and this resulted in the ripple effect of informal learning and mentorship contributing to more involvement and memory. As Sharma et al. (2016) note, it not only reduces the necessity to resort to the assistance of external professionals, but also develops the internal resilience of the rural communities to manage their lives. According to Sharma et al. (2016), critical mass of trained beekeepers is an initial pillar requirement of sustainable widespread resilience, the pathway to peer-led innovation, climate variability resilience and entrepreneurial development. In addition, Sharma et al. (2016) state that the higher the likelihood of participation in a local cooperative, the higher the bargaining power of the trained farmers, which predetermined the increased social sustainability of beekeeping enterprises.

The continuity and frequency of training (refresher training) is a very significant issue to ensure that the beekeepers are in the core competencies and to ensure that they are informed on the best practices that keep on changing. In their case study on an effective beekeeping program, Yap and

Devlin (2015) emphasize that one-off training is insufficient to achieve a lasting impact. Yap and Devlin (2015) record how the frequent refresher training courses reinforced the previous training, alerted farmers to new methods of work, and also became forums for discussing and troubleshooting typical problems. Yap and Devlin (2015) show that the subsequent number of sessions was directly associated with the success of colony colonization, a decrease in colony mortality, and increased productivity. Yap and Devlin (2015) report that these advantages were also compounded in such cases when environmental uncertainties were brought forth, enabling an innovative response to be assimilated. Moreover, Yap and Devlin (2015) state that the energizing training programs have also fostered social cohesion, as constant peer involvement with issues arising from interactions, social connections, and problem-solving has led to an increase in social and environmental sustainability. Yap and Devlin (2015) observe that the economic consequences were also striking: those attendants who participated in several sessions could scale operations more successfully, waste less input, and invest in hive materials and equipment based on data-informed decisions. Yap and Devlin (2015) conclude that constant training is not an auxiliary process but an essential part of any beekeeping model aimed at sustainability.

Bazrafkan and Alipour (2025) provide a return on investment (ROI) analysis of beekeeping training programs, revealing that the intangible and tangible benefits of repeated training participation, such as refresher courses, were provided. Bazrafkan and Alipour (2025) note that the number of follow-ups was a powerful indicator of improved memory of new skills and behavioral changes in the beekeepers. For example, Bazrafkan and Alipour (2025) report that farmers who received periodic training were more confident about the process of queen rearing and swarming control, which was reflected in improved hive performance. According to

Bazrafkan and Alipour (2025), ROI was not only concerned with the yield of honey, but the proper time management, proper record-keeping and the loss of hives, which proves sustainability in every three aspects of the environment, society, and economy. Bazrafkan and Alipour (2025) also mention that the refresher model encouraged the iterative learning since farmers could go over the particular topic or refresh their memory about the relevant regulations and the market conditions. Bazrafkan and Alipour (2025) maintain that it is the dynamic learning environment that makes training relevant and functional in the sphere of quick changes in climatic factors and market demands. Therefore, Bazrafkan and Alipour (2025) conclude that the frequency of the refresher sessions is not a logistical indicator but an operational strategy to develop long-term resilience in the beekeeping industry.

Probably the most pertinent behavioral outcome of capacity-building was the retention of techniques learned during training, which is a potential indicator of whether the capacity-building has achieved sustainable practice. Outwater et al. (2021), in their pilot intervention study in Dar es Salaam, Tanzania, found that the retention of the techniques on the team positively correlated with the changes in the productivity of the beekeeping practices, in addition to social effects evaluated at the level of the community, where the levels of violence have reduced. Outwater et al. (2021) conducted a controlled observation of beekeeping before and after training, and the results showed that the sustainability of techniques, i.e., how to inspect the hive both externally and internally, the use of protective gear, and the use of smoke, improved considerably, especially with follow-up and support systems in place. Outwater et al. (2021) found these noted abilities were related to an increase in the health of the hives, a decrease in colony loss, and an increase in honey production. Outwater et al. (2021) indicate that the maintenance of techniques also allowed trust and ownership in the community to develop, as farmers could demonstrate their knowledge and educate others to support local systems of knowledge. Outwater et al. (2021) show that environmental and social sustainability complement each other by maintaining and utilizing the skills that have been acquired. In addition, Outwater et al. (2021) highlight that unless there is a purposeful intention to monitor and maintain training, most training results may deteriorate, and projects become less effective in the long term.

The retention of techniques was also a key theme in Meilby and Cross's (2019) study of Tanzanian beekeepers, which aimed to understand the motivations and success factors among rural practitioners. Meilby and Cross (2019) report that based on the observational evaluation, successful beekeepers were consistent in techniques such as positioning hives according to the vegetation cover, annual swarm control, and good hygienic harvesting practices. Meilby and Cross (2019) found that these skills retained were directly proportional to increased rates of hive colonization and subsequent sales of honey, thus strengthening environmental and economic sustainability. Meilby and Cross (2019) note that the likelihood of retention was also most enduring in those who underwent repetitive hands-on training and were exposed to mentors. Meilby and Cross (2019) suggest that training programs should not be limited to a theoretical platform but rather incorporate experiential learning, practical demonstrations, and peer support systems. Moreover, Meilby and Cross (2019) observe that core techniques were not forgotten, so the beekeepers were able to create and adjust, rather than following exactly what they had learned. Meilby and Cross (2019) insist that such flexibility is of paramount importance to their sustainability because environmental and market conditions in such areas are unpredictable. Meilby and Cross (2019) come to this conclusion, which is why the identified usage of the acquired practices should become one of the central measures of evaluating the training effectiveness and predicting whether the project addresses sustainability in the beekeeping sector.

2.5 Hive Monitoring and Sustainability of Beekeeping Projects

The frequency of the hives inspection by the farmer constitutes a basic activity in the identification and correction of problems in the colony in a timely manner, resulting in the long-term corporate environmental, social, and economic sustainability. Verbeke et al. (2024) explored European preferences towards the digitalization of hive monitoring and discovered that hive monitoring farmers who monitored their hives regularly had greater abilities to recognize environmental stressors, e.g., the use of pesticides, epidemics, or food scarcity. According to Verbeke et al. (2024), these checks played an important role during the war against colony collapse, allowing a healthier environment for the colony, which eventually resulted in environmental sustainability. Besides, according to Verbeke et al. (2024), frequent check-ups provoked the involvement and management of farmers, increased social capital between practitioners, and enhanced the behavior of sharing knowledge. According to Verbeke et al. (2024), the inspections made the production stable in terms of honey yields and also enabled cutting down on the losses from letting the issues go unaddressed, which made the operations of a hive more economical and efficient overall.

Stojanova et al. (2025) comment on the beneficial impact of smart hives' capabilities that can operate with the help of IoT on the quality and regularity of inspection. The research conducted by Stojanova et al. (2025) revealed that the reactions of farmers are more intentional than systematic in the case of inspections that are supported by the information generated by digital warnings (based on the hive temperature or other vibrations). Stojanova et al. (2025) indicate that such a hybrid approach, which reduces labor costs through regular checks coupled with online nudges, enhances decision-making accuracy. Stojanova et al. (2025) report that routine inspection (by hand or with technology) helps detect problems with the brood, loss of the queen, or intrusion by invasive pests soon enough to avoid significant losses. From a sustainable perspective, Stojanova et al. (2025) argue that this preventative attitude fosters an eco-friendly environment within hives, enhances farmer trust and interest (social sustainability), and stabilizes their yields and incomes (economic sustainability).

Allowing farmers to accurately measure and analyze information on hives (temperature, humidity, hive weight, bee activity, and other factors) is emerging as one of the topics of highest interest in contemporary beekeeping, which would raise sustainability rates by an impressive margin. Zabasta et al. (2025) demonstrated the potential of video recordings as a source for hive tracking using video recognition and environmental sensors. Zabasta et al. (2025) showed that video recordings can assist farmers not only in detecting health issues early but also provide them with the ability to compare hive health over time. Zabasta et al. (2025) explain that digital record-keeping enhances the traceability and transparency of honey production, which is increasingly demanded in the global environment. Zabasta et al. (2025) state that the records also support longitudinal analysis of hive behavior to inform better decisions at both the farm management and policy levels. Zabasta et al. (2025) found that those farmers who possess data are in a better position to use conservation practices that support biodiversity and, hence, environmental sustainability. This is achieved through improved hive management and access to certification.

Urban and Chlebo (2024) further examine the role of precision beekeeping systems in attaining sustainability by providing a lean towards organized documentation of monitoring. Urban and Chlebo (2024) report that regular data logging using connected devices improves beekeepers' knowledge of hive patterns, including foraging periods and population dynamics. Urban and Chlebo (2024) found that those farmers who were good at maintaining accurate monitoring records demonstrated greater resilience to seasonal changes, drought, or pest outbreaks. Urban and Chlebo (2024) also note that these records are useful for making early interventions and planning hive division, supplementary feeding, or honey harvesting. Urban and Chlebo (2024) state that the implementation of monitoring tools within group or program trainings to encourage the idea of collaborative learning enhances social sustainability. Urban and Chlebo (2024) propose that, economically, appropriate data use led to the minimization of inputs wastage and optimization of quality and quantity of honey produced, which makes small-scale production processes more competitive both in the local market and in the global market.

Early identification of issues which can be in a hive, e.g. queen loss, infestation, or shortage of resources, is a vital element in the bee keeping projects. Another technology is the BeeSense system that combines AI and IoT to enable real-time monitoring of hives (Karan et al., 2024). Karan et al. (2024) found that the system could notify beekeepers about those hours, when the temperature was found to be abnormal, when activity was low, or when unusual sounds could be detected, and these are the initial signs of a problem in the colonies. According to Karan et al. (2024), such real-time alerts save time spent by farmers, as now they can respond to the problem in time, and the chance of colony failure is reduced. Karan et al. (2024) reveal that environmental sustainability is enhanced by early recognition through reduction of hive deaths and hive pollination services. Karan et al. (2024) note that it also lessens emotional and economic pressure on farmers, which strengthens social sustainability and provides economic security against costly losses of colonies and crops.

Hadjur et al. (2022) compared various precision beekeeping services and found that smart systems significantly improve the timeliness and reliability of detecting problems. Hadjur et al. (2022) report that sensors, cloud analytics, and mobile alerts also work together, enabling farmers to respond during key periods, such as detecting swarming intentions or disease symptoms, far in advance of the more conventional symptoms that farmers have traditionally observed. Hadjur et al. (2022) argue that being able to provide the intervention correctly and instantly, this technological advantage also contributes to exerting minimal stress on the environment and not disrupting the ecosystem balance, particularly for the bees. Hadjur et al. (2022) further state that timely and responsive capacity has the effect of decreasing the load on labour input, making farmers free to concentrate on value addition, such as processing wax or marketing. Hadjur et al. (2022) claim such efficiencies can be directly translated into economic sustainability and also create a technologically literate community of beekeepers, which will further develop the social aspect.

Hunor et al. (2024) also strongly argue in favor of integrating low-cost sensor technology into hive monitoring and of the importance of accessibility for smallholder farmers. Hunor et al. (2024) found that even cheaper monitoring kits can provide real-time diagnostics of temperature, weight, and sound on hives, which can be used to respond to unusual conditions quickly. Hunor et al. (2024) state that disclosure of issues such as brood chilling or comb collapse can be selected at the right time to ensure the maximum productivity of the hive and reduce bee deaths. Hunor et al. (2024) claim that, socially, by implementing them at the community level, they will facilitate inclusive growth, as it ensures that even farmers who lack resources can engage in modern beekeeping. Hunor et al. (2024) note that, economically, early detection reduces the cost of this expensive emergency care, allowing beekeeping to remain a viable source of income.

2.6 Feedback Action and Sustainability in Beekeeping

The ability of beekeeping projects to address the arising issues is a direct indicator of the responsiveness of the project design and has an impact on the sustainability of the interventions. The study by Page Jr. et al. (2006) on division of labor and foraging specialists in honeybee colonies indirectly, therefore, presents a good metaphor for the manner in which human systems operate in terms of sustainability. Page Jr. et al. (2006) argue that project sustainability is influenced by the way it involves addressing issues concerning farmers in a professional and timely manner. Page Jr. et al. (2006) suggest that the network's capacity to actuate in addressing complaints about the health of the hives, accessibility of tools, or market relationships in a timely manner makes the network self-healing and dynamic. Page Jr. et al. (2006) claim the sensitivity in this aid helps stabilize the environment by reducing loss in the colony, when unavoidable. Page Jr. et al. (2006) show that it also fosters trust and interaction between community members, promoting social sustainability. Page Jr. et al. (2006) further indicate that, economically, resolving issues promptly minimizes losses and increases efficiency, resulting in increased profits and sustained business practices.

The rate at which farmers use feedback in decision-making for beekeeping projects is a significant indicator of inclusivity and the learning process. Although Gonella et al. (2019) prioritize one particular animal shelter sector, Gonella et al. (2019) provide a solid systems-centric sustainability framework that can be applied to address this challenge. Gonella et al. (2019) explain the role of integrating feedback into the system, which involves looping operational realities back into planning, design, and resource allocation, thereby augmenting systemic sustainability. In beekeeping, Gonella et al. (2019) argue that taking such a perspective and factoring in the input of the farmers (like recommendations on where to set the hives, how to respond to pests, or the best time to take training sessions) helps to make interventions based on how life is really experienced on the ground, as opposed to assuming and dictating a solution. Gonella et al. (2019) state that this participatory process of adjustment fosters environmental sustainability by channeling management to ecological cycles, promotes social cohesion by giving farmers a voice, and yields economic outcomes by streamlining strategies based on grassroots understanding, thereby reducing waste and maximizing returns.

The extent or level of flexibility in beekeeping programs is indicated by the number and quality of modifications made to materials, methods, or resources in response to farmers' feedback, and is critical to ensuring that farmers continue to participate in the programs, as well as to maintaining the productivity of the hives. Although Ningombam and Roy (2019) are mostly concerned with writing about an application to automate tea farming techniques, they note that the need to create a structured flow of feedback (based on sensors) that can extend to beekeeping, where this automation of collected feedback or an ecological assessment in a hive design or even feeding patterns could be modified, applies to this scenario. Ningombam and Roy (2019) argue that when such input changes are manifested in a visible way, linked to earlier farmer suggestions, this gives a sense of ownership, enhances morale, and makes the system less susceptible to external shocks. Ningombam and Roy (2019) state that the feasible sustainability contributions of the input changes include replacing fossil fuel, more frequent harvesting of the hives, or modifying the smoker fuel to suit the local flora. Ningombam and Roy (2019) add that these decrease reliance on outside suppliers (economic), lessen environmental disturbances, and increase the embeddedness of undertakings in the local understandings (social).

Reinforcing the same principle, Voigt and Bennett (2018), in their research into reproductive gene expression in mole-rats, emphasize that ensuring environmental feedback and biological response systems are in sync will result in optimal performance. Voigt and Bennett (2018) show that in the case of beekeeping, beekeepers communicate changes in colony behavior, which subsequently result in practical adjustments, such as changes in feed formulation or hive rearrangements. Voigt and Bennett (2018) explain that the program would then shift to be dynamic and biologically reactive. Voigt and Bennett (2018) argue that these are modified adaptations that preserve the hive ecological system (environmental sustainability), add value to the circumstance (social sustainability), and certify that their investments are aligned with quantifiable enhancements in yields (economic sustainability).

2.7 Gaps in Literature Reviewed

Table 2.1: Research Gap and Study Contribution

Author	Study Title	Findings	Knowledge Gaps
Bertoni et al. (2025)	Environmental indicators of hive colonization	The study emphasized ecological conditions influencing hive colonization.	Limited focus on local African contexts.
Popescu & Popescu (2019)	Ecological beekeeping in rural Romania	Training and social identity improved farmer engagement.	Lack of long-term retention and sustainability links.
González Pacheco & Barragán Ocaña (2023)	Innovation and sustainability in apiculture	Highlighted innovation and digitalization in beekeeping.	Innovation focus lacks grassroots data-use insight.
Harianja et al. (2023)	Ecology and beekeeping in agroforestry systems	Found ecological diversity supports colonization.	Emphasizes ecology, not training or M&E integration.
Gring-Pemble & Perilla (2021)	Community empowerment and beekeeping	Reported stronger retention through community-led models.	Community models not linked to M&E systems.
Kouchner et al. (2019)	Environmental performance of beekeeping systems	Identified landscape and pesticide effects on sustainability.	Sustainability framework lacks feedback utilization.
Nat Schouten & Lloyd (2019)	Success and failure in beekeeping projects	Found farmer dropout linked to weak follow-up.	Retention data is anecdotal, lacks structured follow-up.

Patel et al. (2020)	Socio-ecological systems and honey income	Showed market access and climate variability affect income.	Focus on systems but not M&E actionability.
de Graaf et al. (2022)	Data-driven beekeeping in Europe	Emphasized real-time data for colony health and survival.	No application of data feedback in rural African projects.
Santos et al. (2025)	Data sharing in agricultural sustainability	Found collaboration strengthened beekeeping practices.	Capacity building not specific to beekeeping.
Komasilovs et al. (2019)	Modular sensory data for beekeeping	Showed sensors improved hive monitoring and learning.	Focused on sensors, not how lessons are applied.
Dsouza & Hegde (2023)	IoT Smart Hive Monitoring	Demonstrated hive monitoring improved outcomes.	Tech-based monitoring lacks connection to outcomes.
Zacepins et al. (2013)	Precision farming and profitability	Noted profitability improved with transparent data sharing.	Ranking systems omit sustainability impact.
Verbeke et al. (2024)	Hive monitoring attitudes in Europe	Frequent monitoring linked to colony health.	Adoption interest studied, but impact on sustainability unclear.
Zabasta et al. (2025)	Visual monitoring in precision beekeeping	Found video monitoring aids hive health tracking.	Visual monitoring not connected to learning adaptation.
Karan et al. (2024)	AI and IoT for hive behavior	Showed real-time alerts reduced colony collapse risk.	Monitoring tools not linked to timeliness of action.
Stojanova et al. (2025)	IoT-enabled hive monitoring	Farmers responded effectively with sensor warnings.	IoT tools analyzed without farmer-level sustainability effects.
Hadjur et al. (2022)	Precision beekeeping services	Found smart systems improved early detection.	Reviews tech but not intervention impact.
Urban &Chlebo (2024)	Precision beekeeping and record-keeping	Record logging improved resilience and planning.	Focuses on future outlooks, not current application.
Hunor et al. (2024)	Low-cost hive monitoring	Showed accessible monitoring supported smallholders.	Low-cost tools not linked to project effectiveness.
Musaya (2018)	Beekeeping training in South Africa	Reported higher productivity after training.	Training impact not assessed beyond short term.
Sharma et al. (2016)	Farmer adoption of apicultural practices	Found participation improved hive management.	Measures participation, not outcomes.

Yap & Devlin (2015)	Refresher training in beekeeping	Reported refresher sessions improved sustainability.	Success story lacks structured evaluation.
Bazrafkan& Alipour (2025)	ROI of beekeeping training	Showed periodic training improved hive performance.	ROI measured, but long-term impact overlooked.
Outwater et al. (2021)	Training retention in Tanzania	Found technique retention improved hive productivity.	Technique retention not tied to sustainability.
Meilby & Cross (2019)	Motivations of Tanzanian beekeepers	Identified successful practices linked to hive health.	Success factors identified, not measured.
Page Jr. et al. (2006)	Division of labor in bee colonies	Highlighted adaptive systems for colony sustainability.	Focus on biological feedback, not human response systems.
Gonella et al. (2019)	Feedback systems in sustainability	Emphasized importance of integrating feedback.	Feedback studied in animal shelters, not beekeeping.
Ningombam& Roy (2019)	Automation in farming practices	Proposed automated feedback for inputs.	Automation focus, no linkage to sustainability action.
Voigt & Bennett (2018)	Biological feedback in mole-rats	Reported environmental feedback improved outcomes.	Focus on biology, no project response linkage.

2.8 Summary of Literature Review

The reviewed literature indicates that although sustainability in beekeeping has been examined from various aspects, there is a lack of integration between monitoring and evaluation (M&E) activities and project outputs, particularly in rural areas of Africa. Although previous studies have presented training, data use, hive monitoring, and feedback mechanisms, they have not been systematically linked to environmental, social, and economic sustainability indicators. Furthermore, theoretical frameworks are rarely used to interpret the relationship between project inputs, processes, and sustainability. This research fills that gap by basing its discussion on Systems Theory, which illustrates how the associated parts, such as M&E activities, dynamically affect project results. It is also working on the Adult Learning Theory to identify the extent to which follow-up training and refreshers can improve the retention of techniques and behavior change among the farmers. Collectively, all of these theories can provide a comprehensive basis for studying the ways in which M&E practices can sustain beekeeping projects in Makueni County.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter outlines the methods and procedures used to achieve the study objectives. It describes the research design, study area, target population, sampling techniques, data collection instruments, and data analysis procedures. Ethical considerations guiding the study are also discussed to ensure the credibility, validity, and reliability of the findings.

3.1 Research Design

The study adopted a qualitative research approach, particularly a phenomenological research design, to explore the impacts of data exploitation, post-training hive surveillance, and response to feedback on the sustainability of beekeeping projects in Makueni County. The phenomenological methodology is pertinent since it reveals the social, economic, and ecological facets of sustainability in explaining the experiences of the beekeepers, extension officers, and other stakeholders. This design helped the researcher to comprehend the meaning that the participants give to their experiences in the framework of climate-resilient livelihoods and beekeeping interventions. Another issue, which Creswell (2017) implicates with the research of processes and perspectives in the context of real-life situations, is the significance of qualitative designs, which goes in line with the overall aim to investigate the dynamics characterizing sustainability in the case of the beekeeping projects.

3.2 Study Area

The research was conducted in Makueni County, located in Kenya’s arid and semi-arid lands (ASALs). The county spans approximately 8,034 square kilometres in area and has a population of one million people (Ithau& Mwania, 2023). It experiences low and irregular rainfall, ranging from 500 to 650 mm per year, with occasional droughts that restrict crop agriculture; therefore, beekeeping is an alternative and very important source of livelihood (Ithau& Mwania, 2023). The issues of beekeeping and cattle rearing are prime characteristics that describe small-scale agriculture.

The six sub-counties that was included in this research was Makueni, Kibwezi East, Kibwezi West, Kilome, Mbooni, and Kaiti. These areas have dynamic beekeeping programs, which are maintained by donors and the government. The Kenya Climate Innovation Centre, World Vision, Bee Care Apiaries International, and the UNDP are development agencies that help implement climate-smart apiculture through training, hive distribution, regular monitoring, and feedback schemes (Ithau& Mwania, 2023). The strength of sustainability is also enhanced by local associations, such as the Makueni Beekeepers Cooperative Society and the Wote Bee Farmers Association, which assist in training, organizing inspections of hives, and compiling monitoring data.

The choice of Makueni County as the study area was based on the coexistence of environmental necessity, good institutional support, and community involvement. Its ASAL climate leads to great demand in alternative livelihoods that are less rainfall-driven, and the existence of organised cooperatives and various development partners has created a proper structure through which the application of training, hive checks, and feedback actions can be implemented (Kyalo, 2025). The history of apiculture interventions used in the county has many lessons both on the success and on the failing projects, and the county has a large number of active beekeepers (approximately 3,000) maintaining over 20,000 hives, which should provide a representative sample (Kyalo, 2025). All these factors contribute to making Makueni a perfect place to conduct a study on the effects of data use, training follow-up, hive monitoring, and feedback action on the sustainability of beekeeping ventures in terms of the environment, the people involved, and, ultimately, economically.

3.3 Target Population

The target population comprised approximately 150 individuals and institutions directly involved in donor- or government-supported beekeeping projects in Makueni County. These comprised approximately 80 -100 active beekeepers in the six sub-counties who had undergone formal training programmes, project inputs, and were involved in hive management and reporting. Out of this group, 38 beekeepers who are key informants were purposively sampled to take part in the key informant interviews and focus group discussions to give first hand information on how they train, manage hives, and sustain themselves.

It also had approximately 20 to 30 Department of Agriculture, Livestock and Fisheries (DAILF) agricultural extension officers and 10 to 15 monitoring and evaluation officers with implementing partners like the Kenya Climate Innovation Centre, World Vision and the Bee Care Apiaries International. Out of them, 7 officers were interviewed, comprised of 4 extension officers, 2 monitoring and evaluation officers and 1 project coordinator to give a detailed picture of the problems being encountered and how beekeeping programs can be made profitable.

The qualitative part applied key informants such as the agricultural extension officers, M&E officers, project coordinators and leaders of cooperatives and established beekeepers with a history of more than five years of beekeeping. Overall, 53 participants participated in the study, of which 32 people participated in four focus group discussions and 21 people participated in key informant interviews, and they were selected purposely to contribute to the context-related knowledge and bring about other perspectives. This method guaranteed the variety of opinions and made the study manageable and focused.

3.4 Sample Size and Sampling Procedures

The research sample included 53 participants, comprising beekeepers and key project personnel in Makueni County. The participants included 38 beekeepers, 4 extension officers, 2 monitoring and evaluation officers, and 1 project coordinator, since they have first-hand knowledge and experience in training, hive management, monitoring, and feedback practices. The sample size was informed by the idea of data saturation as part of how qualitative research works, in which the respondents were involved until the point where no more information was discovered. Purposive sampling was used so as to make sure that only relevant people were included. The research also conducted 4 focus group discussions, comprising 32 participants in total, and identified separate groups of beekeepers and officers so as to represent different views. This method gave detailed and context-specific data to respond to the research objectives.

3.4.1 Sampling Procedure

Purposive sampling was used in the study. Purposive sampling is suitable, as the support of the beekeeping program and activity remains different across sub-counties, and by sampling participants through direct experience in training, hive management, monitoring, and feedback, it is possible to collect rich context-specific data (Narayan et al., 2023). These benefits make purposive sampling suitable for examining connections between project practices and sustainability by geographic boundaries. The research sample used in the study was informed by the principle of data saturation, as opposed to a statistical formula. Key informants were selected by use of purposive sampling that included 14 beekeepers, 4 extension officers, 2 M & E officers, and 1 project coordinator to offer different views on the sustainability of the beekeeping projects. The intentional sampling of information-action-rich cases is typical of qualitative research since it provides the rich, contextual data that is required to clarify sustainability practices (Narayan et al., 2023). These individuals ensured that the qualitative findings provided rich insights into training, hive monitoring, and feedback practices in beekeeping.

3.5 Data Collection Instruments

Data collection was done using semi-structured interviews and focus group discussions. Semi-structured interview guide comprised of open-ended questions that allow participants to provide detailed accounts. The interview questions explored training delivery approaches, monitoring practices, feedback application, and perceived influences on project sustainability. This approach allowed flexibility in probing and follow-up, enabling the researcher to capture context-specific insights and explore themes as they emerged from the participants' perspectives.

Focus group discussions (FGDs) complemented the interviews by promoting interaction among participants to generate diverse views and shared experiences. Each discussion included 7–9 participants drawn from beekeepers, extension officers, and cooperative leaders to encourage dialogue and collective reflection on training, hive monitoring, data use, and feedback practices. The FGDs enabled the researcher to capture group dynamics, consensus, and differing opinions, providing a richer and more comprehensive understanding of sustainability in beekeeping projects (Sukmawati, 2023). Building on this strength, their application in the present study assisted in the exposure of a delicate understanding of sustainable practices that cannot be translated into numerical measurement. This ensured the reflective representation of the voices of beekeepers and key stakeholders in the findings, and hence the results were based on real-life happenings.

3.5.1 Pilot Testing of the Instruments

Mutomo in Kitui County was used for the pilot tests of the data collection instruments before full-scale data collection. The pilot involved 12 participants, comprising 8 beekeepers in one focus group discussion and 4 key informants (2 extension officers and 2 project staff). The next step was to assess the Focus Group Discussion guide's clarity, coherence, and consistency. The pilot participants provided feedback that was used to revise the tools to reflect the practical realities of implementing these beekeeping indicators so that they accurately capture the intended indicators. Specifically, 5 out of the 8 FGD participants indicated that some questions on data utilization were unclear and required simplification, while 3 participants suggested reordering questions on training follow-up to improve flow. Among the key informants, all 4 respondents noted that items on feedback action needed more probing prompts to capture practical field experiences, and 2 respondents highlighted overlap between hive monitoring and training follow-up questions, which was subsequently corrected. Pilot testing ensured that data utilization, training follow-up, hive monitoring, and feedback action variables are appropriately structured in the instruments, and that respondents can answer in a valid and meaningful way for the study.

3.5.2 Validity of the Instrument

The validity of the study was achieved by having accurate, clear, and relevant research instruments (Ahmed & Ishtiaq, 2021). The focus group discussion guide was reviewed by the supervisor and other peers to assess whether each question was pertinent to the study objectives and whether its terms effectively captured relevant aspects, such as data use, training follow-up, hive monitoring, feedback, and sustainability. It was used by these experts, and any ambiguity that arose was clarified. This also helped identify any ambiguity that may affect the validity of this instrument.

The additional validity was supported by the credibility measures, including expert review of the guides, pilot testing, triangulation of data sources, member checking, and peer debriefing. Participants were able to review their focus group discussion transcripts or summaries to verify the accuracy and eliminate the possibility of misinterpreting certain elements. The different sets of participants who were included in the triangulation, including lead beekeepers, cooperative leaders, and extension officers, were also exposed to similar patterns and attempted to balance out the views. All these measures assisted in making sure that the findings of the focus group discussion guide were contextually grounded and driven by the purpose of the study.

3.5.3 Reliability of the Instrument

Reliability is defined as the consistency of an instrument to give consistent results (Ahmed and Ishtiaq, 2021). In this case, reliability was covered by ensuring the use of procedures that improve the dependability of data obtained in the focus group discussion. The consistency in the line of questioning was taken care of through a discussion protocol that permitted probing. Member checking will also be carried out by presenting the participants with summaries or transcripts of their discussions to ensure that there is accuracy. Moreover, the audit trail of the discussions and coding decisions, as well as thematic development, was kept, which was followed to demonstrate transparency and enable the possibility to interpret the findings consistently. The interview guide was first subjected to a pre-test to determine the suitability, appropriateness, and relevance of the questions. The pre-test was used to make appropriate changes and enhance the quality of the instrument. The reliability of the data was established by using member checking, peer debriefing, and triangulation, which improved the validity and reliability of the results.

3.6 Data Collection Procedure

Ethical clearance was obtained, and permission was sought from the local authorities and the beekeeping organizations in the region before commencing the data collection. All participants were informed and provided their consent to take part in the data collection. Beekeepers, extension officers, project coordinators, and monitoring and evaluation staff were all interviewed in semi-structured interviews. These sessions will take place at locations and times convenient for participants and will last approximately 30 to 45 minutes. All interviews were audio-recorded with participants' permission and supplemented with detailed field notes to ensure accuracy. Data collection spans four weeks to ensure adequate representation of all relevant participant groups and accommodate participants' availability.

3.7 Data Analysis Techniques

The study used data collected through semi-structured interviews and focus group discussions (FGDs). The interview data was in the form of detailed narrations by the beekeepers, agricultural extension officers, cooperative leaders, project coordinators and monitoring and evaluation staff, on their respective experiences on training, hive monitoring, use of data and feedback practices. The FGD data reflected the group of insights, experience and interactions of the participants, which showed that they were exposed to similar challenges and different views concerning sustainability in beekeeping. The two kinds of data were thematically analysed using the framework of Braun and Clarke (2006). NVivo software was used to organize and code the data and this increased rigor and transparency in the analysis process (Jackson and Bazeley, 2019).

Coding was deductive, and was conducted based on dimensions of sustainability such as financial, institutional and programmatic dimensions, and inductive, where the themes were created directly based on the narratives of participants.

The codes obtained in the interviews and focus groups were then categorized into larger themes and sub themes that address the most important areas of interest such as the effectiveness of training, monitoring practices, feedback systems and sustainability outcomes. When examining focus group discussions, specific focus was on the dynamics between participants, areas of agreement and disagreement since it offers a more in-depth analysis than when people are asked individually.

Triangulation has been employed so that the validity of the findings could be enhanced by means of juxtaposing the perspectives that represent different groups of participants and data sources. This activity helped to identify points of intersection, separation and supplement. To give transparency in the process of the analysis, the theme development and coding decisions were recorded using the audit trail.

Lastly, the results were provided in a thematic and narrative format and backed with direct quotes of the participants to demonstrate important arguments. Briefs were also given in tables or figures in the event where appropriate to give a picture of trends and make the interpretation easy. This story, including quotations and visual summons ensured that the results were rigorous and accessible.

3.8 Ethical Considerations

When undertaking this sustainability study of beekeeping projects, the ethical protocols of conducting research were well adhered to. Before data collection, the study informed all the participants with concise information on the objectives of the research, procedures, possible benefits, and any risks that might arise beforehand. This was voluntary participation, and the respondents had the option of dropping out at any point without implications. In order to ensure confidentiality, no personal details were gathered, and all data was kept in safe places and was viewed by the research team. The results were provided in a summary manner to avoid identification of the participants. The institutional ethics review committee was consulted regarding the necessity of carrying out the study, and then the local authorities or community leaders were consulted in case the work was to be carried out in any community. The cultural sensitivities of the communities of beekeepers were observed during the research process, and the information was not utilized in any way other than for academic purposes.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATIONS, AND INTERPRETATIONS

1. Introduction

This chapter gives the analysis and interpretation of qualitative data on the effect of monitoring and evaluation practices to the sustainability of bee keeping projects in Makueni County. The information was gathered with the help of Focus Group Discussions and Key Informant Interviews and processed with thematic analysis according to the framework of Braun and Clarke. Triangulation was also used by evaluating the answers between the various groups of participants so as to increase the credibility and consistency of results.

4.1 Participation Rate

The research was aimed at about 150 participants who were either engaged in beekeeping projects on donors or the Government and those involved in the project as beekeepers, agricultural extension officers, monitoring and evaluation officers, and project coordinators. Focus Group Discussions (FGDs) were used to collect qualitative data, and 3 groups had beekeepers only and 1 group had extension officers and cooperative leaders. The groups of the 3 beekeepers consisted of 8 participants each, adding up to 24 beekeeper participants. The 4th FGD included 8 respondents who were sampled out of extension officers and cooperative leaders. This made the total number of participants in the FGDs to 32 participants. Also 21 Key informant interviews (KIIs) with 14 beekeepers, 4 extension officers, 2 M&E officers, and 1 project coordinator were carried out. In general, the research was able to involve 53 respondents, which means that they were able to represent all the stakeholder groups that were sought.

Table 4.1: Data Collection Summary

Instrument	**Participant Type**	**Number of Groups / Interviews**	**Total Participants**
FGD	Beekeepers	1	8
FGD	Beekeepers	1	8
FGD	Beekeepers	1	8
FGD	Extension Officers & Cooperative Leaders	1	8
KII	Beekeepers	14	14
KII	Extension Officers	4	4
KII	M&E Officers	2	2
KII	Project Coordinator	1	1
Total	–	–	53

4.2 Demographic Characteristics of Respondents

A total of 53 participants were engaged in the study, comprising beekeepers, agricultural extension officers, M&E officers, and a project coordinator. Participants were drawn from all six sub-counties of Makueni County: Makueni, Kibwezi East, Kibwezi West, Kilome, Mbooni, and Kaiti to ensure broad geographic representation. The respondents were different and represented by their gender, age, education and number of years of experience and had different views about bee neglecting practices, training, monitoring of hives and feedback mechanisms. An age is a typical demographic factor in the agricultural research since it determines the adoption of new technologies, physical ability to handle the hives, and a risk tolerance, whereas education determines the literacy to maintain the records, knowledge of the training literature and numeracy to track honey production and sales. Tables 4.2 to 4.4 summarize the demographic characteristics of the respondents.

Table 4.2: Gender Distribution of Respondents

Participant Type	Male	Female	Total
Beekeepers	10	18	28
Extension Officers	3	1	4
M&E Officers	2	0	2
Project Coordinator	1	0	1
FGD Participants (Beekeepers & Officers)	9	9	18
Total	25	28	53

The results show that there is a small female majority (53 percent female, 47 percent male). It is worth noting that the number of female beekeepers (18) is more than that of male beekeepers (10) however all M and E officers and project coordinator are males. This indicates a gender gap in decision making and technical aspects, as women tend to receive more tasks at the production, and less at the management and evaluation, which can affect inclusiveness in project planning, monitoring and feedback procedures.

Table 4.3: Role of Respondents

Role	Number Participants	of % of Total

Beekeepers	28	53%
Extension Officers	4	8%
M&E Officers	2	4%
Project Coordinator	1	2%
FGD Participants (beekeepers & officers)	18	34%
Total	53	100%

The findings indicate that most of the interviewees are beekeepers (53%), and the research is mostly based on firsthand experiences of production. The officers of extension (8 per cent), M E officers (4 per cent) and project coordinator (2 per cent) are underrepresented and this could hinder the richness of the institutional and technical approaches to monitoring and evaluation practices. There are 34% FGD participants (a combination of beekeepers and officers) aimed at capturing interactive and collective insights; still, the overall distribution of the sample demonstrates a rather strong focus on the farm-level experiences, as opposed to project management and evaluation responsibilities.

Table 4.4: Years of Experience of Respondents

Participant Type	**<1 year**	**1–3 years**	**4–6 years**	**>6 years**	**Total**
Beekeepers	2	10	12	4	28
Extension Officers	0	2	1	1	4
M&E Officers	0	1	1	0	2
Project Coordinator	0	0	0	1	1
FGD Participants (Beekeepers & Officers)	2	8	5	3	18

Total	4	21	19	9	53

The findings indicate that beekeepers in particular have an average experience of 1-6 years of experience in beekeeping (22 out of 28) with very few (4) having experience exceeding 6 years. It can be proposed that most of the respondents are quite new to beekeeping and they are likely to heavily depend on further training and guidance. Nonetheless, the statistics do not differentiate between experience in the area of contemporary and traditional beekeeping practices which restricts the further examination of technical capacity and its application of superior practices.

4.3 Objective One: To Explore How Hive Monitoring Contributes to Sustainable Beekeeping in Makueni County

The aim of this objective was to investigate the role of hive monitoring in the sustainable beekeeping in Makueni County. The thematic analysis produced major themes which, by viewing Figure 4.1 below, are regular hive inspection, early identification of pests and diseases, record keeping and scrutiny of performance of the colonies and timely corrective measures. These themes describe the extent to which regular monitoring enhances hive workability, minimizes hive losses and provides strength to a sustainable environmental and economic stability in the long run.

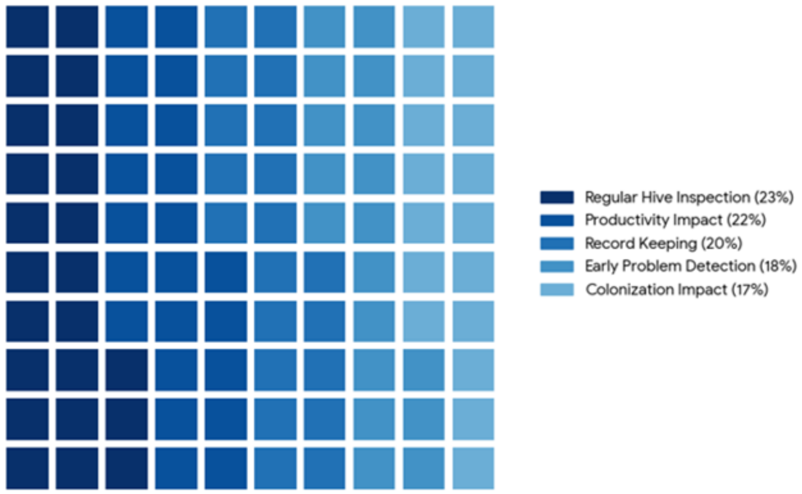

Figure 4.1: Hive monitoring practices and sustainability outcomes

4.3.1 Regular Hive Inspection

The frequent check of the hive by farmers was found to be one of the best practices in ensuring environmental sustainability in beekeeping. It was often described as a continuous and conscious behavior with which farmers communicate with their hives to observe possible dangers and guarantee the fitness of the colonies. It is a continuous farmer- ecosystems interaction in order to prevent the death of colonies and achieve a low level of variation in production. It also demonstrates how monitoring can be incorporated in the normal management practices that help to make the system sustainable.

One beekeeper said:

> "Every month I inspect the hive and make sure that I check the brood pattern and whether the pests are there or not. I remove ants and wax moths as soon as I see them. I've lost a colony in the past as I had delayed the inspections, and I didn't know why it happened" (FGD1-03).

This quote illustrates inspection as a continuous feedback which enables the farmers to respond to ecological indicators within the hive system. The beekeeping business according to Systems Theory is an open system where the environment and the activities of a farmer interplay and influence the equilibrium of the system. Inspection therefore becomes a control aspect that helps to eliminate the imbalance in the system by intervention. It helps farmers detect system perturbation and rectify them to prevent system malfunction.

Under the Results-Based Management Theory, one of the mechanisms of measurement of progress towards the intended results such as survival and productivity of colonies is inspection. It provides the right information in time to be used in managing performance and steering results towards the desired desired results. Regular a hive inspection, Bradbear (2009) adds, reduces the losses per colony and hides the pests in the early stages, whereas Muturi et al. (2018) identify that hive monitoring improves the hive attending and stability of the system. Abebe, Puskur, and Karippai (2014) further contribute that an organized check-up of the smallholder apiculture enhances productivity and survival. This gives an indication that besides the external environment, it is the system feedback that indicates environmental sustainability in order to take early measures and prevent ecological breakdown.

4.3.2 Productivity Impact

One of the key results was the productivity effect of hive monitoring that seemed to be the impact on sustainability in the economy. It illustrates how health in the system correlates with economic performances in respect of livelihood enhancement, honey output and earnings. It shows how system integrity is in connection to the economic performance of the beekeeping system. It also shows the impacts of monitoring on production efficiency and predictability of honey.

One beekeeper said

> "There were two harvests the year I inspected I had to pay school fees and other expenses with the bees which are more predictable when strong" (FGD2-05).

The quote shows how an improved monitoring improves system productivity by enhancing the colony performance and reducing variability. The Systems Theory believes that what is dependent on internal processes such as inspection and detection is the productivity as the component of output. The latter enhances the process of transformation of inputs into outputs by making the system efficient in preventing losses. It boosts the ecological-economic relationship in this manner.

One outcome measure of the Results-Based Management Theory is productivity which is used to depict the effectiveness of monitoring in delivering impact of development. It demonstrates the way a performance monitoring can assist in bettering livelihoods by management of the system. Amulen et al. (2017) testify that the management of colonies is better adopted to enhance production and livelihoods of honeybees, whereas Phelan (2015) points out that an effective management of hives is a critical factor in the profitability of apiculture. Muriithi and Kirimi (2015) also demonstrate that increased farm productivity increases livelihood sustainability for smallholder farmers. This suggests evidence that monitoring practices contribute to economic sustainability through heightened production levels and household resilience.

4.3.3 Record Keeping

Record keeping was identified as a prominent institutional sustainability practice that captures the institutionalisation of monitoring in documentation practices. It was commonly referred to as a way of tracking progress and promoting decision-making and accountability in beekeeping projects. This practice illustrates how monitoring data is institutionalised to inform system management. It also underscores the importance of record keeping in improving coordination within the beekeeping system.

One M&E officer said

> "Record-keeping farmers can also know whether they are improving their production. It is hard to advise them appropriately without written information. Records are used to keep the project and the farmer updated on the progress" (KII-MEO2).

This quote marks the transition from anecdotal monitoring of activities to formalised record-keeping systems that support organisational learning and accountability. In Systems Theory, record keeping is system memory that enables information to be retained across time and system actors. It enhances coordination through a shared understanding of system performance. It helps adaptive management by providing historical information.

In the context of the Results-Based Management Theory, record keeping is a fundamental aspect of results tracking by connecting activities, outputs and results in a structured way. It facilitates evidence-informed decision-making and improves accountability in development initiatives. Gebremedhin et al. (2016) point out that production records help with planning and marketing, while Muriithi and Kirimi (2015) report record-keeping helps farmers stabilise their income and make decisions. The lessons from this is that institutional sustainability requires monitoring within formal record keeping systems that facilitate learning, accountability and sustainability.

4.3.4 Early Problem Detection

Early problem detection came to the fore as a key environmental sustainability practice, emphasising early detection and response to threats facing the hive. It exemplifies the proactive facet of monitoring in which farmers respond to environmental disturbances prior to system collapse. It illustrates the value of responsiveness in preserving system stability and avoiding system collapse. It also shows the importance of monitoring in enhancing system resilience.

An extension officer said:

> "Most of the losses of the colonies occur because the farmers do not detect the problem early. In the case where the checks are done regularly, the problem is detected early. Early intervention prevents absconding and total loss of colonies" (KII-EXT1).

The quote is an example of monitoring as a corrective feedback loop that stabilises the system through intervention. In Systems Theory, early detection is a corrective feedback mechanism that stabilises the system by preventing failure. It guarantees system stability in the face of environmental challenges. So, it increases system resilience via early response.

In Results-Based Management Theory, early detection operates as a performance monitoring process that aligns expected and actual results through timely intervention. According to Morse and Calderone (2000), delayed action in honey bees leads to increased colony mortality, while Desalegn (2014) demonstrates that early pest detection enhances productivity in smallholder farms. This suggests sustainability is linked not only to monitoring frequency but also to the responsiveness and timeliness of system decision-making.

4.3.5 Colonization Impact

The colonization impact has emerged as an environmental sustainability indicator of hive occupancy and colony establishment. It reflects the capacity of the system to sustain colonies in different environments. Colonisation is an indicator of the beekeeping system's stability and sustainability. It also reflects the effectiveness of the system and the sustainability of beekeeping. One extension officer said

> "The success of the colony depends on the management of the hive and other environmental conditions" (KII-EXT2).

This quote exemplifies colonization as a result of environmental and systems management practices. From a Systems Theory perspective, colonization is reflective of system equilibrium, where there is stability through interaction between internal and external system factors. It indicates whether the system is operating effectively in its environment. It is therefore an indicator of system health.

In Results-Based Management Theory, colonization is an indicator of outcomes that reflects whether inputs and processes are leading to desired ecological outcomes. Bradbear (2009) highlights the need for ongoing management to maintain colony stability, and Muturi et al. (2018) link monitoring effort to higher hive occupancy and better system performance. So, long-term sustainability is dependent on stable colony establishment, providing the ecological basis for productivity and resilience.

4.3.6 Comparative Thematic Interpretation

There are different sustainability outcomes for different stakeholder groups in the beekeeping system. Beekeepers focus on productivity and frequency of inspection because they are reliant on short-term ecological and economic consequences. Extension officers prioritize early detection and stability of bee colonies because of their technical role in ensuring system resilience and ecological stability. M&E officers emphasize record keeping due to institutional demands for formalised monitoring and Results-Based Management (RBM). These variations reflect the interaction of actors with different levels of system functioning.

Within Systems Theory, they reflect multiple interacting components of a single adaptive system where actors interact through input, process, output, and feedback. Within Results-Based Management Theory, they represent different "places" along the results chain where actors focus on aspects of performance based on institutional roles. Environmental sustainability is the most prominent dimension, followed by economic sustainability, and institutional sustainability is sustained through documentation. Social sustainability is implicit in practices. The research suggests that sustainability is multifaceted, role-specific, and reliant on the integration of feedback systems and performance monitoring.

4.4 Objective Two: To Explore the Role of Follow-Up Activities in Supporting Sustainable Beekeeping Practices

This objective explored the role of follow-up activities in supporting sustainable beekeeping practices in Makueni County. Thematic analysis identified major themes such as post-training field visits, refresher training sessions, technical support, technique retention, farmer confidence building, and continuous mentorship. These themes demonstrate how follow-up activities reinforce knowledge application, improve farmer commitment, and enhance the continuity of beekeeping practices. Figure 4.2: Training follow-up and sustainability of beekeeping projects in Makueni county presents the findings on the relationship between post-training support and key sustainability indicators among the respondents.

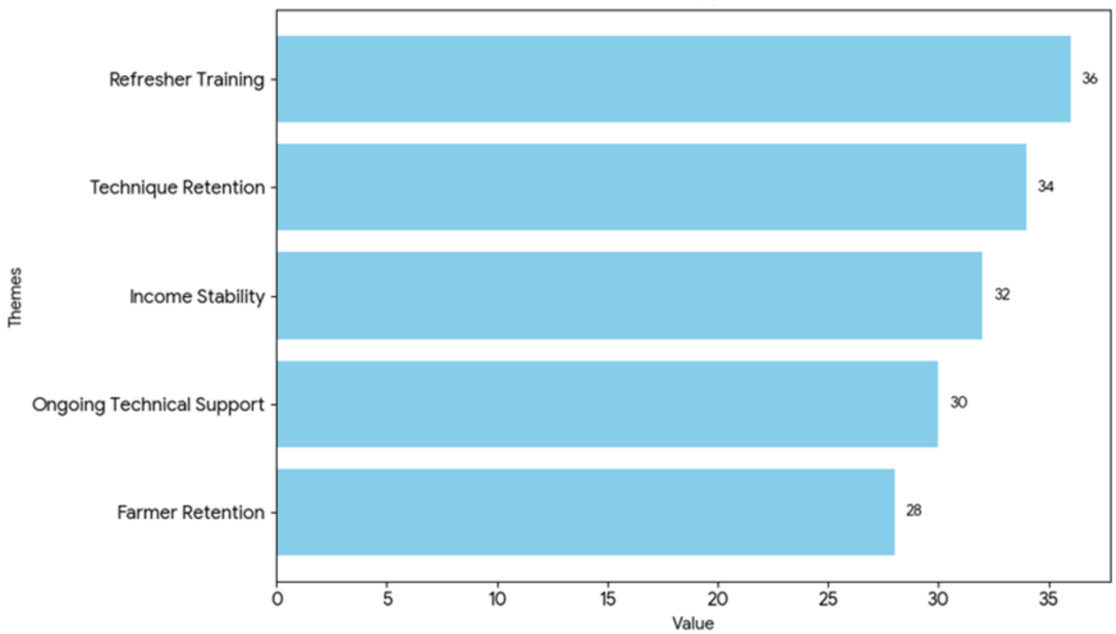

Figure 4.2: Training follow-up and sustainability

4.4.1 Refresher Training

Refresher training was identified as a significant element in the sustainability of beekeeping practices, as it complements the initial training in beekeeping. Interviewees repeatedly explained that refresher training was critical for the correction of errors, improvement of technical knowledge, and maintenance of good hive management skills over time. It was seen as a way to avoid knowledge attrition and sustain the use of recommended apiculture practices. It also represented the need for ongoing learning to sustain the impact of agricultural initiatives.

One beekeeper said:

> "This account shows that beekeeping learning is dynamic and needs to be reinforced to be effective. From a Systems Theory perspective, refresher training is a form of positive feedback that reinforces knowledge circulation within the system and avoids declines in system performance. The system therefore relies on the continued knowledge inputs to sustain equilibrium and enhance adaptability." (KII-EXT2)

For the Results-Based Management Theory, refresher training is an input and process intervention to maintain outputs through reinforcing previous training. Feder, Murgai, and Quizon (2004) stress that ongoing extension contact increases long-term adoption of agricultural technologies, and Davis et al. (2012) note that repeated training increases the consistency of adoption of agricultural practices. Yet, Ragasa and Mazunda (2018) argue that the follow-up of training depends on institutional capacity and resources. This means that follow-up training is critical to sustain outcomes, but requires effective institutional support.

4.4.2 Technique Retention

Retention of techniques proved fundamental to the sustainability of practices in beekeeping, especially as it affects the continuity of improved hive management practices. Participants suggested that farmers who kept in contact with extension officers were more likely to retain proper techniques and avoid mistakes in hive management. This practice demonstrated the importance of continuous mentorship to build technical skills and maintain behaviour change. It also reflected the value of mentorship in facilitating the practical application of training.

One extension officer explained:

> "We regularly visit farmers and see how they are managing their hives and assist them with any challenges they may experience. Where we observe improper practices, we immediately correct them so that the farmers do not lose their colony or abandon the business, and this ongoing support and observation instills confidence and prevents farmers from making errors that can lead to colony collapse or abandoning beekeeping" (KII-EXT3).

This account shows that retention of techniques is reinforced through ongoing engagement between extension systems and farmers. From a Systems perspective, this is a feedback mechanism of support with external actors supporting internal system processes to ensure stability and performance. The system continues to operate through the ongoing correction and support for proper practices.

In the theory of Results-Based Management, technique retention is a result of continuous technical support. For example, Anderson and Feder (2007) contend that productivity growth in agriculture is dependent on continuing advisory services, while other research emphasises that institutional capacity constrains extension. This implies that the retention of techniques enhances sustainability only if it is backed up by ongoing institutional involvement and staffing in extension systems.

4.4.3 Income Stability

Training support and technical assistance was found to be important for economic sustainability through income stability. Respondents described that ongoing training and support led to more consistent production practices, which boosted income stability and helped in household income planning. The example demonstrated the link between technical support and livelihood stability. It also showed the impact of technical support on household economic outcomes over time.

One beekeeper described:

> “As we are continuously trained and visited by extension officers, we know how to manage our hives and avoid big mistakes that we used to make that would reduce our harvests. This gives us more certainty in management and we can plan better for household needs, send children to school with more certainty and reduce the uncertainty that beekeeping used to have; although markets are sometimes uncertain” (FGD1-05).

This shows that income stability reflects output stability of a system based on continued technical support. In Systems Theory, income stability is the result of the stability of a complex system's outputs, which are produced by stabilized processes. The system is more resilient when system processes are stabilised through feedback and reinforcement.

In Results-Based Management Theory, income stability is an outcome indicator that reflects the impact of training programs on sustainable livelihood outcomes. Amulen et al. (2017) contend that improved colony management increases livelihood resilience, while Phelan (2015) notes the link between colony management and income stability. The implication is that training follow-up helps achieve economic sustainability by increasing the stability of production systems and household resilience.

4.4.4 Ongoing Technical Support

Technical support was identified as another important variable in sustainability by offering ongoing support to farmers after training. Farmers noted that ongoing visits and support services reduced mistakes in their beekeeping management, as well as boosting their confidence. The practice was reflective of the role of ongoing institutional interaction in sustaining system performance. It also showcased how support from outside farming systems strengthens the system from within.

One extension officer explained:

> "We make sure that we do not just train the farmers once, but also visit them regularly to help them with the problems they face in their practice. These subsequent visits enable us to address problems early in the process, to correct mistakes before they lead to losses, and to encourage the farmers to continue because they know that they are being supported through the production cycle" (KII-EXT2).

This is an example of ongoing technical support as an ongoing reinforcement process for beekeeping. In Systems Theory, this is an external regulatory input to maintain system stability through correction and reinforcement. The system thus requires ongoing feedback and interaction. In Results-Based Management Theory, continuous technical support is a process intervention that supports outputs and improves outcomes. Limited institutional capacity, especially staffing shortages, was found to be a constraint on this. This means sustainability is enhanced when technical systems are well-resourced to sustain farmer contacts.

4.4.5 Farmer Retention

Farmer retention was identified as a social sustainability outcome for training, follow-up, and support practices. The respondents suggested farmers who did not gain sustained support were more likely to cease beekeeping, whereas farmers with ongoing support continued with the practice. The practice showcased the importance of institutional support for retaining farmer interest and participation. It also highlighted the need for longer-term engagement, as opposed to short-term training.

One farmer discussed:

> "Some farmers gave up on beekeeping because they were facing problems and had no one to help them overcome the obstacles. When extension officers kept up with them, they became confident and started again, but if the extension officers had not taken up the follow-up, many of them would have lost motivation and stopped beekeeping completely" (FGD3-06).

This illustrates the relationship between retention and reinforcing support. According to Systems Theory, retention equates to system stability and continuity, where continued participation is enabled by positive feedback systems. Stability is lost when feedback and support are lacking. In Results-Based Management Theory, retention is an outcome of the impact of training in helping farmers to remain in the system. Amulen et al. (2017) stress that extension activity leads to higher farmer engagement in apiculture enterprises. The lesson here is that social sustainability is reliant on ongoing institutional support that bridges participation and the risk of disengagement.

4.4.6 Comparative Thematic Interpretation

Training follow-up is a central feature of all themes in connecting knowledge transfer with sustainability. Beekeepers focus on refresher training because of its function in bridging practice to learning. Extension officers focus on continued technical support and retention of techniques due to their role in reinforcing the system and stabilizing performance. M&E officers prioritise income stability and retention due to their emphasis on performance outcomes in Results-Based Management systems.

In Systems Theory, these differences reflect the multiple feedback loops within a single adaptive system that maintain stability through knowledge, corrections, and reinforcement. In Results-Based Management Theory, they reflect elements of the results chain where training (input) results in improved practices (output) that result in income stability and retention (outcomes). The research shows that the sustainability of beekeeping systems is achieved through learning and reinforcement processes. Environmental, economic, and social sustainability are all reinforced when training systems are ongoing processes that are institutionalized.

4.5 Objective Three: To Identify the Significance of Hive Setup Verification in Promoting Continuity in Beekeeping

This objective identified the significance of hive setup verification in promoting continuity in beekeeping projects in Makueni County. Thematic analysis revealed themes including proper hive placement, adherence to recommended installation standards, environmental suitability assessment, verification of equipment readiness, farmer compliance, and reduced early abandonment of hives. These themes demonstrate that correct set up verification facilitates colony occupation, minimizes the mistakes in management and fosters the perpetuated activity of projects.Figure 4.3 indicates the results on the correlation between hive setup verification practices and continuity indicators of the respondents.

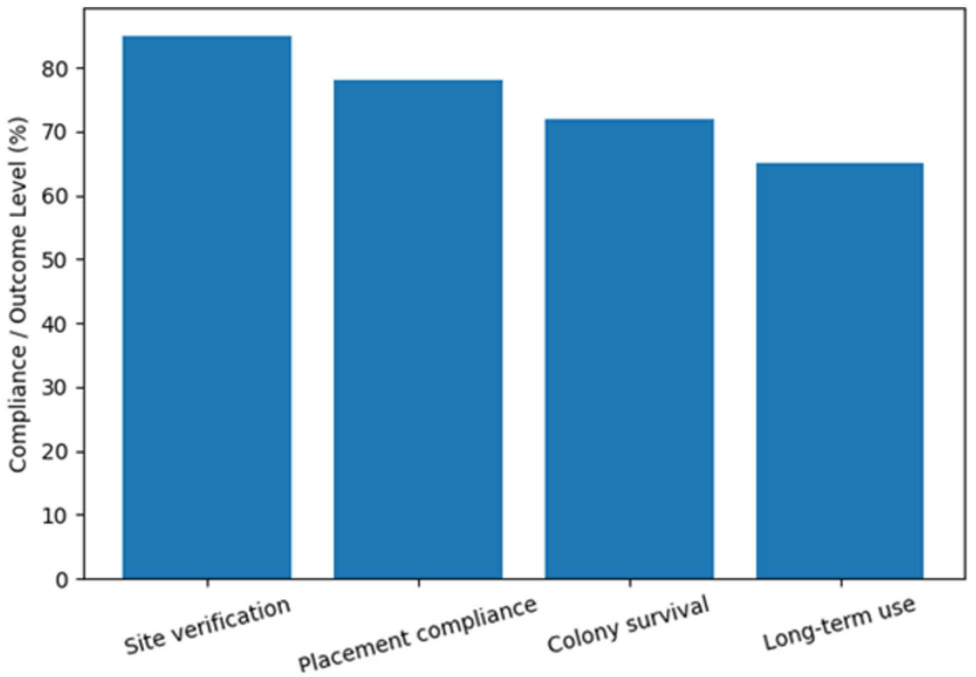

Figure 4.3: Compliance and survival outcomes

4.5.1 Site Verification

Site verification was found to be one of the most significant factors of ecology and sustainability of beekeeping systems. It was most commonly described as the procedure of initial filtering of environmental suitability prior to hives being set up. It is also the symbol of the first ecological conformity of the system requirements, on which the success of a colony is based. It can also be used as a mitigation measure that can reduce long-term risks.

An extension officer explained:

> "When selecting the location, we would initially seek an adequate shade, flowering plants, and access to good water and sources of disturbance (animals or people). What

should be done is to verify this early in order to avoid setting colonies to waste the farmer time and increase the likelihood of the colonies being established (KII-EXT2)".

The explanation shows that site verification is considerable in identifying the appropriateness of environmental conditions to set up the colonies. It is a matching process in input level in Systems Theory where the environment is matched with the system to stabilize the input. The success of the system will be determined by whether or not the physical environment can meet the needs of the system. With Results-Based Management Theory site verification complements the causal relationship between an input (hives installed), and instant outputs (colonies established) by having appropriate conditions of implementation in the initial phases of the management.

As Bradbear (2009) observes, a balance between ecology and apiculture is a key to establishing colonies and maintaining them sustainably, but also Muturi et al. (2018) can show that the proper selection of sites can augment the amount of hives occupied. Desalegn (2014) also reveals that where an inappropriate location has been used, absconding of colonies in smallholder beekeeping increases. Then sustainability begins with installation where the ecological suitability of a system determines the ability of the system to be sustainable.

4.5.2 Placement Compliance

An implementation factor to influence system stability and survival of bee colony consists of Placement compliance. This was defined as the level of adherence to suggested spatial and environmental factors of locating a hive. The practice exemplifies the way in which technical knowledge and the actions of the farmers work in practice. It also depicts the severing of the ideal and the real.

A beekeeper explained:

> "My first hive was quite close to the house since I assumed that this would make it convenient to me, but the colony had gone absconding due to the noise, people, and livestock that frequented the area, but after I had moved the hive to a shaded area where there was no noise, people, and livestock, everything settled down and the colony was much more productive than it used to be (FGD1-06)."

The statement above reveals the impacts of placement on ecological stability of the colony. This is a incomplete mismatch of systems and the environment in Systems Theory, in which a system is improperly placed, generating system disturbances and making the system more susceptible to change. When the interests of humans prevail over nature, then they put the system at risk. According to Results-Based Management Theory, the lower the compliance, the lower the efficiency of the conversion of inputs to outputs which results to variable ecological outcomes.

Anderson and Feder (2007) note that technical advice plays an important role in ensuring agricultural productivity and Bradbear (2009) observes that the location of the hive impacts on colony productivity and survival. The conclusion is that any change that goes against the ecological guidelines will lead to unsteadiness of the system and deterioration of the sustainability performance.

4.5.3 Colony Survival

Colony survival was identified as an intermediate environmental outcome that reflects the adaptability of beekeeping systems to different sets of ecological conditions. It was defined as the capacity of colonies to endure after placement, despite environmental stressors like drought, food scarcity, and disturbance. The practice is an intermediate step between system establishment and its sustainability. It also provides a measure of ecological resilience.

One extension officer noted:

> “Survival of colonies was found to be intermediate environmental phenomenon which indicates the flexibility of beekeeping systems to various combinations of ecological environments. It was characterized as the ability of the colonies to survive upon being placed, regardless of environmental pressures such as drought, food shortage and disturbance. The practice is a transition point between the setting up of systems and sustainability. It offers an indicator of ecological resiliency as well.” (KII-EXT3).

The given statement can serve to illustrate that the conditions of the environment, as well as the initial correspondence of the system, are the factors that can contribute to survival. In Systems Theory, survival is an intermediate stage of stability in which the system's equilibrium is challenged by the environment. The system is open to shocks that occur post-installation and must adapt to maintain equilibrium. In Results-Based Management Theory, survival is an intermediate level of achievement between outputs and impact.

Bradbear (2009) observes that colony survival is highly dependent on environmental stability, whereas Phelan (2015) reports that forage is critical to colony survival. In addition, Muturi et al. (2018) demonstrate that hives in good locations have a greater survival rate than those in bad locations. The upshot is that survival does not just occur at the time of installation but as an ongoing interaction with the environment and system management.

4.5.4 Long-Term Hive Use

Long-term hive use was the last sustainability outcome that reflected the long-term productivity and use of beekeeping systems. It was defined as the degree to which the surviving colonies continue to be productive and useful over time. The practice exhibits the consistency of the performance of the system over the period, considering environmental and management influences. It is also indicative of whether the initial success is a predictive of the longer term livelihoods.

One beekeeper reflected:

> "There were hives that survived the initial period provided well in the first case but at a later stage, they were no longer as productive (in amounts of harvests and income) to us as they were initially (FGD2-02)."

The quote shows that the fact that you survived does not mean that you will be used or be productive. The long-term use of hives, as an example of cumulative system equilibrium is provided in the Systems Theory, based on the continual support and government of the environment. Failing in performance of the system is the way it starts and as the pressures build it loses its effectiveness in the long run. The impact level is whereby in the theory of Results-Based Management, it is the impact where long-term results are expected but not certain.

Phelan (2015) comes to the conclusion that long-term apiculture is sustainable only under the conditions of continuous forage and management, and Bradbear (2009) observes that the productivity of the hives reduces over time when the environmental conditions worsen. This implies that, sustainability is not only based upon effective hive installations and survival but also continued environmental and management to maintain the performance of the system.

4.5.5 Comparative Thematic Interpretation

Throughout the themes, hive setup check is a minimum determinant of sustainability in systems, including installation, survival, and productivity. Beekeepers are more concerned when it comes to positioning their hives considering the experience they had about hive productivity. The emphasis on site verification and compliance of the extension officers is owed to the technical skill of evaluating ecological fit of the sites. The survival and long-term use of the programme are stressed on as the indicators of sustainability of the programme by institutional actors.

These changes are in the Systems Theory, system inputs, processes, outputs and equilibrium overtime in response to change in the environment. They are movement in Results Management Theory of outputs (colonization), results (survival) and impact (long-term use) as contributions in the Results chain beginning with inputs (verification). The findings reveal that initial ecological fit is a very important factor in regard to sustainability, nevertheless; the sustainability also demands continuous environmental maintenance and management after installation.

4.6 Objective Four: To Analyze How the Use of Monitoring Data Influences Sustainable Beekeeping Practices in Makueni County

The aim of this objective studied the impacts of monitoring data utilization to sustainable beekeeping in Makueni County. The themes that were produced with the help of the thematic analysis included evidence-based decision making, sharing findings with the stakeholders, identification of the problem via the usage of the data, adaptive planning, applicability of the lessons learned, and better accountability. These themes show that when monitoring data are used effectively, it boosts the management of the projects, responsiveness towards difficulties, and the sustainability of the beekeeping activities over time. Figure 4.4 shows the results on the connection between the use of beekeeping data and the key sustainability indicators to the respondents.

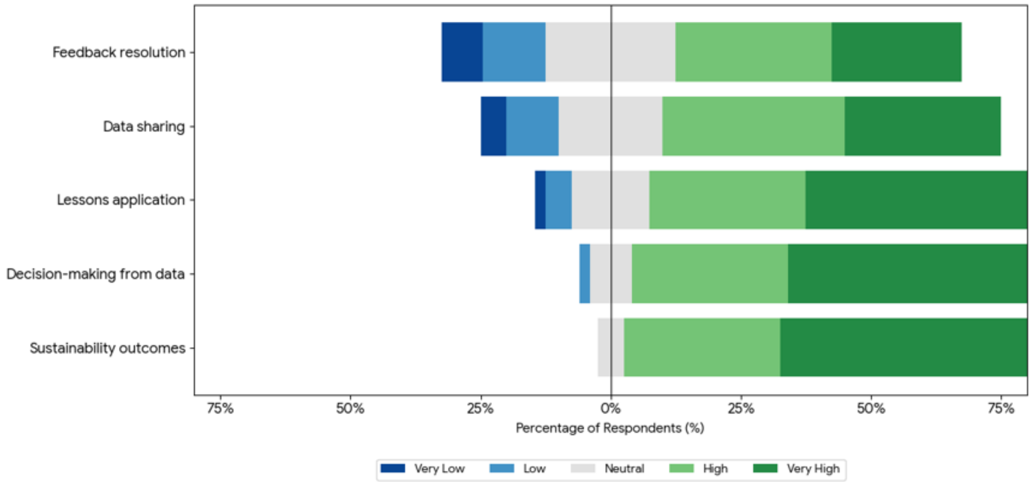

Figure 4.4: Data use practices

4.6.1 Feedback Resolution

The resolution of feedback was also found to be a key but sporadically adopted process that determines the conversion of monitoring information to action in the beekeeping systems. It is an indicator of how many problems that are detected as a result of the monitoring process are solved via the use of systematic response systems. It also brings out the existence of information flows within the system to rectify identified weaknesses. The results indicate that feedback is frequently created and not always closed by action, constraining the responsiveness of the system.

An M & E officer:

> "Information received by farmers on colony survival, production level, and difficulties they encounter during the beekeeping cycles are to be discussed and utilized with farmers, but in some instances, reports are received then not followed up with discussions and hence the same issues reoccur in the next monitoring cycle" (KII-MEO1).

Monitoring systems are generating information and not completely closing the feedback loop. This implies that corrective measures are not taken or are delayed, which undermines system learning. The conclusion is that information is present, but no action is taken. This occurs due to the lack of effective institutional coordination, feedback, and ad hoc interaction with farmers. As Bradbear (2009) literature demonstrates, only the active implementation of feedback turns the monitoring into an effective practice, and Muturi et al. (2018) note that inefficient feedback systems decrease the efficiency of the system. Systems Theory describes this as a faulty feedback loop that minimizes the stability of systems, whereas RBM Theory describes it as the inability to translate monitoring outputs into corrective outputs. This is important since in the absence of feedback resolution, errors are not corrected, the system cannot learn, and the sustainability performance will be reduced in the long run.

4.6.2 Data Sharing

The data sharing was found to be one of the major factors that determine the effectiveness of monitoring of the information circulating in beekeeping systems. It captures the ability of data gathered at the project level to be in a usable form at the farmers' and other stakeholders' level. It also decides whether information will be centralized or distributed in the system. Results indicate that data is gathered on a regular basis but disseminated irregularly among stakeholder groups.

One extension officer explained:

> “Some of that data is provided during monitoring visits, such as colony performance, farmer challenges, and environmental conditions impacting hives, but not all farmers are provided feedback regularly, and in some instances, the data is not made accessible to farmers, who require it the most to make decisions, as part of project reports” (KII-EXT2).

Data flows are discontinuous, which results in unequal access to data. This brings about inconsistent decision-making among the farmers based on whether they get feedback or not. It is interpreted to mean that system learning is not balanced, as only components of the system are educated. This is because of the poor communication frameworks and a low feedback dissemination system. According to literature by Anderson and Feder (2007), extension systems are best used in situations where information is constantly shared, and according to Davis et al. (2012), knowledge diffusion increases adoption and sustainability. This is explained by Systems Theory as a failure in the connectivity of systems, and by the RBM Theory as low dissemination of monitoring outputs. This is important as disproportionate data access translates into disproportionate system performance, which makes the programme less sustainable in general.

4.6.3 Lessons Application

Lesson application was a highly positive yet heterogeneously distributed practice that had an impact on the sustainability of beekeeping systems. It indicates how much monitoring feedback is used by farmers to change their practices. It also shows the ability of the system to adapt to change information into behaviour change. Results indicate that in the areas of lesson application, there is a great improvement in system performance.

One beekeeper shared:

> "We are taken to monitoring feedback meetings and shown where we went wrong in hive management and how we can correct ourselves, and with advice on the correct positioning of hives and time to inspect them, I adopted the practices and found that I was losing fewer colonies and producing more honey than I had done during previous seasons when I was not implementing the advice consistently" (FGD2-03).

According to the statement, Information that is being monitored is being translated into practical behavioural changes. This results in better performance of the systems and minimization of losses. This interpretation is that learning is only effective when farmers put feedback into practice. This is so because participatory involvement enhances knowledge and ownership of recommendations. It has been demonstrated in literature by Feder et al. (2004) that continuous learning enhances the adoption of technology, whereas Davis et al. (2012) note that repeated reinforcement enhances agricultural practice retention. This is explained by Systems Theory as adaptive learning in an open system, and by RBM Theory as transformation of outputs to better outcomes. This is important as in the absence of the application of lessons, monitoring will be descriptive as opposed to transformative.

4.6.4 Decision-Making from Data

Data-driven decision-making proved to be a key factor in determining sustainability performance in beekeeping systems. It shows how much the information on monitoring is utilized in the process of planning and operational decisions. It also shows evidence-based or assumption-driven decisions. Results indicate that enhanced data utilization results in better system performance.

An M&E officer described:

> "Where decisions are made using this data, we have found improved results in colony stability and farmer performance, and interventions do not work as well, and issues are not resolved when data is disregarded" (KII-MEO2).

The statement implies that data is being selectively incorporated in decision-making processes. Where data is utilized, there is an enhancement of system performance, whereas where it is disregarded, inefficiencies will prevail. The meaning is that the quality of decisions is determined by the power of combining evidence. This is due to the fact that the institutional structures facilitate or restrain data-driven governance. Anderson and Feder (2007) focus their literature on the fact that evidence-based extension enhances productivity, and Phelan (2015) focuses on the fact that management decisions directly influence the outcomes of apiculture. This can be described as a control feedback process by Systems Theory and alignment of monitoring outputs with decision-making processes, as explained by RBM Theory. This is important since bad decisions that are made based on data compromise system effectiveness and lower long-term sustainability.

4.6.5 Sustainability Outcomes

The final outcome of a system of using data in beekeeping systems was sustainability. It indicates the stability of the environment, economic performance, and social cohesion that are realized by the use of monitoring systems. It is also the last phase of the effectiveness of the system according to RBM logic. Results indicate that enhanced data use is always associated with positive sustainability results.

A project coordinator said:

> “As long as we monitor data actively at all levels, including feedback sharing to decision-making, we will see more successful colony survival, higher production of honey, and enhanced participation of farmers, but when we only collect data but do not use it, the system tends to be reactive instead of proactive, and the sustainability outcomes will weaken over time” (FGD4-01).

It shows that integrated data use enhances the performance of the system in a multi-dimensional manner. In areas where data is actively used, results are better, and in areas where data is not, the performance of the systems is lower. It can be interpreted that sustainability is based on the integration of all the feedback mechanisms into the system. This is because the use of data in a coordinated manner improves system coherence and responsiveness. Bradbear (2009) and Muturi et al. (2018) mention in the literature that active monitoring enhances the stability and productivity of colonies. This is explained by the Systems Theory as a long-term equilibrium achieved through the integration of feedback and by the RBM Theory as the long-term impact. This is important since it is only when the monitoring systems are incorporated in decision-making and action processes that sustainability will be realized.

4.6.6 Comparative Thematic Interpretation

In all themes, data use is the key pivot to the relationships between monitoring systems and sustainability deliverables. Poor feedback correction and incompatible data exchange constrain learning in the system and decrease the overall responsiveness. Effective lessons application and data-driven decision-making enhance system outcomes in performance and sustainability. These trends demonstrate that sustainability not only relies on data collection but also on the effectiveness of data-to-action transformation.

In Systems Theory, these disparities are portrayed in the power of feedback loops and connectivity of a system that constitute adaptability and stability. In Results-Based Management Theory, they are a measure of the efficiency of transforming monitoring outputs into results and long-term effects. The results show that sustainability is most likely to increase when data systems are fully incorporated in the continuous learning, feedback and decision-making processes.

4.7 Summative Analysis

The chapter has discussed the practice of monitoring and evaluation on the sustainability of beekeeping ventures in Makueni County and their impact on four inter-related targets (hive monitoring, training follow-up, verifying hive setups, and using data). Combined, the results show that the outcomes of sustainability are not determined by single actions, but by the interaction between the technical practices, institutional support, and adaptive feedback mechanisms. Frequent hive inspection was linked to better colony survival and increased productivity, and added to the environmental and economic sustainability. Follow-up training enhanced the retention of techniques, confidence of the farmers, and income stability as part of the main components of social and economic sustainability. Hive setup verification increased ecological appropriateness and long-term continuity of hives, and corporate data use improved adaptive decision-making and aggregate learning among stakeholders.

A combined study indicates that these four elements work in a mutually dependent manner. It is not possible to monitor without feedback, train without following up, hive without verifying, and collect data without using it in order to deepen learning, retention, continuity, and adaptive management. Although the obtained results align with the existing empirical evidence of the significance of extension support and organized monitoring in apiculture (Abebe et al., 2014; Amulen et al., 2017; Muturi et al., 2018), the study also showed contextual limitations, in terms of climatic variability, market unpredictability, and institutional capacity, which moderate the sustainability results. This appreciation can prove useful in the knowledge field that it demonstrates the practices of Monitoring and Evaluation (M&E) in smallholder beekeeping projects are not mechanisms of accountability but a force of operational ecological stability, retention of farmers and stability of their income provided they are well implemented.

Results are very reflective of the postulations of the Systems Theory that considers the projects as dynamic systems comprised of interacting subsystems. A system of many related components within a bigger ecological and socio-economic framework is hive surveillance, education, inspection and feedback on data. There was a greater stability and robustness of the system in areas where feedback loops were implemented and adaptive responses made. The undersaturation of the components in relation to each other, on the other hand, reduced the sustainability therefore showing the systemic nature in the project performance.

The results coincide as well with Results-Based management (RBM) theory which is also concerned with the connection between the inputs and outputs, outcomes and long-term impact. All the inputs were training, inspection, visits to verify, and monitoring activities in this study that were transformed into measurable outputs (improved practice, verified placement, data reports). Such outputs reinforced by follow-up and feedback in such areas resulted in long-term outcomes (surviving of colony, farmer retention, and income stability) and provided broader development impact. Nevertheless, when the components of the results chain lacked, especially in the use of data and institutional follow-up the sustainability channel was undermined.

Overall, the chapter shows that sustainability of the beekeeping projects is determined by the approach of integrating technical management practices as well as structured monitoring, constant learning as well as institutional support. Connecting the results of empirical investigations with Systems Theory and RBM, the study enhances the knowledge of how M&E mechanisms can go beyond the compliant purpose and be adapted to the tool of strengthening environmental, social and economic sustainability in smallholder agricultural initiatives.

CHAPTER FIVE: SUMMARY OF THE FINDINGS, DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Introduction

This chapter gives a holistic summary of the results of the investigation into the effects of monitoring and evaluation practices on sustainability of beekeeping project in Makueni County. It not only synthesizes the key results of the purpose of the research but also argues about their implications in the general framework of the project sustainability and makes conclusions out of the evidence produced. The chapter also presents the theoretical implications of the work, how the results could be applied to the programme that the researcher followed, and suggests the possible practical policy and practice recommendations. Recommendations on future research and how the study can be used to contribute the literature are also outlined.

5.1 Summary of Findings Based on the Research Objectives

5.1.1 Influence of Hive Monitoring on the Sustainability of Beekeeping Projects

The study has determined that monitoring of hives is a critical factor in deciding if the beekeeping project would be sustainable in Makueni County. Beekeepers who inspected their hives regularly were found to have a high survival rate of their colonies; they were able to detect pests and diseases more easily, and they also had a stable honey production, whereas those who observed their hives at random intervals showed low colony survival levels. Regular checks helped to detect early stress-inducing factors in colonies so that corrective actions could be taken in time to minimize absconding and loss of colonies. These practices had a direct contribution to environmental sustainability owing to healthy bee populations and an indirect contribution to economic sustainability in terms of good productivity and reliability of income. The results also indicated that hive monitoring was most practical when they were systematic and guided by the extension officers, which revealed the significance of systematic systems of monitoring beekeeping enterprises.

5.1.2 Influence of Record-Keeping Practices on the Sustainability of Beekeeping Projects

The results indicated that practices of record keeping amongst beekeepers were not evenly practiced, but a significant impact on the sustainability of the project was experienced where the practices were uniformly practiced. Beekeepers who had a record of hives inspection, periods of harvest, and production levels were in a better position to organize their activities, to assess performance patterns, and to make effective management decisions. Record-keeping has also improved communication between farmers and extension or monitoring staff, which has allowed for more specific technical assistance. Some beekeepers thought record-keeping was time-consuming, but the study proved that regular record-keeping enhanced economic sustainability because it increased the predictability of income and evidence-based decision-making. Lack of records, on the other hand, hindered the learning, accountability, and adaptive management in beekeeping initiatives.

5.1.3 Influence of Feedback and Reporting Mechanisms on the Sustainability of Beekeeping Projects

The investigation established that the sustainability of the beekeeping project was greatly affected by the feedback and reporting systems, especially on the motivation of the farmers and learning about the project. Beekeepers tended to correct bad practices, embrace recommended interventions, and be more active in the project where the feedback of the monitoring activities was timely and actionable. Good feedback mechanisms led to the building of trust between farmers, extension officers, and project implementers, therefore, improving social sustainability through increased participation and responsibility. On the other hand, poor feedback mechanisms led to problems that were not solved, less confidence among the farmers, and a deterioration of interest in beekeeping activities. The results point out that feedback is not only a reporting tool but a crucial learning and adaptive process, which promotes long-term project sustainability.

5.1.4 Influence of Capacity Building in Monitoring and Evaluation on the Sustainability of Beekeeping Projects

The study also determined that one of the determinants of the sustainability of beekeeping projects was capacity building in monitoring and evaluation practices. Trained beekeepers who were trained on hive monitoring, interpretation of the data, and simple record keeping had enhanced management skills and were increasingly independent in decision making. Capacity building increased the chances of farmers to detect the issues at early stages, implement the rightful actions, and continue beekeeping practices even after outside assistance. It can be inferred that increased local M&E capacity lessens reliance on project personnel and enhances ownership, which is necessary to ensure the long-term sustainability of beekeeping projects in arid and semi-arid areas like Makueni County.

5.2 Theoretical Implications of the Study

The results of the current study support the relevance of the systems theory and the results-based management theory in the explication of the sustainability of development projects. The interdependence between hive monitoring, record keeping, feedback systems, and capacity building can be seen through the interaction between the project elements, as highlighted in systems theory. The research also promotes the use of results-based management in the sense that it proves that sustainability outcomes can be attained when the use of monitoring information involves active utilization to make decisions and implement corrective measures. These results enrich the current theoretical insights to show the way of acting as a dynamic process, M&E practices contribute to the learning process, its adaptation, and its resilience in the community-based agricultural projects.

5.3 Implications of the Study Findings to the Programme Pursued by the Researcher

This study is directly applicable to the programme that the researcher is undertaking, especially in improving project planning, monitoring, and evaluation competencies. The research offers viable information on the ways M&E practices can be incorporated into project implementation to enhance the sustainability outcomes. It also brings to light the significance of participatory monitoring and capacity building, which are essential skills of professionals who take part in development planning and management. The connection of theory with field-based evidence makes the study more powerful in helping the researcher to design, implement, and evaluate sustainable development interventions.

5.4 Conclusions

The research finds that the central focus of the sustainability of beekeeping projects in Makueni County has to do with effective monitoring and evaluation practices. It was also established that regular hive inspection, regular record keeping, proper feedback, and capacity building played significant roles in increasing the sustainability of the environment, social, and economic. Embarkation of M&E practices in projects that were integrated into normal operations showed increased rates of colony survival, a more stable income, and enhanced farmer interaction. Beekeeping initiatives can only be sustainable through not only the availability of physical inputs but also through sustained learning, feedback, and adaptive management mechanisms with the help of effective monitoring and evaluation systems.

5.5 Recommendations

According to the results of the present research, the sustainability of beekeeping projects in Makueni County should be improved by the combination of practical steps and policy-supporting actions. The routine and periodic hive observation needs to be reinforced with the formation of clear inspection schedules, pest and disease checklists, and templates for reporting the conditions of hives. County Department of Agriculture, with KALRO and the local association of beekeepers, should be at the forefront of implementing these protocols. Policies might make routine inspection of the hive a precondition of technical assistance or subsidies to make sure that the beekeepers can observe and handle the stress in the colony at an early stage, and it will enhance the ecological and economic sustainability.

Regular documentation of beekeepers is also encouraged because it facilitates the adoption of improved planning, appraisal, and decision-making. Simplicity of record-keeping can be made possible and accessible by using simple logbooks or mobile applications to deliver the training and tools through agricultural extension officers, NGOs and local farmer cooperatives. Makueni County might require a policy level in which all the sponsored projects maintain minimal basic records of hives, production, and harvests checks. Responsibility will be strengthened by institutionalizing record keeping, enabling management and making the outcome of project predictable will be encouraged.

Good feedback and reporting frameworks are needed to enhance the involvement, trust and social sustainability of the farmers. Structured channels of communication, such as community review meetings, electronic messaging apparatuses, and forums where sharing of monitoring output is possible, among others, should be established and run by the County Department of Agriculture, community-based organizations, and implementing NGOs. This can be through policies that require timely and actionable feedback in all the projects supported by the county so that the farmers can respond to the challenges and implement the suggested practices as soon as possible. Empowerment of feedback systems will improve involvement, education, and long-term adherence to beekeeping operations.

The other critical strategy is the capacity building of monitoring and evaluation. Trained farmers who know how to collect data, interpret, and make positive decisions are more autonomous and can maintain the projects without the need to be supported all the time. Beekeepers should be provided with regular training and mentorship as well as peer-learning activities by KALRO, agricultural extension services, and development-oriented NGOs. Often, the policy interventions may demand that the capacity-building aspects be incorporated into any agricultural projects to enable the farmers to acquire the skills of adaptive management and ownership of the project.

Furthermore, M&E practices will be incorporated into the policy and institutional structures to enhance the project's sustainability. The Makueni County Assembly, through development partners, should come up with policies that require M&E requirements for all farming programs. This may involve making it mandatory to report the outcomes of projects, basing performance on future support, and motivating projects whose findings show longevity. There should be coordination between the county departments, research institutions, NGOs, and farmer associations to align the M&E practices and to ensure that these practices are aligned to the greater goals of agricultural development.

Lastly, research and innovation should be continued to bring beekeeping practices to suit the local environmental conditions and enhance the outcomes of the projects. Applied research of sustainable hive management, pests and disease control, and digital monitoring technologies has to be done by universities, research institutions, and KALRO. A policy can be used to fund or encourage research in collaboration with the local communities and make sure that innovations are viable and can be extended to smallholder farmers. With such recommendations, the beekeeping projects in Makueni County will be able to reach a higher productivity, fitness, and sustainability.

5.6 Suggestions for Further Studies

Future research should consider adopting quantitative or mixed-method approaches to measure the magnitude of the relationship between monitoring and evaluation practices and sustainability outcomes in beekeeping projects. The comparison of various counties or livelihood projects would also help to gain the insight into contextual differences. It is suggested that longitudinal research on beekeeping projects over a long period results in more profound information on the long-term impacts of the monitoring and evaluation practices on sustainability.

5.7 Contribution to the Body of Knowledge

The study contributes to the body of knowledge by introducing research-based ideas that can guide researchers to further their research and improve the existing body of knowledge on health-related programs. The work contributes to the research in that it presents empirical evidence on the importance of the monitoring and evaluation practices in order to maintain the community-based beekeeping projects in the arid and semi-arid areas. It enhances knowledge by showing how viable M&E elements, including hive checking, documentation, feedback, and capacity building, affect environmental, social, and economic sustainability. The research is closing the gap between theory and practice in the literature of the project management field and providing sufficient information to policymakers, practitioners, and researchers interested in sustainable agricultural development.

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APPENDIX A: Instrument: The Focus Group Discussion Guide

(For Beekeepers and Project Stakeholders in Makueni County)

Introduction

Good morning/afternoon. My name is Lorna Magut, and I am conducting a study on monitoring and evaluation practices and the sustainability of beekeeping projects in Makueni County. The purpose of this The Focus Group Discussion Guide is to gather your experiences and views on this topic. Your participation is voluntary, and all responses was kept confidential. There are no right or wrong answers. I would like to record your answers here and, if you agree, also use an audio recorder to ensure accuracy.

Section A: Respondent Profile

1. Age: ___________________________
2. Gender: _________________________
3. Education Level: __________________
4. Years in Beekeeping: _______________
5. Number of Hives: __________________
6. Main Hive Type: ___________________
7. Membership in Beekeeping Group/Cooperative: ______________________

Section B: Data Utilization

1. Can you describe the type of monitoring or production data you receive about your beekeeping project?
2. a. How often do you receive these reports or updates? — ____
3. b. Who provides this information and in what format (written, verbal, digital)? — _________________________
4. c. How do you use this information in your beekeeping activities? — ____________________________________
5. d. Can you give an example where using monitoring data helped you improve hive productivity? — ___________
6. e. Are there any challenges in understanding or using the data? — ______________________________________

Section C: Training Follow-up

1. Tell me about the training you have received through the beekeeping project.
2. a. Were there any follow-up visits after the initial training? — ____
3. b. How often do refresher trainings happen, and what do they cover? — __________________________________
4. c. How has follow-up support affected your ability to apply what you learned? — __________________________
5. d. Can you recall a specific skill or technique from the training that you still use today? — __________________
6. e. Are there areas where you feel you need more training? — ____

Section D: Hive Monitoring

1. How do you monitor or check the condition of your hives?
2. a. How often do you inspect your hives? — ____
3. b. What specific things do you check during inspections (e.g., pests, honey levels, colony strength)? — ______
4. c. Do you keep records of your inspections? If yes, how? — ____
5. d. Have you ever made changes after identifying an issue during inspection? — ___________________________
6. e. Are there challenges that make regular monitoring difficult? — ____

Section E: Feedback Action

1. What happens when you identify a problem and report it to the project or extension officers?

2. a. Who do you report to and how? — ____
3. b. How quickly are problems addressed? — ____
4. c. Have you received feedback on actions taken after you reported an issue? — ____________________
5. d. Can you share an example where your feedback resulted in a change in the project? — ______________
6. e. Do you feel your input is valued by the project implementers? — ____________________________

Section F: Sustainability Outcomes

1. Environmental Sustainability
2. a. How has your hive colonization rate changed in the past year? — ____________________________
3. b. Are there enough flowering plants and water sources for your bees? — ________________________
4. c. How has the local environment affected your beekeeping? — _______________________________
5. Social Sustainability
6. a. How has beekeeping affected your relationship with your family or community? — ________________
7. b. Do you feel more respected or supported because of your beekeeping work? — __________________
8. c. Do you share knowledge with other beekeepers? — ___________________________________
9. Economic Sustainability
10. a. How has your income from beekeeping changed over time? — ______________________________
11. b. Is your income enough to cover beekeeping expenses? — _________________________________

12. c. Do you have reliable markets for your honey and other products? — __________________________________

13. d. Have you tried value addition like making wax or propolis products? — ________________________________

Section G: Closing Question

1. What suggestions do you have for improving the monitoring, training, hive management, or feedback systems in beekeeping projects in Makueni County? — ____

APPENDIX B: Instrument: Key Informant Interview Guide

(*For Project Coordinators, Extension Officers, Donor Representatives, and M&E Specialists in Makueni County*)

Introduction

Good morning/afternoon. My name is Lorna Magut, and I am conducting a study on monitoring and evaluation practices and the sustainability of beekeeping projects in Makueni County. The purpose of this interview is to gather your views and experiences on this topic. Your participation is voluntary, and all responses was kept confidential. There are no right or wrong answers. With your permission, I will take notes and may use an audio recorder to ensure accuracy.

Section A: Respondent Information

1. Designation/Role: __________________________
2. Organization/Institution: ____________________
3. Years of experience with beekeeping projects: _________
4. Nature of involvement (implementation, training, monitoring, evaluation, etc.): __________

Section B: Data Utilization

1. How is data collected from beekeeping projects within the county used in decision-making?
2. In your experience, how frequently do project teams analyze or share collected data with stakeholders?
3. What challenges exist in applying M&E data to guide project adjustments or planning?
4. How can data utilization be improved to enhance the sustainability of beekeeping projects?

Section C: Training Follow-Up

1. How are follow-up activities conducted after initial beekeeper training sessions?
2. What mechanisms are in place to ensure that trained beekeepers retain and apply their skills?
3. In your view, how do refresher training sessions influence project performance and sustainability?
4. What challenges or gaps do you observe in maintaining consistent farmer engagement after training?

Section D: Hive Monitoring

1. What is the current process for monitoring hive performance and colony health in project areas?
2. Who is primarily responsible for conducting regular hive inspections?
3. How are monitoring records maintained and used to inform decision-making?
4. In your opinion, how does regular hive monitoring contribute to environmental and economic sustainability?

Section E: Feedback Action

1. How is feedback from farmers or field staff collected and integrated into project management?
2. Could you provide examples of situations where farmer feedback led to changes in project implementation?
3. What barriers hinder the effective use of feedback in improving project outcomes?
4. How can feedback systems be strengthened to ensure timely response and action?

Section F: Sustainability Outcomes

1. From your perspective, what factors most strongly influence the long-term sustainability of beekeeping projects?
2. How do current M&E practices contribute to (or limit) environmental, social, and economic sustainability?
3. What policy or institutional support mechanisms could strengthen project sustainability in the county?

Section G: Closing

1. What recommendations would you give to improve monitoring and evaluation systems for beekeeping projects in Makueni County?
2. Is there anything else you would like to add regarding project sustainability or M&E practices?

APPENDIX C: Study Area Map

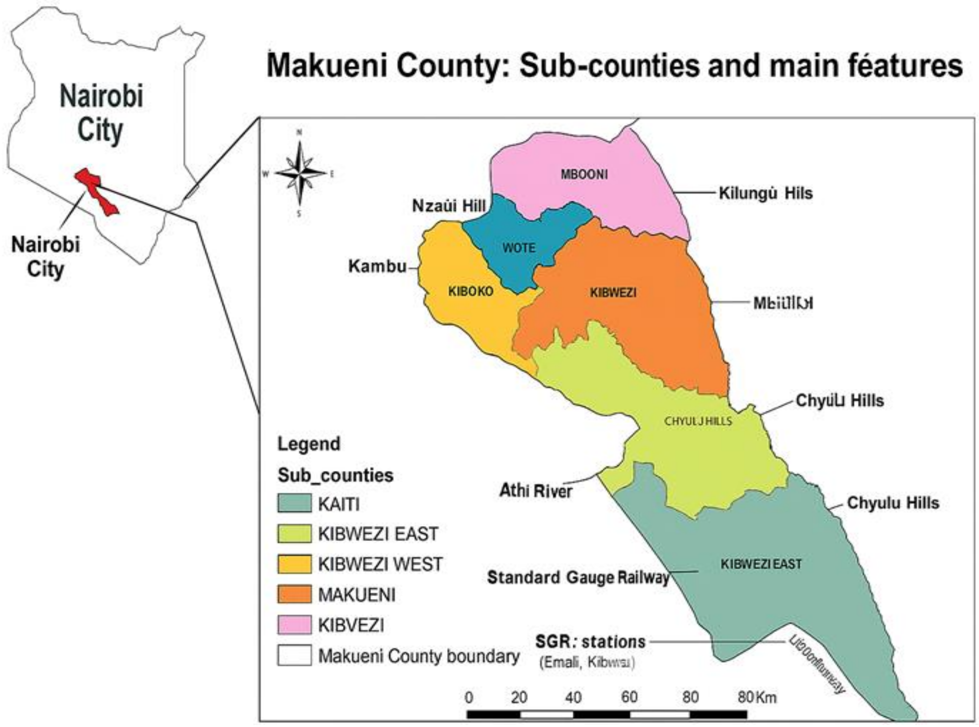

Figure C.1: Study area map

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