Research Article

Volume 2, Issue VII 2026
Page: 01-10
DOI: 10.5281/zenodo.22829275

OPEN ACCESS

Received: 25-08-2026 Accept Date: 08-09-2026 Published: 18-09-2026

HIVE MONITORING PRACTICES AND COLONY PERFORMANCE IN MAKUENI COUNTY, KENYA

BY

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Abstract

Beekeeping is one of the significant livelihood activities in the semi-arid areas of Kenya, contributing to household income, food security, and environmental conservation. However, productivity remains constrained for many beekeepers by low honey production, weak colonies, and colony losses. Drawing on monitoring and control theory from project management, this study assessed hive monitoring practices, namely hive inspection frequency, record keeping, and hive cleaning, and their relationship with colony performance among beekeepers in Makueni County, Kenya. A cross-sectional survey design was adopted, involving 120 active beekeepers selected using stratified random sampling. Data were collected through structured questionnaires and apiary observations. Honey yield, colony strength, and apiary survival were used as measures of colony performance. Data were analyzed using descriptive statistics, correlation analysis, multiple linear regression, and logistic regression. The results showed that more frequent hive inspections were associated with higher honey yield, stronger colonies, and higher apiary survival rates. Consistent record keeping was associated with higher honey yield, while regular hive cleaning was associated with stronger colonies and greater apiary survival. Hive inspection frequency emerged as the most significant predictor of colony performance outcomes among the monitoring practices examined. Beekeepers using Lang troth hives recorded better colony performance outcomes than those using traditional hives. The findings demonstrate that consistent hive monitoring practices can meaningfully improve honey production and colony survival in semi-arid beekeeping systems, offering preliminary evidence that project monitoring and control concepts extend to informal, household-managed livelihood activities, and underscoring the need for beekeeper training and extension support to strengthen the adoption of these practices.

Keywords: Beekeeping, Hive Monitoring, Colony Performance, Honey Yield, Makueni County.

Introduction

In many developing countries, beekeeping is an essential agricultural practice that plays a vital role in the rural economy, food security, environmental protection, and income generation (Bertoni et al., 2025). Apiculture is an important livelihood activity for smallholder farmers, particularly in the arid and semi-arid lands (ASALs) of Kenya, where crop farming is constrained by erratic rainfall and harsh climatic conditions (Perez et al., 2016). In Kenya, Makueni County, located in the semi-arid eastern region, provides favorable conditions for beekeeping because of the increasing adoption of modern beehives, the abundance of acacia species, and other drought-tolerant vegetation (Braga et al., 2021). Consequently, beekeeping has become an important livelihood diversification strategy that enhances household income and resilience among rural communities.

Despite its considerable potential, beekeeping in Makueni County continues to face challenges associated with low honey production, weak colonies, and colony losses, which undermine productivity and the sustainability of apiaries (Mutua et al., 2023). Effective hive monitoring enables beekeepers to assess colony health and productivity, identify emerging problems, implement timely management interventions, and make informed decisions that improve colony performance. In contrast, inadequate monitoring may result in delayed management responses, weakened colonies, and reduced honey production.

Hive monitoring practices refer to the routine management activities undertaken by beekeepers to observe, assess, and maintain the condition of honey bee colonies (Verbeke et al., 2024). The practices examined in this study include hive inspection frequency, record keeping, and hive cleaning. Hive inspection frequency, referred to in project management terms as monitoring intensity, refers to how often a beekeeper opens and examines a hive to assess colony condition and activity (Staszewski, 2025). Record keeping, understood here as information feedback, involves documenting colony activities, honey harvests, hive conditions, and management interventions to facilitate informed decision making (Nganso et al., 2024). Hive cleaning practices, functioning as corrective action, involve maintaining the cleanliness of hives and the surrounding apiary environment to promote colony health, reduce disease risks, and support productivity. These activities parallel the monitoring and control functions central to project management, where routine observation (monitoring intensity), documentation (information feedback), and corrective action are used to track performance against expected outcomes and to trigger timely intervention when performance declines (Kerzner, 2022; PMI, 2021).

This mapping is grounded in monitoring and control theory as codified in the PMBOK Monitoring and Controlling process group, which holds that project performance is regulated through a recurring cycle of observing execution against a baseline, feeding the resulting information back to the responsible party, and initiating corrective or preventive action when a deviation is detected (PMI, 2021; Kerzner, 2022). A smallholder apiary satisfies the minimal conditions under which this cycle can be expected to operate: it is a bounded undertaking with a defined production season, constrained resources, and a measurable output, managed by a single responsible party who both observes performance and acts on what is observed. On this basis, hive inspection functions as the observation step, in which the beekeeper compares the current state of the colony against an implicit expectation of a healthy hive; record keeping functions as the feedback step, in which that observation is captured in a form that can inform subsequent decisions; and hive cleaning functions as the corrective step, taken in response to a perceived decline in hive condition rather than as a fixed routine. Because this cycle has been documented mainly in formally managed development and infrastructure projects, where monitoring is institutionalized through reporting structures and dedicated personnel, it remains an open empirical question whether the same monitoring-performance relationship holds in informal, single-operator livelihood activities that lack any such structure. This study addresses that question directly, using smallholder beekeeping as a setting in which monitoring, feedback, and corrective action occur informally and are enacted by the same individual who depends on the outcome.

Colony performance refers to the measurable outcomes used to evaluate the productivity and overall condition of a honey bee colony. In this study, colony performance is assessed using honey yield, colony strength, and colony survival. Honey yield represents the quantity of honey harvested during a production season. Colony strength reflects the overall health and vitality of a colony based on indicators such as colony population, brood presence, and hive occupancy (Meikle & Holst, 2015). Colony survival, analogous to project continuation in project management terms, refers to the ability of a colony to remain active without collapsing or being abandoned during the production season.

Previous studies have demonstrated that effective hive management and monitoring practices are associated with improved colony productivity and survival among smallholder beekeepers (McMinn-Sauder et al., 2024). Similarly, appropriate hive management practices have been linked to improved colony growth and increased honey yield (Hunor et al., 2024). While monitoring and control theory has been extensively applied to formally managed development and infrastructure projects, comparatively little empirical work has tested whether monitoring intensity predicts performance outcomes in informal, household-managed livelihood activities such as smallholder beekeeping. However, most studies conducted in Kenya have focused on honey production, the adoption of modern hives, or the general constraints affecting beekeeping. Limited empirical evidence exists on how specific hive monitoring practices, including hive inspection, record keeping, and hive cleaning, influence colony performance in semi-arid regions such as Makueni County. Addressing this knowledge gap is important for informing management practices and interventions aimed at improving beekeeping productivity and sustainability.

The objective of this study was to evaluate the level of hive monitoring among beekeepers in Makueni County and determine how hive inspection, record keeping, and hive cleaning practices relate to colony performance in terms of honey yield, colony strength, and colony survival.

Methodology

Study Area

This study was carried out in Makueni County, Kenya, in the eastern semi-arid region of the country between latitude 1°35′ and 3°00′ South and longitude 37°10′ and 38°30′ East. The county experiences low and erratic rainfall, relatively high temperatures, and prolonged dry seasons that influence agricultural activities and rural livelihoods. Despite these climatic conditions, Makueni County has favorable bee forage resources, including acacia species and other flowering plants. Beekeeping is widely promoted in the county because it requires relatively less land and water than crop farming, making it an important alternative livelihood for rural households.

Study Design

The study adopted a cross-sectional survey design supported by apiary assessment. The design enabled the collection of information on hive monitoring practices and colony performance outcomes from beekeepers at a single point in time. It also facilitated the examination of the relationship between hive monitoring practices and colony performance.

Study Population and Sampling

The population in the study included active beekeepers who had their apiaries in the selected areas of Makueni County. The unit of analysis was the beekeeper and the apiaries involved. Active beekeepers were those who kept at least one active honey bee colony during the previous production season. Stratified random sampling was employed to ensure representation of beekeepers across the production zones of the county. The strata were grouped according to selected sub-counties: Makueni, Kibwezi East, Kibwezi West, and Kaiti. Simple random sampling was then used within each stratum to select respondents.

The target population consisted of 171 registered active beekeepers obtained from records maintained by county agricultural extension offices and local beekeeper associations within the selected sub-counties. The sample size was 120 beekeepers and was determined using Yamane's formula, $n = N / [1 + N(e^2)]$, where n represents the sample size, N represents the target population, and e represents the margin of error set at 5%. Substituting the study values into the formula gave $n = 171 / [1 + 171(0.05^2)] = 171 / [1 + 171(0.0025)] = 171 / 1.4275 = 119.75$, which was rounded to 120 respondents. Only beekeepers with active colonies during the previous production season were included in the study. Beekeepers without active colonies and inactive apiaries were excluded from the study.

Pilot Testing, Reliability, and Validity

Prior to data collection, a pilot test was conducted with 10 beekeepers from a different sub-county within the study area to assess the clarity, relevance, and consistency of the research instruments. The findings from the pilot study informed revisions to the questionnaire before the main data collection exercise. Reliability was assessed using Cronbach's alpha coefficient, with an alpha value greater than 0.70 considered acceptable for internal consistency. Content validity was established through expert review by specialists in apiculture and agricultural research.

Data Collection

Structured interviewer-administered questionnaires were used to collect primary data from selected beekeepers between May and August 2025. The questionnaires gathered information on hive monitoring practices, including hive inspection frequency, record keeping, and hive cleaning. In addition, the researcher conducted apiary inspections to verify selected management practices and assess colony condition.

Colony strength was evaluated using observable colony characteristics, including colony population, brood presence, and hive occupancy. Each indicator was rated on a scale of one to five, where five represented the best colony condition and one represented the poorest condition. A composite colony strength score ranging from one to five was calculated as the average of the three component scores.

Standardized observation procedures were followed throughout the field assessments to ensure consistency across apiaries. Honey yield was measured in kilograms using beekeeper reports and verified with available production records from the previous production season where such records existed.

Study Variables

The independent variables were hive monitoring practices, namely hive inspection frequency, record keeping practices, and hive cleaning practices. Hive inspection frequency was measured as an ordinal variable coded as rarely = 1, monthly = 2, biweekly = 3, and weekly = 4. Record keeping and hive cleaning practices were also treated as ordinal variables and coded as 1 for no practice, 2 for occasional practice, and 3 for consistent or regular practice.

The dependent variables were colony performance outcomes, namely honey yield, colony strength, and colony survival during the previous production season. Colony strength was measured as a continuous composite score based on colony population, brood presence, and hive occupancy. Colony survival was determined by the presence of active colonies throughout the production season or whether colonies had collapsed or been abandoned. Apiaries with surviving colonies at the end of the production season were coded as 1, whereas apiaries that failed to survive or were abandoned were coded as 0. To account for the possibility that hive type and beekeeper experience could influence colony performance outcomes, these variables were included as control variables in the regression models. Traditional hives served as the reference category for the dummy variables representing hive type.

Data Analysis

The collected data were cleaned, coded, and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Hive monitoring practices and colony performance outcomes were summarized using descriptive statistics, including frequencies, percentages, means, and standard deviations. Relationships between hive monitoring practices and colony performance outcomes were examined using correlation analysis. Multiple linear regression analysis was used to determine the association between the independent variables and the continuous outcome variables, namely honey yield and colony strength. Logistic regression analysis was performed to determine the relationship between the independent variables and colony survival during the previous production season.

Categorical predictors were coded before estimating the regression models. Ordinal variables were assigned ordered numerical codes, while dummy variables with predetermined reference categories were created for nominal variables such as hive type. Diagnostic tests were performed before regression analysis to verify model assumptions. The normality of continuous variables was assessed using histograms and the Shapiro-Wilk test, while multicollinearity among predictor variables was evaluated using variance inflation factors (VIF). The goodness of fit of the logistic regression model was assessed using the Hosmer-Lemeshow test. Statistical significance was evaluated at the 0.05 level.

Ethical Considerations

The study adhered to established ethical standards throughout the research process. Before data collection, the purpose and procedures of the study were explained to all participants, and informed consent was obtained from each respondent. Participation was voluntary, and respondents were informed of their right to withdraw from the study at any stage without penalty. All personal and farm-level information was anonymized to ensure confidentiality during analysis and reporting. Ethical approval for the study was obtained from CUEA Institutional Review Board before commencement of data collection.

Results

Hive Monitoring Practices Among Beekeepers

Table 1: Socio-management characteristics and hive monitoring practices among beekeepers (N = 120)

Variable	Category	Frequency	Percentage (%)
Beekeeper experience	< 3 years	26	21.7

Variable	Category	Frequency	Percentage (%)
	3–5 years	48	40.0
	> 5 years	46	38.3
Hive type used	Traditional hives	31	25.8
	Lang troth hives	57	47.5
	Kenya Top Bar hives	32	26.7
Hive inspection frequency	Weekly	29	24.2
	Biweekly	45	37.5
	Monthly	33	27.5
	Rarely	13	10.8
Record keeping practices	Consistent records	49	40.8
	Occasional records	37	30.8
	No records	34	28.4
Hive cleaning practices	Regular cleaning	71	59.2
	Occasional cleaning	36	30.0
	No regular cleaning	13	10.8

Table 1 shows that the majority of beekeepers (40.0%) had three to five years of experience, and most (47.5%) kept Lang troth hives. Hive inspections, or monitoring intensity, occurred most frequently (37.5%) on a biweekly basis, while 40.8% of beekeepers maintained consistent records (information feedback) and 59.2% practiced regular hive cleaning (corrective action). These findings indicate a moderate level of adoption of recommended hive management practices among beekeepers in Makueni County.

Honey Yield by Hive Inspection Frequency

Figure 1: Mean Honey Yield by Hive Inspection Frequency

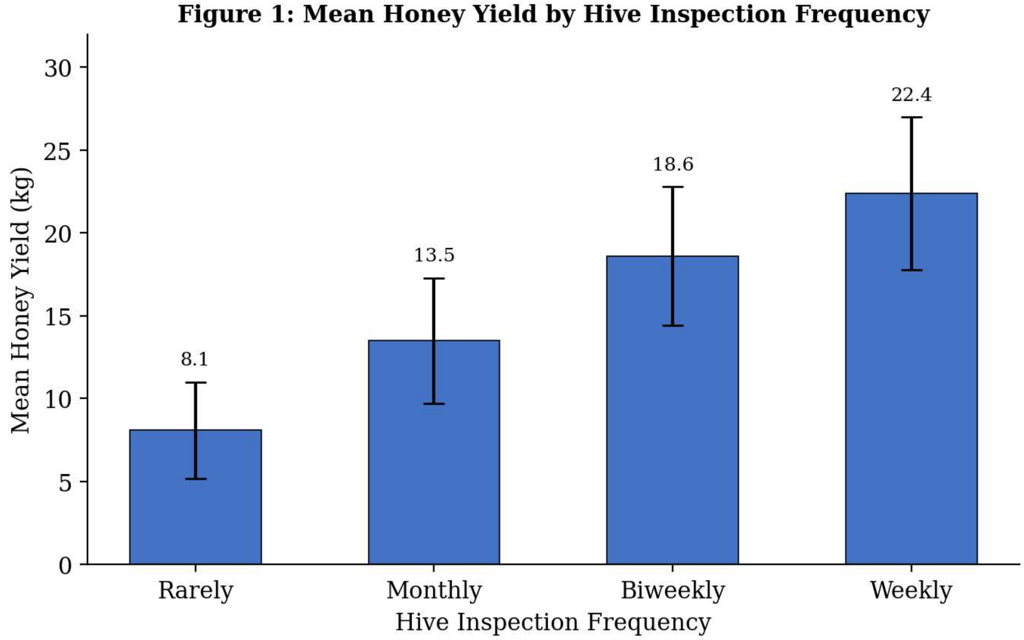

Figure 1 shows that mean honey yield increased consistently with the frequency of hive inspection, that is, with monitoring intensity. Beekeepers who inspected their hives weekly recorded the highest mean honey yield (22.4 kg), followed by those who inspected biweekly (18.6 kg) and monthly (13.5 kg), while beekeepers who rarely inspected their hives recorded the lowest mean honey yield (8.1 kg). Corresponding colony strength scores and apiary survival rates followed the same pattern, rising from 2.6 and 53.8%, respectively, among beekeepers who rarely inspected their hives, to 4.3 and 93.1% among those who inspected weekly. These results indicate a positive association between hive inspection frequency and colony performance outcomes.

Colony Performance Outcomes by Hive Type

Table 2: Colony performance outcomes by hive type

Hive Type	Mean Honey Yield (kg)	SD (Yield)	Mean Colony Strength Score	Apiary Survival (%)
Traditional hives	10.8	3.4	2.9	64.2
Kenya Top Bar hives	15.6	4.1	3.7	79.4
Langstroth hives	21.3	5.3	4.2	88.1

Table 2 shows that Langstroth hives recorded the highest mean honey yield (21.3 kg), colony strength score (4.2), and apiary survival rate (88.1%). Kenya Top Bar hives recorded intermediate performance, while traditional hives recorded the lowest performance across all three indicators.

Figure 2: Comparison of Colony Performance Outcomes by Hive Type

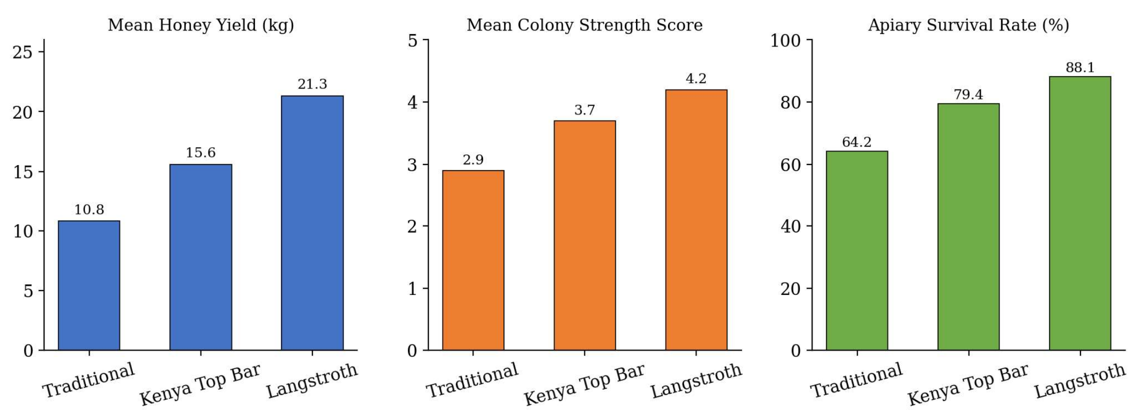

Figure 2 illustrates the differences in colony performance outcomes across the three hive types. Langstroth hives consistently outperformed Kenya Top Bar and traditional hives on all three indicators, while traditional hives recorded the lowest honey yield, colony strength, and apiary survival. These results suggest that colony productivity and survival were higher among beekeepers using modern hive technologies.

Factors Associated with Colony Performance Outcomes

Table 3: Correlation matrix for hive monitoring practices and colony performance outcomes

Variable	Honey Yield	Colony Strength	Apiary Survival
Hive inspection frequency	0.64**	0.59**	0.53**
Record keeping practices	0.48**	0.41**	0.36*
Hive cleaning practices	0.44**	0.46**	0.33*
Beekeeper experience	0.29*	0.26*	0.24*

**p < 0.05; **p < 0.01.*

Table 3 shows the correlation matrix for hive monitoring practices, beekeeper experience, and colony performance outcomes. Hive inspection frequency (monitoring intensity) exhibited the strongest positive correlation with honey yield, colony strength, and apiary survival. Record keeping (information feedback) and hive cleaning practices (corrective action) were also positively and significantly correlated with all three colony performance outcomes, while beekeeper experience showed weaker, though still significant, positive correlations with colony performance outcomes.

Table 4: Multiple linear regression results for honey yield and colony strength

Predictor Variable	Honey Yield β	p-value	Colony Strength β	p-value
Hive inspection frequency	0.46	0.001	0.41	0.002
Record keeping practices	0.29	0.013	0.24	0.021
Hive cleaning practices	0.26	0.018	0.31	0.010
Beekeeper experience	0.15	0.089	0.13	0.102
Kenya Top Bar hive use	0.22	0.017	0.25	0.014
Langstroth hive use	0.34	0.006	0.37	0.004

Model statistics: Honey yield model: $R^2 = 0.58$, $F = 19.86$, $p < 0.001$. Colony strength model: $R^2 = 0.52$, $F = 17.03$, $p < 0.001$.

Table 4 shows that hive inspection frequency (monitoring intensity) was the strongest predictor of honey yield ($\beta = 0.46$, $p = 0.001$) and colony strength ($\beta = 0.41$, $p = 0.002$). Record keeping (information feedback) and hive cleaning practices (corrective action) also significantly predicted honey yield and colony strength, whereas beekeeper experience was not a statistically significant predictor of either outcome. Use of Kenya Top Bar and Langstroth hives significantly predicted higher honey yield and colony strength relative to traditional hives, with Langstroth hive use showing the largest effect. The honey yield model explained 58% of the variance in honey yield, while the colony strength model explained 52% of the variance in colony strength.

Table 5: Logistic regression results for apiary survival status during the previous production season

Predictor Variable	Odds Ratio	95% CI	p-value
Hive inspection frequency	2.58	1.42–4.71	0.002
Record keeping practices	1.84	1.09–3.12	0.019
Hive cleaning practices	1.67	1.01–2.76	0.031
Beekeeper experience	1.21	0.86–1.71	0.271
Kenya Top Bar hive use	1.63	0.89–2.97	0.084
Langstroth hive use	2.91	1.44–5.86	0.004

Reference category for hive type: Traditional hives.

Table 5 shows that hive inspection frequency (monitoring intensity), record keeping (information feedback), and hive cleaning practices (corrective action) were all significant predictors of apiary survival, that is, project continuation, with monitoring intensity showing the largest effect ($OR = 2.58$, $p = 0.002$). Beekeeper experience was not a statistically significant predictor of apiary survival. Langstroth hive use significantly increased the odds of apiary survival relative to traditional hives ($OR = 2.91$, $p = 0.004$), while Kenya Top Bar hive use showed a positive but non-significant effect. The Hosmer-Lemeshow test indicated an adequate model fit ($\chi^2 = 6.42$, $p = 0.491$), confirming that the logistic regression model was appropriate for the data.

Discussion

The study examined hive monitoring practices and colony performance outcomes among beekeepers in Makueni County. The findings showed that hive monitoring practices varied among beekeepers, with most respondents conducting hive inspections, or monitoring intensity, biweekly (37.5%), while 40.8% maintained consistent production records (information feedback) and 59.2% practiced regular hive cleaning (corrective action). These findings suggest moderate adoption of recommended hive management practices among beekeepers within the study area. The variation in monitoring practices may explain differences observed in colony performance outcomes across apiaries.

The study established a significant relationship between hive monitoring practices and colony performance outcomes. Beekeepers with high monitoring intensity, that is, those who conducted weekly hive inspections, recorded the highest mean honey yield (22.4 kg), while those with low monitoring intensity, who rarely inspected their hives, recorded the lowest mean honey yield (8.1 kg). Correlation analysis further showed that monitoring intensity had strong positive relationships with honey yield ($r = 0.64$, $p < 0.01$), colony strength ($r = 0.59$, $p < 0.01$), and apiary survival ($r = 0.53$, $p < 0.01$). Multiple linear regression analysis also showed that monitoring intensity significantly predicted honey yield ($\beta = 0.46$, $p = 0.001$) and colony strength ($\beta = 0.41$, $p = 0.002$), while logistic regression results showed that higher monitoring intensity significantly increased the likelihood of apiary survival, or project continuation (OR = 2.58, $p = 0.002$). These findings indicate that regular hive monitoring may support timely colony management and improved colony productivity. This pattern is consistent with, though not a direct test of, project management evidence that monitoring intensity is positively associated with performance outcomes, as more frequent observation allows problems to be identified and corrected before they compound (Kerzner, 2022).

Record keeping practices (information feedback) and hive cleaning practices (corrective action) were also positively associated with colony performance outcomes. Beekeepers who maintained consistent records and practiced regular hive cleaning generally reported higher honey yields and stronger colonies compared to those who did not. Regression analysis showed that information feedback significantly predicted honey yield ($\beta = 0.29$, $p = 0.013$) and colony strength ($\beta = 0.24$, $p = 0.021$), while corrective action significantly influenced honey yield ($\beta = 0.26$, $p = 0.018$) and colony strength ($\beta = 0.31$, $p = 0.010$). These findings suggest that proper hive management practices contribute to improved colony condition and productivity within semi-arid beekeeping systems. Consistent record keeping in particular reflects the role of information feedback in project control cycles, where documentation enables timely, evidence-based decision making rather than reactive management (PMI, 2021). This parallels findings from formally managed development and infrastructure projects, where the presence of a functioning feedback mechanism, rather than monitoring activity alone, is what allows a detected deviation to be translated into a corrective response (Kerzner, 2022); the present results suggest that this same feedback-to-correction link operates even when record keeping is informal and unstructured, as in a smallholder apiary.

The study also found differences in colony performance outcomes across hive types. Langstroth hives recorded the highest mean honey yield (21.3 kg), colony strength score (4.2), and apiary survival rate (88.1%), compared to traditional hives, which recorded lower performance outcomes. Regression analysis showed that Langstroth hive use significantly predicted honey yield ($\beta = 0.34$, $p = 0.006$) and colony strength ($\beta = 0.37$, $p = 0.004$), while logistic regression analysis showed that use of Langstroth hives significantly increased the likelihood of apiary survival (OR = 2.91, $p = 0.004$). These findings suggest that improved hive technologies may enhance colony management efficiency and productivity.

The findings of the study are consistent with previous studies that reported positive relationships between hive management practices and colony productivity among smallholder beekeepers. Previous studies by Hunor et al. (2024) and Ithau& Mwania (2023) similarly reported that frequent hive inspections and proper colony management practices improved honey production and colony survival. The findings also align with Meikle & Holst (2015), who identified colony population, brood presence, and hive occupancy as key indicators of colony strength and productivity. The observed superiority of Langstroth hives in colony productivity is also consistent with studies reporting improved productivity among beekeepers using modern hive technologies.

Implications

The study results have significant implications for beekeeping development, extension, and agricultural policy in semi-arid regions like Makueni County. Extension officers and apiculture development programs should therefore focus on capacity-building activities that encourage good hive management practices, particularly frequent hive inspection, consistent record keeping, and regular hive cleaning, among smallholder beekeepers. In addition, greater access to improved hive technologies could enhance the productivity and profitability of beekeepers, given the superior performance of Langstroth hives observed in this study.

Limitations

The cross-sectional design limited the ability to establish causal relationships between the study variables. In addition, some information on apiary survival and honey yield relied on beekeeper recall and records from the previous production season, which may have introduced recall bias. A further limitation concerns the scope of the project management interpretation offered in this study. The mapping of hive inspection, record keeping, and hive cleaning onto monitoring intensity, information feedback, and corrective action is analogical rather than derived from validated project management measurement instruments, and the sample is drawn from a single, informal livelihood activity within one county. The project management conclusions drawn here should therefore be read as exploratory evidence that an established project management framework can be meaningfully applied to informal, household-managed activities, not as a generalizable test of monitoring and control theory across project types or contexts. Future research could strengthen this line of inquiry by applying validated project monitoring and control instruments, by comparing informal livelihood activities against formally managed projects within the same study, or by extending the analysis to other informal, resource-constrained settings to assess whether the observed relationships hold more broadly. Nevertheless, the study provides useful evidence on the role of hive monitoring practices in influencing colony performance outcomes among beekeepers in semi-arid regions.

Conclusion

The study concludes that hive monitoring practices, understood as a form of project monitoring and control, are important determinants of colony performance among beekeepers in Makueni County, offering preliminary, analogical evidence consistent with monitoring and control theory in an informal, resource-constrained project setting. Overall, better hive monitoring practices, particularly higher monitoring intensity, stronger information feedback, and consistent corrective action, were associated with improved honey yield, stronger colonies, and higher apiary survival, or project continuation. Additionally, beekeepers using improved hive technologies such as Langstroth hives recorded superior colony performance compared to those using traditional hives. These findings demonstrate that consistent hive monitoring practices play a central role in supporting colony productivity and survival in semi-arid beekeeping systems. Future studies should apply longitudinal designs to better establish causal relationships between hive monitoring practices and colony performance over time.

Acknowledgements

The author acknowledges the support received from the Catholic University of Eastern Africa and extends sincere appreciation to all respondents who participated in the study, as well as individuals who provided assistance during data collection and fieldwork.

Funding

This research received no external funding.

Conflict of Interest

The author declares no conflict of interest.

Author Contributions

Lorna Magut was responsible for conceptualization, methodology, data collection, data analysis, and manuscript writing.

Data Availability

The data that support the findings of this study are available from the author upon reasonable request.

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