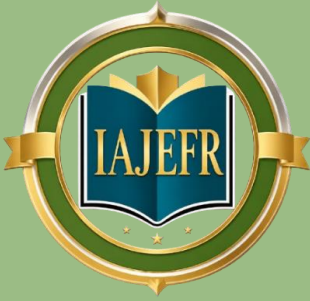




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SMALLHOLDER FARMERS IN TANA RIVER COUNTY, KENYA**

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Abstract:

Purpose of the Study: This study examined the effect of crop management practices on household welfare among smallholder farmers in Tana River County, Kenya. Specifically, it assessed whether adoption of improved crop management practices enhances household food security and welfare among households registered under the Kenya Climate Smart Agriculture Project (KCSAP).

Methodology: The study adopted a cross-sectional analytical research design using a quantitative approach. A multistage sampling technique selected 356 households from a target population of 4,850 KCSAP-registered households. Primary data were collected using structured questionnaires and analyzed using descriptive statistics, Pearson correlation, and simple linear regression in SPSS Version 29.

Findings: Out of the 356 questionnaires administered, 338 were returned, yielding a 94.9% response rate. Descriptive findings indicated a high adoption of crop management practices, including improved seed varieties, crop rotation, intercropping, and pest and disease control, alongside moderate household food security. Crop management practices exhibited a strong positive and statistically significant relationship with household welfare ($r = 0.684$, $p < 0.01$). Regression analysis revealed that crop management accounted for 46.8% of the variation in household welfare ($R^2 = 0.468$, $F(1,336) = 295.60$, $p < 0.001$), demonstrating that improved crop management significantly enhances household welfare among smallholder farmers.

Conclusion: The study concludes that crop management practices significantly improve household welfare among smallholder farmers in Tana River County. Strengthening agricultural extension services, promoting certified climate-resilient seed varieties, and enhancing farmer training on integrated crop management can improve household food security and support sustainable rural livelihoods in the county.

Keywords: *Crop management; Household welfare; Smallholder farmers; Food security*

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1.0 INTRODUCTION

1.1 Background of the Study

Crop management refers to the deliberate set of agronomic decisions and practices, ranging from seed selection, planting arrangement and rotation to pest, disease and post-harvest handling, that farmers apply to raise productivity and stabilise output under variable growing conditions (Kananu et al., 2023). Among smallholder farmers in sub-Saharan Africa, where over 80% of farms are below two hectares and rainfall is increasingly erratic, the manner in which crops are managed on the available land has a direct bearing on household food availability, dietary quality and disposable income (Frempong et al., 2023). Household welfare, commonly proxied by indicators of food security such as dietary diversity, meal adequacy and the ability to access sufficient food throughout the year, is therefore closely tied to the crop management choices that farming households make each season.

Kenya's arid and semi-arid lands (ASALs), which cover about 80% of the country's landmass and are home to a substantial share of its population, are particularly exposed to this relationship. Tana River County, an ASAL county in the Lower Eastern region, experiences bimodal but unreliable rainfall, recurrent dry spells and limited irrigation infrastructure, conditions under which the choice of seed varieties, cropping patterns and pest management approaches can mean the difference between a harvest that sustains a household and one that does not. Government and development-partner programmes, including the Kenya Climate Smart Agriculture Project (KCSAP), have consequently prioritised the promotion of improved crop management practices in counties such as Tana River as a pathway to strengthening household welfare and resilience to climate variability.

1.1.1 Global Perspective

Globally, the management of cropping systems has evolved into a formal component of agricultural policy rather than an informal farm-level decision. In the European Union, crop diversification and rotation are embedded in the Common Agricultural Policy (CAP) 2023-2027 through the Good Agricultural and Environmental Condition 7 (GAEC 7) standard, which requires farms above a defined arable-land threshold to rotate crops as a condition for receiving direct payments, reflecting an official recognition that cropping decisions affect soil productivity, farm income stability and, ultimately, food supply reliability (European Commission, 2023). Complementing this policy architecture, field-level evidence from Finland shows that structured crop rotation measurably improves both yield outcomes and pest suppression: a multi-year experiment on spring wheat under different tillage systems found that rotated fields produced significantly higher yields and lower pest incidence than continuously cropped fields, underscoring



that even in a high-input, mechanised farming context, the sequencing of crops on a given plot remains a determinant of productivity (Jalli et al., 2021).

In Asia, where landholdings are typically small and fragmented, crop management is similarly linked to household-level welfare rather than purely to farm profitability. In Manipur, India, a study using the Heckman sample selection model found that households that diversified their cropping enterprises, rather than depending on a single staple, achieved measurably better household food security, with the extent of diversification, non-farm income and household size shaping the strength of this relationship (Aheibam et al., 2023). Collectively, the European and Indian experiences illustrate that whether in a subsidy-driven commercial farming system or a smallholder subsistence system, deliberate crop management choices, rotation, diversification and locally adapted varietal selection, consistently translate into more stable production and improved household-level food outcomes, providing a global evidence base against which the Kenyan experience can be situated.

1.1.2 Regional Perspective

Within Africa, the link between crop management and household welfare has been documented most extensively in West and Southern Africa. In northern Ghana, panel data collected from more than 2,500 households across 49 villages showed that greater crop diversity was positively associated with improved dietary diversity, reduced incidence of hunger, lower food expenditure and higher consumption of home-grown produce, demonstrating that diversified cropping functions as a household-level risk-management and nutrition strategy in a rain-fed farming environment comparable to that of Lower Eastern Kenya (Frempong et al., 2023). Ghana's experience is instructive because it combines relatively favourable natural resource endowment with persistent regional disparities in hunger and poverty, mirroring the intra-country welfare gaps observed between high- and low-potential agricultural counties in Kenya.

In Southern Africa, evidence from Mpumalanga Province, South Africa, shows that smallholder maize farmers who adopted conservation-agriculture-aligned crop management practices, specifically minimum tillage and crop diversification, realised significantly higher household income than non-adopters, with the combination of both practices generating the largest welfare gain (Oduniyi et al., 2022). This finding is significant because it isolates crop management, as distinct from input subsidies or market access, as an independent driver of household welfare even in a middle-income agricultural economy with better-resourced extension services than Kenya's ASAL counties. Taken together, the West and Southern African evidence indicates a consistent regional pattern: households that actively manage their cropping systems, rather than relying on a single crop and conventional tillage, are measurably better off, a pattern that provides the



immediate regional backdrop against which Kenya's own experience, and that of Tana River County specifically, can be understood.

1.1.3 Local Perspective

In Kenya, the welfare implications of crop management have been most rigorously demonstrated in the Nyando Basin, where the adoption of stress-tolerant varieties of maize, beans, cowpea, pigeon pea and sorghum within climate-smart villages improved household dietary diversity by 40% and reduced food insufficiency by 75% relative to non-adopting households (Radeny et al., 2022). A separate study among smallholder coffee farmers in Kirinyaga County found that higher crop diversification, achieved through varietal diversity, intercropping and rotation, was significantly associated with a more favourable household food consumption category, even though coffee farmers derive most of their cash income from a single export crop (Kananu et al., 2023). These two studies, drawn from a high-potential county and a climate-vulnerable basin respectively, indicate that the welfare-enhancing effect of crop management holds across Kenya's diverse agro-ecological zones.

Tana River County presents a more constrained version of this same challenge. The county's economy is predominantly agro-pastoral, rainfall is bimodal but unreliable, and access to certified seed, extension services and post-harvest facilities remains limited compared with higher-potential counties such as Kirinyaga or those within the Nyando Basin. Under the Kenya Climate Smart Agriculture Project, smallholder households in Bura, Galole and Garsen constituencies have been introduced to improved seed varieties, crop rotation, intercropping and integrated pest and disease control as a deliberate strategy for strengthening household food security. However, county-specific empirical evidence on whether, and to what extent, these crop management practices are translating into measurable household welfare gains in Tana River County remains scarce, a gap that this study sought to address.

1.2 Statement of the Problem

Household welfare in Tana River County remains persistently fragile, with recurrent drought cycles, erratic rainfall and limited irrigation infrastructure exposing smallholder farming households to seasonal food shortages and low dietary diversity. Although the Kenya Climate Smart Agriculture Project and related county interventions have promoted improved crop management practices, including certified drought-tolerant seed varieties, crop rotation, intercropping and integrated pest and disease control, as a pathway to strengthening household food security, the extent to which these practices are actually associated with improved household welfare outcomes in the county has not been sufficiently established empirically.



Existing Kenyan evidence on crop management and household welfare is concentrated in comparatively higher-potential and better-resourced areas. Studies in the Nyando Basin (Radeny et al., 2022) and Kirinyaga County (Kananu et al., 2023) have demonstrated strong positive associations between crop management practices and household food security, but these findings cannot be generalised to Tana River County given its distinct agro-ecological constraints, weaker market access and lower extension service density. Broader sub-Saharan African evidence from Ghana (Frempong et al., 2023) and South Africa (Oduniyi et al., 2022) similarly confirms the welfare-enhancing potential of crop management, yet these studies are drawn from farming systems that differ markedly from the agro-pastoral, drought-prone context of Lower Eastern Kenya.

Consequently, county administrators, agricultural extension officers and development partners implementing KCSAP-related interventions in Tana River County currently lack context-specific, quantitatively grounded evidence on the relationship between crop management practices and household welfare. Without such evidence, it is difficult to justify continued or expanded investment in specific crop management interventions, or to identify which practices most effectively translate into improved household food security within the county's unique operating environment. This study therefore sought to determine the effect of crop management practices on household welfare among smallholder farmers in Tana River County, Kenya, addressing this contextual and empirical gap.

1.3 Purpose of the Study

The purpose of the study was to determine the effect of crop management practices on household welfare among smallholder farmers in Tana River County, Kenya.

1.4 Research Hypothesis

H01: Crop management practices do not significantly influence household welfare among smallholder farmers in Tana River County, Kenya.

2.0 LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Sustainable Livelihoods Theory

The Sustainable Livelihoods Approach (SLA), developed by Scoones (1998) and subsequently elaborated by development practitioners including Serrat (2017), provides the theoretical anchor for this study. The framework is concerned with how individuals and households build, sustain and enhance their livelihoods within a given social and environmental setting. It identifies human,



social, natural, physical and financial capital as the set of livelihood assets available to a household, all of which shape the strategies a household can pursue and the outcomes it can realise. These assets exist within a broader context of vulnerability, comprising external shocks such as drought, erratic rainfall and crop failure, that can substantially undermine livelihood sustainability irrespective of a household's asset base.

The theory further posits that improved welfare and reduced vulnerability are achieved through the effective deployment and combination of available livelihood assets, with households understood as active agents capable of organising their resources to withstand shocks and improve their standard of living. This framing is directly applicable to the present study because it offers a structured lens through which to analyse the relationship between crop management, understood here as a strategy for deploying natural and human capital, seed choice, land, labour and agronomic knowledge, and household welfare among smallholder farmers in Tana River County. Specifically, the theory guides the evaluation of how crop management practices strengthen a household's asset base, buffer it against climate-related shocks such as drought and erratic rainfall, and ultimately translate into improved food security outcomes (Serrat, 2017). A key strength of the Sustainable Livelihoods Theory is its holistic character: it accommodates multiple, interacting dimensions of livelihood assets while explicitly recognising external vulnerability, and it foregrounds household agency in strategic decision-making, making it well suited to explaining why household welfare outcomes vary even among farmers exposed to similar climatic conditions.

2.2 Empirical Review

Crop Management and Household Welfare

Radeny, Rao, Ogada, Recha and Solomon (2022) examined the impact of climate-smart crop varieties and livestock breeds on the food security of smallholder farmers within climate-smart villages in the Nyando Basin, Kenya. The study combined propensity score matching with an endogenous treatment effect model applied to household-level survey data, with the adoption of stress-tolerant crop varieties, including maize, beans, cowpea, pigeon pea and sorghum, as the key independent variable and household dietary diversity score and food insufficiency as the outcome measures. The results showed that adopting households recorded a 40% improvement in dietary diversity and a 75% reduction in food insufficiency relative to non-adopters. While methodologically robust in addressing selection bias, the study's reliance on a single climate-smart-village setting limits its generalisability to counties such as Tana River, where institutional support for climate-smart agriculture is comparatively less established, and its cross-sectional design restricts insight into whether these welfare gains are sustained over successive seasons.

In a related Kenyan context, Kananu, Kingori and Muriithi (2023) investigated the effect of crop diversification on household food security among smallholder coffee farmers in Kirinyaga County.



Using a descriptive design and structured household questionnaires administered to a sample of 408 farmers selected through multistage sampling, the study constructed a crop diversification index and a food consumption score, then applied a multinomial logistic model to estimate the influence of landscape heterogeneity, crop varietal diversity, intercropping and crop rotation on the probability of a household falling into a more food-secure consumption category. The findings indicated that intercropping and crop species diversity were the strongest predictors of improved food consumption scores, although more than half of sampled households still experienced at least one month of seasonal food insecurity annually. The study's focus on a single cash crop system, coffee, and its associated agro-ecological zones limits direct comparison with the more agro-pastoral, drought-prone farming systems characteristic of Tana River County.

Beyond Kenya, Frempong, Gross and Owusu (2023) analysed the effect of crop diversity on food scarcity, dietary diversity and the sale and consumption of own-produced crops among 2,553 farm households across 49 villages in northern Ghana, using panel data collected in 2015 and 2018 and a fixed-effects modelling approach. The study found that greater crop diversity was consistently associated with better dietary diversity, reduced hunger incidence, lower food expenditure and higher consumption of home-grown produce. Although the panel design strengthens causal inference relative to purely cross-sectional studies, the West African rainfall and market context differs sufficiently from Lower Eastern Kenya that the magnitude of the observed effects may not transfer directly to the Tana River setting.

Similarly, Oduniyi, Chagwiza and Wade (2022) used a multinomial endogenous switching regression model on cross-sectional data from smallholder maize farmers in Mpumalanga Province, South Africa, to estimate the income effects of adopting minimum tillage, crop diversification, and a combination of the two as conservation-agriculture-aligned crop management practices. The study found that farmers who adopted both practices jointly realised the largest income gain, of over 60%, relative to non-adopters. While the study offers strong evidence that crop management practices independently raise household income even without accompanying input subsidies, its South African setting, characterised by comparatively stronger market infrastructure and extension coverage than Tana River County, again raises questions about the direct transferability of the magnitude of these effects to the Kenyan ASAL context.

Taken together, this body of empirical evidence consistently demonstrates that crop management practices, whether framed as stress-tolerant varietal adoption, crop diversification, intercropping or conservation-agriculture-aligned practices, are positively and often substantially associated with improved household welfare, measured variously through dietary diversity, food consumption scores, food insufficiency or household income. However, three gaps recur across the reviewed studies. First, none was conducted in an agro-pastoral, drought-prone ASAL setting comparable to Tana River County, leaving open the question of whether the welfare-enhancing effect of crop



management holds under more severe resource and climatic constraints. Second, most studies rely on cross-sectional designs, limiting insight into whether observed welfare gains are sustained across seasons. Third, county-specific quantitative evidence linking crop management practices to household welfare in Tana River County itself remains absent from the literature, which is the specific gap this study addresses.

2.3 Conceptual Framework

A conceptual framework outlines key variables and their presumed relationships, providing a basis for interpreting findings against study objectives (West et al., 2020). Crop management practices constitute the independent variable, while household welfare operationalised through food security indicators forms the dependent variable. The framework positions crop management as the focal predictor, acknowledging that smallholders in Tana River County implement these practices alongside soil, water, and livestock management within the climate-smart agriculture system, jointly shaping household welfare outcomes.

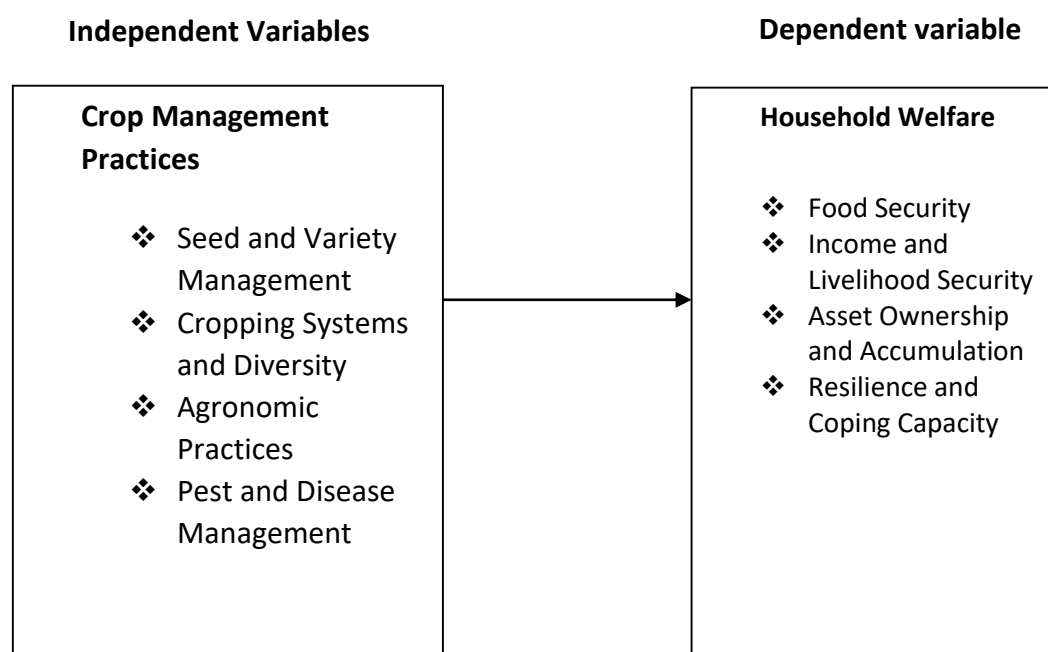


Figure 1: Conceptual Framework

Source: Researcher (2025)



3.0 RESEARCH METHODOLOGY

The study employed a cross-sectional analytical research design using a quantitative approach. The target population comprised 4,850 smallholder farming households registered under the Kenya Climate Smart Agriculture Project (KCSAP), with household heads or principal agricultural decision-makers serving as respondents. A multistage sampling technique was applied to select 356 households from Bura, Galole and Garsen constituencies. Primary data were collected using a structured questionnaire containing predominantly five-point Likert-scale items measuring crop management, soil management, water management, livestock management, capacity building and household welfare indicators. Completed questionnaires were coded, cleaned and analysed using SPSS Version 29. Descriptive statistics, including frequencies, percentages, means and standard deviations, summarised respondent characteristics and study variables. Pearson correlation analysis examined the relationship between crop management and household welfare, while simple linear regression determined the effect of crop management on household welfare at a 5% level of significance.

4.0 RESEARCH FINDINGS AND DISCUSSION

4.1 Response Rate

Out of the 356 questionnaires that were administered to the sampled household heads and principal agricultural decision-makers in Bura, Galole and Garsen constituencies, 338 were duly completed and returned, giving a response rate of 94.9%, as presented in Table 4.1.

Table 1: Response Rate

Category	Frequency	Percentage (%)
Questionnaires administered	356	100.0
Questionnaires returned and usable	338	94.9
Questionnaires not returned/unusable	18	5.1
Total	356	100.0

Source: Researcher (2026)

This response rate is considered adequate for analysis and generalisation of the study findings, since a response rate of 50% is generally considered adequate for analysis, 60% is regarded as good, and a rate above 70% is rated as excellent (Mugenda & Mugenda, 2019). The achieved response rate of 94.9% therefore indicates excellent participation and provides a sufficient basis for reliable statistical analysis. The high response rate is attributable to the multistage sampling approach, which allowed enumerators to physically locate and engage sampled households, combined with follow-up visits to households that had not returned completed instruments during the initial data collection round.

4.2 Descriptive Statistics

Crop Management Practices

The first objective of the study was to determine the effect of crop management practices on household welfare among smallholder farmers in Tana River County. Respondents were asked to rate their level of agreement with six statements on crop management using a five-point Likert scale, with the findings presented in Table 2.

Table 2: Descriptive Statistics on Crop Management Practices

Statement	Mean	Std. Dev.
During farming, I use improved seed varieties.	4.180	0.790
As a method of crop management, I practice crop rotation.	4.050	0.830
In farming, I integrate intercropping as one of the methods of crop management.	3.860	0.880
I adopt recommended practices during the farming process.	4.260	0.740
I take measures to control pests and diseases.	4.120	0.810
Climate-resilient crops are used on the farm.	4.060	0.780
Average	4.088	0.805

Source: Researcher (2026)

The results show an overall mean of 4.088, indicating that sampled households in Tana River County have, on average, adopted crop management practices to a high degree. Adherence to recommended agronomic practices recorded the highest mean (4.260), suggesting that farmers who have received KCSAP-related training are largely applying the agronomic guidance provided to them. The use of improved seed varieties (4.180) and pest and disease control measures (4.120) similarly scored highly, consistent with the emphasis that climate-smart agriculture programmes in ASAL counties place on drought-tolerant, certified seed as a first line of defence against erratic rainfall. Intercropping recorded the lowest, though still relatively high, mean (3.860), which may reflect the comparatively higher labour and knowledge demands of intercropping relative to single-practice interventions such as seed selection, a pattern also noted among Ghanaian smallholders adopting diversified cropping systems (Frempong et al., 2023). The relatively low standard deviations across all items (ranging from 0.740 to 0.880) indicate a fairly consistent level of practice adoption across the sampled households, suggesting that KCSAP-related extension messaging has achieved reasonably uniform uptake across Bura, Galole and Garsen constituencies.

Household Welfare (Food Security)

The dependent variable of the study, household welfare, was measured through five statements capturing household food security. The descriptive results are presented in Table 3.

**Table 3: Household Welfare (Food Security)**

Statement	Mean	Std. Dev.
My household is able to access sufficient food to meet our daily needs.	4.120	0.810
My household usually consumes a balanced and nutritious diet.	3.980	0.850
My household can obtain adequate food throughout the year without major difficulty.	3.890	0.890
My household rarely experiences shortages of food.	3.950	0.870
My household can afford to purchase sufficient food whenever it is needed.	4.060	0.800
Average	4.000	0.844

Source: Researcher (2026)

The overall mean score of 4.000 indicates that sampled households in Tana River County generally report a favourable, though not uniformly strong, level of food security. Access to sufficient daily food recorded the highest mean (4.120), while the ability to obtain adequate food throughout the year without major difficulty recorded the lowest mean (3.890), suggesting that seasonal food shortages, likely linked to the county's unreliable bimodal rainfall pattern, remain a more persistent welfare challenge than day-to-day food access. This pattern is broadly consistent with findings from Kirinyaga County, where more than half of surveyed coffee-farming households reported at least one month of seasonal food insecurity despite generally favourable food consumption scores (Kananu et al., 2023), reinforcing that seasonal variability, rather than chronic food unavailability, is often the binding constraint on household welfare among Kenyan smallholder farmers.

4.3 Inferential Statistics

Correlation Analysis

Pearson correlation analysis was conducted to determine the strength and direction of the relationship between crop management and household welfare before estimating the regression model. Pearson's correlation coefficient was appropriate because it measures the degree and direction of the linear relationship between two continuous variables (Field, 2024). The correlation coefficient (r) ranges from -1 to +1, where values closer to +1 indicate a strong positive relationship, values closer to -1 indicate a strong negative relationship, and values close to zero indicate little or no linear relationship. The results are presented in Table 4.

Table 4: Pearson Correlation between Crop Management and Household Welfare

Variable	Household Welfare	Crop Management
Household Welfare	1	
Crop Management	0.684**	1



Correlation is significant at the 0.01 level (2-tailed).

Source: Researcher (2026)

As presented in Table 4, crop management exhibited a strong, positive, and statistically significant relationship with household welfare ($r = 0.684$, $p < 0.01$). The findings indicate that increased adoption of improved crop management practices is associated with improved household welfare among smallholder farmers in Tana River County. The positive coefficient suggests that households implementing practices such as improved seed varieties, crop rotation, intercropping, timely planting, appropriate fertilizer application, and effective pest and disease management are more likely to experience better food security, higher farm income, and improved overall welfare. The statistically significant relationship justified the inclusion of crop management in the regression analysis to determine its influence on household welfare. These findings are consistent with previous studies, which established that improved crop management practices significantly enhance agricultural productivity and household welfare among smallholder farmers (Radeny et al., 2022; Kananu et al., 2023).

Regression Analysis

A simple linear regression model was estimated to determine the effect of crop management on household welfare among smallholder farmers in Tana River County. The model summary, analysis of variance and regression coefficients are presented in Tables 5, 6 and 7 respectively.

Table 5: Model Summary

R	R Square	Adjusted R Square	Std. Error of Estimate
0.684	0.468	0.466	0.5234

a. Predictors: (Constant), Crop Management. Source: Researcher (2026)

The findings indicate an R value of 0.684, confirming a strong positive relationship between crop management and household welfare among smallholder farmers in Tana River County. The coefficient of determination (R^2) was 0.468, indicating that crop management practices explain 46.8% of the variation in household welfare. This demonstrates that practices such as the use of improved seed varieties, crop rotation, intercropping, adherence to recommended agronomic practices, and pest and disease control contribute substantially to improved household food security outcomes. The adjusted R^2 value of 0.466 confirms that the regression model is reliable in explaining this relationship, while the standard error of estimate of 0.5234 indicates an acceptable level of prediction accuracy. The results suggest that although crop management is a substantial determinant of household welfare, other factors, including soil management, water management, livestock management and capacity building, which recorded their own significant



correlations with household welfare in Table 6, also contribute to the remaining variation in household welfare not explained by crop management alone.

Table 6: ANOVA

Model	Sum of Squares	df	Mean Square	F
Regression	80.981	1	80.981	295.60
Residual	92.021	33	0.274	
Total	173.002	337		

a. *Dependent Variable: Household Welfare.*

b. *Predictors: (Constant), Crop Management. Source: Researcher (2026)*

The ANOVA findings show that the regression model was statistically significant, with an F-value of 295.60 and a significance level of $p < 0.001$. This implies that crop management significantly affects household welfare among smallholder farmers in Tana River County. Since the p-value was less than 0.05, the study rejected the null hypothesis (H_0) that crop management practices do not significantly influence household welfare among smallholder farmers in Tana River County, Kenya. The results confirm that improvements in crop management practices are associated with measurable improvements in household welfare, and that households which more fully adopt improved seed varieties, crop rotation, intercropping and integrated pest and disease control are more likely to achieve better food security outcomes.

Table 7: Regression Coefficients

Model	B	Std. Error	t
(Constant)	1.310	0.161	8.137
Crop Management	0.658	0.0383	17.18

a. *Dependent Variable: Household Welfare.*

Source: Researcher (2026)

The regression coefficients reveal that crop management has a positive and statistically significant effect on household welfare ($\beta = 0.658$, $p < 0.001$). This means that a one-unit improvement in crop management practices leads to a 0.658-unit increase in household welfare, holding other factors constant. The t-value of 17.18 and significance level below 0.05 provide strong evidence that this relationship is statistically significant. The constant term of 1.310 indicates that some baseline level of household welfare would persist even in the near-absence of structured crop management, reflecting the contribution of other livelihood assets and coping strategies, although this baseline welfare level would remain considerably below that achieved by households practising improved crop management. The regression equation for the study is expressed as:

$$\text{Household Welfare} = 1.310 + 0.658 (\text{Crop Management})$$



These findings imply that crop management is a significant predictor of household welfare among smallholder farmers in Tana River County. Wider adoption of improved and climate-resilient seed varieties, more consistent practice of crop rotation and intercropping, and stronger uptake of recommended agronomic and pest management practices are likely to contribute positively toward improved household food security in the county.

4.4 Discussion of Findings

The findings of this study affirm the strong, positive relationship between crop management and household welfare that has been documented across diverse agro-ecological and institutional settings. The correlation coefficient of 0.684 and the regression finding that crop management explains 46.8% of the variation in household welfare in Tana River County are consistent in direction, though somewhat more moderate in magnitude, with the substantially larger welfare gains reported among climate-smart-village households in the Nyando Basin, where stress-tolerant variety adoption improved dietary diversity by 40% and reduced food insufficiency by 75% (Radeny et al., 2022). This difference in magnitude is plausible given that Tana River County's agro-pastoral, drought-prone environment and comparatively thinner extension infrastructure present more binding constraints on the full realisation of crop management benefits than the more intensively supported Nyando Basin climate-smart villages.

The finding also resonates with evidence from Kirinyaga County, where crop diversification practices, particularly intercropping and varietal diversity, were the strongest predictors of improved food consumption scores among coffee-farming households (Kananu et al., 2023), and with the Ghanaian evidence that greater crop diversity is consistently associated with better dietary diversity and reduced hunger (Frempong et al., 2023). The South African finding that combined adoption of minimum tillage and crop diversification generated the largest household income gains among conservation-agriculture practices (Oduniyi et al., 2022) further supports the interpretation that crop management, when practised as an integrated bundle of practices rather than a single isolated intervention, yields the most substantial welfare benefits. Viewed through the Sustainable Livelihoods Theory, these findings suggest that crop management functions as a mechanism through which Tana River County households deploy their natural and human capital, land, labour, seed and agronomic knowledge, to buffer themselves against the vulnerability context created by erratic rainfall and recurrent drought, thereby improving their livelihood outcomes (Serrat, 2017).

5.0 SUMMARY OF THE STUDY

The study set out to determine the effect of crop management practices on household welfare among smallholder farmers in Tana River County, Kenya. Descriptive results showed a generally high level of crop management practice adoption (overall mean = 4.088), led by adherence to recommended agronomic practices, use of improved seed varieties, and pest and disease control,



while intercropping, though still well adopted, lagged slightly behind the other practices. Household welfare, measured through food security indicators, recorded a moderately favourable overall mean of 4.000, with day-to-day food access scoring more strongly than the ability to secure adequate food consistently throughout the year, pointing to seasonal food shortages as the more persistent welfare challenge in the county. Inferential analysis confirmed a strong, positive and statistically significant correlation between crop management and household welfare ($r = 0.684$, $p < 0.01$), and regression analysis established that crop management practices significantly predict household welfare, accounting for 46.8% of the variance in welfare outcomes ($F(1, 336) = 295.60$, $p < 0.001$), leading to the rejection of the null hypothesis. These findings collectively demonstrate that crop management is a substantial and statistically significant driver of household welfare among smallholder farmers in Tana River County, consistent with the theoretical expectation, drawn from the Sustainable Livelihoods Theory, that the deliberate deployment of livelihood assets through improved agronomic practice strengthens household resilience and welfare outcomes.

6.0 CONCLUSION

The study concludes that crop management is a significant and substantial driver of household welfare among smallholder farmers in Tana River County. Households that more fully adopt improved seed varieties, practice crop rotation and intercropping, follow recommended agronomic guidance, and actively manage pests and diseases report measurably better food security outcomes than those that do not. While crop management alone explains a considerable share of the variation in household welfare, the strong correlations recorded by soil management, water management, livestock management and capacity building indicate that crop management operates most effectively as part of an integrated climate-smart agriculture strategy rather than as an isolated intervention. The persistence of seasonal food access challenges, despite generally high crop management adoption, further suggests that agronomic improvements alone, absent complementary investment in water storage and post-harvest infrastructure, may not be sufficient to fully insulate Tana River County households from the county's underlying climatic vulnerability. Overall, the findings affirm that continued investment in crop management extension and farmer training remains a worthwhile and evidence-based strategy for strengthening household welfare in the county.

7.0 RECOMMENDATIONS

Based on the study findings, the following recommendations are proposed. First, county and national agricultural extension agencies should strengthen and sustain farmer training on crop management, with particular emphasis on intercropping, which recorded comparatively lower adoption than other practices, to close this specific practice gap. Second, KCSAP implementers



and county government should expand access to certified, climate-resilient and drought-tolerant seed varieties in Bura, Galole and Garsen constituencies, given the strong contribution of improved seed use to both crop management adoption and household welfare. Third, given that crop management explained less than half of the variation in household welfare, county government and development partners should pursue an integrated climate-smart agriculture approach that combines crop management with soil management, water management, livestock management and capacity-building interventions, rather than promoting crop management in isolation. Fourth, because seasonal rather than chronic food shortages emerged as the more persistent welfare challenge, investment in water storage, small-scale irrigation and post-harvest handling infrastructure should accompany crop management interventions to help households bridge lean periods between harvests. Finally, county planners should institute periodic household-level monitoring of crop management adoption and welfare outcomes to track progress and adapt interventions to emerging challenges in the county's agro-pastoral farming systems.

8.0 AREAS FOR FURTHER RESEARCH

Future research should consider a longitudinal design that tracks the same households across multiple farming seasons to establish whether the welfare gains associated with crop management observed in this cross-sectional study are sustained over time. Further studies could also examine the relative and combined contribution of soil management, water management, livestock management and capacity building alongside crop management within a full multiple regression model, to establish the extent to which these practices interact to shape household welfare in Tana River County. Additionally, comparative studies across other ASAL counties with differing levels of KCSAP implementation intensity would help establish whether the magnitude of the crop management-household welfare relationship observed in this study is unique to Tana River County or generalisable across Kenya's wider arid and semi-arid farming systems.

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