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FOOD SECURITY

INFLUENCE OF CROPPING METHOD PRACTICE ON FOOD SECURITY AMONG SMALLHOLDER FARMERS IN SOLAI, NAKURU COUNTY

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ABSTRACT

Purpose of the Study: The study set out to investigate the effect of cropping methods specifically crop rotation and intercropping on food security among smallholder farmers in Solai, Nakuru County, Kenya.

Statement of the Problem: Smallholder farmers in Solai face persistent challenges of climate variability, soil degradation, and limited adoption of sustainable farming practices. These constraints undermine agricultural productivity and threaten household food security. Despite the recognized benefits of conservation agriculture, evidence on the contribution of specific cropping methods to food security in this context remains inadequate.

Research Methodology: The study employed a cross-sectional descriptive and correlational design. Data was gathered from 100 respondents, including 95 farmers and 5 key stakeholders. Structured questionnaires based on a 5-point Likert scale were administered, complemented by in-depth interviews. Quantitative data was analyzed using regression and correlation techniques, while qualitative data was thematically analyzed.

Findings: Regression results demonstrated a significant positive effect of cropping methods on food security ($\beta = 0.472$, $p = 0.000$). Pearson correlation further indicated a strong positive relationship ($r = 0.902$, $p = 0.000$). The findings revealed that intercropping and crop rotation practices enhanced food supply, improved soil fertility, and supported sustainable agricultural systems.

Conclusion: The study concludes that the adoption of crop diversification strategies is essential for addressing food security challenges among smallholder farmers in Solai. Conservation agriculture practices provide both immediate and long-term benefits, contributing to resilience against climate shocks.

Recommendation: The study recommended that agricultural extension services and targeted awareness programs be strengthened to promote the uptake of intercropping and crop rotation.

Keywords: *Conservation Agriculture, Cropping Methods, Food Security, Smallholder Farmers*.

BACKGROUND OF THE STUDY

Conservation Agriculture (CA) is a sustainable farming approach based on three core principles: minimal soil disturbance, permanent soil cover, and crop rotation or intercropping (Friedrich, 2019). It aims to enhance soil health, conserve water, and boost biodiversity while improving yields and resilience among smallholder farmers facing climate-related challenges (FAO, 2018). CA emerged in the 20th century as a response to soil degradation and has since evolved into a globally recognized strategy for sustainable agriculture. By 2020, approximately 125 million hectares globally were under CA practices (FAO, 2020), illustrating its potential to address food insecurity and climate vulnerability. In Asia, China has promoted CA to improve water conservation and food production (Xin & Li, 2021), while in the U.S., conservation tillage spans over 100 million acres (USDA, 2019). Similarly, UK farmers use CA to reduce erosion and enhance environmental sustainability (Defra, 2022).

In sub-Saharan Africa, CA improves soil fertility and water management, with Zambia reporting over 2.5 million hectares under CA (Giller et al., 2011). Countries like Tanzania and Ethiopia also integrate CA to improve food security in diverse agroecological conditions (Kassam et al., 2015; Alemu et al., 2017). In Kenya, CA adoption is rising, with farmers using crop residue retention, agroforestry, and legumes like Mucuna and Sunnhemp to enhance soil health (Owino, 2010). In the Nzoia Basin, nitrogen-fixing legumes and fodder crops contribute to soil improvement and livestock nutrition (Diop et al., 2023). Despite progress, many Kenyan farmers still rely on traditional methods or partial CA adoption. The Solai region in Nakuru County presents a critical area for studying CA's role in improving food security and climate resilience (Andala & Sirengo, 2019). The USAID-funded Conservation Agriculture Practices Plus (CAP) project in Solai supports smallholder households especially women through training, diversification, and improved nutrition, aligning with Kenya's development goals (USAID, 2021).

This study, examining the ongoing ADS-CR-implemented CA project in Solai, aims to contribute to knowledge on CA's potential to enhance food security and climate change mitigation, informing sustainable agricultural strategies to improve resilience and livelihoods.

OBJECTIVE

To determine the influence of cropping method practice on food security among smallholder farmers in Solai, Nakuru County.

HYPOTHESIS

H_{01}: Cropping method practice have no statistically significant influence on food Security among smallholder farmers in Solai, Nakuru County.

EMPIRICAL REVIEW

Empirical evidence affirms that diversified cropping method practices including crop rotation, intercropping, and general crop diversification have a measurable and positive impact on food security among smallholder farmers across diverse agro-ecological regions. These practices are shown to improve crop productivity, stabilize yields, enhance environmental sustainability, and increase household incomes core components of food security. For instance, Micheni, Gathungu, and Muriithi (2023) found a strong positive relationship between crop diversification and productivity among smallholder coffee farmers in Kirinyaga County, Kenya. Their study indicated that practices like crop rotation contributed 13.4% to productivity, while crop species diversity accounted for 56.6%. The findings emphasized the role of diversified cropping methods in boosting food availability and underscored the importance of supporting farmers through agricultural extension services.

Supporting this, Jalli et al. (2021) conducted a field experiment in Finland comparing monoculture and diversified cropping methods under different tillage regimes. Their results revealed that diversified cropping improved spring wheat yields by 30% in no-tillage and 13% in ploughed systems. Additionally, diversified methods reduced disease incidence and enhanced plant health, contributing to more reliable yields. Similarly, Raseduzzaman (2016), through a meta-analysis and field trials, demonstrated that cereal-legume combinations significantly enhanced yield stability and land-use efficiency in tropical climates. The research also revealed that while nitrogen fertilizer had limited influence on total intercrop yield, proper crop composition was key to maintaining productivity, thus enhancing food security.

Further reinforcing these insights, Yang et al. (2024) conducted a six-year field study in China's North Plain. The study found that integrating legumes and cash crops into cereal rotations increased yields by 38%, reduced nitrous oxide emissions by 39%, and improved soil organic carbon by 8%. These findings confirm that diverse cropping method practices not only improve productivity and farmer income but also promote environmental sustainability—an essential factor in long-term food security. Taken together, these studies provide strong empirical support for promoting diversified cropping methods in regions like Solai, Nakuru County, where smallholder farmers face climate variability and limited land resources. Implementing such practices can play a pivotal role in enhancing resilience, productivity, and sustainability in food systems.

THEORETICAL FRAMEWORK

This study was anchored on the Diffusion of Innovations Theory which was advanced by Everett Rogers in 1962. This theory explains how new ideas, technologies, and practices spread within a society or social system over time (Rogers, 1962). It identifies five key elements influencing adoption: innovation itself, communication channels, time, the social system, and adopter categories. Rogers (1962) categorized adopters into innovators, early adopters, early majority, late majority, and laggards, describing their varying willingness to embrace new practices. The theory has evolved to incorporate modern advancements in technology diffusion and critiques regarding its applicability across different cultural and economic contexts (Greenhalgh *et al*., 2021). Some scholars argue that the model may oversimplify the adoption process, ignoring factors like resistance to change and external barriers (Sharma & Reddy, 2023).

A fundamental aspect of this theory is its application to agricultural innovations, directly relating to the first specific objective of the study: determining the influence of cropping method practices on food security among smallholder farmers in Solai, Nakuru County. The theory suggests that the adoption of new cropping methods depends on how information about these methods is disseminated and received (Rogers, 1962). Greenhalgh *et al*. (2021) highlights that effective knowledge-sharing mechanisms, such as farmer-to-farmer learning, extension services, and demonstration farms, significantly influence the rate of adoption. However, some critics argue that adoption is not just a function of exposure but also of economic constraints, policy

environments, and individual willingness to take risks (Sharma & Reddy, 2023). This study applies the theory to explore how knowledge dissemination affects cropping method adoption and, consequently, food security.

In critiquing the Diffusion of Innovations Theory, it is evident that while it provides a robust framework for understanding adoption patterns, it has limitations. Proponents argue that it effectively explains how new agricultural practices spread and highlights the importance of social networks in influencing adoption (Rogers, 1962). However, critics contend that the theory assumes a linear adoption process and underestimates the role of structural barriers such as inadequate policy support and economic constraints (Sharma & Reddy, 2023). Despite these critiques, the study employs this theory to assess how conservation agriculture practices influence food security outcomes among smallholder farmers.

The relevance of this theory to the study lies in its ability to explain how conservation agriculture practices are adopted and the factors influencing their diffusion. The theoretical framework guides the study by providing a structured understanding of how cropping methods, minimum tillage, and soil cover are disseminated among smallholder farmers. By aligning with this theory, the study establishes a clear linkage between conservation agricultural practices and food security, providing a basis for analyzing their effectiveness in the Solai location.

CONCEPTUAL FRAMEWORK

The conceptual framework illustrates the relationship between the independent variable, cropping methods (encompassing practices such as diverse crops, soul fertility, pests and disease management), and the dependent variable, food security (measured by affordability of food, access to farm produce, and stability of food supply). Figure 1 shows the relationship between the study variables.

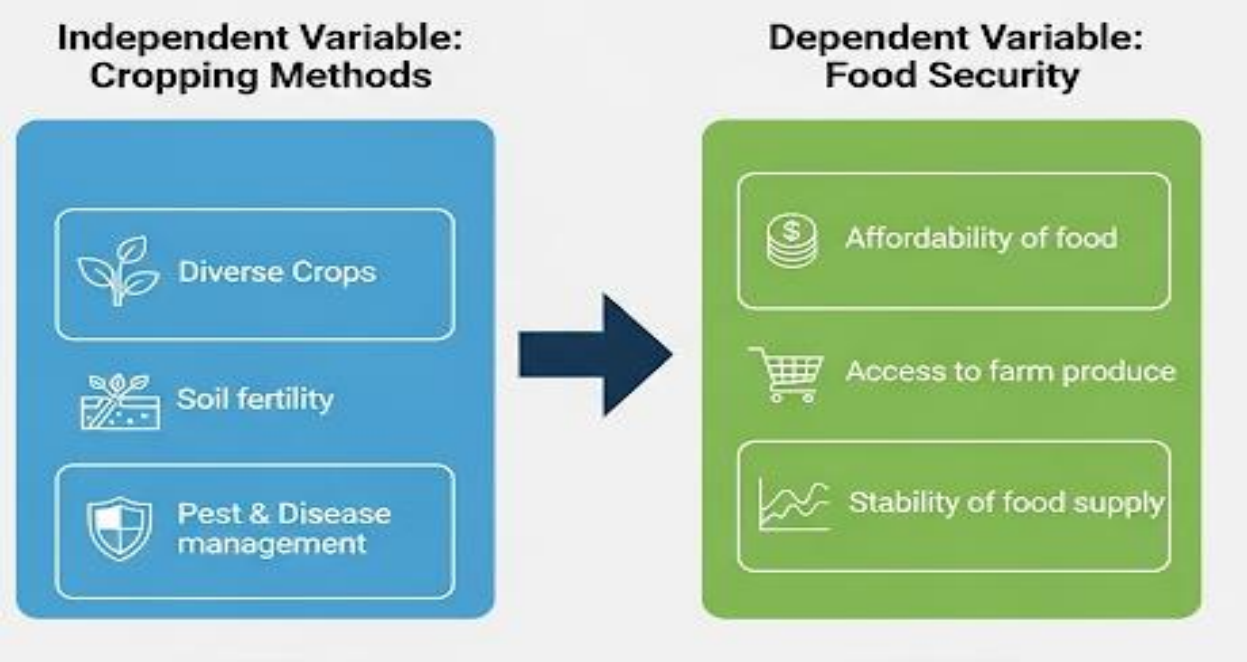

Figure 1: Conceptual Framework

Source: Author (2025)

METHODOLOGY

A cross-sectional descriptive and correlational research design was employed to capture a snapshot of Cropping Methods and their impact on food security, while exploring relationships between variables. The target population comprised 137 individuals in Solai, Nakuru County: 125 smallholder farmers registered under the Anglican Development Services-Central Rift (ADS-CR) CA project, 6 ADS-CR staff, 2 ward agricultural officers, and 4 local administrators (chief and assistants). Using Fisher's formula, a sample of 107 respondents was selected: 95 farmers via simple random sampling and 12 stakeholders (ADS-CR staff, agricultural officers, administrators) via purposive sampling. Structured Likert-scale questionnaires (1–5) were administered to farmers during household visits to assess perceptions of cropping methods and food security. Structured interviews with stakeholders provided qualitative insights. Research assistants facilitated language interpretation for respondents with literacy or language barriers. Ethical approvals were obtained from Kabarak University and NACOSTI, with informed consent secured from participants. Descriptive statistics (means, standard deviations, frequencies) summarized perceptions, while inferential analyses (Pearson correlation, multiple regression)

tested relationships. Diagnostic tests ensured model robustness: normality (Shapiro-Wilk, p = 0.065), multicollinearity (VIF < 5), heteroscedasticity (Breusch-Pagan, p = 0.292), autocorrelation (Durbin-Watson = 1.92), and outlier detection (standardized residuals < ±3). The regression model was:

$Y = \beta 0 + \beta_1 X_1 + \varepsilon.$

Where;

Y = Food Security

X1 = Cropping Method

β0 = Intercept

β1 = Coefficient

ε = Error term

Data was analyzed using SPSS Version 25, with results presented in tables.

RESULTS & DISCUSSION

The study achieved a 93.46% response rate, with 100 out of 107 expected responses (Table 5). Descriptive and inferential analyses, supported by diagnostic tests, confirmed the significant influence of cropping methods on food security.

Table 1: Response Rate

Response	Number of Respondents	Percentage (%)
Expected responses	107	100%
Received responses	100	93.46%
Responses not received	7	6.54%

DESCRIPTIVE STATISTICS

The researcher sought to establish the relationship between Cropping Methods on Household Food Security among smallholder farmers in Solai Location, Nakuru County. The findings are as shown in Table 2.

Table 2: Cropping Methods on Household Food Security

Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation
Planting of diverse crops has led to increased household food availability	20	27	11	31	20	2.78	1.338
Cropping method has helped in improving soil fertility	19	31	7	35	8	2.74	1.300
Cropping method has enabled me to manage pests and diseases	19	29	6	36	10	2.75	1.329
Utilizing cropping method techniques enhances food security resilience	21	27	12	32	8	2.69	1.293
Cropping Methods promote efficient land use	22	23	12	37	6	2.54	1.234
Overall Average						2.70	1.2988

Key: SD - Strongly Disagree, D - Disagree, N - Neutral, A - Agree, SA - Strongly Agree

The study findings revealed that cropping methods had a moderate influence on household food security, with an overall mean of 2.70 and a standard deviation of 1.299. Among the specific practices, planting diverse crops showed the highest influence on household food availability (Mean = 2.78, Std. Deviation = 1.338), suggesting its relative importance. Additionally, cropping methods contributed to soil fertility improvement (Mean = 2.74, Std. Deviation = 1.300) and pest and disease management (Mean = 2.75, Std. Deviation = 1.329), though their influence was not significantly higher than the overall mean. Further, the study found that utilizing cropping techniques enhanced food security resilience (Mean = 2.69, Std. Deviation = 1.293), while Cropping Methods promoting efficient land use had the lowest mean (2.54, Std. Deviation = 1.234), indicating a relatively weaker impact.

These findings suggest that while cropping methods play a role in food security, their influence varies. Practices with mean values below the overall average of 2.70, such as land use efficiency, indicate lower perceived influence compared to those above the mean. This aligns with prior research by Akinyi et al. (2021), which found that while diverse cropping methods improve food availability, their impact on soil fertility and pest control remains limited. These results emphasize the need for enhanced farmer training to maximize the benefits of cropping practices and address their weaker aspects.

Table 3: Conservation Agriculture on Food Security

Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Deviation
Transition to Conservation Agriculture has improved farm productivity	20	27	16	30	7	2.49	1.210
Conservation agriculture practices have expanded access to farm produce	21	30	14	26	9	2.50	1.299
Conservation practices have provided stability in food supply	21	28	13	29	9	2.42	1.224
The community has experienced an improvement in food affordability	20	25	16	29	10	2.41	1.248
We have gained easier access to farm produce through conservation methods	24	23	13	29	11	2.46	1.077
Overall Average						2.45	1.212

Key: *SD - Strongly Disagree, D - Disagree, N - Neutral, A - Agree, SA - Strongly Agree*

The study findings revealed that conservation agriculture had a moderate influence on food security with an average (Mean 2.45, Std. Deviation 1.212). It was revealed that the transition to conservation agriculture has improved farm productivity with a (Mean 2.49, Std. Deviation 1.210). The study also showed that conservation agriculture practices have expanded access to farm produce with a (Mean 2.50, Std. Deviation 1.299).

Further, the study found that conservation practices have provided stability in food supply with a (Mean 2.42, Std. Deviation 1.224). It was also established that the community has experienced an improvement in food affordability with a (Mean 2.41, Std. Deviation 1.248). Additionally, the study revealed that farmers have gained easier access to farm produce through conservation methods with a (Mean 2.46, Std. Deviation 1.077). The overall mean of 2.45 and standard

deviation of 1.212 suggest a generally neutral to negative perception regarding the impact of Conservation Agriculture on food security. This aligns with past studies such as those by Wekesah (2019) and Harris-Fry et al. (2020), which indicated that while CA practices can contribute to food security, challenges in productivity, distribution, affordability, and stability remain significant. Therefore, while CA may hold potential for enhancing food security, its influence is still subject to contextual factors and may require further refinement and support to address ongoing issues.

PEARSON CORRELATION

Table 4: Correlation Between Cropping Method Food Security Among Smallholder Farmers

		Food Security Among Smallholder Farmers
Cropping Method	Pearson Correlation	.902
	Sig. (2-tailed)	.000
	N	100

The Pearson correlation coefficient of 0.902 between the cropping method and food security among smallholder farmers, as presented in Table 3, indicates a very strong positive relationship. With a 2-tailed significance level of 0.000 and a sample size of 100, the result is highly statistically significant. This suggests that the choice or influence of the cropping method is strongly associated with improved food security outcomes for smallholder farmers. The strong correlation implies that variations in cropping methods could substantially impact the level of food security achieved by these farmers. These aligns with Micheni, Gathungu, and Muriithi's (2023) study in Kenya, where crop diversification was found to have a positive influence on productivity.

REGRESSION ANALYSIS

Table 5: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		β	Std. Error	Beta		
1	(Constant)	.157	.090		1.743	.085
	Cropping Method	.472	.074	.464	6.341	.000

a. Dependent Variable: Food Security Among Smallholder Farmers

Table 4 displays the regression coefficients assessing the influence of cropping method on food security among smallholder farmers. The unstandardized coefficient (β = 0.472) suggests that for every one-unit improvement in cropping method, food security increases by 0.472 units, assuming all other factors remain constant. The standardized coefficient (Beta = 0.464) indicates a moderately strong positive influence. The relationship is statistically significant (t = 6.341, p = 0.000 < 0.05), demonstrating that cropping method is a meaningful predictor of food security. Although the constant term (β = 0.157) has a positive value, it is not statistically significant (p = 0.085 > 0.05), implying limited predictive power when the cropping method is excluded from the model. These results lead to the rejection of the null hypothesis (H_{01}), as the coefficient for cropping method (β = 0.472, p = 0.000 < 0.05) indicates a significant positive influence on food security. This aligns with Micheni *et al*. (2023), Jalli (2021), Raseduzzaman (2016), and Yang (2024), where diversified cropping methods were linked to increased productivity and stability, reinforcing the importance of adopting varied cropping strategies for enhancing food security.

CONCLUSION

From the findings, it was concluded that diversified cropping methods have a positive influence on food security in Solai, Nakuru County. The adoption of practices such as crop rotation and intercropping improved food availability and soil health, leading to enhanced agricultural productivity. The study confirmed that varied cropping systems contribute to greater resilience against climate-related challenges, thus ensuring more stable and sustainable food production. Therefore, the conclusion drawn from the findings is that cropping methods play a significant role in enhancing food security among smallholder farmers in the region. The Conservation agriculture project practices in Solai has relied heavily on community leaders, particularly lead farmers, to spread new agricultural techniques. Their grassroots engagement has been vital for extending the project's influence, demonstrating how pivotal local figures are in changing agricultural practices at the community level.

RECOMMENDATIONS

The findings of this study show that diversified cropping methods have a positive influence on food security in Solai, Nakuru County. It is recommended that farmers across Kenya be encouraged to adopt diversified cropping methods such as intercropping and crop rotation to improve food security and ensure sustainable agricultural practices. The government, agricultural extension services, and NGOs should offer training programs, technical support, and access to resources to promote these practices nationwide. Collaboration among stakeholders is essential to enhance awareness and facilitate the adoption of these beneficial agricultural techniques. Future research could expand the study to include a more diverse range of agricultural communities, examining the influence of cultural differences on the adoption of sustainable farming practices.

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