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Influence of Banana Production Practices and Constraints in Banana Production among Small-holder Farmers in Masaba South Sub-County, Kisii County, Kenya

Nyamwamu Nyarang'o Charles[1]*, Pascaline Jeruto[2], Lizzy Mwamburi[3]

[1,2,3] School of Science, Biological Sciences department, University of Eldoret, P. O. Box 1125 Eldoret, Kenya.

ABSTRACT: Globally, consumption of banana (*Musa spp*) as fruit is due to its high nutritional and medicinal value and thus, it is considered as a powerhouse of nutrients that maintain good health. However, banana production has been influenced by various agricultural practices and faced several constraints over the years. Therefore, this study sought to establish the influence of banana production practices and constraints among small-holder banana production farmers in Masaba south sub-county, Kenya. A household survey was carried out to collect primary data. Four administrative wards were purposefully sampled for the study. Quantitative and qualitative data were collected using a semi-structured questionnaire and key informant interviews. Questionnaires were administered to 196 households and 5 key informants to collect data on the influence of banana production practices and constraints among farmers. Data collected was subjected to both descriptive and inferential analysis. Williams Hybrid was found to be the most popular variety with a frequency of 82.1% followed by Gros Michel at 70.4%, Apple bananas (sugar bananas) at 69.4% while Plantains and Cavendish were at 62.2% and 55.6% respectively. Majority, 87.2% of the farmers embraced pure stand production system whereas 12.9% did not embrace the system. However, 97.5% of the farmers adopted intercropping system while only 2.5% did not embrace the system. 91.8% of the farmers adopted use of tissue culture planting materials while 8.2% did not embrace them. 100% of the farmers used suckers as planting materials. Pests and diseases were the prevalent constraints in banana production, rated at 100%. Therefore, there is need to address the influence of banana production practices and constraints among farmers in Masaba South sub county through targeted interventions and policy support is essential for sustainable banana production in Kenya.

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Corresponding Author: Nyamwamu Nyarang'o Charles

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INTRODUCTION

Worldwide consumption of banana (*Musa spp*) as fruit is second after apple due to its high nutritional and medicinal value (Kirogo, 2006). It is a powerhouse of nutrients that maintain good health (Kirogo, 2006). It is rich in potassium, carbohydrates and vitamin A, providing over 25% of the carbohydrate requirements for more than 70 million people in the world (Njue, 2015).

In most developing countries, banana is ranked as the fourth food crop after rice, wheat and maize, and is a principal source of employment as well as on-farm and off-farm income in its major production areas (Tumuhimbise and Talengera, 2018). In Kenya, banana is a major food and cash crop that contributes significantly to the diets of many people, and the Gross Domestic Product (GDP) of the Kenyan economy (Kahangi, 2002; Nguthi, 2007). However, banana production is very low ranging from 4.5-10 tons/ha compared to the international levels of 40-50 tons/ha (Njue, 2015).

In Latin America, a region known for its banana exports, the adoption of sustainable agricultural practices has been critical. A study by Hernández *et al*., (2016) highlighted that farmers who implemented integrated pest management (IPM) techniques saw a reduction in the incidence of banana pests and diseases, which in turn improved yield quality and quantity. This study emphasized the importance of training and extension services in promoting IPM practices among banana farmers.

In Asia, particularly in India, banana production is influenced by both traditional and modern agricultural practices. Singh *et al*., (2018) investigated the impact of drip irrigation systems on banana yields in Maharashtra. Their findings indicated that farmers using drip irrigation experienced significant water savings and increased banana production compared to those relying on traditional

irrigation methods. This study demonstrated the potential benefits of adopting modern irrigation technologies in enhancing banana productivity.

The Pacific region also presents unique challenges for banana farmers. According to a study by Lal and Vickers (2020), in Fiji, climate change and extreme weather events, such as cyclones, pose significant threats to banana production. The study recommended the development of climate-resilient banana varieties and the implementation of agroforestry systems to mitigate the impacts of climate change on banana farming.

Moreover, a global review by Ploetz *et al.,* (2021) identified that *Fusarium wilt*, caused by the fungus *Fusarium oxysporum* f. *sp. cubense*, remains a significant constraint to banana production worldwide. The study recommended international collaboration in research and development to breed resistant banana varieties and to implement effective quarantine measures to prevent the spread of this devastating disease.

In contrast, African countries face significant challenges related to banana production. According to a study conducted by Nkuba *et al*., (2017) in Tanzania, farmers reported that limited access to quality planting materials and fertilizers were major constraints. This study also found that banana bacterial wilt was a prevalent issue, severely affecting banana yields. The study emphasized the need for improved disease management strategies and better access to agricultural inputs to enhance banana production in the region.

In Kenya, one of the major influences on banana production practices is the adoption of improved banana varieties. According to a study by Wasilwa *et al*., (2016), farmers who adopted tissue-cultured banana plants experienced a 20% increase in yield compared to those using traditional suckers. The study attributed this improvement to the disease-free nature of tissue-cultured plants and their higher resistance to pests and diseases.

Njiru *et al*., (2018) found that the combined use of organic manure and inorganic fertilizers significantly boosts banana yield. This study indicated that farmers who applied both types of fertilizers saw an increase in yield by approximately 15%, suggesting that integrated nutrient management practices are crucial for enhancing banana production.

A report by the Kenya Agricultural and Livestock Research Organization (KALRO) in 2019 emphasized the importance of proper irrigation techniques in increasing banana productivity. The report pointed out that regions utilizing drip irrigation systems had yields 25% higher than those relying on rain-fed agriculture.

Despite these advancements, banana farmers in Kenya face several constraints. Disease prevalence, particularly Fusarium wilt, remains a significant challenge. According to Mwangi *et al.*, (2020), Fusarium wilt affects over 30% of banana plantations in key production areas. The study suggests that without effective disease management strategies, such as resistant varieties and proper sanitation, banana production could decline drastically.

A study by Kariuki and Kimani (2021) highlighted that 40% of banana farmers struggle with accessing reliable markets. The lack of proper infrastructure, such as roads and storage facilities, exacerbates post-harvest losses, leading to reduced income for farmers. The study advocated for improved market linkages and infrastructure development to enhance market access and reduce losses.

Moreover, according to a study by Otieno *et al*., (2022), erratic weather patterns have led to unpredictable banana yields. The study found that prolonged droughts and unseasonal rains adversely affected 50% of banana farmers in arid and semi-arid regions. The study recommended the adoption of climate-smart agricultural practices to mitigate these impacts. Therefore, this current study sought to assess the influence of banana production practices and constraints in banana production among small-holder farmers in Masaba south sub-county, Kisii county, Kenya.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Masaba South Sub-County, Kisii County, Kenya. It is located in the western parts of Kenya between the latitude of 0^0 $30^/$ and 1^0S and longitude 34^0 $38^/$ and 35^0 with 5 administrative wards; Ichuni, Nyamasibi, Masimba, Gesusu and Kiamokama (Figure 1). The headquarters of the sub-county are located in Masimba town. The Sub-County typically has a hilly landscape with many ridges and gorges and with several permanent rivers crisscrossing the landscape. The Sub-County has fertile soils that support the agricultural activities engaged in by the local community. Close to 75% of the area of study is rich in red volcanic soils. The area falls between the altitudes of 1800–2350 m above sea level. It covers 161.9 km^2 with a local population of 143,250, of which 48.82% are male, while 51.18% are females spread across 26,132 households in the sub-county (Kisii County Government, 2023). The highland equatorial climate experienced in the area is responsible for the bimodal rainfall pattern characterized by two rainy seasons with an average annual rainfall of 1500 mm. The maximum temperatures in the area range between 21^0C to 30^0C while the minimum temperatures range between 15^0C to 20^0C. The area is comprised of small-scale farmers who have a high dependency on rain-fed agriculture. The sufficient rain amounts received in the region, coupled with the moderate temperatures, make the region suitable to support tea and coffee farming. Other crops typically grown in the region include maize, groundnuts, sweet potatoes, beans, bananas, and finger millet. Agriculture employs an estimated 80% of the population either directly or indirectly (Kisii County Government, 2023).

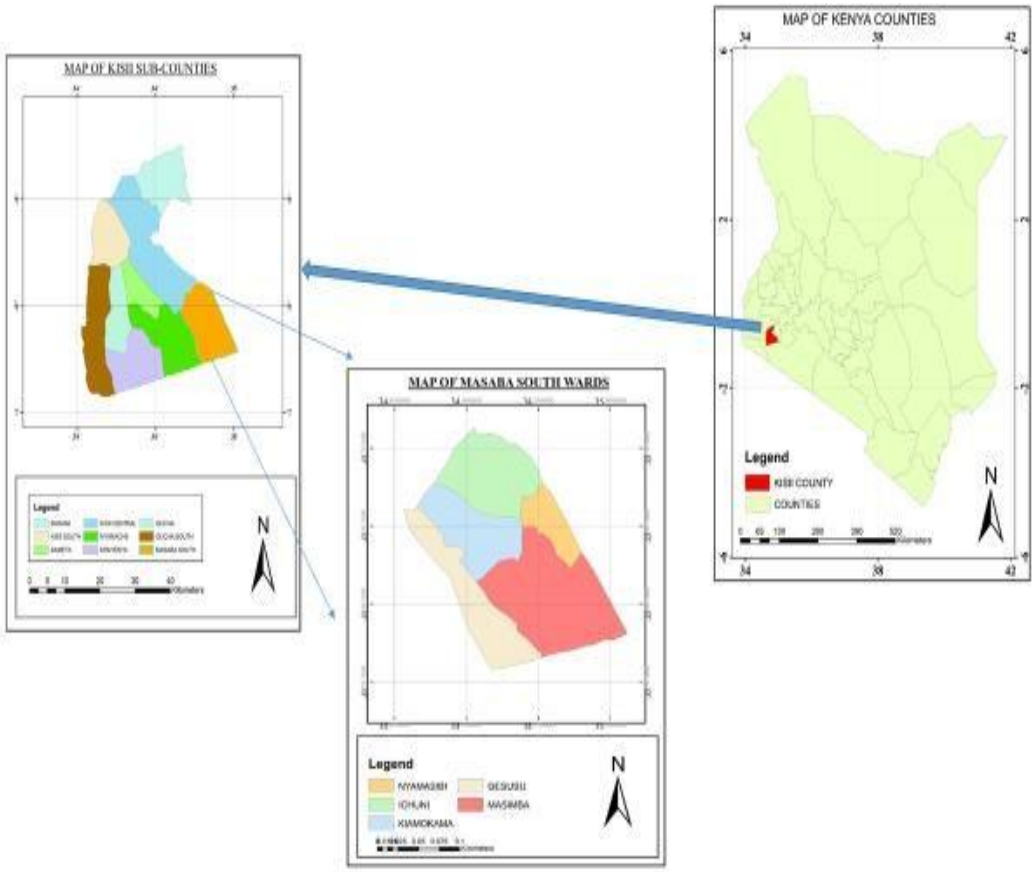

Figure 1: Map showing Masaba South Sub County, Kisii County where the study was conducted.

Sampling Frame

The target households for this study were selected by utilizing a multi-stage random sampling procedure, according to Sedgwick, (2015). The sub-county was purposively selected as it is prone to land use changes, according to Robinson, (2014). Then, three administrative wards (Masimba, Ichuni and Gesusu) were selected from the sub-county to be representative of the five wards based on their physiographical and natural conditions, location in the sub-county, food security situation, and types of farming system. This was followed by the random selection of 12 sub-locations (4 from Masimba, 3 from Ichuni and 5 from Gesusu) and finally, households were sampled randomly based on probability proportional to size in each ward.

From each of the three wards, proportionate sampling of households was done to make a sample size of 196 households for the study. The households were assigned numbers using lists obtained from the Ministry of Agriculture field extension officers. The starting point of sampling the households was determined by randomly picking wrapped papers numbered from 001 to 196 from a container. Administration of questionnaires was done on households to collect data.

Sample Size

Sample size of the households was determined by formula as proposed by Cochran, (1977). Sample size was estimated at 95% confidence level (z), 7% level of precision, with the expected proportion of households experiencing land use changes from population of the farmers assumed to be 50%, (p=0.5) and hence q=p 1=0.5; as follows;

$$\text{Households} = \frac{1.96 \times 0.5\ (0.5)}{0.07} = 196$$

The households were distributed in the three administrative wards proportionately based on the population (Table 1). The selected heads of the households, whether male or female was implicitly assumed to be the sole decision makers in banana production.

Table 1: Sample size distribution for each ward

Name of ward	No. of sub-locations	Total population	No. of households
Masimba	8	77,019	71
Ichuni	5	69,726	64
Gesusu	9	66,869	61
Total	22	213,614	196

Source: *Kenya Bureau of Statistics (KNBS), 2019 census data*

Data collection

Both primary and secondary data were used for this study. Data was collected between the second week of November 2023 and the last week of December 2023. Primary data was collected by the use of pre-tested structured questionnaires entailing, primarily closed-ended and open-ended questions.

Data Analysis

The data collected was subjected to descriptive analysis (frequencies and percentages) and inferential statistics (paired sample t-test) aided by SPSS software (version 27).

RESULTS

Banana varieties grown among smallholder farmers

Williams Hybrid was found to be the most popular with a frequency of 82.1% followed by Gros Michel at 70.4%, Apple bananas (sugar bananas) at 69.4% while Plantains and Cavendish were at 62.2% and 55.6% respectively as shown in Table 4.1.

Table 4.1: Banana varieties grown among smallholder farmers

S/No	Banana Variety	YES		NO	
		Freq.	Perc.	Freq.	Perc.
1	Cavendish	109	55.6	87	45.4
2	Williams Hybrid	161	82.1	35	17.9
3	Gros Michel	138	70.4	58	29.6
4	Apple Bananas (Sugar Bananas)	136	69.4	50	30.6
5	Plantains	122	62.2	74	37.8

There was a statistical significance ($p<0.05$) on banana varieties grown among smallholder farmers as shown in Table 4.2.

Table 4.2: Statistical analysis on banana varieties grown by the farmers

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Y - N	35.68000	20.16065	9.01612	10.64724	60.71276	3.957	4	.017

Banana production practices

The study sought to establish banana production practices among small holder farmers.

Production systems

Majority, 87.2% of the farmers indicated that they did not embrace pure stand production system whereas 12.9% agreed that they embraced the system. However, 97.5% of the farmers indicated that they adopted intercropping system while only 2.5% indicated that they did not embrace the system as illustrated in Table 4.3.

Table 4.3: Production systems

S/No	Production system	YES		NO	
		Freq.	Perc.	Freq.	Perc.
1	Pure stand production system	25	12.9	171	87.2
2	Intercropping system	191	87.5	5	2.5

There was no statistical significance ($p>0.05$) on production systems among the small holder banana growing farmers (Table 4.4).

Table 4.4: Statistical analysis on production systems among the banana growing farmers

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Y – N	5.35000	112.64211	79.65000	-1006.69921	1017.39921	.067	1	.957

Planting materials

Ninety-one-point eight percent of the farmers indicated that they adopted use of tissue culture planting materials while 8.2% indicated that they did not embrace tissue culture planting materials. All, 100% of the farmers agreed that they used suckers as planting materials as shown in Table 4.5.

Table 4.5: Planting materials

Nature of planting material	**Yes**		**No**	
	Freq	Perc	Freq	Perc
Adoption of tissue culture planting materials	180	91.8	16	8.2
Use of suckers	196	100	0	0

There was a statistical significance ($p<0.05$) on planting materials among the small holder banana growing farmers (Table 4.6).

Table 4.6: Statistical analysis on planting materials among small holder banana growing farmers

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Y – N	91.80000	11.59655	8.20000	-12.39088	195.99088	11.195	1	.047

Routine banana management practices

Weeding was carried out by 93.9% of the farmers, de-leafing was embraced by 96.9% of the farmers while 3.1% of the farmers did not carry out the practice. Majority, 84.7% of the farmers did not carry out pest and disease control while 15.3% of them carried out the management practice. Additionally, 86.7% of them carried out denavelling while 13.3% of them did not embrace this routine management practice as illustrated in Table 4.7.

Table 4.7: Routine banana management practices

S/No	**Banana management practices**	**YES**		**NO**	
		Freq.	**Perc.**	**Freq.**	**Perc.**
1	Weeding	184	93.9	12	6.1
2	De-leafing	190	96.9	6	3.1
3	Pest and disease control	30	15.3	166	84.7
4	Denavelling	170	86.7	26	13.3

There was a statistical significance ($p<0.05$) on routine banana management practices among the small holder banana growing farmers (Table 4.8).

Table 4.8: Statistical analysis on routine banana management practices among small holder banana growing farmers

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Y – N	46.40000	77.67316	38.83658	-77.19533	169.99533	1.195	3	.031

Banana production constraints

Pests and diseases were rated highly, each at 100% to be a constraint in banana production among the farmers. They were followed by the high cost of fertilizers at 97.9%, unreliable market at 96.9% while soil sampling & testing and lack of organic manures at 95.9% and 93.4% respectively as presented in Table 4.9.

Table 4.9: Banana production constraints

S/No	Constraints	YES		NO	
		Freq.	Perc.	Freq.	Perc.
1	Pests	196	100	0	0
2	Diseases	196	100	0	0
3	High cost of fertilizers	192	97.9	4	2.1
4	Lack of organic manures	183	93.4	13	6.6
5	Soil sampling and testing challenges	188	95.9	8	4.1
6	Unreliable market	190	96.9	10	3.1

There was a statistical significance ($p<0.05$) on banana production constraints among the small holder banana growing farmers (Table 4.10).

Table 4.10: Statistical analysis on banana production constraints

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Y – N	94.70000	5.07976	2.07380	89.36911	100.03089	45.665	5	.000

DISCUSSION

Banana Varieties Grown Among Smallholder Farmers

The findings indicate that Williams Hybrid is the most popular banana variety among smallholder farmers, with a frequency of 82.1%. This was followed by Gros Michel at 70.4%, Apple bananas (sugar bananas) at 69.4%, Plantains at 62.2%, and Cavendish at 55.6%. These preferences align with earlier studies, such as that by Wasilwa *et al*., (2016), which noted a growing trend towards adopting improved banana varieties due to their higher yield and disease resistance. The high adoption rate of Williams Hybrid suggested its suitability to local growing conditions and its perceived economic benefits by farmers. Additionally, the popularity of Gros Michel and Apple bananas can be attributed to their preferred taste and market demand, consistent with the findings of Njiru *et al*., (2018) which highlighted the importance of market preferences in variety selection.

Banana Production Practices

Production Systems

A significant majority of farmers (87.2%) indicated that they did not embrace pure stand production systems, preferring intercropping systems, which 97.5% of farmers adopted. This preference for intercropping is supported by studies like that of Otieno *et al*., (2022), which emphasized the benefits of intercropping in maximizing land use efficiency and improving soil health. Intercropping systems allow farmers to diversify their crops, thereby reducing risks and enhancing food security.

Planting Materials

The study established a high adoption rate of tissue culture planting materials (91.8%), while all farmers (100%) reported using suckers as planting materials. The widespread use of tissue-cultured plants is supported by findings obtained by Mwangi *et al*., (2020), who noted the benefits of tissue-cultured bananas in terms of disease resistance and improved yield. The concurrent use of suckers suggested that while farmers are open to new technologies, they also rely on traditional practices, possibly due to the lower initial costs and ease of access to suckers.

Routine Banana Management Practices

Routine management practices such as weeding (93.9%) and de-leafing (96.9%) were commonly embraced by farmers, indicating a high awareness of the importance of these practices in maintaining banana health and productivity. However, pest and disease control practices were less commonly adopted, with only 15.3% of farmers implementing them. This finding aligns with the

challenges noted by Kariuki and Kimani (2021), who observed that limited access to pest and disease management resources significantly hampers banana production.

Banana Production Constraints

Pests and diseases are universally recognized as major constraints, with 100% of farmers identifying them as challenges. This is consistent with Mwangi *et al*., (2020), who highlighted the pervasive issue of Fusarium wilt in banana plantations. The high cost of fertilizers (97.9%) and unreliable market access (96.9%) were also significant constraints. These issues are well-documented in a study by Njiru *et al.,* (2018) and Kariuki and Kimani (2021) both noting the economic pressures faced by smallholder farmers due to high input costs and market volatility. The lack of soil sampling and testing (95.9%) and organic manures (93.4%) further exacerbated these constraints, limiting the farmers' ability to optimize soil health and fertility.

CONCLUSION

The farmers planted different banana varieties, such as Williams Hybrid, which demonstrated high adoption rates due to their suitability to local conditions and economic benefits. The preference for intercropping systems among farmers highlighted the significance of diversified cropping practices in enhancing land use efficiency and food security.

The high adoption rate of tissue-cultured planting materials reflected farmers' recognition of their benefits, particularly in terms of disease resistance and yield improvement. However, the concurrent use of traditional suckers indicated a need for balancing new technologies with accessible, cost-effective practices.

Routine management practices, such as weeding and de-leafing, were widely practiced, indicating a general awareness of their importance. However, the limited adoption of pest and disease control measures points to significant challenges in accessing necessary resources, impacting overall productivity.

Pests and diseases, particularly *Fusarium wilt*, were major constraints in banana production, underscoring the need for effective disease management strategies. Economic pressures, including high fertilizer costs and market access issues, further constrain production, highlighting the importance of supportive infrastructure and market linkages. Additionally, the lack of soil health practices such as soil sampling and the use of organic manures, points to areas where farmers could benefit from targeted interventions and support.

Recommendations

Overall, the study recommends for integrated approaches that combine improved agricultural practices, effective resource management, and supportive policies to enhance the sustainability and productivity of banana farming among smallholder farmers in Kenya.

Conflict of Interest

"The author(s) declare(s) that there is no conflict of interest."

There was no role of the funding sponsors in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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