

Research Application Summary

**Assessment of papaya distribution and its production practices in Kenya: A case study of Kiambu, Kitui and Meru counties**

Matswane, C.,<sup>1,2</sup> Rimberia, F. K.,<sup>1</sup> Karanja, J.<sup>1</sup> & Kavoo, A.<sup>1</sup>

<sup>1</sup>Department of Horticulture and Food Security, Jomo Kenyatta University of Agriculture and Technology, P.O. Box, 62000-00200, Nairobi, Kenya

<sup>2</sup>Department of Crop and Soil Sciences, Botswana University of Agriculture and Natural Resources, Private Bag 0027, Gaborone, Botswana

**Corresponding Author:** [cmatswane@gmail.com](mailto:cmatswane@gmail.com)

---

**Abstract**

Papaya (*Carica papaya* L.) plays a vital role in human diets as a source of minerals and vitamins. Documentation of papaya distribution and its production practices is important for designing farmer training programs on its production practices to help combat food and nutrition insecurity at the household level. The aim of this study was to document papaya distribution and assess its production practices in Kenya. Survey interviews were done in Kiambu, Meru and Kitui counties, between February and April 2021. Farmers were purposively sampled, interviewed using a semi-structured questionnaire integrated in an-Open Data Kit software; with focused group discussions. Descriptive analysis and comparative statistics were used to evaluate differences between farmers' socio demographics characteristics and production practices. Results showed that most interviewed farmers were males compared to 40 and 18% females in Kiambu and Kitui, respectively. Most farmers (39%) preferred growing papaya for domestic and financial reasons and it was mostly intercropped (76%) with other crops. Farmers' land was used both for residential and farming purposes by 69% of respondents. Farm ownership averaged at 3 acres (1.2 ha) in 57% of sampled farms with 81% of farmers practicing papaya farming on less than an acre of the total land. Use of organic fertilisers, manual watering and transplanting during dry and short rainy seasons were practiced by most farmers. Our research findings showed that there is need to enhance training of farmers on papaya production practices and the potential benefits of growing papaya to help improve nutritional outcomes and household livelihoods in Kenya.

Key words: *Carica papaya*, Kenya, production barriers

**Resume**

La papaye (*Carica papaya* L.) joue un rôle essentiel dans l'alimentation humaine en tant que source de minéraux et de vitamines. La documentation de la distribution de la papaye et de ses pratiques de production est importante pour concevoir des programmes de formation des agriculteurs sur ses pratiques de production afin de lutter contre l'insécurité alimentaire et nutritionnelle au niveau des ménages. Le but de cette étude était de documenter la distribution de la papaye et d'évaluer ses pratiques de production au Kenya. Des entretiens d'enquête ont été réalisés dans les comtés de Kiambu, Meru et Kitui, entre février et avril 2021. Les agriculteurs ont été délibérément échantillonnés, interrogés à l'aide d'un questionnaire semi-structuré intégré dans un logiciel Open Data Kit ; avec des discussions de groupe ciblées.

Une analyse descriptive et des statistiques comparatives ont été utilisées pour évaluer les différences entre les caractéristiques sociodémographiques des agriculteurs et les pratiques de production. Les résultats ont montré que la plupart des agriculteurs interrogés étaient des hommes contre 40 et 18 % de femmes à Kiambu et Kitui, respectivement. La plupart des agriculteurs (39%) préféraient cultiver la papaye pour des raisons domestiques et financières et elle était principalement associée (76%) à d'autres cultures. Les terres des agriculteurs étaient utilisées à la fois à des fins résidentielles et agricoles par 69 % des répondants. La propriété agricole était en moyenne de 3 acres (1,2 ha) dans 57% des fermes échantillonnées, 81% des agriculteurs pratiquant la culture de la papaye sur moins d'un acre de la superficie totale. L'utilisation d'engrais organiques, l'arrosage manuel et le repiquage pendant les saisons sèches et courtes des pluies étaient pratiqués par la plupart des agriculteurs. Les résultats de nos recherches ont montré qu'il est nécessaire d'améliorer la formation des agriculteurs sur les pratiques de production de papaye et les avantages potentiels de la culture de la papaye pour aider à améliorer les résultats nutritionnels et les moyens de subsistance des ménages au Kenya.

Mots clés : *Carica papaya*, Kenya, barrières à la production

---

## Introduction

The world is faced with lack of sufficient food to feed its growing population. Maintaining food security is difficult as people do not have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. In Africa over 27 million people are food insecure and require humanitarian assistance, a 39% increase in food insecurity since 2016 (FAO, 2020). Food insecurity remains a persistent problem in East Africa with the highest prevalence of undernourishment, despite the fact that the region produces enough food to feed itself. Persistent droughts, high costs of domestic food production and low purchasing power are some of factors accelerating food insecurity in Kenya with 3.4 million people in 2017 suffering from acute food insecurity (Situation, 2017). Reports have shown varying national rates with 25% of children aged below five years stunted due to malnutrition in Kenya, with highest rates in in Kitui and West Pokot counties both at 46%.

Fruit and vegetable consumption is highly recommended for better health. Fresh fruits are known to play a very significant role in food security and human nutrition, as sources of vitamins, minerals and dietary fibre. Papaya (*Carica papaya* L.), which belongs to the Caricaceae family, is a popular fruit native to the tropical America (Parni and Verma, 2014). The edible portion of a ripe papaya fruit has a high nutritive value (Parni and Verma, 2014) and a rich source of powerful antioxidants (Aravind *et al.*, 2013). It is primarily a fresh-market fruit, used in drinks, jams, pectin, candies and as crystallised fruit. It can effectively treat and improve all types of digestive and abdominal disorders like constipation (Aravind *et al.*, 2013). Papaya is mostly produced along the tropical climacteric areas in Africa where there are warmer temperatures and adequate rainfall. It was introduced in Kenya centuries ago where it is mostly grown for domestic and financial purposes mostly by small-scale farmers (Asudi *et al.*, 2010). Quality and productivity of papaya is highly affected by its production practices such as soil type, water quality and quantity, plant nutrition, use of pesticides, storage and processing. Transplanting of papayas is mostly done during the dry or short rainy seasons as they hardly survive under water logging conditions as excess irrigation water results in plant death due to

reduced oxygen concentration in the root system (Campostrini *et al.*, 2010). Reports on irrigation effect on water and nutrient supply to the plant has shown that it can affect the nutritional and antioxidant capacity of fruit. Good weed control practices have also shown to increase papaya yields. Inorganic and organic fertilisers have a positive effect on plant growth, quality and yield when used at the recommended dosages. Due to their high nutrient demands, papaya require nutrients continuously in large amounts especially during its vegetative growth in readiness for the reproductive stage. Research indicates that high environmental temperatures accompanied by droughts can result in poor fruit set and maturation of papaya. Knowledge of papaya production practices by farmers can improve its production, yield and quality of its fruits in Kenya. The main aim of this research was to document papaya distribution and assess its production practices in Kenya.

## Methodology

**Study Sites.** The study was carried out between February and April 2021 in three agro-ecological zones of Kenya, i.e., being Kiambu, Kitui and Meru counties. Kiambu County is located in the Central Kenya region and lies on the geographical coordinates of 1.1748° S and 36.8304° E at an elevation of 1720 m above sea level. Its average annual temperature is about 18°C and receives an annual rainfall of about 674 mm. Kitui and Meru counties are located in the Eastern Kenya region. Meru County is on the Upper Highlands at a latitude of 0.0515° N and 37.6456° E longitude at an elevation of 1600 m above the sea level. Its average annual temperature is about 20.1°C and receives an average annual rainfall of about 550 mm. Kitui County is on the Lower highlands at a latitude of 1.6833° S and 38.3166° E longitude at an elevation of 1121.20 m above sea level. Its average annual temperature is about 21.9°C and receives an average annual rainfall of about 881 mm.

**Experimental design.** An interview research design was used to collect qualitative and quantitative data for farmers' socio demographics, papaya distribution and its production practices using the purposive sampling method, with 30% of farmers from each county. Agricultural extension officers and key informants knowledgeable on sampled papaya farming areas were consulted to get correct identification of papaya farmers.

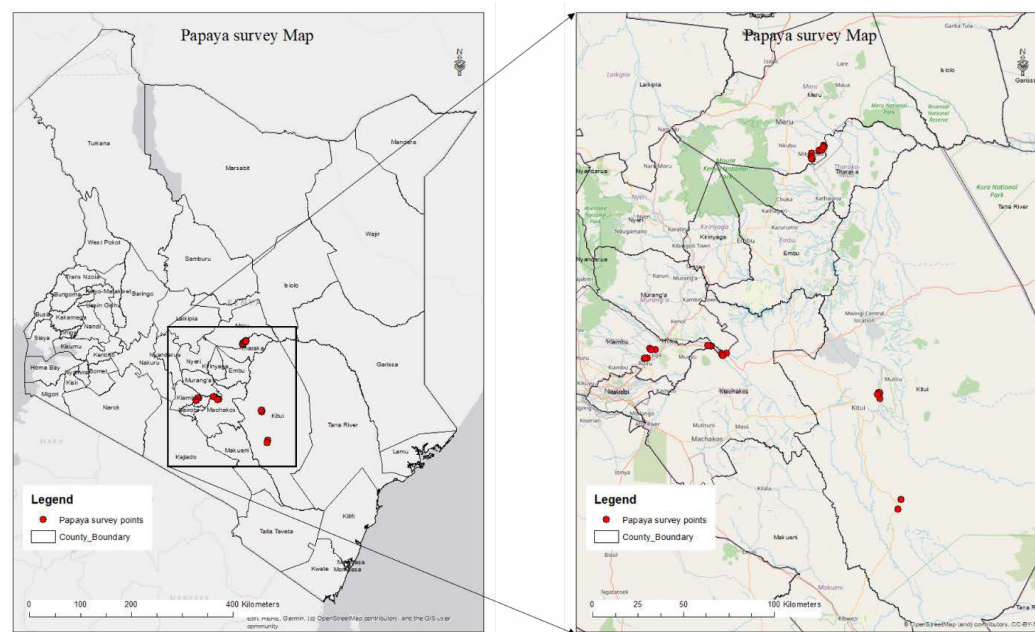
**Data collection.** Data were collected through survey interviews with the different papaya farmers being the respondents. The survey forms consisted of structured and non-structured questions. The questionnaires were then translated into the Open Data Kit (ODK) software for ease of data collection using mobile phones. Mapping of the surveyed fields was done using the encompassed Global Positioning System (GPS) receiver. The interviews focused on assessing the farmers' socio demographic characteristics including gender, age, marital status, household head, household number, education level and their source of income; and papaya production practices. Focused Group Discussions (FGDs) were also conducted (average of 8 people per county) to assess the levels of papaya production and the practices employed in production. These discussions were organized by either the Agricultural extension officer or the key informant farmer for the respective counties.

**Data analysis.** Collected data were downloaded from the ODK server and exported to STATA version 15 (USA) for further analysis. Descriptive analysis of the collected data was done by calculating means, percentages and frequencies. Comparative statistics were used to evaluate differences between farmers' socio demographics and production practices in the three counties.

Quantitative analysis was done using analysis of variance (ANOVA) while qualitative data was analysed using emerging themes which are presented as narratives and triangulated with the quantitative data.

## Results and Discussion

**Papaya distribution.** Results from this study have shown that papaya farm distribution was different in all the three counties. Papaya distribution in Meru County was reported in seven villages located between altitudes of 859 and 1050 meters (m) while in Kitui County, farmers were sampled in three villages located between altitudes of 656 and 873m above sea level (a.s.l) (Figure 1). In Kiambu County, nine villages located between altitudes of 1351 and 1533m a.s.l. were visited for survey of papaya farmers. A total of thirty-seven farmers were interviewed with twelve, nine and sixteen from Meru, Kitui and Kiambu counties, respectively. Differences in papaya distribution patterns could be attributed to different climatic conditions, farm practices or their proximity to the urban market. Papaya grows well under tropical climates like those in Meru and Kitui counties while Kiambu County experiences a warm and temperate climate. Proximity of Kiambu County to the urban market is advantageous for commercial production of papaya. Fruit production in Kenya is an important foreign exchange earner and contributes to food, employment and farm incomes for the rural population. Documentation of papaya fruit crops in the different counties in Kenya is necessary to encourage farming where climatic conditions are not limiting, and to reduce exports or increase imports of fruits. Statistics show that Kenya may have enough food at national level but that does not guarantee household and individual food availability as the government continues to feed most of its food insecure population with imported food. Also, information on papaya distribution is important as the fruit crop has high economic returns and has a potential as an export crop. Reports have shown that papaya was ranked as the 6th fruit of importance contributing 4% of the fruit's subsector with the recent ranking of fruits contribution to the Kenyan Gross domestic product (GDP).



**Figure 1. Distribution of the surveyed papaya farms in Meru, Kitui and Kiambu counties, Kenya**

**Farmers' demographic characteristics.** The results of this survey indicated that papaya farming is male dominated with 38% and 22% of females in Kiambu and Kitui counties (Table 1). In Kiambu County, 63% of farmers were males while in Kitui and Meru counties, males farmers were at 78% and 100%, respectively. Households were mainly headed by married male adults in Kiambu (87.5%), Kitui (100%) and Meru (100%). Unmarried female household heads (12.5%) were reported only in Kiambu County. Agriculture has been male dominated for many years with few females due to its labour intensive activities while women have the primary responsibility of taking care of the household and raising children. Even though women play a major role in the agricultural economy; making two-thirds of the agricultural labour force and produce the majority of Africa's food, rural women in Kenya are heavily dependent on males due to the socially constructed traditional gender roles that define the division of labour (Onyalo, 2020), and hence are subordinates in all traditional roles defined by the society.

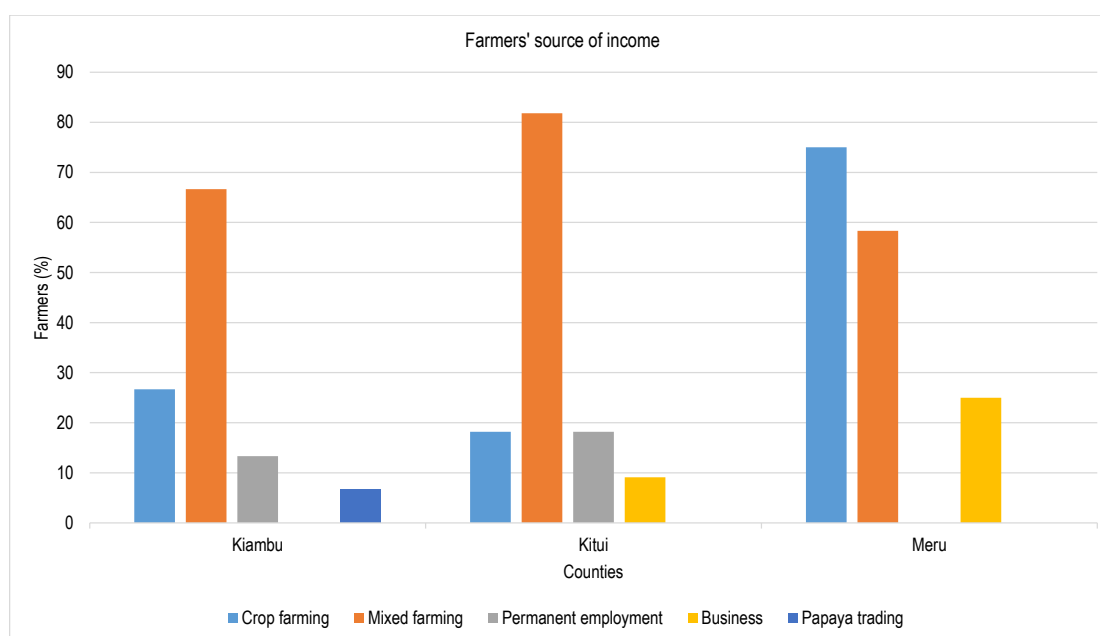
Research has shown that eliminating the barriers to women's becoming more efficient farmers could help more Africans find a route out of poverty (Gender and Index, 2015) as this will reduce the productivity gap and increase food security. Research has also shown that female headed households are food insecure and have low incomes due to the rural-urban migration of men in search of paid employment in towns and cities, either in their own country or abroad (Onyalo, 2020). The farmers' average ages were 46-60 years in Kiambu and Kitui, compared to 36-45 years in Meru. Adults are good at making sound decisions concerning agricultural practices. The average number of persons in most households was 5-8 for Kiambu (62.5% of households) and Kitui (77.8% of households) counties. In Meru, 33% of farmers had a household size of 1-4 persons while 17% had a household size of more than 8 (Table 1). Large families tend to have an effect on farming systems that have high labour requirements and thus, a potential for sustainability (Mbinda *et al.*, 2021) on papaya production. From this study, the average household number/size in the surveyed counties were above Kenya's average household size of 3.9 persons.

**Table 1. Socio demographic characteristics of sampled papaya farmers in Kiambu, Meru and Kitui counties, Kenya**

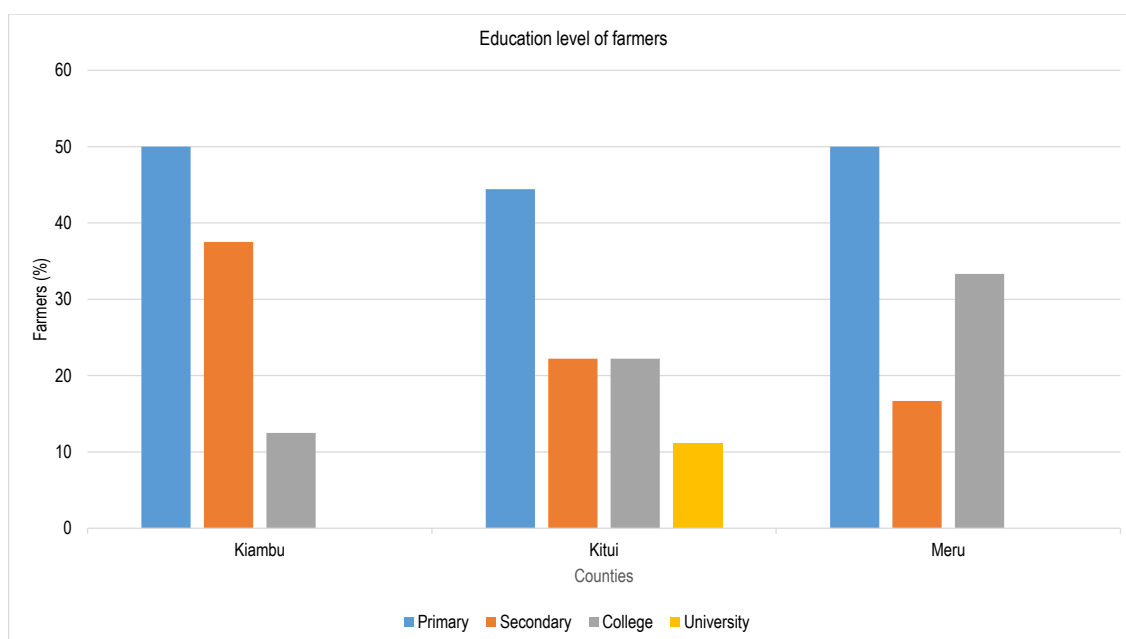
Variable	Category	Kiambu (%)	Kitui (%)	Meru (%)
Gender	Male	62.5	77.8	100
	Female	37.5	22.2	0
Age (years) of respondents	20 - 35	12.5	11.1	8.3
	36 - 45	12.5	22.2	41.7
	46 - 60	68.8	66.7	16.7
	Above 60	6.3	0	33.3
Marital status	Single	12.5	0	0
	Married	87.5	100	100
Household head	Male	87.5	100	100
	Female	12.5	0	0
Household number	1 to 4	37.5	22.2	33.3
	5 to 8	62.5	77.8	50
	Above 8	0	0	16.7

**Farmers' source of income.** Agricultural production is considered the main source of money and security for the majority of households in Kenya. Majority of the farmers relied mostly on mixed farming as their main source of income. Crop farming was mostly done in Meru (75%), Kiambu (27%) and Kitui (18%) while mixed farming was mainly practiced in Kitui (82%), Kiambu (67%) and Meru (58%) (Figure 2). Meru and Kitui counties are generally more settled agricultural communities which form a good entry point for transfer of crop related technologies. Rural people's reliance on agriculture for their livelihoods and the high share of their expenditure on food in their household budgets, make agriculture the key to poverty and hunger alleviation.

**Education level of farmers.** Over fifty percent of the respondents, in all counties, had a minimum of primary level education necessary to understand basic papaya farming skills (Mbinda *et al.*, 2021). Farmers who had secondary education were reported at 38%, 22% and 17% in Kiambu, Kitui and Meru counties, respectively. College graduate farmers were reported at 12.5%, 22% and 33% at Kiambu, Kitui and Meru counties, respectively, with 11% of university graduate farmers reported in Kitui County only (Figure 3). Improved papaya production and management require high level of expertise from farmers in order to be implemented effectively. Studies have shown that educated farmers are generally more open to innovative ideas and new technologies that promote positive change in farming (Madisa *et al.*, 2010). Kenya, like other African countries have now effectively eliminated the gender gap in primary education, as it has increased access to primary education for most people in the past decade. Educated farmers will also have a better knowledge of the benefits of adopting improved papaya production practices and will more likely adopt the practice compared to the uneducated ones.



**Figure 2. Sources of income of the sampled papaya farmers in Kiambu, Kitui and Meru counties in Kenya**



**Figure 3. Education levels of the sampled papaya farmers in Kiambu, Kitui and Meru counties, Kenya**

**Farmers' production practices.** In Kenya, production practices of most crops, including papaya, are mostly affected by among others, lack of farming knowledge and skills, changing climatic conditions, intensive capital funds and lack of agricultural land which results in the country being food insecure. Information gathered from the FGDs was that most farmers were not formally trained on papaya farming, with less than 5 years practicing papaya farming; this resulted in poor production practices. Farmers also expressed challenges which affect papaya farming like pests and diseases, poor/low irrigation water, lack of farm inputs, lack of market, lack of skills and high inputs prices. This study have shown that over 70% of the sampled farmers did not have a papaya nursery which resulted in use of easily available and low quality seedlings. Plants were transplanted mostly during the short rainy and dry seasons to avoid flooding from heavy rains. Waterlogging in papaya plants results in plant death due to reduced oxygen concentration in the root system (Campostrini *et al.*, 2010). High environmental temperatures and droughts have been reported to negatively affect papaya fruit set and maturation resulting in poor plant growth and reduced yields. Different irrigation systems were used by farmers with 68 and 26% of them mostly using manual watering and sprinklers respectively (Table 2). Less than 20% of the total farmers used drip, flood, mulching and rain-fed irrigation in their papaya farms. Adequate and reliable irrigation water is necessary as it can affect the nutritional and antioxidant capacity of the fruit. Papaya plants were mostly grown as intercrops since papaya was not the main fruit crop (76%) as indicated by the farmers' responses. They were intercropped with other fruits like bananas, mangoes, oranges and field crops (maize, cassava, pigeon peas, and beans) to utilize space in-between the plants and time during their vegetative growth. Majority of farmers (88%) preferred using organic fertilisers on their papaya farms compared to 12% who used inorganic ones like kraal manure (cow/goat). These fertilisers contain most of the required plant nutrients necessary for good plant growth and quality attributes. Farmers reported use of urea, DAP, NPK and kraal manure. Domestic (24%) and financial (37%) reasons were reported for growing papayas. Data on production practices was pooled for all the three counties.

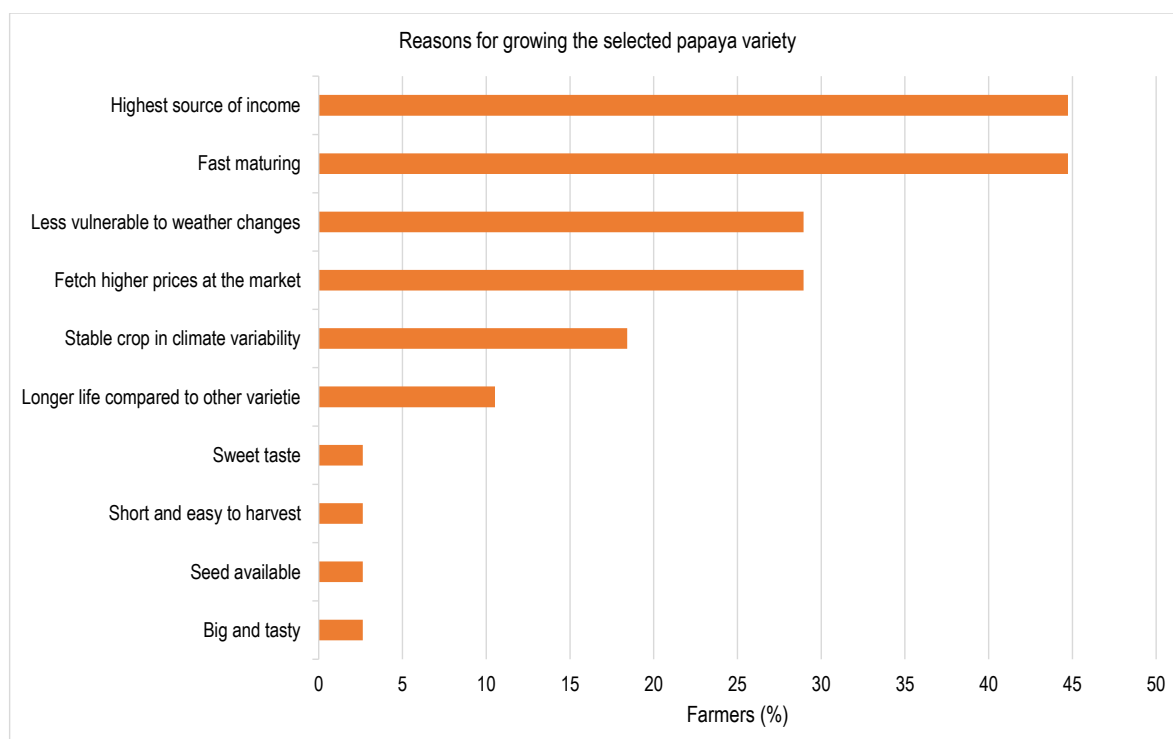
**Table 2. Production practices of the sampled papaya farmers in Kiambu, Meru and Kitui counties, Kenya**

Production Practices	Description	Percent (%)
Production nursery	Yes	28.95
	No	71.05
Transplanting	Dry season	60.53
	Rainy season (short)	65.79
	Rainy season (long)	52.63
Irrigation practices	No irrigation	7.89
	Drip	7.89
	Sprinkler	26.32
	Flood	2.63
	Manual watering	68.42
	Mulching	2.63
Fertilisers	Organic	88.24
	Inorganic	11.76
Farming system	Standalone	24.32
	Intercropped	75.68
Farming period	Less than 5 years	70.27
	6-10 years	27.03
	16-20years	2.7
Papaya main fruit crop	Yes	24.32
	No	75.68
Reasons for Growing Papaya	Market	37
	Domestic	24
	Both domestic and market	39

**Reasons for growing the selected Papaya variety**

several reasons were reported by farmers for growing the different papaya varieties. Fast maturing and highest source of income; and higher price and less vulnerable to weather changes were the most reasons ranked at 45% and 29% respectively (Figure 4). Most farmers depend on farming as their source of income hence they preferred growing papayas for the aforementioned good traits. Mountain and Solo were the common varieties reportedly grown by most farmers while other farmers did not know the papaya varieties they had planted.





**Figure 4. Reasons for growing the selected papaya variety by the sampled papaya farmers in Kiambu, Meru and Kitui counties, Kenya**

**Farmers' land ownership.** From this study, 92% of men owned their farm land compared to 5% of women. Although it has been observed that women make up two-thirds of the agricultural labour force, they produce the majority of Africa's food and play a major role in the agricultural economy (Gender and Index, 2015). Women still have much less access to, or control over, critical productive resources such as land, as confirmed by this study. Customary land tenure systems in Africa do not allow women to control or own land with only 15% of women landowners. In Kenya, customary laws still restrict women from owning land or from inheriting it from their husbands or families. The customary land laws deny women access to land, since land traditionally is inherited by men, thereby creating an insecure situation for women regarding the land they cultivate. While agriculture is still regarded as the backbone of Africa's economy, employing 70% of the population (Gender and Index, 2015), farmers are still allocated less agricultural land for farming. From this study, majority of farmers had less than five acres of land used for both residential and farming purposes. Fruit crops have always been grown in small farms (Yabs and Awuor, 2016) where they are intercropped with other field and vegetable crops. This study is in agreement with the above mentioned as more than 80% of the respondents had grown their papaya crops in areas less than one acre (Table 3)

**Table 3. Land ownership of the sampled papaya farmers in Kiambu, Meru and Kitui counties, Kenya**

Variable	Frequency (F)	Percent (%)
<b>Tenure</b>		
Own with title	25	69.44
Rented	6	16.67
Community owned	5	13.89
<b>Ownership</b>		
Man	34	91.89
Woman	2	5.41
Other	1	2.7
<b>Land size</b>		
Less than 1 acre	12	32.43
1 to less than 5 acres	21	56.76
5 to less than 10 acres	2	5.41
More than 10 acres	2	5.41
<b>Land size under papaya production</b>		
Less than 1 acre	29	80.56
1 to less than 5 acres	7	19.44

## Conclusion

It can be concluded that farmers in Kenya practice papaya farming for financial and domestic reasons hence formal training is encouraged to equip farmers with the necessary production practices of papaya to boost farming and household livelihoods. Low agricultural land acquisition seems to hinder papaya farming even though most farmers are learned and can easily execute most of the papaya production practices well.

## Acknowledgement

Support for this research was made possible through a capacity building competitive grant Training the Next Generation of Scientists provided by Carnegie Cooperation of New York through the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM). A great appreciation goes to all the interviewed farmers, Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Botswana University of Agriculture and Natural Resources (BUAN) for their support. This paper is a contribution to the Seventh Africa Higher Education Week and RUFORUM Triennial Conference held 6-10 December 2021 in Cotonou, Benin.

## References

- Asudi, G. O., Ombwara, F., Rimberia, F. and Ateka, E. M. 2010. Collection and documentation of Papaya germplasm in Kenya. 233-237pp. In: Second RUFORUM Biennial Meeting, Entebbe, Uganda.

- Aravind, G., Bhowmik, D., Duraivel, S. and Harish, G. 2013. Traditional and medicinal uses of *Carica papaya*. *Journal of Medicinal Plants Studies* 1 (1): 7-15.
- Campostrini, E., Pommer, C. V. and Yamanishi, O. K. 2010. Environmental factors causing physiological disorders in papaya plants. *Acta Horticulturae* 851; 453–458.
- Food and Agriculture Organisation (FAO). 2020. Food Security and Nutrition in the World. In IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. Rome, Italy.
- Gender, A., and Index, E. 2015. Empowering African Women: An Agenda for Action. Africa Gender Equality Index. Côte d'Ivoire. 30pp.
- Madisa, E., Assef, Y. and Obopile, M. 2010. Assessment of production constraints, crop and pest management practices in Peri-Urban vegetable farms in Botswana. *Egyptian Academic Journal of Biological Sciences* 1(1): 1–11. <https://doi.org/10.21608/eajbsh.2010.17011>
- Mbinda, W., Kavoo, A., Maina, F., Odeph, M., Mweu, C., Nzilani, N. and Ngugi, M. 2021. Farmers' knowledge and perception of finger millet blast disease and its control practices in western Kenya. *CABI Agriculture and Bioscience* 2 (1): 1–12. <https://doi.org/10.1186/s43170-021-00033-y>
- Onyalo, P.O. 2019. Women and agriculture in rural Kenya: role in agricultural production. *International Journal of Humanities and Social Science* 4 (4):1-10.
- Parni, B., and Verma, Y. 2014. Biochemical properties in peel, pulp and seeds of *Carica papaya*. *Plant Archives* 14 (1): 565–568.
- Situation, F. S. 2017. Kenya: Nutrition Profile. 1–7. Accessed 30/08/2021. <https://www.usaid.gov/global-health/health-areas/nutrition/countries/kenya-nutrition-profile>.