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Banana Production Systems, Constraints and Management Strategies in Nyeri County, Kenya

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Abstract

Banana (*Musa acuminata* L.), ranks first among horticultural fruits in Kenya. The crop accounts for 17.8% of the total value and 34.5% of all fruits. The crop is mainly grown for food security and income generation mainly by smallholder farmers. In Kenya, the crop is one of the prioritized value chains for upgrading. The aim of the study was to conduct a situation analysis on banana production in Tetu and Othaya sub-Counties of Nyeri County. Data on household characteristics, banana production practices and constraints and marketing was collected from banana farmers and subjected to Statistical Package for Social Sciences (SPSS) version 25.0. The study indicated that 81% of households' heads were males. The respondents (80%) depended on farming for livelihood. Farmers mainly grew banana cooking variety Uganda green (42.5%), ripening variety Sweet banana (21.49%) and Muraru (20.18%). Most farmers used suckers (72%) obtained from own farm (50%) and community (37%) as planting materials. Only 3% of the respondents used tissue culture (TC) banana plantlets. Local market (46%) absorbed most of the banana produce. The main constraints identified to affect banana production were delayed rainfall (60%), diseases (60%), lack of improved varieties (57%) and field pests (48.5%). The findings from this study showed that men are more involved in banana production and farmers had not embraced tissue culture technology for clean planting materials and yield improvement. Therefore, there is a need for gender inclusion in banana production and training programs which are essential for raising awareness TC banana technology for disease management and increased yield for enhanced food security and income.

Keywords: banana, food and nutritional security, income, cultivars, tissue culture technology

1. Introduction

Banana and plantain (*Musa* spp. L.) collectively referred to as banana is among the 20 top food crops globally (FAO, 2020). It is an important fruit in tropical and subtropical regions and essential staple food for many developing countries. Banana is among the world's most popular fruit and food crop cultivated after rice, wheat and maize (Aurore et al., 2009; Woldu et al., 2015). It is a key food security and cash crop feeding millions of people worldwide (FAO, 2021). Almost all the cultivated bananas are seedless triploid varieties derived from two diploid species, A genome (*M. acuminata*) and B genome (*M. balbisiana*) resulting in the genome groups AAA, AAB and ABB (Simmonds & Shepherd, 1995). Small-scale farmers in sub-Saharan Africa (SSA) grow different banana varieties such as cooking, desert, brewing and roasting types. The cooking banana types are the most important, for household food security and income generation by millions of smallholder farmers in SSA (Alemu, 2017; Dotto et al., 2018; Marimo et al., 2020). They are largely cultivated in mixed-crop fields and backyards of most homesteads with low or no external inputs like fertilizers, pesticides and chemicals for disease management and control. Banana productivity in SSA remains low at 7.3 million metric tonnes/ha mainly because of the widespread negative impact of several pests and diseases (Wachira et al., 2013; Alemu, 2017; FAO, 2021).

In Kenya, banana accounts for 17.8 and 32.73% of the total value of domestic horticulture and fruit export. Banana is the leading fruit in Kenya, under 72,486 ha with a production of 1,871,521 tons valued at 216.63 US

Dollars (HCD, 2020). The banana is source of income, and employment for a large rural population and contributes significantly to the national economy annually (HCD, 2020; Karienye & Kamiri, 2020). Because of its importance, banana production has out-scaled considerably from the high rainfall/high production areas to the lower rainfall/low production arid and semi-arid lands (ASALs) (Karienye & Kamiri, 2020). In Kenya, banana is a source of food and nutrition security providing much needed energy, minerals and vitamins. The fruit is consumed mainly as fresh fruit, cooked or processed food items, alcoholic beverages or confectionery. Its pulp is dried and ground into flour for feeding the children (Rabbani et al., 2004; Sarawong et al., 2014). In addition, it is an important source of livestock feed. Flowers of some banana varieties are used in traditional folk medicine (De Souza et al., 2004; Kumar et al., 2012; Zaini et al., 2022).

Despite its importance its full potential has not been fully realized. Yields of 30 to 40 t/ha are possible but harvest of 10 t/ha or less are realized. The production of banana is mainly constrained by stresses such as unpredictable rainfall, lack of clean planting materials, poor soil fertility and high incidence of pests and diseases (Mbaka et al., 2008; Thuo, 2018; Karienye & Kamiri, 2020). According to Karienye and Kamiri (2020), the banana ecological requirements and need production systems have been investigated. However, the endogenous production systems and constraints, current varietal diversity and the varietal preference criteria, management practices, sources of inputs and the strategies implemented by farmers are either not clearly documented or unknown in Kenya.

Knowledge on banana varieties contributes to a better understanding of environmental adaptation and the efficient utilization of genetic resources (Turcotte et al., 2017; Van de houwe et al., 2020; Wada et al., 2022). Thus, appreciating the farmers' preferred varieties and identification, cultivation, utilization and conservation is important to conserve genetic resources (Turcotte et al., 2017; Van de houwe et al., 2020; Solgotra & Chauhan, 2023). An understanding of farmers' knowledge is essential for planning research and development activities and in situ conservation strategies (Jarvis et al., 2000; Wada et al., 2022). Understanding the socio-demographic factors is also crucial as they influence farmers' decision (Mwadzingeni et al., 2022). The study aimed to evaluate banana production systems, constraints and management strategies in Nyeri County, Kenya. The objectives of the study were: to determine gender involvement and experience in banana production, importance and utilization of the crop, establish constraints to banana production, identify the common banana varieties grown in the area and determine sources of banana planting materials.

2. Materials and Methods

2.1 Description of the Study Area

The study was carried out in Othaya and Tetu sub-Counties of Nyeri County in Kenya. The County occupies 3325 km^2 and has a population of 759,164 persons (KNBS, 2019). The County is neighbor to Kirinyaga County to the East, Nyandarua to the West, Murang'a to the South, Laikipia to the North and Meru County to the North East. Nyeri County is composed of 8 sub-Counties namely: Kieni East, Kieni West, Mathira East, Mathira West, Nyeri Central, Mukurweini, Tetu and Othaya (CSP, 2019). The arable land in the County is 987.5 km^2, while 758.5 km^2 is non-arable land. Land in the County is owned by individuals as freehold and mainly subsistence farming is practiced. Majority of the smallholders have a mean land holding size of one hectare (CSP, 2019).

According to County Integrated-Development-Plan, 2018-2022, the area experiences two rain seasons namely long rains (March to May) and short rains (October to December), which occasionally changes due to climatic conditions. The annual rainfall is 1,200-1,600 mm (long rains) and 500-1,500 mm (short rains). The County lies between 3,076 meters and 5,199 meters above sea level and has a monthly mean temperature of 12.8 ºC to 20.8 ºC (County Strategic Plan 2018/19-2022/23).

2.2 Sampling Method

The first stage was purposeful selection of two sub-Counties namely Tetu and Othaya based on their record in banana cultivation and availability of banana fields. This was informed by the preliminary survey and discussions with the agricultural extension officers of each sub-County. Multi-stage sampling technique was used to select farmers in the study. A total of 73 farmers with experience in growing bananas were purposely selected with the assistance of the local leaders, extension officers and head of the farmer groups in the two sub-Counties.

2.2 Data Collection

Individual interviews with farmers were conducted using semi-structured questionnaires and focus group discussions. The interview was conducted in the respondent's native language (Kikuyu or Kiswahili). Before collecting farmers' perception, they were informed about the banana situational analysis and its benefits, clearly

underlining the fact that the results would be used for academic and research purposes and that no commercial interest will be attached to it. A verbal agreement was obtained from the authorities of local communities prior to administering the interview. The information provided by the farmers included varieties cultivated, preferred traits, sources of planting material, constraints to banana production, field management practices, harvesting, utilization, marketing and ripening. In addition, banana fields were physically observed.

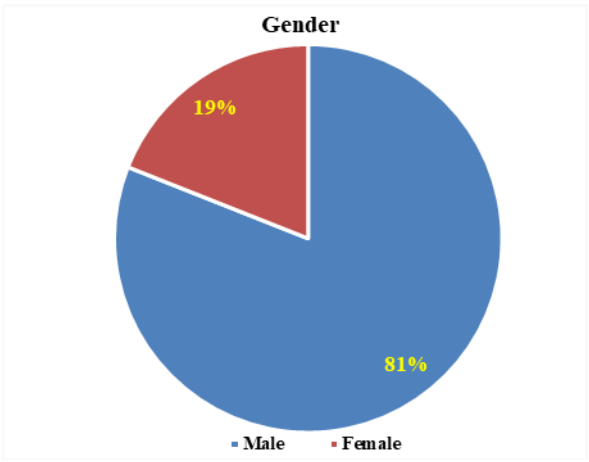
2.3 Data Analysis

The data was coded, organized and subjected to statistical analysis using Statistical Package for Social Sciences (SPSS) version 21.0. The results were presented using tables, pie charts and graphs.

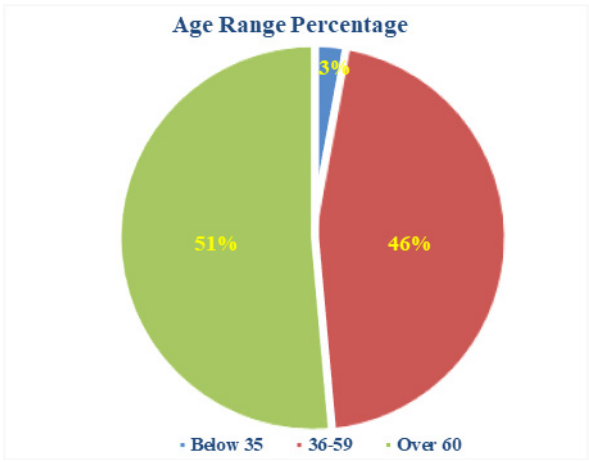
3. Results

3.1 Demographic and Household (Socio-demographic) Characteristics of Banana Farmers

The socio-demographic characteristics of the interviewed farmers are presented in Figure 1. The respondents were 81% males and 19% female farmers (Figure 1A). Majority of the respondents (51%) were aged > 60 years, those aged 25-59 years were 46% and 3% were < 35 years old (Figure 1B). In terms of education level, 47.06% of the respondents had primary, 41.18% had secondary and only 5.88% had tertiary level of education (Figure 1C). Over 80% of the respondents were entirely dependent on farming while 20% were also involved in secondary occupation (Figure 1D).



(A)



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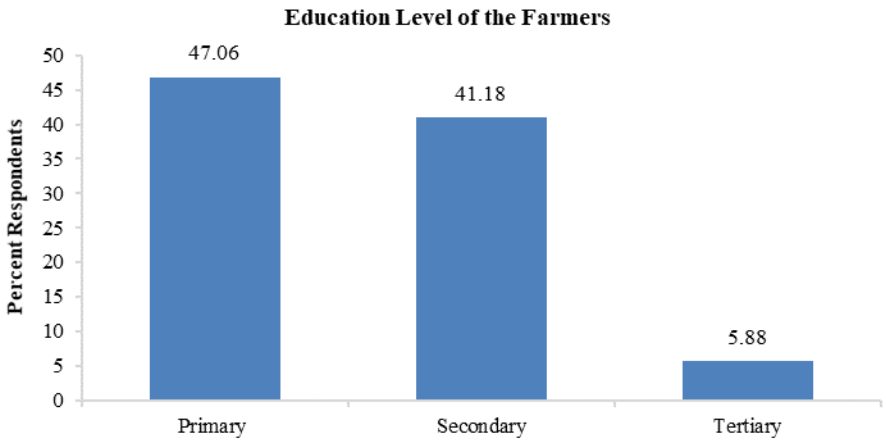

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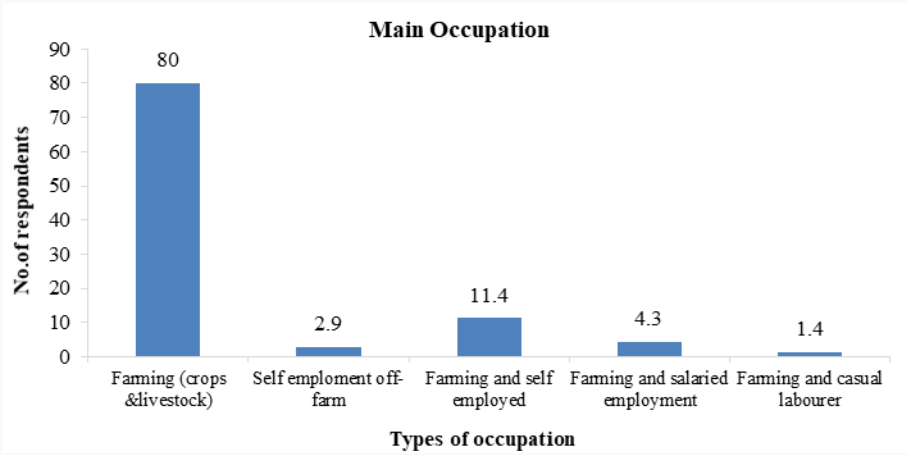

(D)

Figure 1. Socio-demographic characteristics of the respondents: (A): Gender; (B): Age range; (C): Education level of the farmers; (D): Main occupation of the respondents

3.2 Banana Farming Experience

The farmers at the rate of 19.9%, 18.5% and 15.6% had experience in banana farming in the range of 21 to 30, 31 to 40 and 11 to 20 years, respectively (Figure 2).

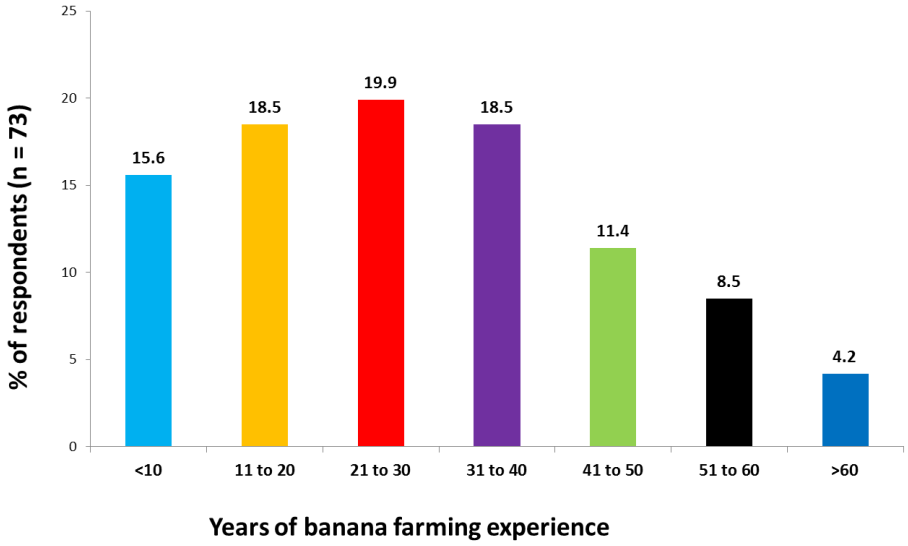

Figure 2. Farmers' experience in banana cultivation

3.3 Banana Utilization

It was noted that farmers used banana domestically as food (34%), animal feed (6%) and for commercial purposes (60%) (Figure 3).

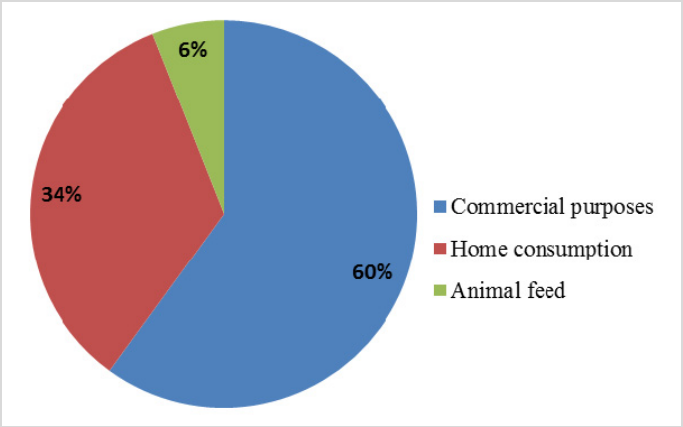

Figure 3. Utilization of banana by respondents

3.4 Banana Production Constraints

Several banana production constraints were identified as follows; delayed onset of rains and diseases (60%), lack of improved varieties (57%) and insect pests (48.5%). In addition, lack of supporting poles (3%), lack of market (4.2%) and small land sizes (4.2%) were mentioned (Figure 4).

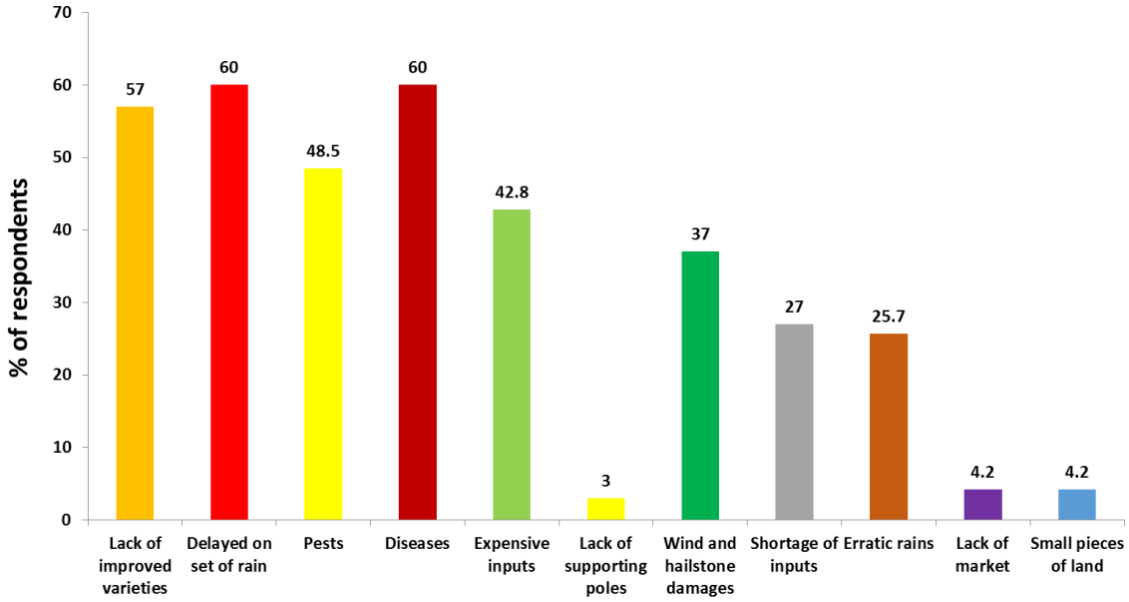

Figure 4. Constraints to banana production

In terms of banana field pest infestation moles were ranked highest (90%). The banana weevil (8.6%), nematodes (4.30%), aphids (1.4%) and fruit flies (1.4%) were also reported by the farmers (Figure 5).

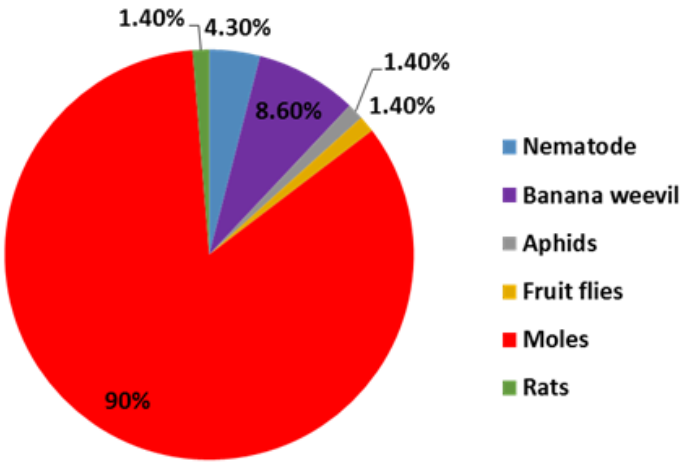

Figure 5. Banana field pests

The banana, cigar end rot (28.60%) and *Fusarium wilt* (18.70%) were the major diseases reported. Anthracnose was the least (5.70%) common of the diseases reported to affect banana production (Figure 6).

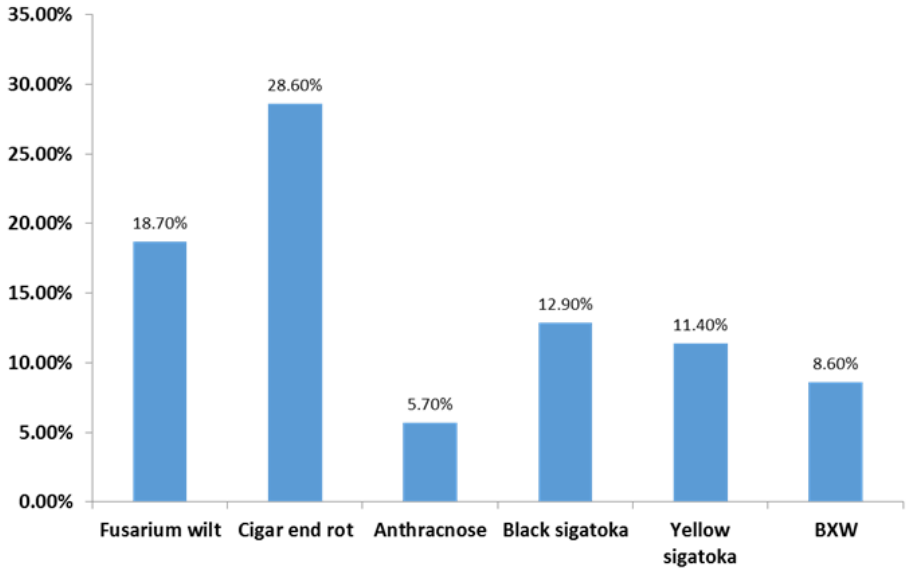

Figure 6. Banana diseases

3.5 Banana Marketing and Marketing Information

Farmers (46%) sold their banana in the local markets while, 14% and 8% sold through the middlemen and at farm gates, respectively (Figure 7).

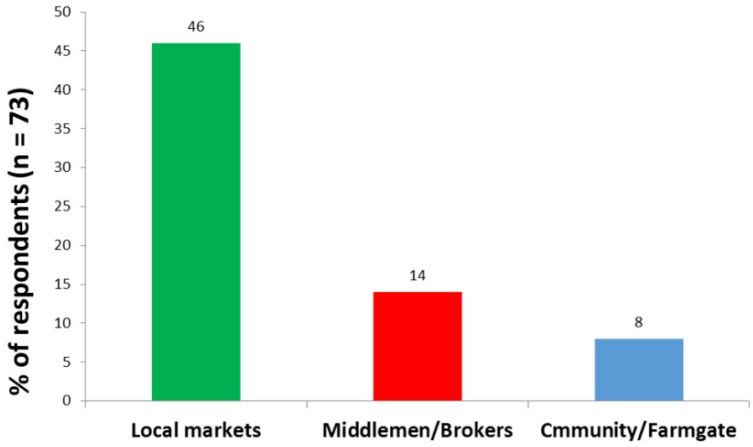

Figure 7. Banana marketing channels

3.6 Banana Planting Materials

The planting materials preferred and used by farmers were suckers (72%), combination of tissue culture plantlets and suckers (25%) and tissue culture plantlets alone (3%) (Figure 8).

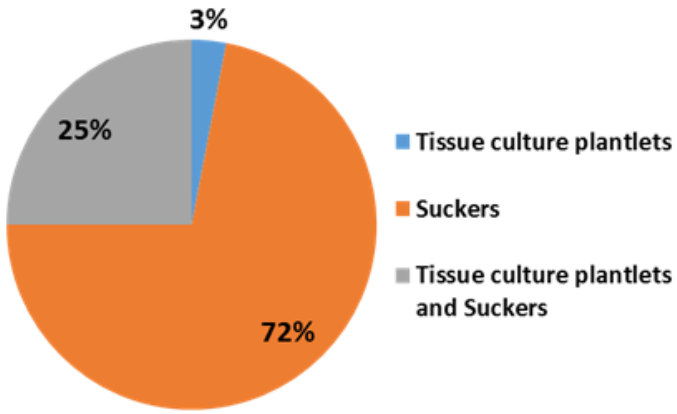

Figure 8. Planting materials used by farmers

The farmers sourced planting materials from neighbors/communities (50%), their own farms (37%) and research institutions/private nurseries/farmer training centers (13%) (Figure 9). Farmers preferred using suckers (72%) from their farms/community.

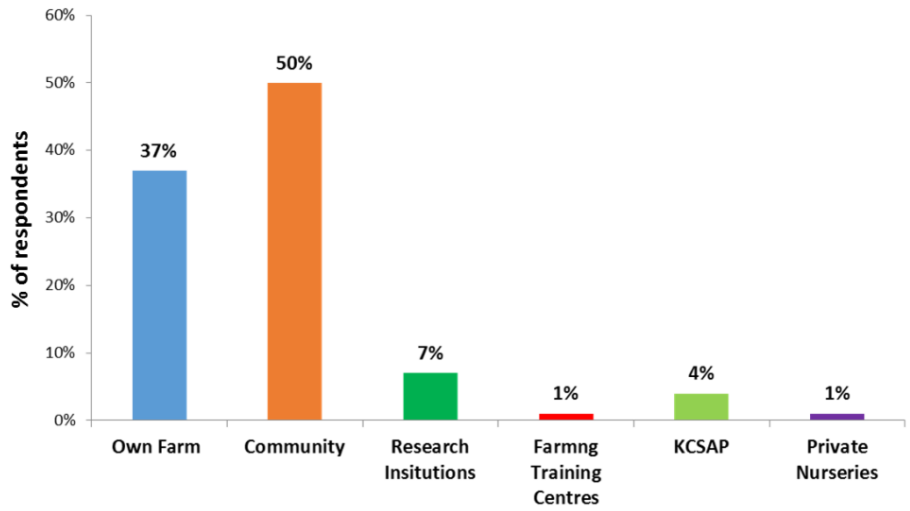

Figure 9. Source of planting materials

3.7 Farmer Preferred Banana Cooking and Ripening Varieties

Smallholder farmers in the Nyeri grew a wide range of cooking and ripening banana varieties. A total of 14 cooking types and 16 ripening varieties were reported during the study. The most preferred cooking banana variety was Uganda green (42.58%) followed by Kikuyu (23.23%), Gichagara (9.03%), Zanzibar (6.45%) and Mutahato (4.52%). Other cooking types grown by few farmers were Mugithi (3.23%), Nusu Ng'ombe (2.58%), Ng'ombe (1.94%), Munyegenya and Kigoto each at 1.29% as well as Kigondoro, Nyakae, Tunuko and Mutore each at 0.65% (Figure 10).

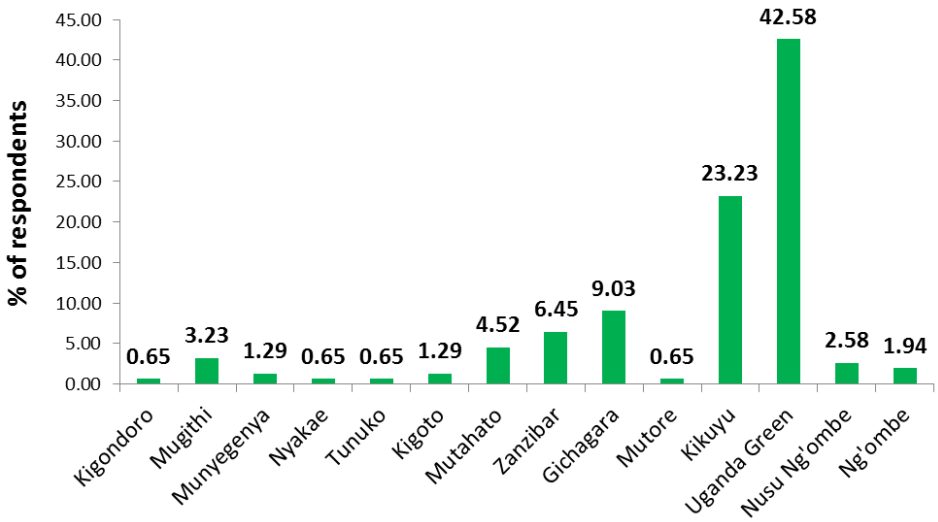

Figure 10. Banana cooking varieties

The banana ripening varieties mentioned were Sweet banana (21.49%), Muraru (20.18%), Njuru (18.86%), Kampala (14.47%), Williams (6.14%) and Grand Naine (5.70%). Other ripening type varieties grown by few farmers were Kisii sweet and FHIA 17 (each at 3.07%), Dwarf Cavendish (1.75%), Zanzibar, Mbiri and Israel (each at 0.88%), Giant Cavendish, Kifunda and Kibutu (each at 0.44%) (Figure 11).

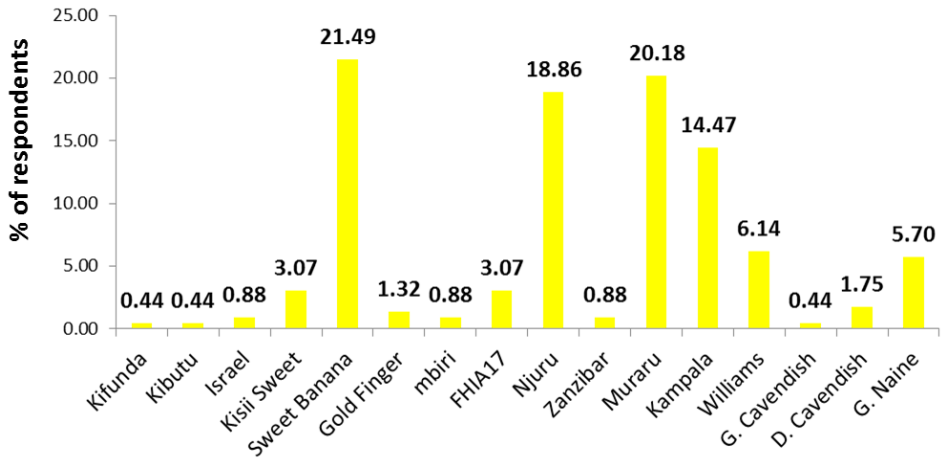

Figure 11. Banana ripening varieties

4. Discussion

4.1 Socio-demographic Characteristics

The study results indicated that banana farming in Othaya and Tetu sub-Counties was a male-dominated venture. This may be attributed to land ownership where males have an advantage in land-ownership. This could be attributed to greater access and use of land by males compared to female farmers (Melesse, 2018; Nyabaro et al., 2019; Nkengla-Asi, 2020). Lack of access to resources such as land and power of decision-making has reduced women's influence in crop production (Rietveld & Farnworth, 2018; Nyabaro et al., 2019; Nkengla-Asi, 2020). This study however, contradicts a similar study by Wahome et al. (2021) on banana production in the Eastern part of Kenya, who reported a greater percentage of females in banana production as compared to males. The study findings could be related to the purpose as a commercial crop and thus male are more involved in the production. A study in Uganda by Akankwasa et al. (2020) reported that banana plantations for cash were managed by men.

The study results indicated that majority of the banana farmers were more than 60 years old. This could be attributed to rural-urban migration by the younger generation who perceive agriculture as a low-paying venture (Kising'u, 2016; Eckert et al., 2019). The findings are in agreement with Muthee et al. (2019) and Nyabaro et al. (2019) who reported the engagement of older generations of farmers in banana farming. Majority of the farmers (94.12%) had basic education. Nyabaro et al. (2019) reported 9 years as the mean for adult formal education. It is suggested that farmer level education impacts on banana production in terms of access and use of farmer training materials as well as how they interpret and respond to new information (Wahome et al., 2021). Study by Kabuga et al. (2012), Mwangi and Kariuki (2015) and Makawia (2018) reported that literacy levels are directly linked to higher adoption rates of new farming technologies.

4.2 Crop Utilization

The study observed that banana farming was mainly used as source of income (60%) and source of human food and livestock feed. The finding is in conformity with Alemu (2017) and Brown et al. (2017) who reported that the crop contributes to food security and income generation especially in sub-Saharan Africa. In Kenya, banana is a major horticultural export fruit (HCD, 2020) thus an income generating crop to many households. A study by Heslop-Harrison and Schwarzacher (2007) reported that banana is a major export crop in most tropical and sub-tropical countries.

4.3 Banana Production Constraints

The rainfall onset, diseases and pests, poor marketability and lack of improved varieties with desirable traits were identified as factors affecting banana production in Nyeri. The study identified delayed onset of rains and diseases as the most serious impediment to banana production. The Nyeri County in the Central region of Kenya was reported to receive inadequate, unreliable and poorly distributed annual precipitation to support crop production. The rains have been unpredictable and erratic making it hard to plan on farming (CIDP, 2019). According to Opeyemi et al. (2016), low rainfall and temperature significantly contributes to low banana yield. This calls for the development of drought resistant banana varieties with improved yield.

The study reported moles (90%) as the most serious banana field pest. Farmers have reported banana loss worth USD 320 in Nyeri due to mole infestation (Daily Nation, 2014). Moles create an underground network of tunnels disrupting plant root system as they break up the soil. Moles infested banana plants just topple. Banana disease end Cigar Rot (28.6%) was also identified as a threat to banana production which is also confirmed by Daily Nation (2014). Nevertheless, farmers (46%) sold their banana produce to the local market with 14% involving brokers.

4.4 Planting Materials

The study found that farmers used suckers (72%) as planting materials. The suckers were sourced from their own farms (37%) or neighbors/community (50%) probably due to their low cost, availability and known desired characteristics and qualities since the farmers are the custodians of the materials. The use of vigorous suckers reduces the crop growth period resulting in fast succession of harvests and higher yields (Swennen et al., 1984). Suckers have low multiplication rates, injury of banana plant during removal and potential spread of pests and diseases, leading to reduced banana productivity (Tumuhimbise &Talengera, 2018).

The source of planting material determines the quality of produce. Smallholder farmers prefer suckers from their neighbors/community or their own suckers since they cheap and available (Wasala, 2014; Muthee et al., 2019). The low adoption and use of tissue culture banana (3%) could be due to lack of information and the cost associated with such materials. This is confirmed by FSPN (2015) report on the socioeconomic, technological, institutional and environmental factors attributable to low adoption of tissue culture banana as the source of clean planting materials.

4.5 Farmer Preferred Banana Varieties

The farmers in the study area produced cooking and ripening banana varieties. The most preferred cooking variety was Ugandan green (42.5%) followed by Kikuyu (23%). The ripening variety mainly grown was Sweet banana and Muraru at 21.49% and 20.18%, respectively. Farmers' cultivar selection and preference is mainly determined by its market (Mbaka et al., 2008). The Ugandan green is one of the most popular coking banana varieties, locally called Matoke. The variety is high yielding and tolerant to Panama, Cigar and end rot diseases. It also requires low maintenance in the field (Agcenture, 2023). The Sweet banana and Muraru were the most preferred ripening variety. The former is the most sought variety due to its small size, good aroma, exceptionally sweet taste and fine texture, thus fetching high market price. However, according to Daily Nation (2020), the Sweet banana variety is facing extinction due to *Fusarium wilt* disease that has potential of wiping an entire plantation.

5. Conclusions

This study concluded that males dominate banana production and majority of the farmers are more than 60 years old. The importance of banana production was in the order of income, food and feed. The production of banana was severely constrained by delayed onset of rains and disease infections. Moles and Cigar end rot being the most serious banana field pests and diseases, respectively. Most of the banana produce was absorbed in the local markets. Majority of farmers used suckers from their own farms and community to propagate banana. Banana variety Ugandan green was the most preferred cooking type, while Sweet banana and Muraru were the most preferred varieties for ripening. There is need for sensitization and training on tissue culture banana technology for disease management and increased yield as well as gender inclusion in banana value chain. In addition, there is need to carry out soil and water management through affordable rain water harvesting methods like Zai pit, dams among others.

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Authors Contributions

EWK, CNN and ENN conceptualized the study and designed the methodology. MWK and ENN conducted statistical analysis of the data and created figures and tables. EWK, CNN, MWK and ENN collected and analyzed data. EWK and ENN drafted the manuscript. EWK, CNN, MWK and ENN assisted with the writing, editing and formatted the manuscript according to journal guidelines. EWK coordinated the study and ensured timely completion and also managed communication among authors. All authors read and approved the final manuscript.

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