Production, Seed Management and Utilization of Velvet Bean (*Mucuna pruriens* L. Dc) in Western Kenya

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Abstract

Mucuna pruriens (velvet bean) is a high yielding leguminous crop, high in crude protein content, which is used as animal feed and to improve soil fertility. Farmers are also increasingly interested in its nutritive capacities as food and animal feed. However, production of velvet bean faces many constraints such as unavailability of quality seed and lack of standardized agronomic practices, seed management and utilization strategies. The purpose of this research was to investigate the agronomic practices, seed management and utilization strategies of velvet bean production in Bungoma County, Kenya. A total of 56 farmers, divided in 10 groups were interviewed. A structured questionnaire was used to collect data while the Epi info 7 computer software program was used to analyze the data. Four types of velvet bean seeds were obtained from farmers during the survey. Most farmers surveyed in June 2019, had a proportion of farm under velvet bean cultivation less than 0.5 acre, have been planting velvet bean seed in one year and did not deploy seed selection criteria in the field. The reasons cited for crop popularity include: soil fertility, nutrition, drought tolerance, pest and disease tolerance, food security and medicinal. Most farmers did not intercrop velvet bean with other crops. However, 30% of the farmers intercropped velvet bean with maize, 2% intercropped with groundnut and rotated with common bean. Seed quality assurance activities carried out in the field by farmers were weeding, removing diseased plants or off types and planting seed plants separately. All parts of velvet bean possess valuable properties. The methods of preparing velvet bean for cooking were soaking the seeds and removal of seed coat. The main cooking method cited was boiling the seeds. Forty eight percent of the farmers indicated that they sold seed to other farmers and 16% to Agriculture Office. This study therefore recommends that agronomic and seed management practices need to be standardized to improve seed quality at farm level hence increase the production of velvet bean.

Keywords: Agronomic practices, seed management, utilization, velvet bean

INTRODUCTION

Velvet bean *(Mucuna pruriens)* is a climbing lianas and shrub of the Fabaceae family. This leguminous crop is typically found in tropical woodlands. It has the ability to both restore soil and provide food (FAO, 2011). Velvet bean has multiple functions that could help smallholder farmers boost their livelihoods by increasing livestock and crop production. Compared to other legumes, velvet bean fixes more nitrogen, which helps improve soil fertility (Muoni et al., 2019). According to

Jonathan et al. (2015), the velvet been is an emerging multiple-use crop with a lot of potential for enhancing biodiversity and soil.

According to Kenya Vision 2030 and the National Food Security and Nutrition Policy (NFSNP), the Government of Kenya (GOK) has consistently emphasized local food production as one of the means of alleviating household food insecurity (GOK, 2008a, b). Despite these efforts, food insecurity continues to persist with about 53% of the people in the rural areas being overall poor while 51% are food poor (GOK, 2008c). Farmers in Western Kenya face a number of food production constraints, resulting in high food insecurity. Cropping systems are impacted by several among them; climate change, limited access to adequate inputs, unpredicted and insufficient rainfall, increased drought frequencies, compromised soil quality and fertility and inadequate knowledge (Muoni et al., 2019). A fifty percent increase in grain yield was recorded at demonstration farms in Kakamega, Bungoma, and Siaya counties that used velvet bean as an intercrop or rotation crop in maize grown under conservation agriculture systems (Ministry of Agriculture Annual report 2018). Farmers in Western Kenya are growing velvet bean to improve food security, improve soil conservation and fertility, and increase livestock feed as well as human food. This implies that domestication is increasing as well as the market and cultivation areas. Therefore, it is important for farmers in these areas to have adequate knowledge on velvet bean seed production.

The purpose of this survey was to investigate and document farmer's agronomic practices, seed management and utilization strategies in Western Kenya in an effort to increase the production of velvet bean in this region.

METHODOLOGY

The study was carried out in Bungoma County between 10th to 15th June 2019, and targeted farmer groups growing velvet beans. Bungoma County is located on the southern slopes of Mount Elgon in western Kenya covering an area of about 3,032 km^2. It borders the Republic of Uganda to the northwest, Trans-Nzoia County to the northeast, Kakamega County to the east and southeast, and Busia to the west and southwest (Ralph et al., 2005). The County is divided into 9 sub counties namely Bumula, Bungoma Central, Bungoma North, Bungoma South, Bungoma west, Kimilili, Mt. Elgon, Webuye East and Webuye West. The county receives between 400 and 1800 mm of annual rainfall, with annual temperatures varying between 10 and 32 ºC (ASDSP, 2014). Agriculture is the primary source of income and employment with maize, beans, finger millet, sweet potato, banana, Irish potato, and various vegetables being the main food crops grown in the county.

Member of farmers groups selected using purposive sampling from a list of farmers growing velvet bean for each group (fifty-six farmers, divided in 10 groups) in Bungoma County (Table 1). A structured questionnaire was used to collect data on farmers characteristics, agronomic practices, seed management and utilization strategies in Bungoma County. Interview sessions were conducted during visits to respondents 'homes. Responses were filled in the questionnaires and observations on the agronomic practices, seed management, sizes of the farmlands, type of food cultivated etc., were done after the interview sessions.

Table 2: Number of farmers growing velvet bean for each group in Bungoma County

Farmers group	Number of velvet bean farmers	Number of farmers group	Percentage of velvet bean farmers (%)
Nambuyakhaka 7	22	32	Yetanabukokholo 8 30 27 Mulomandala 6 6 100
Ngarisha 5	25	20	Namasa star 6 18 33 Subila FFS 7 15 47
Tabuti lima 1	15	7	Integrated community health
organization 4	18	22	Musangafu help group 8 30 27 Wakipu 4 15 27 **Total**
56	**194**	**29**	

Data Analysis

The Epi info 7 software was used to analyze the data. To obtain results, the data was collected, grouped into categories, meanings extracted, coded, entered, and analyzed. To determine the adequacy, credibility and usefulness of the data according to the study's objectives, further evaluation and analysis were done. Both qualitative and quantitative data were described and organized using descriptive statistics (percentages). The results were presented using pie charts and bar graphs.

RESULTS

The presentation and discussion of the results include farmer's characteristics, agronomic practices, seed management and utilization strategies of velvet bean in Bungoma County.

Farmers' Characteristics

The farmer's characteristics captured in this study included: education levels of the respondents, different sub county surveyed, reason for joining farmers group and sources of income. About 84% of all the respondents had attained upper primary and secondary school education; only 5% had attained a no formal education (**Figure 1)**.

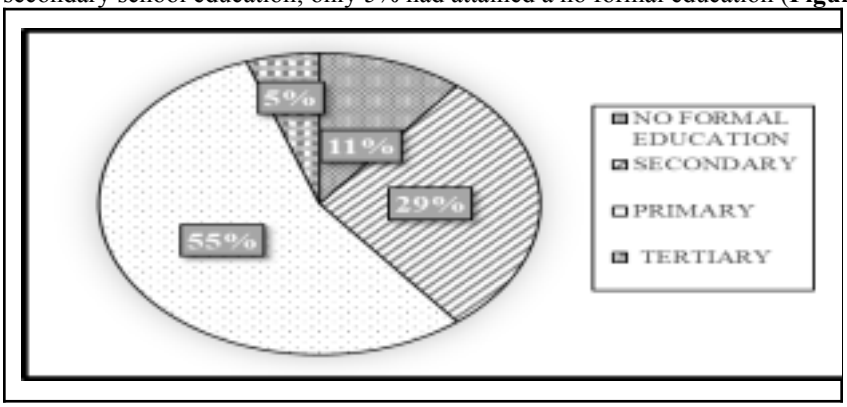

Figure 1: Education levels of velvet bean farmers in Bungoma County

Five Sub Counties were surveyed according to the number of farmer's group. 65% of the respondents were located in Bumula. Bulondo and Sangalo had less percentage of

farmers surveyed (2% each). Following this observation, farmers in Bumula are more actively involved in velvet bean production than the others Sub County.

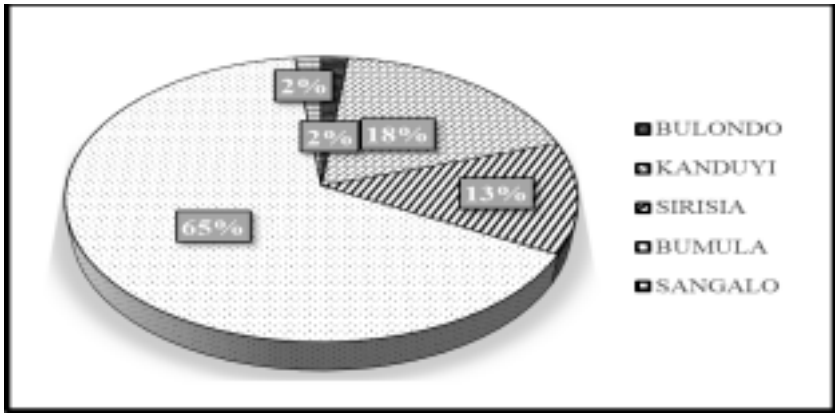

Figure 2: Areas surveyed in Bungoma County

Majority of the respondents have joined a farmers group for seed production (86%), commodity marketing (71%) and social support (68%) and 41% have joined a farmers group for saving and credit.

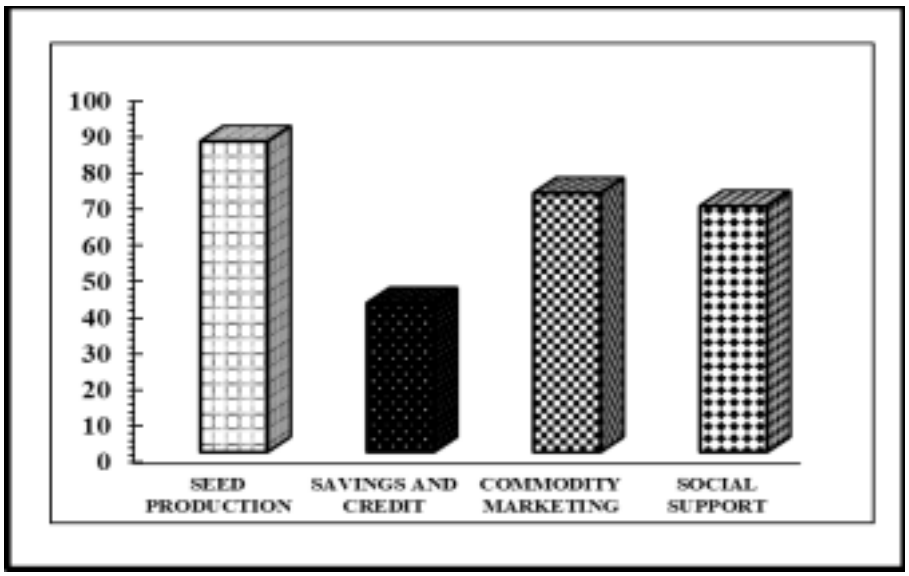

Figure 3: Reasons for joining farmers group involved in velvet bean cultivation in Bungoma County

Most of the farmers groups had food crop farming (98%) as their main activity, followed by livestock farming (23%), business (23%) and cash crop farming (18%). Some farmers (2%) had casual labor as source of income.

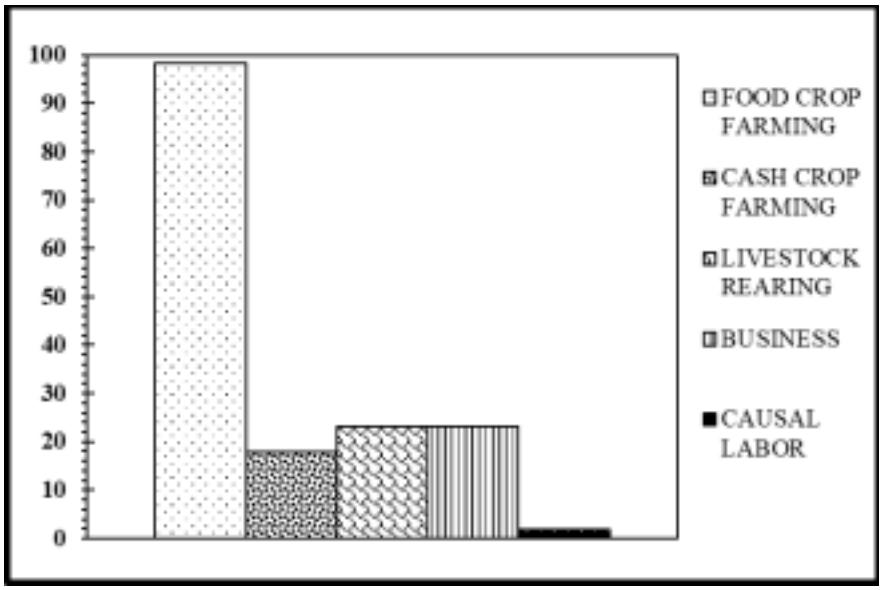

Figure 4: Source of income of farmers involved in velvet bean cultivation in Bungoma County

Agronomy of Velvet Bean

Majority of the respondents surveyed in June 2019, had less than 0.5 acre under velvet bean cultivation.

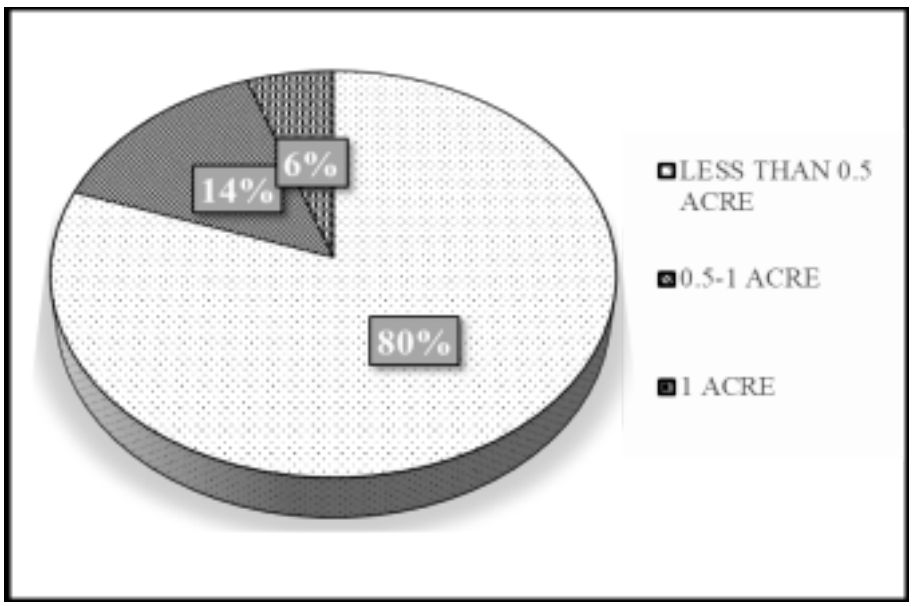

Figure 5: Proportion of farm under velvet bean cultivation

In Bungoma County, the reasons cited for crop popularity included: soil fertility (100% of farmers surveyed), nutrition (96%), drought tolerance (89%), pest and disease tolerance (73%), food security (54%) and medicinal (21%).

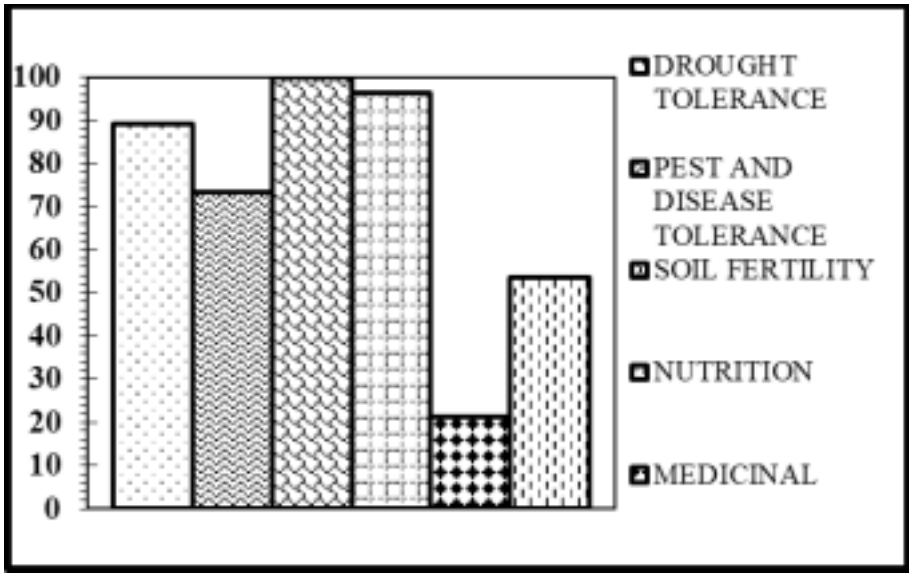

Figure 6: Reasons for crop popularity cited by velvet bean farmers in Bungoma County

On average 80% of the farmers indicated that the main reason for low popularity of velvet bean seed was difficulty in cooking. Also 64%, 54% and 45% of the farmers respectively indicated velvet beans take long to germinate and establish, have long maturity period and there is difficulty in accessing the seed.

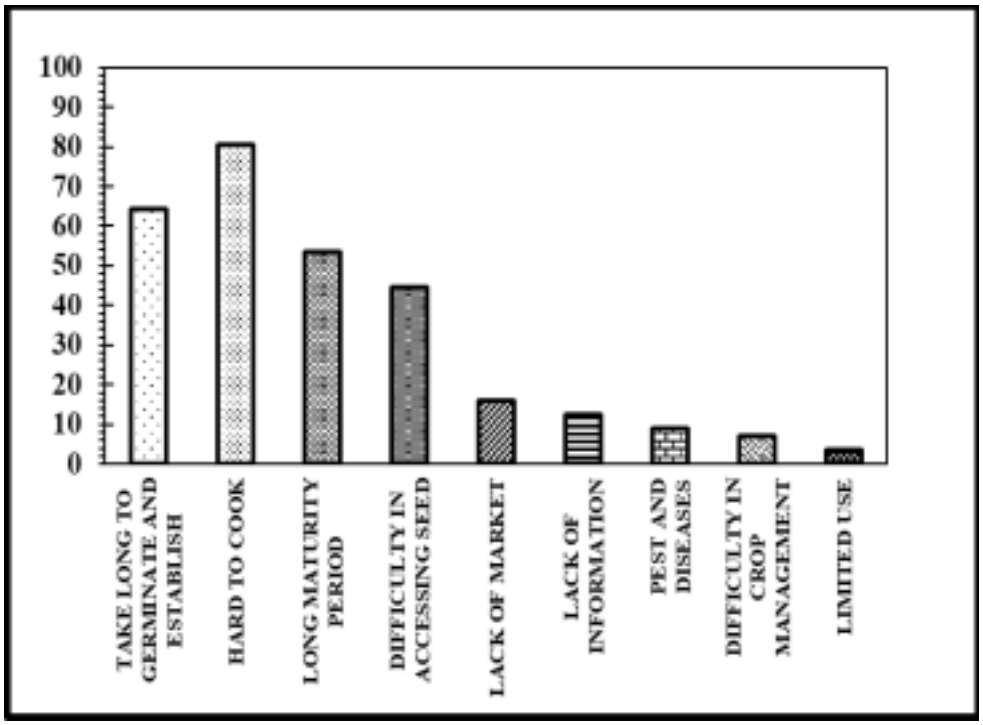

Figure 7: Reasons for low popularity of velvet bean farmers in Bungoma County Seed management practices

Most of the farmers (66%) did not intercrop velvet bean with other crops. However, 30% of the farmers intercropped velvet bean with maize, 2% intercropped with groundnut, banana and in rotation with beans**.**

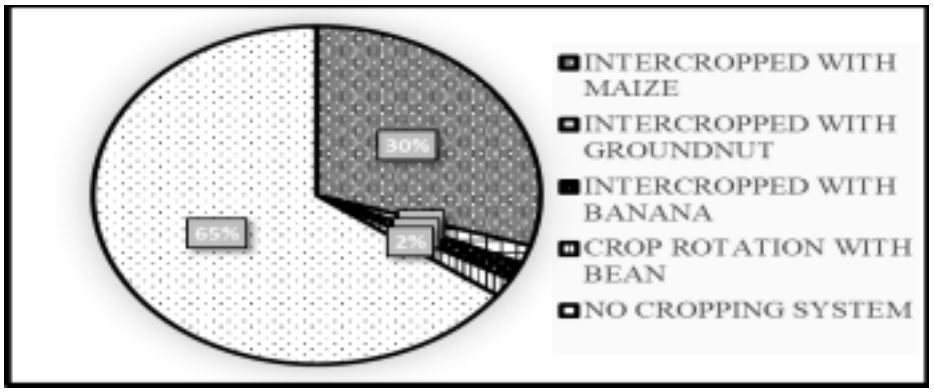

Figure 8: Cropping system used by farmers in Bungoma County

Plate 1: Velvet bean intercropped with maize without application of fertilizer

Plate 2: Maize planted with application of fertilizer

Plate 3: Velvet bean intercropped with banana without application of fertilizer

Plate 4: Velvet bean planted separately without application of fertilizer

Most of the farmers (43%) weeded velvet bean thrice and others weeded once (16%) or twice (41%).

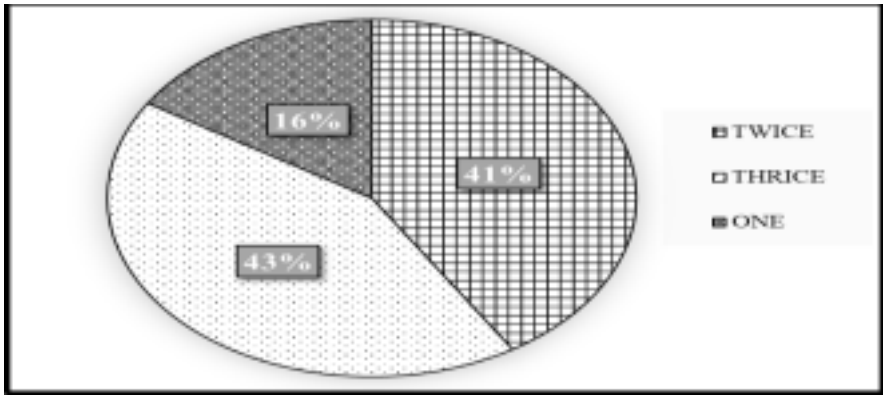

Figure 9: Frequency of weeding of velvet bean farmers in Bungoma County

On average 52% of the farmers have been planting velvet bean seed for one year, 30% for two years and few (7%) more than three years and 11% are not planting it yet.

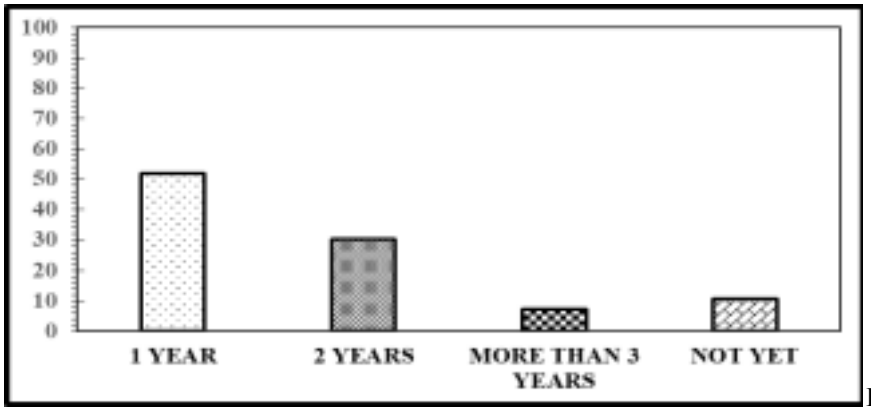

Figure 10: Duration of growing velvet bean by farmers in Bungoma County

Most of the farmers (61%) did not use any seed selection criteria in the field. However, 29% harvested seeds from healthy looking plants and pods, 20% harvested from high yielding plant.

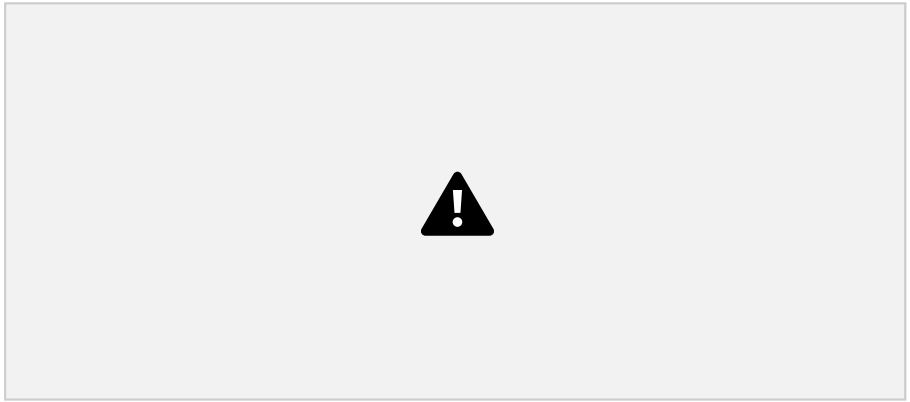

Figure 11: Seed selection criteria used by velvet bean farmers in Bungoma County

The seed quality assurance activities carried out in the field by farmers were weeding (98%), removing diseased or off types (25%) and planting separately (23%).

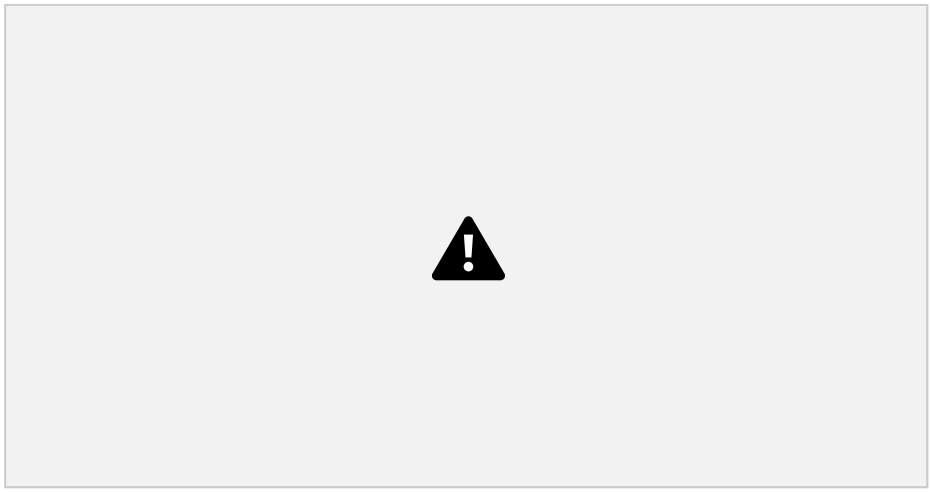

Figure 12: Seed quality assurance activities carried out in the field by velvet bean farmers in Bungoma County

Utilization

Seventy three percent of the farmers indicated that velvet bean seed can be used as food (e.g., chapati, mandazi, cooked beans, porridge, tea), 48 % as medicine (e.g. asthma, blood pressure, improve sexual function), 36 % as beverage, 25% for improving soil fertility and only 4 % for oil extraction for used for soap making.

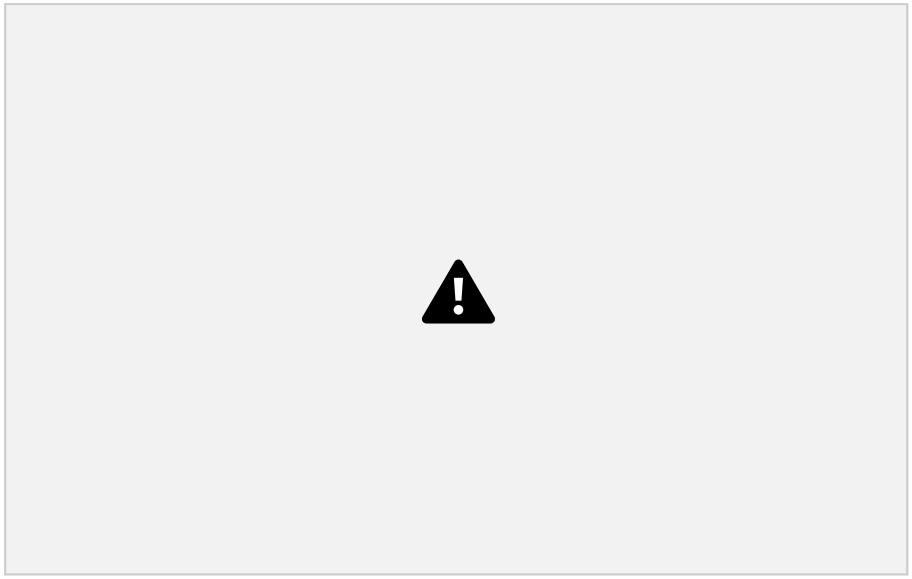

Figure 13: Use of velvet bean seed by farmers in Bungoma County

Farmers mentioned that the main uses of velvet bean leaves were improving soil fertility (95 %), used as animal feed f (34%) and as a cover crop (32%). Few farmers indicated that they used velvet bean leaf to inhibit Striga weed and 4 % consumed the leaf as vegetable (boiled or boiled and fried).

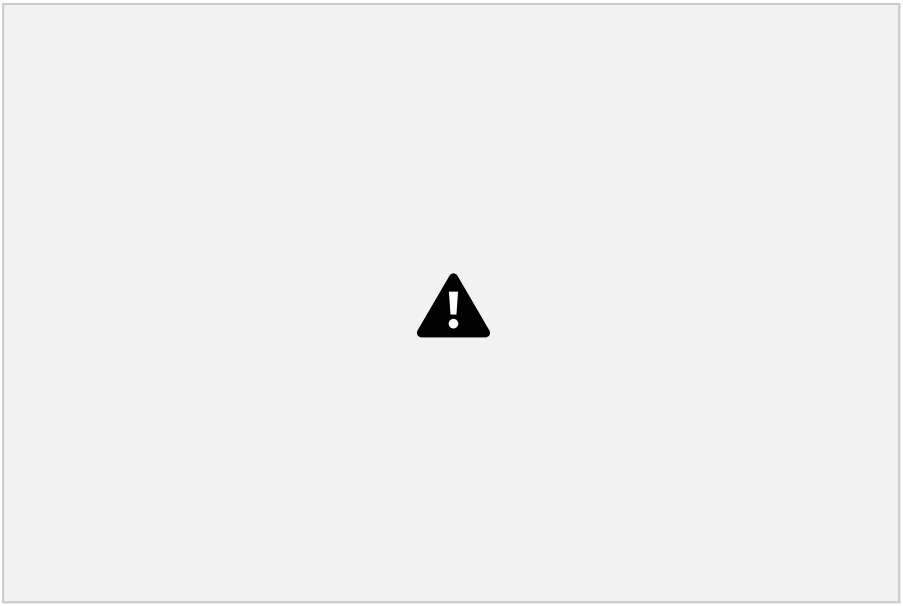

Figure 14: Use of leaf by velvet bean farmers in Bungoma County

Small percentage of the respondents (2 %) indicated that velvet bean flower can be used as medicinal tonic (e.g. ulcer: flowers added in boiling water) and a beverage. Majority of the farmers (96 %) did not know the use of the flower.

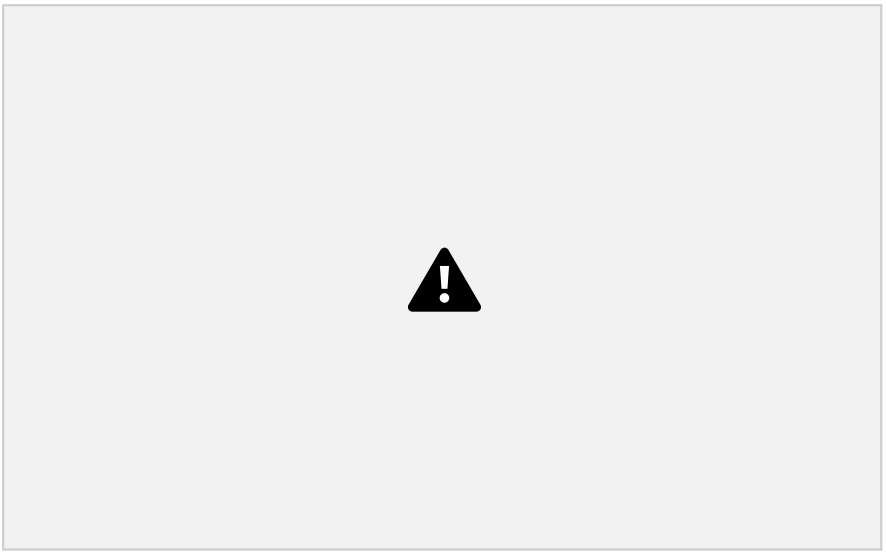

Figure 15: Uses of velvet bean flowers as indicated by farmers in Bungoma County

Majority of the respondents (52%) said that velvet bean root can be used to improve soil structure. Others said it can be used to break hard pan (23%), prevent soil borne diseases (11%) and prevent soil erosion (9%), as medicine (e.g. treatment of teeth) (7%) and 4% to control animal attack.

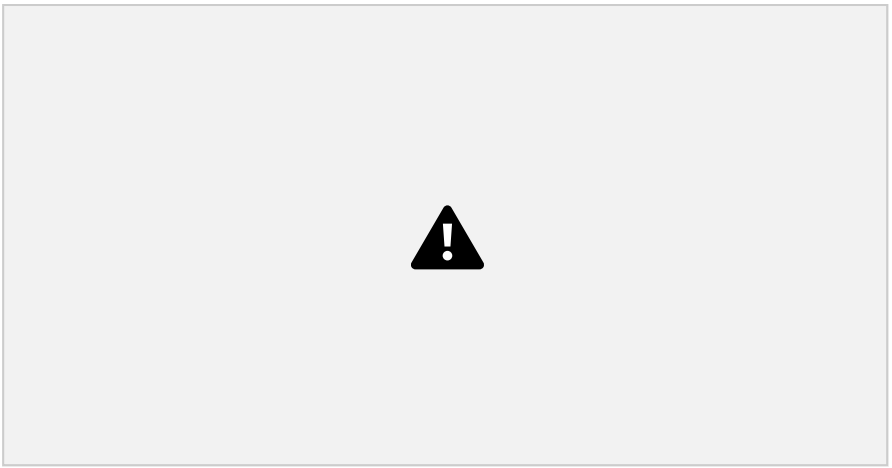

Figure 16: Uses of velvet bean roots indicated by farmers in Bungoma County

Over half (61%) of the respondents did not mention the use of the pod but 25% said the pod can be decomposed for fertilizer, 7% said it can be used as animal feeding, 5% as firewood and 2% as medicine (e.g., asthma, blood pressure).

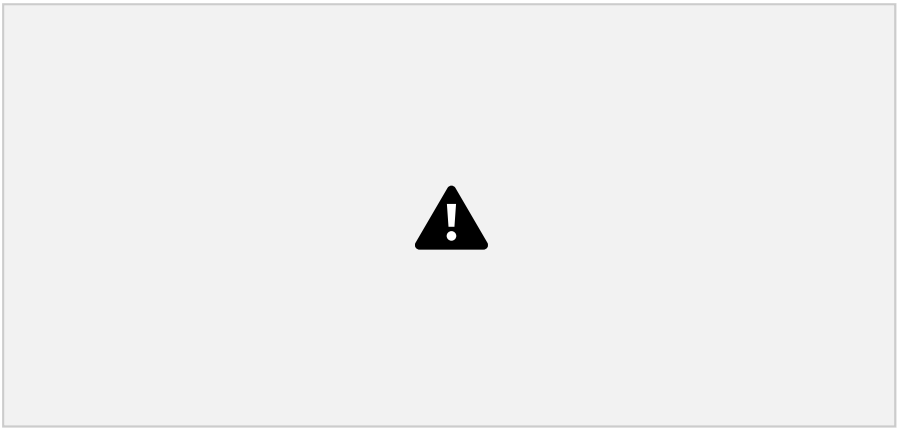

Figure 17: Uses of velvet pod by as indicated by farmers in Bungoma County

Over half of the farmers (55%) used velvet bean plant daily, 25% weekly, 9% occasionally and 5% monthly.

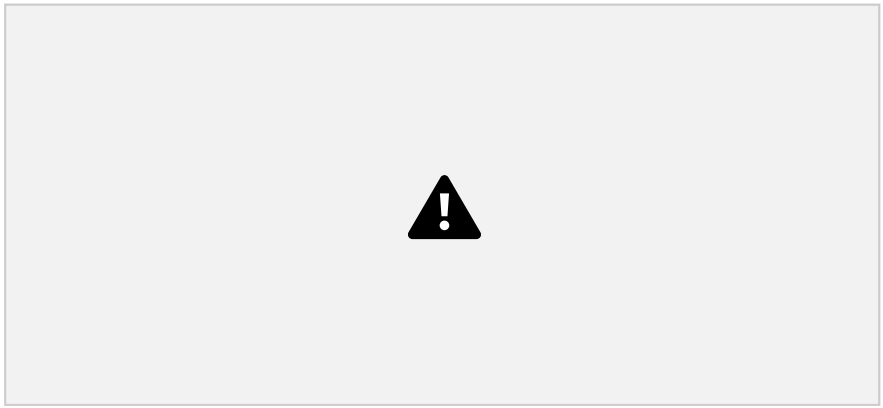

Figure 18: Frequency of velvet bean use by farmers in Bungoma County

The main cooking method cited by farmers was boiling the seeds (96%). Few farmers indicated that velvet bean seed can be roasted (14%) or baked (2%).

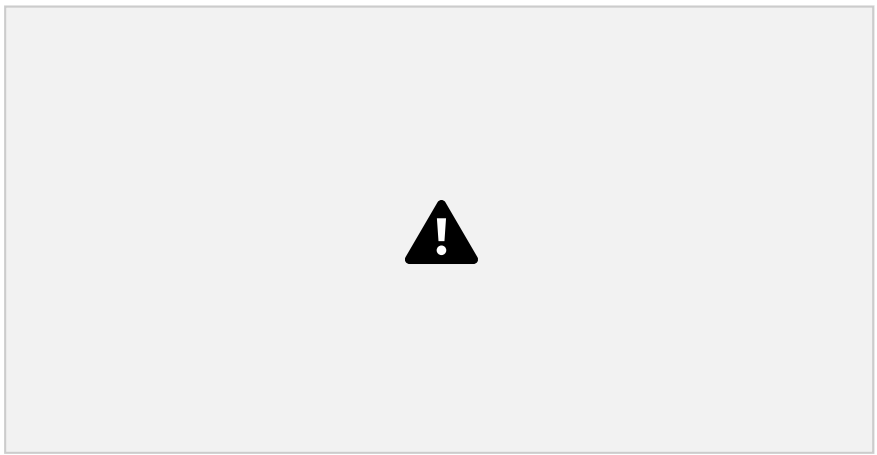

Figure 19: Main cooking methods of velvet bean by farmers in Bungoma County

Most of the respondents (89%) prepared the velvet seeds for cooking by soaking for 10min. Others removed seed coat (86%) while 2% of the respondents indicated that the seed can be ground before cooking.

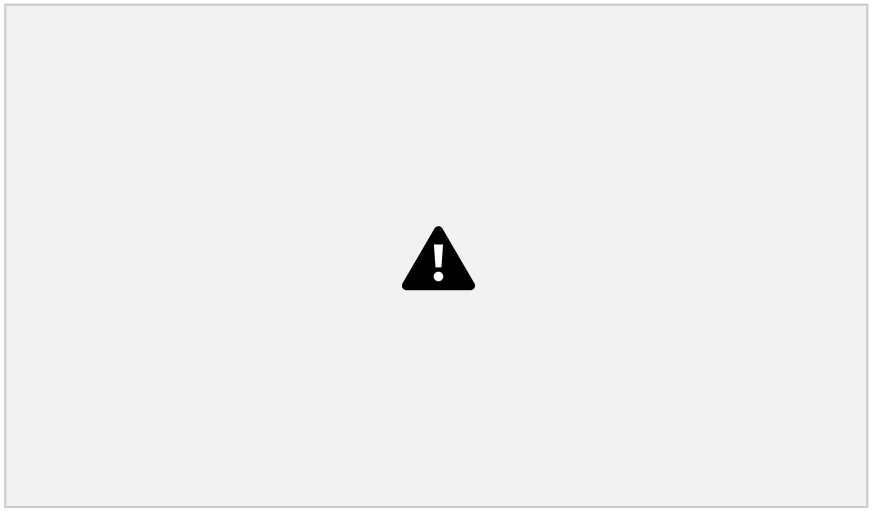

Figure 20: Preparatory methods for cooking velvet bean among farmers in Bungoma County

Constraints

Majority of the farmers cited reasons like high prices of seeds (86%), limited seed (82%), and lengthy time to cook the seed (55%) as constraints to velvet bean production. Other respondents indicated constraints such as high labor (43%), lack of space to storage seeds before selling (27%), limited market (27%), long time to grow (11%) and dry (13%) the seed, no enough materials for drying the seeds (9%), rotting (7%), lack of money for gunny bags (5%), lack of knowledge and low popularity of the crop (2%).

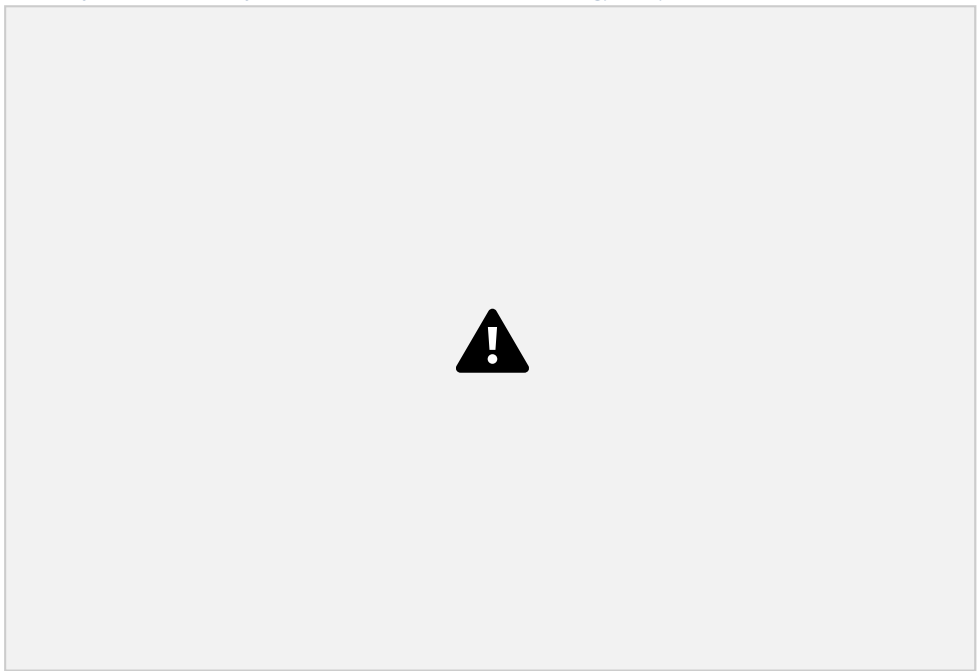

Figure 21: Main constraints of velvet bean production and utilization as reported by farmers in Bungoma County

DISCUSSION

Majority of the farmers had primary level of education which can affect the use of new technologies on leguminous production. This is consistent to the findings of Icheria (2012), who identified that one of the most significant determinants of increased household food production and acceptance of new habits is the number of years spent in formal education. Because of their low educational levels (most attained primary and secondary school education), there was a limitation in the flow of knowledge and adoption of new food production behaviors within this group.

Farmers in Bumula are actively involved in velvet bean production than the others Sub Counties because majority of the respondents were concentrated in the Sub-County. Majority of the respondents have joined a farmers group for seed production, commodity marketing and social support. This is consistent with findings that farmers primarily organize themselves into groups to learn successful farming methods, procure agricultural inputs collectively, and sell their agricultural products collectively (Adong et al., 2012). Due to numerous challenges such as inadequate credit, high interest rates, lack of storage facilities, lack of ready market, lack of technical skills, and high marketing and transaction costs, small holder farmers are highly vulnerable to poverty (Abaru et al., 2006; Shiferaw et al., 2006; Haqueet al., 2011; Curtis, 2013; Sikwela and Mushunje, 2013). Collective action in the form of a farmer group can provide solutions to these various challenges. Furthermore, findings by Tallam (2015) indicated that the principal components that influence effectiveness of collective action in Bungoma County were the level of trust, leadership skills, unity and effective participation.

According to the results, in Bungoma County, 56 farmers were growing velvet bean seed during the survey. However, many farmers were about to start growing velvet

bean seed. Few farmers have been planting velvet bean more than three years. However, its cultivation is increasing in Bungoma County. In Western Kenya, a total of 325 farmer groups (7500 individual farmers) are actively involved in velvet bean production (Wabwoba and Mutoro, 2019).

Most farmers groups were involved in food crop farming as their main activity which can be attributed to a more favorable climate for crop farming. Few farmers intercropped velvet bean with maize, groundnut or banana. Some practiced crop rotation with common bean. Velvet bean has been reported to increase the soil fertility. The use of legumes as associated or rotation crops, or their cultivation as green manure, was a technique for replenishing soil nitrogen that had been depleted by crops, as well as providing the organic matter needed to keep the soil's physical and chemical conditions favorable for long-term crop development (Mulvaney et al., 2009). A study by Khan et al (2009) indicated that Intercropping has the benefit of lowering the risk of harvest losses by growing many crops at the same time. When beans and maize are grown together, the food supply is spread out over a longer period of time since the bean harvest occurs before the maize harvest. In the same way, if the grains are consumed, the farmers would have a more consistent cash flow.

The majority of respondents weeded thrice or twice to keep the crop clear of weeds by weeding as soon as they appeared. Land productivity has also decreased as a result of an increase in weed infestations, pests, and diseases (Mulvaney et al., 2009; Yates et al., 2011). Velvet bean, on the other hand, is one of the best crops for reclaiming weed infested soil (Wulijarni-Soetjipto et al., 1997; Hellin, 2006). After two seasons of intercropping corn with velvet bean, it had been shown that the legume had depleted the grass population (Coultas et al., 1996). Farmers controlled weed populations in the field in order to reduce pathogens and their vector populations.

Less than 30% of the respondents used healthy looking plants, pods and high yielding plant in the field as seed selection criteria. The most seed quality assurance activities carry out in the field by farmers were weeding, removing diseased or off types and planting separately velvet bean from others crop. In Bungoma County, few velvet bean farmers picked seeds from healthy plants and avoided any mechanical damage on the pod or other plant parts harvested. This is consistent to the finding of Salamanca (2015) who indicated any damage, such as small wounds or bruises, may cause microorganisms to reach the seed, compromising its quality while in transit or long term storage. Therefore, farmers need to assure high quality products to increase production of velvet bean.

In Bungoma County, farmers mentioned all parts velvet bean plant were medicinal. This is consistent to the findings of Sathiyanarayanan et al (2007) who indicated that all parts of velvet bean possess valuable medicinal properties. Velvet bean has been investigated for its antidiabetic, aphrodisiac, antineoplastic, antiepileptic, and antimicrobial activities.

Farmers in this study also indicated that seed can be used as food, beverage, soil nutrient, livestock feed, cover crop and oil extraction for soap making. This is consistent with Wabwoba and Mutoro (2019) who indicated that velvet beans can be used for soil rehabilitation and food. Velvet bean is primarily used as a cover crop and green manure because it establishes easily and does not necessitate extensive soil preparation (Cook et al., 2005).

Few farmers indicated that they used velvet bean leaf to inhibit *Striga* sp. weed and consumed the leaf. The velvet bean foliage, once slashed into a thick mulch, protects the soil from erosion, prevents weed germination, and improves soil moisture (Buckles et al., 1998). Maize grown in monocropping has also been shown to be more susceptible to striga than maize intercropped with velvet bean (Khan et al., 2006). Striga is less prevalent in areas with high soil fertility because the crops have higher Striga tolerance. Intercropping legumes improves soil productivity and offers shade, which disadvantages Striga (Khan et al., 2006).

Small percentage of the respondents indicated that velvet bean flower can be used as medicinal and beverage. Few farmers said the pod can be decomposed for fertilizer, used as feeding, as firewood and as medicinal. Pods and seeds can be ground into a high-protein meal and fed to all types of livestock, though monogastrics should be fed limited quantities (Chikagwa-Malunga et al., 2009).

Velvet bean foliage protects the soil from erosion, inhibits weed germination, and improves soil moisture retention (Buckles et al., 1998). Vine and foliage have been shown to be used as ruminant grass, hay, or silage, while pods and seeds may be ground into a meal and given to both ruminants and monogastrics as food. (Eilittä et al., 2003; Chikagwa-Malunga et al., 2009). The velvet bean foliage, once slashed into a thick mulch, protects the soil from erosion, prevents weed germination, and improves soil moisture (Buckles et al., 1998).

Farmer used velvet bean root to improve soil structure (break hard pan, prevent soil erosion). Others said the roots can be used to prevent diseases, as medicinal and to control animal attack. The velvet bean is well known for being resistant to most pests and diseases with the key substance in its allelopathy being L-DOPA (L-3, 4-dihydroxyphenylalanine), which is released from its root (Yokotani et al., 2004) and are not subject to attack by small mammals or insects suggesting a feeding repellent property (Soares et al., 2014).

Most of the farmers frequently used velvet bean plant daily. It can be explained by the multiple use of the plant. The main cooking method cited by farmers was boiling the seeds. Few farmers indicated that velvet bean seed can be roasted and baked. The preparatory methods for cooking were soaking the seed and removal of seed coat. Few of the respondents indicated that the seed can be ground for cooking. Cook et al. (2005) and Pugalenthi et al. (2005) indicated that to reduce the antinutritional factor content of the seeds, methods such as boiling for one hour, autoclaving for 20 minutes, water soaking for 48 hours and then boiling for 30 minutes, or soaking the cracked seeds for 24 hours in 4% Ca $(OH)_2$ have been suggested. According to Dossa et al. (1998), grilling keeps the nutritional quality of the seeds better than cooking them even though was contrary to an earlier study by Laurena et al. (1991) where Velvet beans were said to be better boiled than roasted.

CONCLUSION

Based on the above result, we can conclude:

A majority of the respondents had a proportion of farm under velvet bean cultivation being less than 0.5 acres with the main reason for non-popularity of velvet bean seed being long cooking period, long germination period poor field establishment, long maturity period and difficulty in accessing seed. The most reasons for velvet bean

popularity included soil fertility enhancement, nutrition, drought tolerance, pest and disease tolerance, food security and medicinal uses.

Most of the farmers did not intercrop velvet bean with other crops but few of them used velvet bean for improvement of local maize cultivars. Some rotated other crops with the bean. Most of the farmers did not deploy seed selection criteria in the field, the most seed quality assurance activities carry out in the field were weeding, removing diseased plants and off types and planting separately velvet bean from others crops.

Velvet bean has the potential to improve the agricultural ecosystem's functional properties and efficiency. Standardization of agronomic and seed management practices will improve seed quality at farm level and hence increase the production of velvet

bean.

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