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Research Application Summary

Factors affecting sweetpotato production and soil fertility challenges among smallholder farmers in Kenya

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Abstract

Sweetpotato *(Ipomea batatas)* is an important food crop in Kenya, but farmers experience low production and thus their food and income security is threatened. This study was done to document factors affecting sweetpotato production and soil fertility challenges in Kenya. A survey was carried out between 21st January 2016 to 13th February 2016 in Kakamega and Elgeiyo Marakwet Counties in Kenya using structured interviews and observations. The features factored in the study were demographic factors, ranking of crops, access to agricultural information, soil fertility challenges and strategies used by the farmers to overcome these constraints. Results indicate that women are the predominant (55.9 %) sweetpotato growers. Majority of the farmers (54.6 %) had attained primary education. Individual land ownership was the norm (76.3 %) with most farms owing 1.0 to 3.0 acres (0.3 - 1.1 ha). Sweetpotato was ranked as the third most important (48.0 %) crop. Many farmers (61.2.0 %) get planting material from other farmers. High cost of fertilisers and low soil fertility in addition to soil erosion were the major soil fertility challenges experienced by sweetpotato growing farmers in west Kenya. Rotational cropping, intercropping and use of animal manure were among the strategies undertaken by the farmers to improve soil fertility. The study used OLS regression to determine the level of productivity per acre. Diagnostic test before regression analysis was carried out. The statistic $F(6, 143) = 12.18$ ($p < 0.05$) indicated that factors which include agro-ecological zone, access to agricultural information, sweetpotato variety and use of fertilizer explained 31 per cent variation in productivity levels per acre. The OLS results indicate that the base level productivity is approximately 38 bags per acre with other significant factors being the sweetpotato variety, agro ecological zone, access to agricultural information and use of fertiliser (organic/ inorganic). It can be concluded that the low level of education among the smallholder farmers necessitates simpler ways of disseminating agricultural information. Training on use of fertilisers should be given priority to avoid continuous cropping without mineral replenishment.

Key words: Demographic factors, *Ipomea batatas*, soil fertility improvement, West Kenya

Resume

La patate douce (*Ipomea batatas*) est une culture alimentaire importante au Kenya, mais les producteurs connaissent une faible production, ce qui menace par conséquent, leur sécurité alimentaire et leur revenu. Cette étude a été réalisée pour documenter les and Elgeiyo Marakwet Counties, in Kenya using structured interviews and observations. facteurs affectant la production de la patate douce et les problèmes de fertilité de sols

au Kenya. Une enquête a été menée entre le 21 janvier et le 13 février 2016 dans les comtés de Kakamega et Elgeiyo Marakwet au Kenya au moyen d'entretiens structurés et d'observations. Les caractéristiques prises en compte au cours de l'étude étaient les facteurs démographiques, le classement des cultures, l'accès à l'information agricole, les problèmes de fertilité de sols et les stratégies utilisées par les agriculteurs pour surmonter ces contraintes. Les résultats indiquent que la plupart des producteurs de patate douce sont des femmes (55,9%). Le niveau d'éducation atteint par la majorité des producteurs (54,6%) est l'enseignement primaire. La propriété foncière individuelle était la norme (76,3%) avec des superficies allant de 1,0 à 3,0 acres (0,3 à 1,1 ha). La patate douce a été classée comme la troisième (48,0%) plus importante cultures. Nombreux producteurs (61 2,0%) reçoivent du matériel de plantation de leurs paires. Le coût élevé des engrais, la baisse de la fertilité des sols, en plus de l'érosion des sols sont les principaux problèmes de fertilité de sols rencontrés par les producteurs de patate douce à l'ouest du Kenya. La rotation des cultures, l'association des cultures et l'utilisation de la fumure animale font partir des stratégies utilisées par les producteurs pour améliorer la fertilité du sol. L'étude a utilisé la régression MCO pour déterminer le niveau de productivité par acre. Le test diagnostic avant analyse de régression a été effectué. La statistique F (6, 143) = 12,18 ($p < 0,05$) a indiqué que les facteurs tels que la zone agroécologique, l'accès à l'information agricole, la variété de patte douce et l'utilisation d'engrais expliquent 31 % des variations de niveaux de productivité par acre. Les résultats de la régression MCO indiquent que le niveau de productivité de base est d'environ 38 sacs par acre, avec la variété de patate douce, la zone agro-écologique, l'accès à l'information agricole et l'utilisation d'engrais (organique / inorganique) comme autres facteurs significatifs. On peut donc conclure que le faible niveau d'éducation des petits producteurs nécessite de plus simples moyens de diffusion de l'information agricole. La priorité doit être mise sur la formation à l'utilisation des engrais afin d'éviter les cultures continues sans reconstitution minérale.

Mots clés: Facteurs démographiques, Ipomea batatas, amélioration de la fertilité des sols, Ouest du Kenya

Introduction

Sweetpotato (*Ipomea batatas*) is a perennial storage tuber crop grown in Kenya both as a food and cash crop (Kivuva *et al.,* 2014) mostly under small scale. Currently, there are many varieties under cultivation by farmers in Kenya with skin and flesh colours ranging from orange, deep purple, white to yellow. The orange fleshed sweet potato varieties are gaining popularity due to their higher contents of β-carotene which is a precursor of vitamin A. Among the most popular orange fleshed sweet potatoes cultivated in Kenya include Vitaa, Kembu 10, Kakamega 4, Simama, and Kabonde (Hagenimana *et al.,* 2001; Kivuva *et al.,* 2014) .They can be eaten raw or boiled, smashed and used together with wheat flour to make chapati and mandazi or finally ground to make flour which can be used to fortify porridge or baking flour. In addition, their tubers have industrial uses such as production of starch, alcohol and wine. Both the tubers and vines are used also as livestock feed (Hagenimana *et al.,* 2001; Ramirez) http://www.fao.org/docrep/003/t0554e/t0554e14.htm accessed on 14/7/15).

Sweetpotato is ranked the third most important crop in Kenya. This confirms the importance of the crop as a cushion against food insecurity. This is in tandem with reports by CIP (2010) and Okonya and Kroschel (2014). Though the crop has great potential for ensuring food security, low soil fertility, in particular deficiencies of phosphorus, potassium and sulphur has been a setback to productivity (Bailey *et al.,* 2008). Further to this, Okonya and Kroschel (2014) pointed out that agro-ecological zones do influence sweetpotato production. Other than the factors mentioned demographic factors and access to agricultural advisory services influence crop productivity as pointed out by Kebeney *et al.* (2015). Thus, this study envisaged bringing to the limelight the factors affecting sweetpotato production, soil fertility challenges among the respondents.

Methodology

A diagnostic field survey covering 152 sweetpotato small scale farmers was carried out in Kakamega and Elgeiyo Marakwet Counties in West Kenya with different agro-ecological zones. Makunga location in Kakamega County is found under lower midland 3 agro-ecological zone (cotton zone). On the other hand, Kibargoi location in Elgeiyo Marakwet is found under lower midland 5 agro-ecological zone (cotton zone). Structured interviews and observations were used for data collection. Pre-testing of the questionnaire was done among 15 farmers in Beta farm, Uasin Gishu County to validate the interview instruments. Questionnaires and observations were used to collect data. The main features factored in the study were demographic factors, ranking of crops among the respondents, access to agricultural information as well as soil fertility challenges and strategies used by the farmers to overcome them. In Kibargoi location, 42 respondents were interviewed and 110 respondents from Makunga location. Data from the cross sectional survey were then sorted, coded and analyzed using Statistical Package for Social Sciences version 18.0 (SPSS, 2008). The study used OLS regression to determine the level of productivity per acre. Descriptive statistics was used in data presentation.

Results

Gender distribution among the respondents. Table 1 shows gender of the respondents from the two locations, Makunga and Kibargoi in Kakamega and Elgeyo marakwet Counties, respectively. The results show more female respondents (64.5 %) in Makunga compared to male (35.5 %). On the contrary, in Kibargoi location, the male respondents were more (66.7 %) than the female (33.3%).

Level of education. The level of education of the respondents in Makunga and Kibargoi locations is presented in Table 2. Majority of the respondents in both locations attained primary education (53.6 % and 57.1 %, respectively). The respondents with secondary education were 36.4 % and 26.2 % while college and university was 5.4 % and 14.3 %, respectively. Those with no formal education were 4.5 % and 2.4% in the respective locations.

Table 1. Gender distribution of the respondents

Gender		Location		Total
		Makunga	Kibargoi	
Male	Count	39	28	67
	% within Location	35.5%	66.7%	44.1%
Female	Count	71	14	85
	% within Location	64.5%	33.3%	55.9%
Total	Count	110	42	152
	% within Location	100.0%	100.0%	100.0%

Table 2. Level of education of respondents in the two different locations of the study

Education level		Location		Total
		Makunga	Kibargoi	
No schooling	Count	5	1	6
	% within Location	4.5%	2.4%	3.9%
Primary	Count	59	24	83
	% within Location	53.6%	57.1%	54.6%
Secondary	Count	40	11	51
	% within Location	36.4%	26.2%	33.6%
College	Count	5	6	11
	% within Location	4.5%	14.3%	7.2%
University	Count	1	0	1
	% within Location	0.9%	0.0%	0.7%
Total	Count	110	42	152
	% within Location	100.0%	100.0%	100.0%

Land tenure systems. Figure 1 shows the land tenure systems among the farmers. Of all the respondents, 76.3% had freehold land, 21.7 % had communally owned land while 2% had leasehold land. This indicated that most of the farmers had free access to land.

Table 3 gives information on land size of the respondents. The results indicate that majority of the farmers (38.8 %) had one acre and below while 27.6 % had between one to three acres. Respondents with four to five acres were less than 10 % in both locations while those with above five acres were less than 5%.

Table 4 shows the ranking of food crops according to their importance in food security by the target farmers interviewed. Maize, beans, sweet potato and millet were the most important to the farmers in that order. It is of importance to note that though soy bean was ranked among the least important, it had the same percentage with millet which is of significance to the respondents. Likewise, desmodium scored 37.5 % though ranked least important.

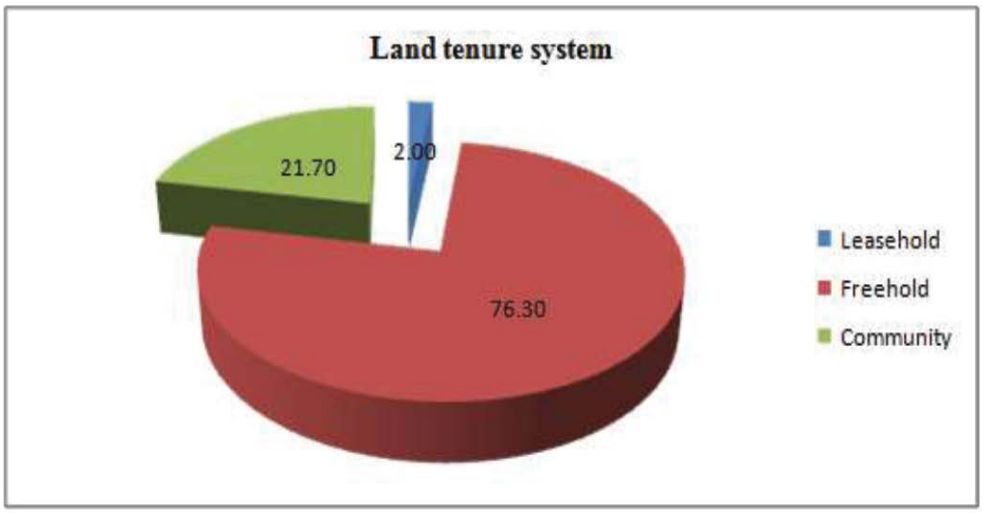

Fig. 1. Land tenure systems in the two different locations of the study

Table 3. Land size distribution in the two different locations of the study

Land size		Location		Total
		Makunga	Kibargoi	
1.00 acres and below	Count	44	15	59
	% within Location	40.0%	35.7%	38.8%
1.10 to 2.00 acres	Count	29	8	37
	% within Location	26.4%	19.0%	16.4%
2.10 to 3.00 acres	Count	19	8	27
	% within Location	17.3%	19.0%	11.2%
3.10 to 4.00 acres	Count	6	4	10
	% within Location	5.5%	9.5%	6.6%
4.10 to 5.00 acres	Count	5	3	8
	% within Location	4.5%	7.1%	4.6%
5.10 to 6.00 acres	Count	4	1	5
	% within Location	3.6%	2.4%	2.6%
7.00 to 8.00 acres	Count	1	2	3
	% within Location	0.9%	4.8%	2.0%
10.00 to 25.00 acres	Count	2	1	3
	% within Location	1.8%	2.4%	2.0%
Total	Count	110	42	152
	% within Location	100.0%	100.0%	100.0%

Uses of sweetpotato tubers are indicated in Figure 3. The data show that 80.6% of the tubers are used for human food, 15.1% for income and 4.3% for animal feed. This indicates that the crop is a food security crop.

Figure 4 shows the source of sweetpotato cuttings that the farmers planted. It indicates that they mostly sourced planting materials from other farmers (61.2 %). Other sources of planting materials were research institutions (24.5 %), own fields (7.9 %), and training institutions and family members (less than 4 % each).

Table 4. Ranking of crops grown in relation to food security in the two different locations of the study

Crop	Food security rank	Count	Column N %	Column Responses %
Sorghum	Least important	43	28.3%	5.1%
Millet	Most important	43	28.3%	5.1%
Maize	Most important	138	90.8%	16.4%
Soybean	Least important	43	28.3%	5.1%
Beans	Most important	97	63.8%	11.5%
Sweet potato	Most important	73	48.0%	8.7%
Irish potato	Least important	50	32.9%	5.9%
Desmodium	Least important	57	37.5%	6.8%
	Total	152	100.0%	100.0%

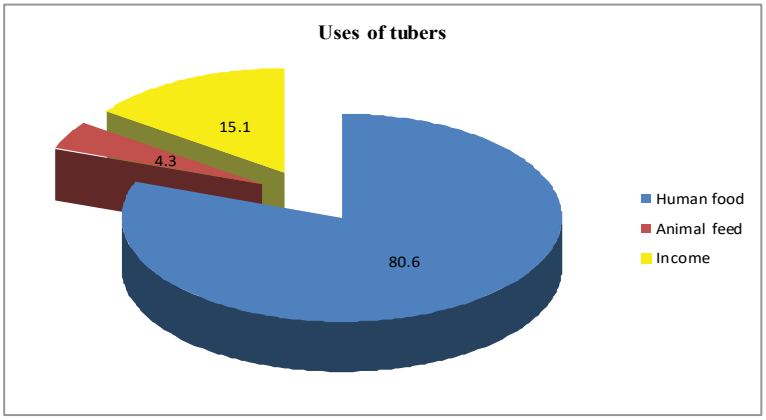

Fig. 3. Uses of tubers by respondents in the two different locations of the study

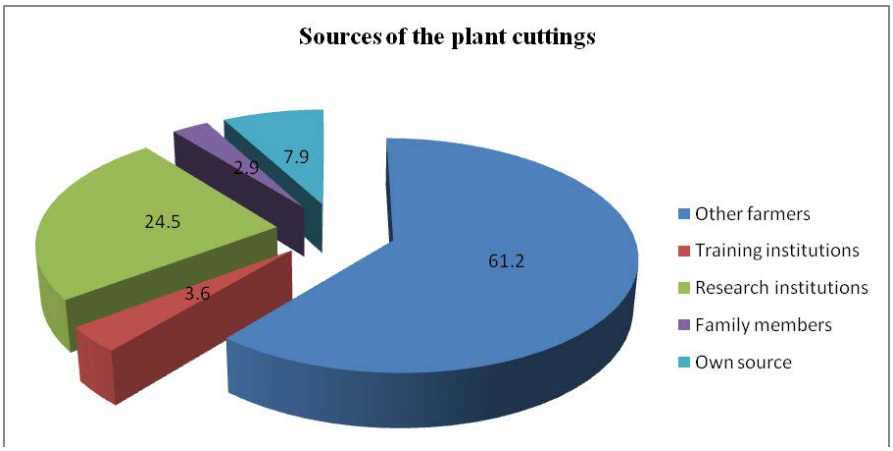

Figure 4. Sources of plant cuttings

Figure 5 shows the use of organic and inorganic fertilisers in crop production. The data show that 31 % of the respondents used organic fertilisers while 69% did not. On the other hand, 10.7 % used inorganic fertilisers while 89.3 % did not.

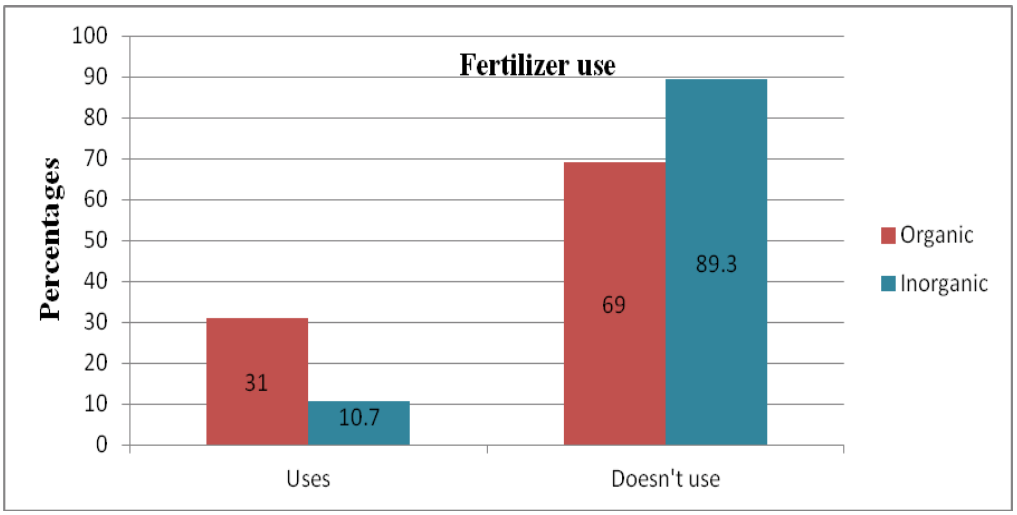

Figure 5. Fertiliser use among respondents in the two different locations of the study

Figure 6 gives the frequency of access to agricultural information by farmers. Results show that 57.6 % got information one to three times in a year, 28 % four to six times annually while 14.4 % accessed extension services seven to twelve times in a year.

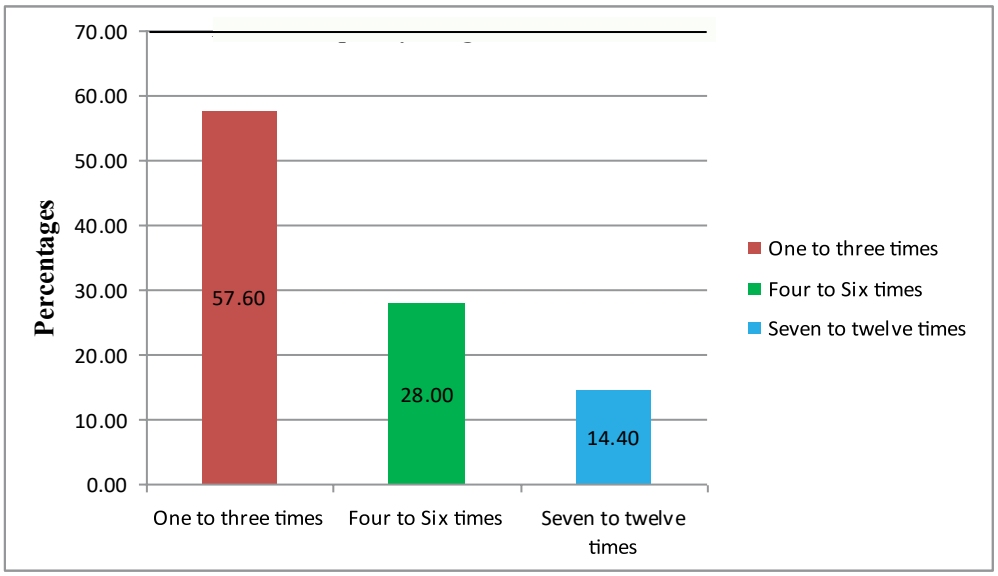

Figure 6: Frequency of access to agricultural information in the two different locations of the study

Soil fertility challenges experienced by farmers. The challenges faced by the respondents in terms of soil fertility are presented in Table 5. High cost of fertilizer was viewed as the main challenge followed closely by inherent low soil fertility and soil erosion. Soil fertility management strategies undertaken by the respondents are given in Table 6. Majority of the farmers practiced rotational cropping system (58.6 %) while use of organic animal manure and intercropping system contributed less than 20 % each and inorganic fertilizer less than 10 %. Soil fertility management using crop residue is uncommon among the respondents with only 3.9 % employing the strategy.

Table 5. Farmers' perception on soil fertility challenges in the two different locations of the study

Fertility status	Frequency	Valid Percent	Cumulative Percent
Low soil fertility	51%	33.8%	33.8%
Soil erosion	43%	28.5%	62.3%
Delayed fertilizer supplies	2%	1.3%	63.6%
Drought	2%	0.7%	64.2%
High cost of fertilizer	54%	35.8%	100.0%
Total	152	100.0	

Table 6. Soil fertility improvement strategies used by the respondents

Soil management practice	Frequency	Percent	Cumulative Percent
Rotational cropping system	89%	58.6%	58.9%
Intercropping system	19%	12.5%	71.5%
Use of inorganic fertilizer	12%	7.9%	78.8%
Use of organic animal manure	26%	17.1%	96.0%
Use of crop residue	6%	3.9%	100.0
Total	151	100.0	

Intercropping was viewed as having advantages in terms of plant nutrient addition (13.8 %) and soil fertility improvement (36.3 %) as indicated in Table 7. Use of cover crops scored 9.2 % while improvement in crop productivity captured 7.3 %.

Table 7. Advantages of intercropping as viewed by the respondents

Practice	Frequency	Valid Percent	Cumulative Percent
Adds soil nutrients	15%	13.80%	13.80%
Cover crops	10%	9.20%	23.00%
Breaks diseases and pest lifecycle	7%	6.40%	29.40%
Improve productivity	8%	7.30%	36.70%
Improves soil fertility	69%	36.30%	100%
Total	109	100.0	

Normality test

Variable	Observations	W	z	Prob>z
Agro-ecological zone	152	0.98024	1.915	0.02775
Previous yield for sweet potatoes	152	0.57950	8.851	0.00000
Use of organic fertilizer	152	0.87067	6.177	0.00000
Intercropping system with sweetpotatoes	152	0.87731	6.057	0.00000
Access to agricultural information	152	0.77539	7.429	0.00000
Sweetpotato variety	152	0.98577	1.169	0.02121

When the Shapiro-Wilk statistical tests was used to assess the actual degree of departure from normality, the normality assumption was not met. W – value was significantly smaller than 1. The data on W – values shows that most of the variables were significantly closer to 1 with the exception of previous land size for sweetpotatoes, implying that data were normally distributed.

The ANOVA analysis showed that $R^2 = 0.3382$ and adjusted $R^2 = 0.3105$, which indicated that about 31 per cent of variations in the productivity is explained by a number of factors listed in the coefficient table.

Discussion

Demographic factors, fertiliser use, access to agricultural advisory services, agro ecological zone and soil fertility challenges are among the main factors that influence sweetpotato production in West Kenya. In Kakamega County, farm activities are mostly carried out by women. The results are in agreement with Ogeto *et al.* (2013) and Kebeney *et al.* (2015) who reported that women are the main producers of food crops and play a significant role in ensuring food security at household level. The opposite was the case for Elgeiyo Marakwet County where men were more involved than women. This contrasts the report by World Bank (2012) who noted that in sub Saharan Africa, women are the majority involved in smallholder food production. Literacy level and socio-economic factors were noted to play a role in the production of the crop. The findings are in agreement with ACCI (2013) which indicated that education level influences articulation of new agronomic strategies as well as adoption of new technologies to improve crop productivity.

Majority of the farmers owned land (76.3 %) and this agrees with the findings by Kebeney *et al.* (2015) who reported that 54.7 % in their study owned land. Other authors (Mugurwe *et al.,* 2013) reported similar findings implying that land ownership is important among farmers in Kenya. Land size among the respondents ranged between one to three acres (0.4-1.1 ha) implying that the majority of them were smallholder farmers. Similar findings were reported by Owino and Mugurwe (2013) who reported that in Nambale, Busia County, most farmers owned land ranging from 0.4 to 1.2 hectares.

Vines used to propagate the crop were obtained from fellow farmers. This points out to the limited access to agricultural information and good agronomic practices. This could impact negatively on crop productivity. Okonya and Kroschel (2014) indicated similar findings among sweetpotato growing farmers in Uganda and further pointed out that inaccessibility to agricultural advisory services can lead to low technology adoption. High cost of fertilisers and low soil fertility in addition to soil erosion are the major soil fertility challenges experienced by sweetpotato growing farmers in west Kenya. According to ACCI (2013), majority of smallholder farmers in western Kenya live below the poverty line. The results in this study are similar and highlights input cost challenges among the respondents and this could have direct effect on crop productivity. According to Kisinyo *et al.* (2012), low inherent soil fertility is a serious setback and this is attributed to, among other factors, the original parent material from which the incumbent soil was formed from (Brady and Weil, 2008).

Rotational cropping, intercropping and use of animal manure are among the strategies undertaken by the farmers to improve soil fertility. In addition to that, farmers were of the opinion that production of sweetpotato did not require fertiliser although animal manure could be applied when available. Rotational cropping and intercropping are also practiced by small scale farmers in Uganda. Findings reported by Okonya and Kroschel (2014) concur with those of this study and shows the significance of these management strategies among smallholder farmers.

Conclusion

Demographic factors play a significant role in sweetpotato production. In that regard, level of education among the smallholder farmers need to be considered and simpler ways of disseminating information used to ease articulation of agricultural information. Training on use of fertilizers should be given centre stage because continuous cropping without mineral replenishment depletes the soils of plant essential nutrients.

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