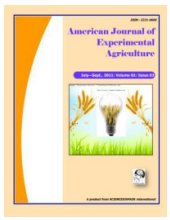

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Socioeconomic Factors and Soil Fertility Management Practices Affecting Sorghum Production in Western Kenya: A Case Study of Busia County

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Authors' contributions

This work was carried out in collaboration between all authors. Author SJK designed the study, performed field survey and wrote the first draft of the manuscript. Author BMM wrote the protocol. Author JMRS, WKN and AKK managed the analyses of the study. Author BMM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Sorghum (*Sorghum bicolor L.* Moench), though ranked as the third most important staple food crop in Kenya, farmers still experience periodic crop failure and this is a threat to food and income security. This paper attempts to find the underlying factors responsible for low production and establish farmers' perceptions on soil fertility management. A cross-sectional study was carried out in Busia County, to relate socioeconomic factors and soil fertility management aspects affecting

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sorghum yields. Structured interviews and observations were used for data collection, considering the variables: demographic factors, income, farmers' perception on soil fertility replenishing options, access to agricultural advisory services and yields of sorghum. Results indicate that women are predominant (57.3%) sorghum producing farmers in the County. Literacy level reveals majority of the farmers (49.3%) have primary education as optimum suggesting sorghum production to be through hands-on experience. Individual land ownership was the norm with most farms being 1.5 to 2.0 hectares. Income among respondents is below USD 1.25 per day. Sorghum is ranked very important (56.7%) and is a resource against food shortage. Many farmers (41.3.0%) use traditional seed from previous harvests with 24.0% purchasing seed from agro-dealers or being provided by non-Governmental organizations/projects. Intercropping is associated with food security, improved yields and land inadequacy and not to soil fertility restoration. Inadequate knowledge on the role of legumes and crop residue recycling in soil fertility improvement exists and 38.7% of farmers have access to agricultural information. Gender, social norms, literacy, fertilizer use, accessibility to advisory services and farmers' perception on soil fertility management options are concluded to impact on sorghum production in Busia County. The existing database on the alternative researched options to restore soil fertility and increase crop yields could be channeled through demonstration plots to farmers in a participatory manner in order to facilitate adoption.

Keywords: Busia county; demographic factors; income; soil fertility management.

1. INTRODUCTION

Socioeconomic factors influence agricultural production and thus, have to be considered when appraising the potential of a given farm. Social norms, constraints to knowledge, labour availability, financial and credit constraints [1,2] are among the factors impacting on agricultural production. According to [3,4], women are the majority involved in smallholder food production. This notwithstanding, researchers [5] pointed out that women constituted 60 % of the illiterate population in sub-Saharan Africa. The researcher [6] was of the opinion that more years of formal education has direct influence on better understanding and adoption of new technologies. Other researchers [7] reported that input prices and economies of scale with respect to inputs can also contribute intercropping of crops in a given piece of land.

In Western Kenya, soil fertility has been noted as the major setback to improved yields [8,9]. Research findings have indicated use of inorganic fertilizers [10-12] as a way of restoring the low inherent soil fertility in Western Kenya, Busia County inclusive. Other studies [13,14] reported on intercropping as being a possible option to restore fertility in the depleted soils of the region. These research interventions are aimed at improving soil fertility and enhancing crop yields.

Despite the alternative ways put forward by the researchers mentioned above, it is worth noting that sorghum (S*orghum bicolor* L. Moench), though ranked as the third most important staple food crop [15,16], the farmers in the growing areas still experience periodic crop failure and this is a threat to food and income security. The unanswered questions then are: (i) What are the underlying factors responsible for the low sorghum production in Western Kenya and in particular Busia County? (ii) What are the farmers' references used in appraising interventions and promotion of relevant soil fertility management practices that can lead to sustainable soil fertility improvement and enhanced yields? There is need therefore, to consider the references used by farmers in appraising interventions and promotion of relevant soil fertility management practices.

Thus, the study sought to establish the relationship of socio-economic factors and soil fertility management aspects that govern sorghum production in Busia County to better understand the farmers' basic principles of evaluating different soil fertility management practices aimed at promoting relevant options for sustainable soil productivity.

2. MATERIALS AND METHODS

2.1 Study Design and Sampling Procedure

A cross-sectional study was carried out among sorghum smallholder farmers in Busia County, Kenya to identify socio-economic factors and soil

fertility management aspects affecting the production of the crop. Structured interviews and observations were used to collect data from May to June, 2013. The variables under the study in regard to socio-economic factors were demographic factors and economic status of the households. In regard to soil fertility management aspects, the focus was on farmers' perception on use of agricultural inputs, agricultural advisory services, intercropping and recycling of crop residues. Sorghum growing areas in Busia County are Butula, Matayos, Funyula, Nambale and Busia Township. Using the divisions of each district, locations where farmers grew sorghum were stratified into two: lower and upper catchment leading to choice of stratified random sampling technique being used. Lists of farmers growing sorghum were obtained from Technical Assistants in the Ministry of Agriculture in the respective divisions and locations within the districts in the County. The names were then randomly selected as per the respective catchment and the villages. A sample population size was arrived at using the table on sample size selection and standardization equation,

$$n = (n0 \times N)/ (1 + (n0 - 1))$$

Where; N is the known population; n is sample size; and n0 is the unknown population [17,18].

Instruments of data collection were pre-tested in Butula district on 20 respondents [19] to ensure reliability and validity and revised before actual administering of the structured interviews and observations. Information was also sourced from extension service providers from the Ministry of Agriculture, non-Governmental organizations and local leaders to facilitate formation of general opinion about behavour of the variables under investigation. The structured interview schedules were then administered to 150 farmers in a face-to-face interview and their responses recorded accordingly. Farmers' evaluation of major soil management practices was based on the advantages and disadvantages perceived about the different practices.

2.2 Statistical Data Analysis

The information derived from the respondents were sorted, coded and analyzed using Statistical Package for Social Sciences version 18.0 (SPSS v18.0) [20] and descriptive analysis using MS-excel.

3. RESULTS AND DISCUSSION

3.1 Demographic Factors of the Smallholder Sorghum Farmers

3.1.1 Gender and age

Demographic factors among the smallholder sorghum farmers are presented in Table 1. The results showed that majority of respondents (57.3%) were female and 42.7% being male. The findings are in agreement with other works [4,21-24] who reported women participation in farming to be above 50%. The findings of this study reveal that 38% of the farmers belong to age group of 38 and 47 years, 24.7% aged between 28 and 37 years and 20% of them aged between 48 and 59 years. Researchers, [21] reported 30-39 years to be the majority (36.7%) while 40-49 years represented 26.6% of the respondents in farm activities. Elsewhere, [25] researching on adoption of integrated natural resource management indicated majority of farmers to be between 31-40 years of age. The age bracket by the reports mentioned suggests that age group is considered to be prime, most productive in terms of energy, responsibility and food providers to the household. Sorghum is considered a traditional crop and thus the younger farmers prefer to grow maize in preference to the crop.

3.1.2 Marital status, education level and household size

The data derived further highlights that most of the small holder farmers (85.3%) were married, with 12% widowed and 2.7% single. From the respondents, 49.3% had primary education level with 40.7% having secondary education and 6.7% had no formal education. Additionally, 1.3% and 2.0% had finished adult education as well as above diploma qualifications respectively. The findings indicate that majority of the small holder sorghum farmers had pre-secondary qualifications and thus, understanding and application of agricultural extension technical advices and practices may be a challenge. The study findings support the reports [2,6,13,26,27,28,29] that were of the opinion that education plays a role in the understanding and the practice of new interventions. Study results indicate the number of household ranged from 1 to 20. The highest family size (64.1%) had between 6 and 10 members, with 25.3% being 1-5 members in the family and 10.7% being 11-20

members. Family size noted agrees with data presented by [29] that the household size ranged between 7-9 members in Busia County. Family household is the major source of labour and thus imperative during farming activities such as planting, weeding and harvesting.

3.1.3 Land ownership, size, income and ranking of sorghum crop among the respondents

Type of land ownership, total land size, income earned from growing sorghum and the ranking of the crop by the respondents is summarized in Table 2.

Data derived indicated 54.7% of the farmers individually owned land, with 42.0% being family owned (inherited) and 3.3% leased the land for growing sorghum. In Busia County, the title deeds to the land is held by men implying that they do play a big role in decision making yet considering gender participation in crop production, women participation is over 50% [21]. The study findings are in line with [30] who highlighted ownership of land in Kenya to be on individual basis. Other studies [27,31,32], reported majority of farmers in Western Kenya owned land and that land ownership was primarily by men.

The findings contrast with a report from Ejura-Sekyedumase district in Ghana [28] who indicated that more females (88.9%) than male (75.4%) had access to land as a result of the matrilineal system of inheritance practiced. Farm size was in the range of <0.2 to >1.5 ha among the sample population. From the study 29.3% of the farmers had 1.5- 2.0 ha of land, while 27.3% owned between 0.6 and 0.9 ha of land and 23.3% between 0.3 and 0.5ha. The findings on land size are similar to those established by [32] who reported 31.5% of the respondents to own farm size of 0.4 to 1.2 ha.

The results obtained from the sample population further indicated that most of the farmers (49.3%) earned income less than USD 25, with 44.7% earning less than USD 63 and 5.3% earned above USD 125 at the end of sorghum growing season. On a daily basis, income of the respondents was tallying with [29], who indicated income among the communities in Busia County as being below USD 10.63 (exchange rate of Kenya shillings 80 per US dollar). The findings also shows the income of the respondents falls below the International critical level of US dollar 1.25 per day [33].

Table 1. Demographic factors of small holder sorghum farmers

Demographic factors	Variable	Frequency	Percent
Gender	Male	64	42.7
	Female	86	57.3
	Total	**150**	**100.0**
Age (years)	18 -27	10	6.7
	28 -37	37	24.7
	38 -47	57	38.0
	48 – 59	30	20.0
	> 60 years	16	10.7
	Total	**150**	**100.0**
Marital status	Single	4	2.7
	Married	128	85.3
	Widowed	18	12.0
	Total	**150**	**100.0**
Level of Education	No formal education	10	6.7
	Adult education	2	1.3
	Primary education	74	49.3
	Secondary education	61	40.7
	Others	3	2.0
	Total	**150**	**100.0**
Family size	1-5 members	38	25.3
	6-10 members	96	64.1
	11-20 members	16	10.7
	Total	**150**	**100.0**

Source: Field survey, May-June, 2013

Table 2. Land ownership, farm size, income and perception of sorghum among the respondents

Economic factor	Variable	Frequency	Percent
Type of ownership	Individual	82	54.7
	Family owned	63	42.0
	Leased	5	3.3
	Total	**150**	**100.0**
Farm size in hectares (ha)	< 0.2	10	6.7
	0.3 – 0.5	35	23.3
	0.6 – 0.9	41	27.3
	1.0 – 1.5	20	13.3
	1.5 – 2.0	44	29.3
	Total	**150**	**100.0**
Income from growing of sorghum (USD)	Less than 25	74	49.3
	Less than 63	67	44.7
	Above 125	8	5.3
	No response	1	0.7
	Total	**150**	**100.0**
Ranking of sorghum among other crops	Very important	59	39.3
	Important	85	56.7
	Less important	6	4.0
	Total	**150**	**100.0**

Source: Field survey, May-June, 2013. Exchange rate used was Kenya shillings 80 for 1USD

Majority of the farmers (56.7%) ranked sorghum as an important crop in comparison to other crops and 39.3% ranking it as very important. The findings highlight the role sorghum plays in food security and as a cushion against unpredictable maize yields. The importance linked to sorghum by the respondents was based on fear of maize lethal necrotic disease (MLND) that had been reported [16] to have caused 100% maize loss in the primary MLND outbreak zones in Kenya and speculation that the disease could spread to other maize growing areas in the Country.

3.2 Soil Fertility Management Practices

3.2.1 Use of agricultural inputs and soil fertility replenishment

Use of agricultural inputs and soil fertility replenishment options among the respondents are presented in Table 3. The results showed that 78% of the farmers bought agricultural inputs (seeds and inorganic fertilizer) of which 58.7% expressed use of certified seeds. It is important to note farmers perceived that because they already have crops that were grown from certified seeds, there is no need to procure the same seasonally, and hence they use their own seeds from previous harvests. Further to this, 24.0% of the farmers sourced seed from agro-dealers or non-Governmental organizations in the County through project participation.

It was imperative to note that 41.3% planted own seed stored from the previous harvest and the farmers were of the opinion that the seeds are safe since the grains are rarely attacked by storage pests. The farmers' perspective on source of sorghum for planting suggests the reason for the low yields of sorghum prevalent in the County.

Both inorganic (31.3%) and organic (60.0%) fertilizers were used by the respondents. Majority of the respondents preferred organic fertilizer due to their level of income and the high cost associated with inorganic fertilizers. The inorganic fertilizers used by the respondents were mainly sourced from projects run by NGOs and thus their use on sorghum production was limited.

Table 3. Agricultural inputs and fertilizer use by the respondents

Farm inputs	Category	Frequency	Percent
Buy agricultural inputs bought	Yes	117	78.0
	No	33	22.0
	Total	**150**	**100.0**
Use certified sorghum seeds	Yes	88	58.7
	No	62	41.3
	Total	**150**	**100.0**
Source of improved seeds	Seed producers	5	3.3
	Relatives/neighbours	11	7.3
	Own seed	62	41.3
	Seed dealers/shops	36	24.0
	Project/organization	36	24.0
	Total	**150**	**100.0**
Fertilizer(s) applied	Inorganic fertilizer	47	31.3
	Farm yard manure	42	28.0
	Compost manure	20	13.3
	Recycling of crop residues	29	19.3
	None	12	8.0
	Total	**150**	**100.0**

Source: Field survey, May-June, 2013

3.2.2 Intercropping as a farm practice among the respondents

Intercropping of sorghum with other crops and their respective percentages are outlined in Fig. 1. From the results, it can be deduced that majority of the farmers (54%) practiced intercropping of sorghum with various legumes with 24.7% being common beans and soybean standing at 5.3%. The farmers' perception on intercropping sorghum with green grams or cowpeas was to find a source of vegetables for the household during the short rains and for use during the dry season. The derived data also noted that a high percentage of the respondents (46.5%) do plant their crops as pure stands without intercropping.

3.2.3 Benefit of intercropping

The smallholder farmers' perceptions on advantages and disadvantages of intercropping in reference to crop yields and soil fertility improvement are presented in Table 4. From the findings, it was established that the smallholder sorghum farmers had varied opinions and perceptions on the importance of intercropping on crop yields and soil fertility improvement. Out of the sampled population, 30.0% associated intercropping to improved crop yields, with 17.3% noting that intercropping reduced yields and 7.3% were of the opinion that intercropping of crops had no benefits. It was also noted that 45.3% of the respondents do not practice intercropping hence could not give their opinions on the advantages and disadvantage of the practice. The practice was considered to be traditional and individual farmers intercropped their various crops depending on their objectives regardless of proper agronomic requirements of the crops. The results point out inadequate knowledge regarding intercropping among the respondents.

With regard to soil fertility improvement, 13.3% recognized intercropping improved soil productivity while 30.7% were of the opinion that intercropping reduced soil productivity. A sample population of 46.7% could not relate intercropping with crop yields and soil improvement. The respondents associated intercropping with food security, improved yields and subsequent sale of the surplus to meet the household needs and due to inadequate land. The findings indicate that importance of intercropping and growing of nitrogen fixing legumes for soil fertility is not understood by the respondents and lack information on the same. Thus, from the data derived, it was imperative to note that low crop yields could be attributed to intercropping without putting consideration other agronomic requirements of crop combinations. The report of the study supports other researchers [34] who pointed out that the importance of nitrogen fixing legumes in regard to soil fertility improvement is not well understood by the smallholder farmers in western Kenya.

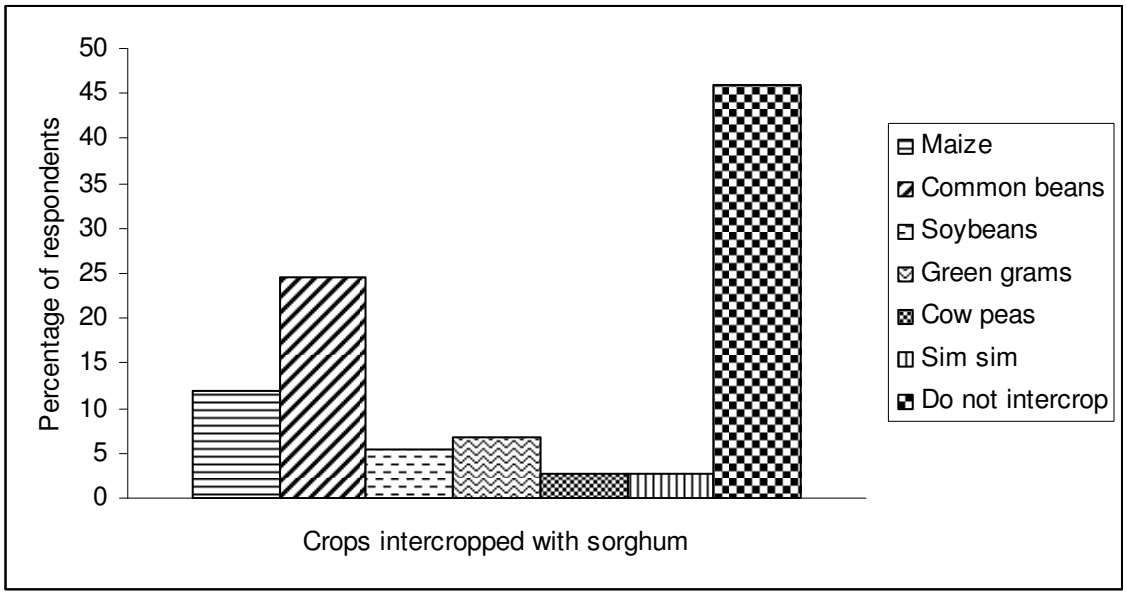

Fig. 1. Crops intercropped
Source: Field survey, May-June, 2013

Table 4. Smallholder farmers' perceptions on intercropping in reference to crop yields and soil fertility improvement

Advantage/disadvantage of intercropping	Frequency	Percentage
Crop yields		
Improved	45	30.0
Reduced	26	17.3
No change	11	7.3
No response	68	45.3
n = 150		
Soil fertility improvement		
Improved	20	13.3
Reduced	46	30.7
No change	14	9.3
No response	70	46.7
n = 150		

Source: Field survey, May-June, 2013

3.2.4 Recycling of crop residues for soil fertility improvement

Ultimate use of crop residues among the sample population is summarized in Fig. 2. Majority of the farmers 53.3% recycle the residues from sorghum by incorporating them into the soil to enhance its fertility, with 9.3% using it for mulching and 6.0% for fodder. However, 5.3% of the respondents burn the crop residues and 4.7% compost them. Out of the sample population, 21.3% take the legume residues out of the field during harvest to shell the legume grain and neglect the residues thereafter. The results illuminate that though intercropping is practiced by the smallholder households, importance of soil fertility improvement through recycling of residues is not well understood as a soil fertility management practice among the respondents.

3.2.5 Accessibility to agricultural information

Contact of agricultural extension officers with the sample population are presented in Table 5. From the study most farmers (61.3%) had no

contacts with agriculture extension officers and 38.7% did receive agricultural extension services and information. However, those farmers who had contacts comprised of 28.7% once, 6.7% twice and 3.3% thrice during the crop growing season.

The findings showed that there is limited accessibility of agricultural information and probably promotion of new technologies suited to the requirements of smallholder farmers with respect to the prevailing demographic factors and this could affect the overall productivity and crop yield improvement and sustainability.

The results of the study indicate lack of dissemination of agricultural information, training and other related knowledge which could have had direct influence on the crop production. The researchers, [35] had reported on wide communication gaps between researchers and farmers that had contributed to lack of awareness of new agricultural practices among smallholder households. According to [36], appreciable information from research activities in western Kenya has been documented but not easily accessed and furthermore, in most cases they are outdated. The results of the study emphasizes the need to close the existing dissemination gaps and ensure research findings are communicated to the target farmers for awareness and possible adoption of new agronomic practices and soil fertility management options.

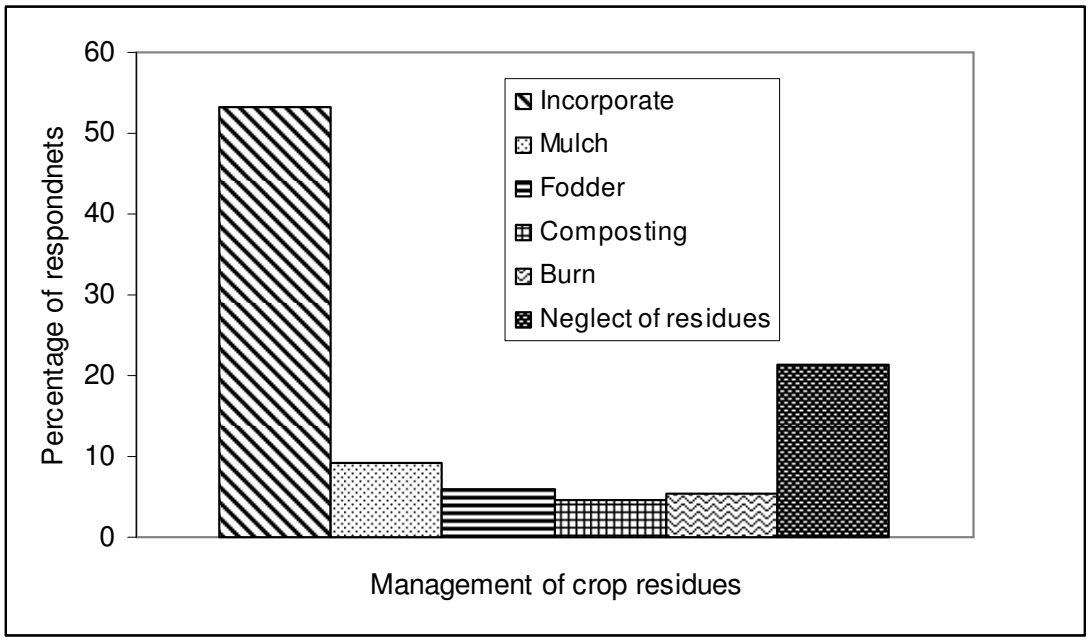

Fig. 2. Crop residue management among the respondents
Source: Field survey, May-June, 2013

Table 5. Accessibility to agricultural information

Contact with agricultural extension staff		Frequency	Percentage
Yes		58	38.7
No		92	61.3
How many times?	1	43	28.7
	2	10	6.7
	3	5	3.3
	Not at all	92	61.3

Source: Field survey, May-June, 2013

3.2.6 Yields of sorghum

In the year 2011, most of the farmers (60.0%) harvested between 0.09 and 0.18 tonnes, with 30.0% harvesting 0.18 – 0.36 tonnes and 10.0% harvested less than 0.09 tonnes. The number of tonnes harvested by farmers in 2012 varied. Most of the farmers (34.7%) harvested 0.09 tonnes of sorghum, with 19.3% of them harvesting 0.18 tonnes, while 10.7% harvested 0.27 tonnes, 10.0% got 0.36 tonnes and 25.0% harvesting less than 0.09 tonnes of sorghum. In terms of yields, there exists a close similarity in both years i.e. no remarkable change in yields suggesting stagnation rather than improvement. The findings imply that sorghum production is grown basically for subsistence but when the production is high some it is sold in the local markets. It agrees with report by [29] which indicate sorghum is grown as a subsistence crop. In case of maize crop failure, the yields of sorghum cannot probably be taken as a cushion against hunger.

4. CONCLUSION

Gender disparity, social norms and education level are demographic factors associated with the experienced low sorghum yields in Busia County. With regard to soil fertility management aspects, minimal fertilizer use, perception of the farmers on soil fertility management options and inaccessibility to advisory services are concluded to impact on sorghum production in the County. A database of the alternative researched options to restore soil fertility and increase crop yields could be developed and demonstration plots on the same findings be set up to involve farmers' participation and perhaps facilitate adoption. Extension service delivery needs to be provided to both men and women with emphasis on intercropping of cereals with nitrogen fixing legumes and residue management to improve soil fertility and enhance crop yields.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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