academicJournals

Vol. 8(47), pp. 6055-6067, 5 December, 2013
DOI: 10.5897/AJAR12.2123
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Sorghum production for food security: A socio-economic analysis of sorghum production in Nakuru County, Kenya

Robert M. Ogeto[1], Erick Cheruiyot[2], Patience Mshenga[3] and Charles N. Onyari[4]

[1]Kenya School of agriculture, P. O. Box 1909-10100, Nyeri, Kenya.
[2]Department of Crops, Horticulture and Soil Sciences, Egerton University, P. O. Box 536, Njoro, Kenya.
[3]Department of Agricultural Economics and Agribusiness Management, Egerton University, P. O. Box 536, Njoro, Kenya.
[4]Embu University College, P. O. Box 6-60100, Embu, Kenya.

Accepted 21 November, 2013

Kenya's Vision 2030 identifies agriculture as one of the key sectors to deliver sustainable economic growth and improved livelihoods for the poor in the rural areas. However, the sector continues to face several endemic and emerging constraints that require special attention. During the first two decades after independence, Kenya's economy grew at an average rate of 6 percent per year and this was substantially driven by a robust agriculture sector. However, until about five years ago, the overall economy barely grew, partly as a result of a decline in agricultural activities. The agriculture sector continues to face challenges in production due to frequent and prolonged drought hence the need for drought resistant crops like sorghum. The utility of sorghum is in its climatic adaptability and household as well as industrial use. However, there is a remarkably low production as well as consumption among Kenyan communities against the food security challenges. This paper provides insights into the socio-economic characteristics of farmers and the factors that influence their participation in its production. Simple random and snowball sampling methods were applied in collecting data from 207 farmers using a questionnaire. Data collected was analyzed using the double hurdle model. Of the factors under study, only land tenure, gender, farm size and educational level were significantly influencing sorghum production in the study area. It was recommended that more women should be encouraged to participate in sorghum production as it was found that they participated in sorghum production more than men.

Key words: Sorghum production, development, food security, Nakuru County.

INTRODUCTION

Kenya's Vision 2030 has identified agriculture as one of the key sectors to deliver sustainable economic growth and improved livelihoods for the poor in the rural areas. However, the sector continues to face several endemic and emerging constraints at the global, regional and national level that require special attention. During the first two decades after independence, Kenya's economy grew at an average rate of 6% per year and this was

*Corresponding author. E-mail: robertmoracha@yahoo.com.

substantially driven by a robust agriculture sector (MOA, 2009). However, until about five years ago, the overall economy barely grew, partly as a result of a decline in agricultural activities. Despite experiencing mixed results over the years, agriculture still remains a major contributor towards the Kenyan economy though its share of the Gross Domestic Product (GDP) declined from 23 percent in 2007 to 22 per cent of real GDP in 2010 and 24% in 2011 (KNBS, 2010). Besides, the sector is the growth engine for the non-agricultural sector with a multiplier effect of about 1.64. Furthermore, agriculture provides 75 percent of the country's industrial raw materials and employs over 80 percent of Kenya's workforce (MOA, 2009).

Food security and development in Kenya

Food security has moved to the forefront of the development debate, and it is likely to remain a chief development concern in Sub-Saharan Africa in the foreseeable future. The compounding effects of sharp increases in food prices in 2007 up to mid-2008 and the global economic downturn of 2009 are estimated to have reversed the steady decline experienced from the late 1960s to 2004-2006 in the proportion of undernourished population in developing countries (FAO, 2009). Estimates suggest that the share of the population in developing countries suffering from hunger increased in both 2008 and 2009, reaching close to 20 percent (FAO, 2009). In Sub-Saharan Africa, estimates indicate an increase in the proportion of undernourished from 28 percent in 2004-2006 to 29 percent in 2008 (UN, 2009). This implies a reversal in progress towards achievement of Millennium Development Goal 1, to halve the population living in hunger decreased by 2015 from 1990 levels, both globally and in Africa.

Climate change will compound these challenges. Africa is the region most at risk of hunger linked to climate change. Globally, the number of people at risk of hunger is projected to increase 10-20 percent by 2050 as a consequence of climate change (IFPRI, 2009). This is due to weak coping capacities and the acute vulnerability of agricultural production to climate shocks and stresses.

In Kenya, declining performance of the sector in terms of its growth has been one of the major concerns facing policy makers and those having interests in the sector. A decline in agriculture has thus, far reaching implications in terms of employment and income inequality as well as food security for the country (UNDP, 2002). Agricultural productivity is needed for growth since the actual yields of major crops in Kenya are far below the potential yield (Karugia, 2003). There is need to expand areas under crop production and this could mean venturing into dry areas hence the need for drought tolerant crops like sorghum to bridge this gap. Sorghum is a very important source of food and farm income for smallholder farmers, which can be enhanced especially if linked to new markets (Hamukwala, 2010). Sorghum is important to a substantial number of farm households in the East African region, especially in the semiarid areas. Most cultivars of these drought resistant grains represent food for the household, and cash income if there is a market for the sale of surplus production. Some cultivars are also grown for brewing, which offers another source of cash (Schmidt, 1988).

The utility of sorghum as a cereal crop

Despite its major contribution, the agriculture sector continues to face challenges in production due to frequent and prolonged drought both locally and internationally. Drought is perhaps the most prevalent abiotic stress affecting plant growth, survival and productivity in the world (FAO and ICRISAT, 1996). It is reported that the effect of drought is more pronounced in the Semi-Arid Tropics (SAT), where rainfall is generally low, erratic and poorly distributed. The drastic effect of drought can be reduced by growing drought tolerant crops such as sorghum. Sorghum is the world's fifth most important cereal, in terms of both production and areas planted. It is primarily grown in areas experiencing low rainfall. Most of these areas are unsuitable for the production of other grains unless irrigation is available (FAO and ICRISAT, 1996). Sorghum is unique in its ability to produce under a wide array of harsh environmental conditions where other crops grow or yield poorly. It is grown with limited water resources and usually with low fertilizer supply or other inputs by a multitude of smallholder farmers in many countries (FAO, 1995).

Total consumption of sorghum closely follows the global pattern of output, since most of it is consumed in the countries where it is grown. It is used for human food and as animal feed (FAO, 1995). This report further indicates that, although in the early 1990s a very large part of the sorghum output was used directly as human food, its share has continuously declined in quantity since then. On the other hand sorghum consumption as animal feed has more than doubled from 30 to 60% since the early 1990s. While total food consumption of all cereals has risen considerably during the past 35 years, world food consumption of sorghum has remained stagnant, mainly because it is regarded in many countries as an inferior grain, although the crop compares nutritionally well with other grains.

As human food, sorghum has many uses with some of its products being: dehulled boiled sorghum, sorghum stew, sorghum *pilau*, sorghum green grams *pilau*, sorghum *ugali*, sorghum ginger biscuits, sorghum bread, sorghum queen cakes, sorghum cake, sorghum *chapatti*, sorghum porridge and sorghum beverage (MOA, 2007). Other uses of sorghum include use of stalks as dry

season fodder and as fencing materials in addition to industrial uses as animal feed, making of industrial starch and fuel for alcohol production.

There are good prospects for the expansion of the industrial market for sorghum if its yields can rise fast enough to catch up with yields of competing cereals (FAO and ICRISAT, 1996). In spite of these prospects, sorghum tends to be grown in traditional farming systems. As a result, the yields generally average less than 1 ton/ha and vary considerably from year to year with majority of sorghum growers not producing enough to meet family requirements in most years.

In Kenya, sorghum is grown principally in the often drought-prone marginal agricultural areas of Eastern, Nyanza and Coast Provinces. Farm production went up from 118,227 t in 2002 to 126,433 t in 2003 (EPZA, 2005). Production of sorghum increased by a dramatic 75 percent from 602,910 bags in 2008 to 1,055,051 bags in 2009 with some slight improvement on the yield per ha to 6.09 bags; much lower compared with the 14.0 bags/ha recorded in 2005 and 10.5 bags/ha recorded in 2007. The area under the crop also registered an increased acreage to 173,172 ha in 2009 from 104,041 ha in 2008 a 67% increase. The acreage further increased to 254, 125 ha in 2011 from 225,762 ha in 2010 a 13% increase. This increase is attributed to increased area dedicated to the crop on account of being drought resistant and hence a primary poverty eradication vehicle especially in marginal areas (MOA, 2012).

Research data on the influence of socio-economic factors on participation and extent of participation in sorghum production in Kenya is not available. The objective of this research was to study the influence of socio-economic factors on participation and extent of participation in sorghum production in Njoro and Rongai of Nakuru County.

Sorghum production in Nakuru County

Over the years, Kenya has experienced diminishing rainfall amounts probably due to the effects of the global climate change. This has led to decreased food production making her a food deficit country with most areas receiving relief food supplies in many of the years. This has necessitated the government to come up with programmes to encourage the growing of drought tolerant crops like sorghum as a means of ensuring food security and improved incomes. The demand for sorghum is gradually increasing owing to industrial needs such as brewing by East African Breweries Limited. However, sorghum production remains low despite the added agribusiness benefit.

Though Nakuru County is among the high potential areas for sorghum, indications are that only a few farmers are engaged in commercial production and that the farmers are not able to produce sufficient quantities for consumption and get surplus for sale. The current status of sorghum cultivation in the County is not clear and underlying factors to lack of response to emerging trends in sorghum demand needs to be determined if the crop's promotion is to be effectively effected. However, there has been paucity of research with regard to the socio-economic and institutional characteristics of sorghum producers and the acreage under sorghum production. There is therefore need to analyze the socio-economic factors influencing participation and extent of sorghum production as an initial step to finding the solution to increasing sorghum cultivation among smallholder farmers in Nakuru County.

METHODOLOGY

Study area

The study was conducted in Njoro and Rongai Districts in Nakuru County. Nakuru County lies within the Great Rift Valley and borders eight other districts namely, Kericho, and Bomet to the West, Koibatek and Laikipia to the North, Nyandarua to the East, Narok to the south West and Kajiado and Kiambu to the south. The County covers an area of 7,235.3 Sq Km and is located between longitudes 35" 28" and 35" 36" and latitudes 0" 12" and 1" 10" South (NCAPD, 2005). It lies about 2100 m above sea level.

The area surrounding Nakuru town is known for its agricultural potential with numerous small farms and also vast agricultural enterprises. The main crops grown and marketed in Nakuru County include coffee, wheat, barley, maize, and beans.

The crops provide the primary raw material for the manufacturing industries found in Nakuru. These industries include flour milling and grain ginneries. However some areas of Nakuru County are marginal, hence conducive for production of sorghum in such areas.

Rongai district comprises four divisions, eighteen locations and thirty seven sub-locations. It falls within an altitude range of between 1650 and 1850 m above sea level (a.s.l) with a temperature range of between 17 and 29°C. There are three agro-ecological zones namely Lower Highland 3 (LH_3), Upper Midland 2 ($UM_{2)}$ and Upper Midland 3 (UM_3). The annual rainfall is between 600-1000 mm. As per the 2009 census, the district population is 142,127 with 33,868 farm families which form 24% of the population (Jaetzold and Schmidt, 2010). The major crops in the district include maize, wheat, sorghum, finger millet, cow peas, beans, Irish potatoes, sweet potatoes, fruits, vegetables and cassava whereas the major livestock include dairy cows, dairy goats and poultry.

Njoro district comprises four divisions, twenty one locations and forty four sub-locations. There is a wide variation in altitude with Mauche lying within 2100- 2500 m a.s.l, Mau Narok 1700-2850 m a.s.l and Lare 1650-2200 m a.s.l. with a temperature range of between 11 and 24.5°C. The divisions lie within varied agro ecological zones with Mauche lying within UH1, UH2, and LH, Mau-Narok lies within UH1, UH2,LH, Njoro lies within UH2, UH3 and LH3 while Lare lies within LH2, LH4 and UM3. The annual rainfall is between 600-1800 mm as per the 2009 census, the district population is 287,648 with 35,012 farm families which form 12.17% of the population (Jaetzold and Schmidt, 2010). The major crops in the district include Maize, Beans, Wheat, Irish potatoes, Cabbages, Kales, Carrots, Pyrethrum and Sorghum, whereas the major livestock include dairy cows, dairy goats, sheep and poultry. The study area particulars are shown in Figure 1.

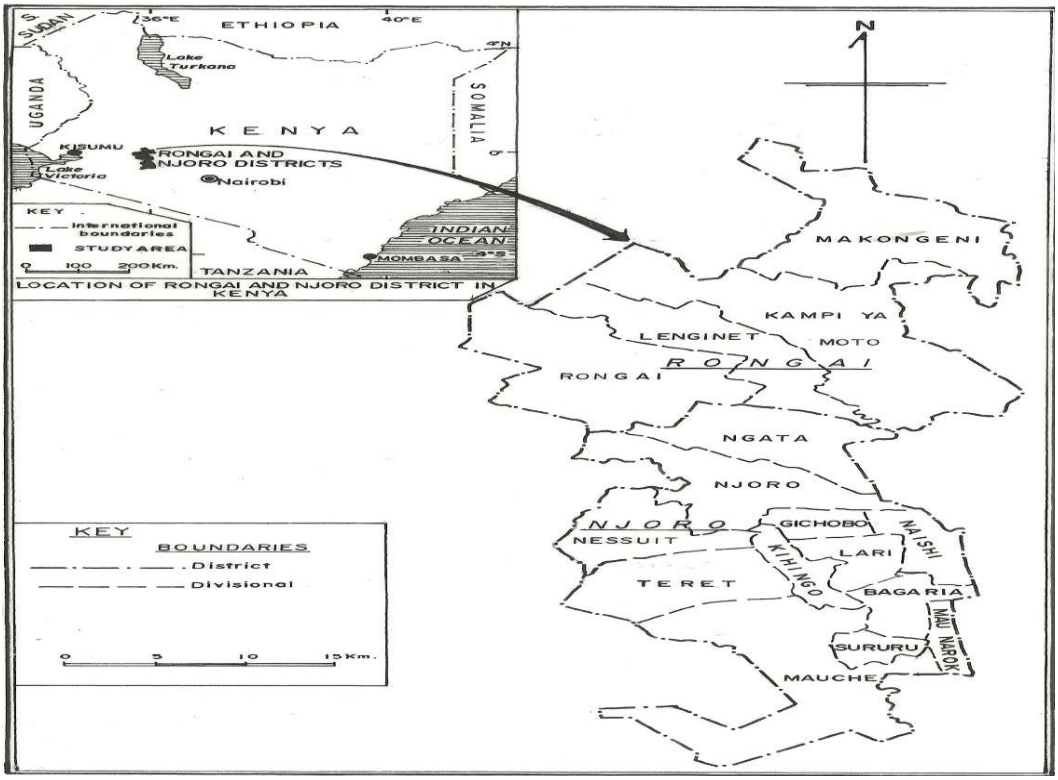

Figure 1. The study area particulars.

Data collection

In Kampi Ya Moto Division, simple random sampling was applied in order to choose a sample of 105 farmers from a sample frame that was provided by the District Agricultural office. This method of sampling involved giving a number to every member of the population in the sampling frame, placing the numbers in a container and then picking any number at random. The subjects corresponding to the numbers picked were included in the sample.
In Njoro Division, both purposive and snowball sampling were applied. In the division, the number of sorghum farmers was so small as compared to non sorghum farmers and not well known, hence simple random sampling alone could not be used. Snowball sampling is useful when the population that possesses the characteristics under study is not well known and there is need to find subjects. Purposive sampling was first used to identify sorghum farmers in the division who will form part of the sample. Snowball sampling was then applied using the purposively identified cases to identify more sorghum farmers to form part of the sample. In snowball sampling, initial subjects with the desired characteristics (sorghum farmers) were identified using purposive sampling technique. The few identified subjects were then asked to name others that they know to be producing sorghum until the list was exhaustive. Then simple random sampling was applied to select non sorghum farmers from the sampling frame until the desired sample size of 102 farmers was attained.

Analytical technique

The double hurdle regression model was used. It models non-participation and potential participation apart from the observed participation. It is a two tier decision or selection equation and the outcome depends on the selection to participate. The empirical model is as shown as follows:

Double hurdle empirical model:

$$y_{i1}^{*} = Q_i'\alpha + v_i \quad \text{Participation decision}$$

$$y_{i2}^{*} = X_i'\beta + u_i \quad \text{Extent of participation}$$

$$y_i = X_i'\beta + u_i \quad \text{If } y_{i1}^{*} > 0 \text{ and } y_{i2}^{*} > 0$$

$$y_i = 0 \quad \text{Otherwise}$$

Where: y_{i1}^{*}: Latent variable describing the household's decision to participate in sorghum production; y_{i2}^{*}: Latent variable describing households' extent of sorghum production; y_i : Observed dependent variable; Q_i : Vector of variables explaining the participation decision; X_i : Vector of variables explaining the extent of sorghum production; v_i, u_i: respective error terms assumed to be independent and distributed as $v_i \sim N[0, \alpha^2]$ and $u_i \sim N[0, \alpha^2]$.

The first equation defines the participation decision and non-participation decision model where y_{i1}^{*} takes the value of 1, if a household made a decision to produce sorghum and 0 if no production. This equation was used for analysis for objective one. The second equation defines the intensity of participation where y_{i2}^{*} is the acreage under sorghum production. Q_i and X_i define socio-economic factors that affect the discrete probability of participation or non-participation and intensity of participation respectively. The socio-economic factors under consideration were: Age of household head, gender of household head, household size,

Figure 2. Participation in sorghum production in Nakuru County by gender.

storage facilities, household income and educational level attained by the farmer. v_i and u_i are the error terms of estimation in the participation and intensity of participation functions respectively. According to Gujarati (2004) and Pallant (2007), the coefficients measure the expected change in the model for a unit change in each independent variable, all other independent variables being equal. The sign of the coefficients shows the direction of influence of the socio-economic variable and it therefore follows that in this study, a positive value in tier 1 indicates an increase in the likelihood that a household will participate in sorghum production and a positive value in tier 2 indicates an increase in the likelihood that the household will put more land under sorghum production. On the other hand, a negative value in tier 1 shows that the household is less likely to participate in sorghum production and in tier 2 that the household is less likely to increase the acreage under sorghum.

The significance values (P-values) show whether a change in the independent variable significantly influences the dependent variable at a given level. In this study, the variables were tested at the 5% and 10% significance levels. Thus, if the significance value is greater than 0.1, then it shows that there is insufficient evidence to support that the independent variable influence the dependent variable. If the significance value is equal to or less than 0.1, then there is enough evidence to support a claim presented by the coefficient value. If the significance value is less than or equal to 0.05, then the variable is significant at 5% significance level. If the significance value is greater than 0.05 but less than or equal to 0.1, the variable is significant at 10% significance level. The standard error measures the standard deviation of the error in the value of a given variable (Hill et al., 2001; Gujarati, 2004).

RESULTS AND DISCUSSION

Socio-economic characteristics of sorghum farmers

Gender of farmers

The results on demographic characteristics showed that there were a larger proportion of females (54.6%) as opposed to males (45.4%). This was as expected given that farming in the region is dominated by women who are involved in such enterprises as sorghum farming, which is grown in the two regions for subsistence purposes. This is in agreement with findings of Doss (1999) that women are more involved in subsistence crop production unlike men. The phrase 'the African farmer and her husband' also expresses the importance of women farmers in Africa, where some 80% of all those engaged in food production are women. On average, women work more hours than men in producing food as they produce the bulk of the food for local or family consumption (Commonwealth Secretariat, 2001). The findings of the study further revealed that a larger proportion of women participate in sorghum production (50.5%) as opposed to males (49.5%) of the total number of farmers who participated in sorghum production as shown in the Figure 2. This implies that women are more involved in sorghum production than men. This agrees with Doss (1999) who concludes that a frequently made distinction is that cash crops and export crops are "male crops," while subsistence crops are "female crops". The standard explanation for the division of crops by gender is that women are responsible for feeding the family and thus prefer to grow small scale subsistence crops for household consumption at the expense of commercialization, whereas men are responsible for providing cash income.

Age distribution of farmers

Age of the household head is an important aspect in agriculture because it determines experience one has in a certain type of farming. Household head's experience further influences household members' farming activities since they usually provide guidance (Ngqangweni and Delgado, 2003). The results of the study revealed that majority of the farmers were of young ages with 36.7 and 26.6% of the farmers falling in the 30-39 and 40-49 age ranges respectively which is the most active age in life in terms of enterprise development and management. Majority of the famers were in the range of between 30-59 years with a few farmers over 60 years. The average age of the farmers was 43 years which implies that majority of the farmers in the study area are of medium age groups. The study further revealed that 52.9% of the farmers who were below 30 years were participating in sorghum production. On the other hand, 57.9% of the

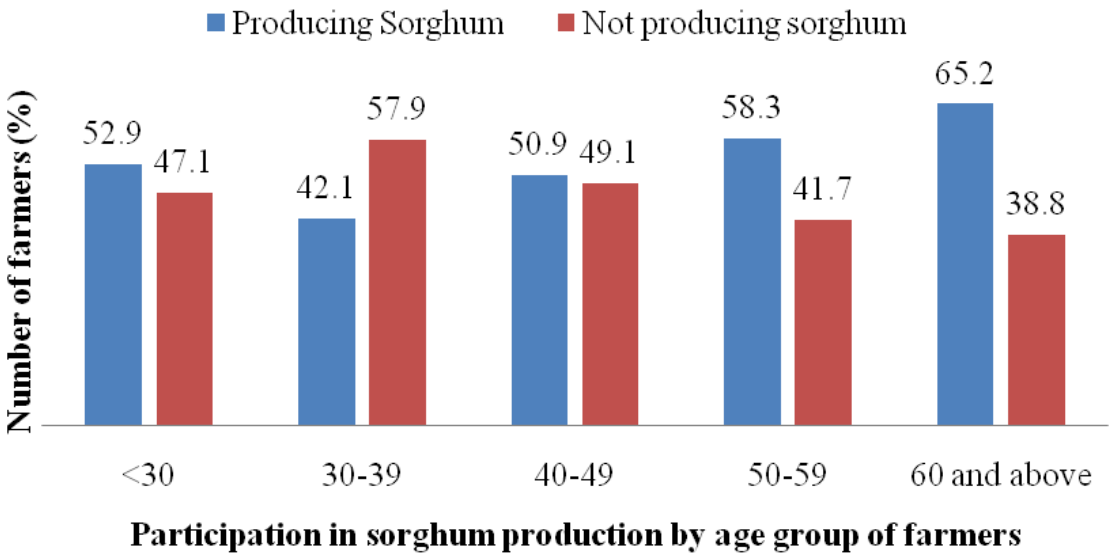

Figure 3. Participation in sorghum production in Nakuru County as per age group of farmers.

farmers who were between 30 and 39 years did not participate in sorghum production with only 42.1% participating as shown in the Figure 3. In the age group of 40 to 49 years, 50.9% were participating in sorghum production. In the age group of 50 to 59 years, 58.3% of the farmers were participating in sorghum production whereas in the age group of farmers who are 60 years and above, 65.2% participated in sorghum production. The results implied that the probability of participation in sorghum production increased as the age of the farmers increased. This means that older farmers in the study area were participating in sorghum production more than the younger farmers. This could be because sorghum becomes a good substitute for grains like maize in the diet of most elderly people. It is often recommended for feeding by elderly people especially those with diabetic complications.

Education level of farmers

Education is an important aspect in enterprise development and farm management. The results showed that 41.1, 42.5 and 10.1% of the respondents had primary, secondary and tertiary level of education, respectively. Only 6.3% of the respondents reported to have no formal education. Majority of the farmers in the study area had primary and secondary education. This generally means that most of the respondents are literate. These results were in agreement with the findings of UNESCO that showed that about 38% of the adult population in sub-Saharan Africa, or 153 million adults cannot read or write and that over 60% of these are women (UNESCO, 2010). The findings further showed that 69.2% of the farmers without education were participating in sorghum production as shown in the Figure 4. Out of the 85 farmers with primary education, 54.1% were producing sorghum whereas out of the 88 farmers with secondary education 47.7% of the farmers were producing sorghum. Only 38.1% of the farmers with tertiary education were producing sorghum. The results generally indicate a declining number of farmers who produce sorghum as the level of education increases. This implies that famers with low level of education (no education and primary level) in the study area were participating more in sorghum cultivation than those with higher education (secondary and tertiary levels). This gave an implication that the probability of participation in sorghum production in the study area decreases as the level of education of the farmer increases. As the level of education of the farmers increase, their probability of getting off-farm engagements increases (Weir and Knight, 1999). They will also in most cases have a tendency of producing high value crops with big margins as compared to sorghum. These could be the reason for the declining production trends in sorghum production as education levels increased.

Land tenure system

Land tenure provides the legal and normative framework within which all agricultural as well as other economic activities are conducted. When tenure rights are certain, they provide incentives to use land in a sustainable manner or invest in resource conservation whether for

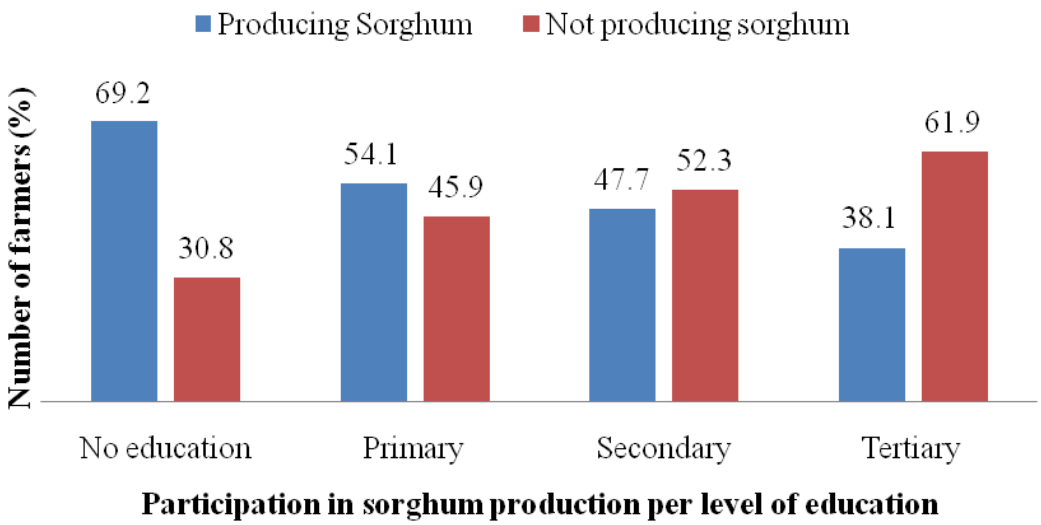

Figure 4. Participation in sorghum production in Nakuru County as per level of education of farmer.

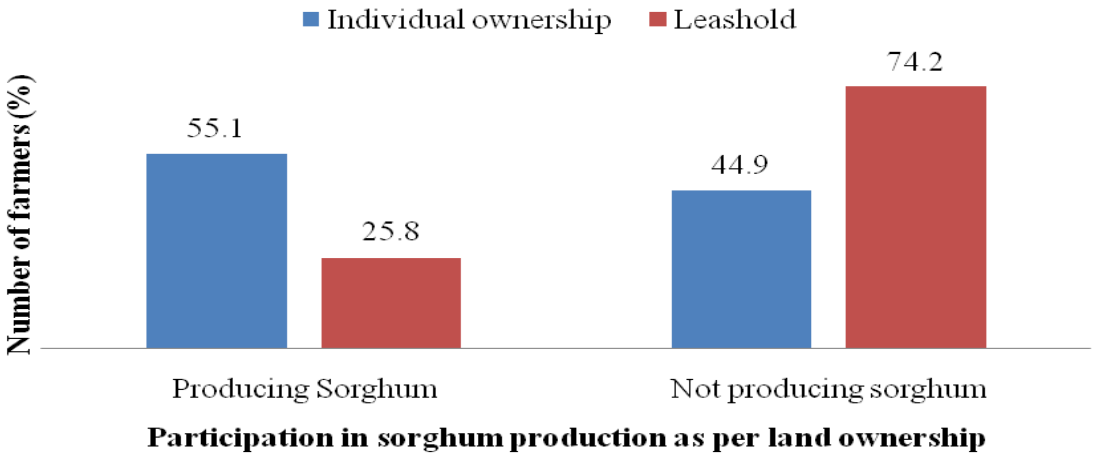

Figure 5. Participation in sorghum production in Nakuru County as per land tenure systems.

the individual or group of individuals (Ogolla and Mugabe, 1996). Land tenure types and policies also tend to determine the nature of agriculture and influence other land use practices (Waiganjo and Ngugi, 2001). It was noted that 84% of the farmers in the study area had individual land ownership while 16% owned land on leasehold. This implied that a majority of the farmers in the study area owned land on individual basis as is often the case in Kenya (Kameri-Mbote, 2005). This is important because it gives farmers an opportunity to invest in the land for productive purposes. The results further indicated that 55.1% of the farmers with individual ownership of land were cultivating sorghum as shown in the Figure 5. On the other hand, only 25.8% of the farmers with leased land were cultivating sorghum. The results show that farmers in the study area on individual ownership of land participated more in sorghum production as compared to those with leased land. This gave an indication that majority of the farmers with leased land were giving priority to other high value crops for higher returns as opposed to sorghum which was produced majorly for subsistence by majority of the farmers even with those on individual land ownership.

Household size

The household is the major source of farm labour in small-scale agriculture, although most sorghum farming operations in the study area are gender specific. Women

Table 1. Sorghum production in Nakuru County as influenced by household sizes of farmers.

Household size distribution			Participation		Total
			Yes	No	
	<4	Count	17	16	33
		Household size distribution (%)	51.5	48.5	100.0
	4-6	Count	57	66	123
		Household size distribution (%)	46.3	53.7	100.0
	7-9	Count	22	15	37
		Household size distribution (%)	59.5	40.5	100.0
	>9	Count	9	5	14
		Household size distribution (%)	64.3	35.7	100.0
Total		Count	105	102	207
		Household size distribution (%)	50.7	49.3	100.0

Source: Sorghum survey, Njoro and Kampi Ya Moto divisions, December 2011 – June 2012.

play a major role especially during harvesting, threshing, winnowing and bagging of sorghum. Nganga (2009) attributes large household sizes to the desire to have enough family labour and hence farmers keen on using family labour instead of hired labour will in most cases have more children. In his study, the use of free child labour was also positively associated with family size implying that families that rely on child labour tend to have more children. This is especially true for women who use older children as baby-sitters as they perform other chores both inside and outside the household. The findings of this study showed that about 59.4% of the farmers had between 4 and 6 members in their household, while about 17.9% of the farmers had between 7 to 9 persons in their households. Only 6.8% had over 9 persons in their household. The average household size was 6 persons and this was almost in tandem with Kenya's mean household size of 5.1 persons (GOK, 1994). Only about 24.7% had more than 6 family members of the household which are fairly large sizes. This means that majority of the farmers in the study area generally had large household sizes. Generally, as family sizes increase, household demands increase which constrains family income unless there is a steady source of income a reason for a positive relationship between household size and poverty levels in most developing countries. It was further noted that 51.5% of the farm households with less than 4 family members were not producing sorghum whereas 46.3% of the farmers with household sizes of between 4 and 6 family members were producing sorghum as shown in the Table 1. However, the percentage of those producing sorghum increased as the household sizes increased, as about 59.3% of the famers who had between 7 and 9 family members were producing sorghum. The percentage of those producing increased further to 64.3% for farmers with over 9 family members. These results gave an implication that the likelihood of farmers in the study area of participating in sorghum production increased as the household sizes increased. As household size increases, the demand for various household items increases which in turn reduces the disposable income for production. This means little income is available for purchase of farm inputs and this could lead to production of sorghum by majority of the big households since sorghum requires very little input investment.

Farm size

Farm size plays an important role in deciding what enterprises farmers undertake and the land size to be put under each of those enterprises. The study results showed that majority of the farmers in the study area, that is, 72% of 207 farmers, had less than 4 acres. Overall, 19.3% of the farmers had between 4 and 8 acres and 3.9% having between 9 and 13 acres, with only 4.8 per cent having more than 13 acres of land for farm operations as shown in the Table 2. The results showed that majority of the famers had limited sizes of land for farm production.

The findings also indicated that more farmers with large farm sizes participate in sorghum production than those with small farm sizes. Out of the 149 farmers with less than 4 acres of land, 48.5% participate in sorghum production and 50.9% of 40 farmers with 4-8 acres produce sorghum as shown in Figure 6. On the other hand, 50% of the farmers with between 9 and 13 aces participate in sorghum with an equal number not participating. About 80% of the farmers with over 13 acres produce sorghum. Farmers with larger farm sizes

Table 2. Ranges of farm sizes in Nakuru County.

Farm size in acres	Number of farmers	Percentage of farmers
<4	149	72.0
4-8	40	19.3
9-13	8	3.9
>13	10	4.8

Source: Sorghum survey, Njoro and Kampi Ya Moto divisions, December 2011 – June 2012.

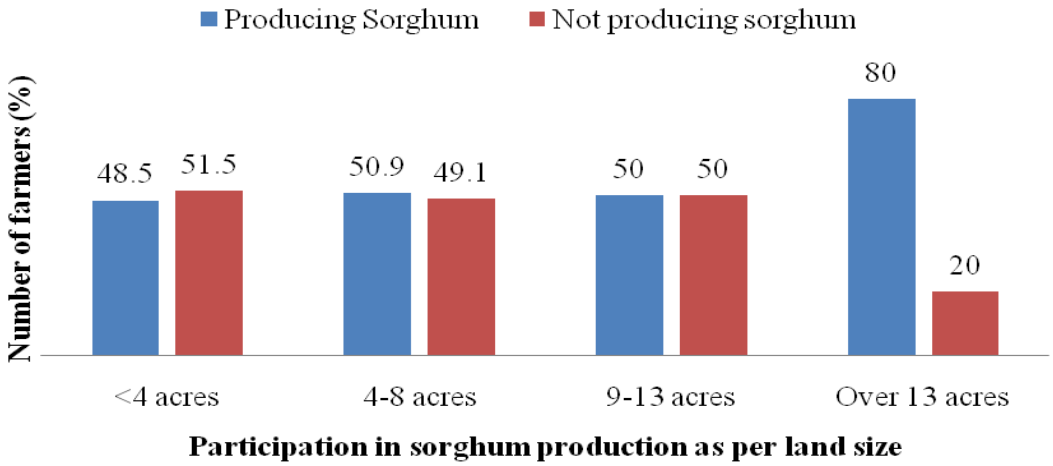

Figure 6. Participation in sorghum production in Nakuru County as per farm size.

are participating more in sorghum production as compared with those with small farm sizes. This means that the probability of participation in sorghum production in the study area increases fairly as the farm sizes increase which gives a positive relationship between farm size and participation in sorghum production. This could be occasioned by the fact that as land size increases, it gives room for more alternative enterprises.

Household income

Household income is important in determining the types and scale of enterprises to be undertaken by farmers. From the findings, there were two main sources of income namely farm income and off-farm income. Sources of farm income mainly include revenues from farm crop and livestock produce and revenues earned from farm assets. Sources of off-farm income included mainly off-farm employment. Out of the 207 farmers, 56.7% had no off-farm income and wholly relied on farm income while 43.3% of the farmers had access to both farm and off-farm sources of income. It was also noted that out of the 207 farmers, 64.3% had incomes ranging from Kshs 800 to Kshs 10, 000 per month which indicate that income could be a limiting factor of production among farmers in the study area as only 12.6% had incomes of over Kshs 20,000 per month. This gave an implication that majority of the farmers in the study area may not be having access to adequate disposable income for farm investment hence limiting and prioritizing the types of enterprises undertaken at farm level. About 51.6% of the farmers with income of less than Kshs 10,000 did not participate in sorghum production whereas in the income category of between Kshs 10,000 and Kshs 20,000, 56.4% of the farmers participated in sorghum production as shown in Figure 7.

On the other hand, 50% of farmers with income of over Kshs 20,000 participated in sorghum production. This showed that farmers with higher incomes participate more in sorghum production as compared to those with low incomes. This also gives an implication that as farm incomes increase in the study area, the likelihood of participation in sorghum production also increases hence a positive relationship between household income and participation in sorghum production in the study area. This could be due to the fact that farmers with more income have enough resources for alternative enterprises. They could also be investing in sorghum production to make use of the available demand by EABL

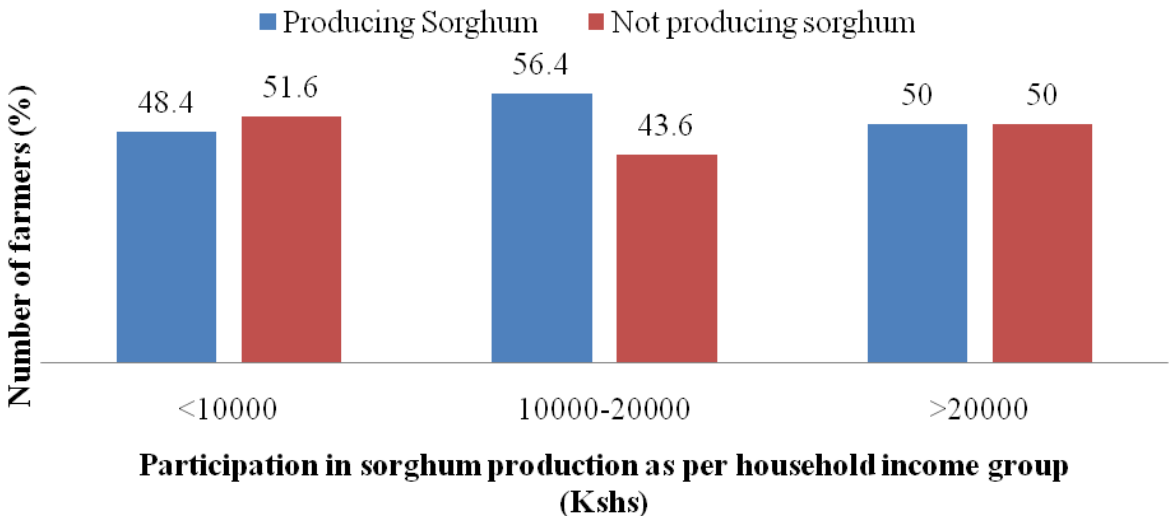

Figure 7. Participation in sorghum production in Nakuru County as per category of household income.

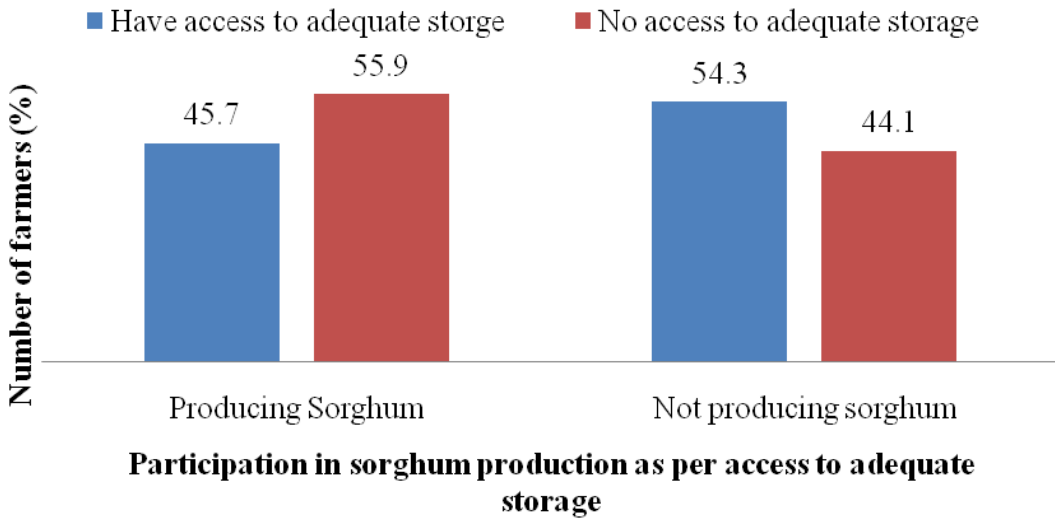

Figure 8. Farmer participation in sorghum production on the basis of access to storage.

and other markets.

Access to adequate storage facilities

Storage facilities are important in decision making on cereal enterprise selection depending on varying storage requirements. About 50% of the farmers in the study area have access to adequate storage facilities. This means that half of the farmers in the study area have got access to adequate storage facilities for their produce. About 55.9% of the farmers without adequate storage were participating in sorghum production whereas only 45.7% of farmers with adequate access to storage were participating in sorghum production as shown in Figure 8. The results indicate that more farmers without access to adequate storage were producing sorghum than those with access to adequate storage. This showed that storage might not be a major consideration in sorghum production in the study area. Both those with or without access to adequate storage have almost equal chances of participating or not participating. Low sorghum production needs little storage space and thus storage facility is not a key factor influencing participation in sorghum cultivation.

Model empirical results

The main objective was to identify the socioeconomic

Table 3. Double hurdle results for participation in sorghum production

Variable	Tier 1 (Participation in sorghum production)					
	Coef.	Std. Err	z	Significance (p>|z|)	[95% Conf. Interval]	
AGE	-0.0024	0.0107	-0.23	0.822	-0.0235	0.0186
HHSIZE	-0.0064	0.0572	-0.11	0.910	-0.1187	0.1058
GENDER	-0.3601	0.1922	-1.87	0.061**	-0.7367	0.0165
EDLEVEL	-0.0418	0.0300	-1.40	0.163	-0.1006	0.0169
LANDTENURE	-0.5726	0.2567	-2.23	0.026*	-1.0757	-0.0695
FARMSIZE	0.0473	0.0252	1.87	0.061**	-0.0021	0.0968
HHINCOME	-0.00001	0.00001	-0.93	0.353	-0.00003	0.00001
ADQTSTORE	0.1574	0.1874	0.84	0.401	-0.2099	0.5247
_cons	2.6955	1.4653	1.84	0.066**	-0.1764	5.5674

N = 207; * and * * statistically significant at 5% and 10% significance level respectively. Land tenure is significant at 5%. Gender and farm size are significant at 10%.

factors that influence participation and extent of participation in sorghum production among the smallholder farmers in the study area. The data collected was analyzed using the double hurdle model. The double hurdle regression results of participation and the extent of participation in sorghum production are presented in Tables 1 and 2. The tables show the estimated coefficients (α value), standard error and significance values of independent variables in the model. As indicated in Tables 1 and 2, some predictor variables influence decisions in participation in sorghum production significantly in tier 1 and some variables also influence extent of sorghum production significantly as shown in tier 2. Out of the 8 independent variables used in the model in tier 1, only land tenure was statistically significant at the 5% significance level whereas gender of the household head and farm size were statistically significant at the 10% significance level as shown in Table 3.

Gender of the household head had a negative sign. It had been expected that the variable could have a positive or negative sign. The significance values of 0.061 showed that there was enough evidence to support that if the number of households headed by males increases then the likelihood of participation in sorghum production diminishes and vice versa. From the results on gender, it had been shown that there were slightly more women producers of sorghum than men. This agrees with Doss (1999) and Curran and Cook (2009) who indicated that women are more likely to participate in production of crops which are more of a subsistence nature than men. They argue that women are usually responsible for cultivating food for home consumption on household plots whereas men usually grow the main cash crop on personal plots. In many areas, women are also allowed to cultivate and gain income on a personal plot but because sorghum is not often used as a cash crop, women are the primary cultivators.

Land tenure had a negative sign. It had been expected that the variable could have a positive or negative sign. The significance value of 0.026 indicates that there was enough evidence to support that land tenure affects participation in sorghum production. A close examination showed that majority of the farmers not participating in sorghum production were those on leasehold. This is what could be the cause of the negative value of the correlation coefficient in statistical terms. Farmers who are on individual ownership are expected to participate more than those on leasehold but only 45% of them were not participating and this could also be contributing to this scenario. Waiganjo and Ngugi (2001) noted that tenure insecurity whether customary or statutory tenure regimes undermine the effectiveness of farming activities. They conclude that land tenure types and policies tend to determine the nature of agriculture and influence other land use practices. Farm size had a positive sign and a significance value of 0.061. This means that there was enough evidence to support that as farm size increases; the likelihood of participation in sorghum production also increases. The positive sign indicated a positive relationship between farm size and participation in sorghum production in the study area. This indicates that as land size increases the likelihood of participation in sorghum production increases. This could be probably because, as farm size increases, more enterprises can be undertaken simultaneously. Farmers with larger farm sizes are also more likely to adopt modern varieties of sorghum for higher returns which is in agreement with Nambuya et al. (2005) who found that adoption of improved varieties is positively correlated to farm sizes, and that most farms with small land holdings were not growing improved varieties. This means that most small scale farmers grew indigenous varieties and had a lower likelihood of participating in sorghum production as compared to large scale farmers. Out of the 8 independent variables used in the model in tier 2, only educational level and land tenure were statistically significant at the 5% significance levels as shown in

Table 4. Double hurdle results for extent of participation in sorghum production

Variable	Tier 2 (Extent of Participation in sorghum production)					
	Coef.	Std. Err	z	Significance (p>|z|)	[95% Conf. Interval]	
AGE	-0.0056	0.0074	-0.75	0.455	-0.0202	0.0090
HHSIZE	0.0602	0.0419	1.44	0.151	-0.0220	0.1424
GENDER	0.0846	0.1289	0.66	0.512	-0.1682	0.3373
EDLEVEL	0.0446	0.0219	2.04	0.041*	0.0017	0.0875
LANDTENURE	0.3648	0.1800	2.03	0.043*	0.0120	0.7176
FARMSIZE	0.0091	0.0093	0.97	0.332	-0.0092	0.0274
HHINCOME	5.79e-06	7.24e-06	0.80	0.424	-8.40e-06	0.00002
ADQTSTORE	-0.0539	0.1300	-0.41	0.679	-0.3087	0.2010
_cons	-0.8409	0.9659	-0.87	0.384	-2.741	1.0522
sigma						
_cons	0.4346	0.0631	6.89	0.000*	0.3111	1.5582

N = 207; * statistically significant at 5% significance level. Educational level and land tenure are significant at 5%.

Table 4.

Educational level of the household head has a positive sign and a significance value of 0.041. This means that there is enough evidence to support that as the educational level of the household head increases the likelihood of more acreage under sorghum cultivation increases. Therefore as the farmers' education level increased there were greater chances of increasing the acreage under sorghum in the study area as it had been hypothesized. This agrees with the findings of Wakili (2012). He asserted that more years of formal education is imperative for better understanding and adoption of new technologies which subsequently make it possible to move closer to the frontier. Furthermore, educated farmers are expected to be more receptive to improved farming techniques and therefore should have higher level of technical competencies than farmers with less education. Farmers with low level of education would be less receptive to improved farming techniques as they have low adaptive capabilities.

Land tenure has a positive sign and a significance value of 0.043. There is enough evidence therefore to support that as the number of households with individual land tenure increases, the likelihood of more acreage under sorghum production increases. From the earlier results on land tenure, majority of the households with individual land ownership were producing sorghum. The tenure system is important in decision making in terms of choice of enterprises. It is much more convenient to make production decisions when land is individually owned than when leased and this could be the reason for the positive influence of land tenure on extent of sorghum production.

CONCLUSION AND RECOMMENDATIONS

It was concluded that land tenure, gender of household head, farm size and educational levels of household head were significantly influencing sorghum production in the study area. It was also concluded that if more women were encouraged to participate in sorghum production, then this could lead to tremendous increase in sorghum production in the study area.

To fully tap the potential of increased participation and acreage under sorghum production in the study area, more women should be encouraged to participate in sorghum production as it was found that they participated in sorghum production more than men. Emphasis should also be given to the significant variables by maximizing on their influence especially those that influence sorghum production positively. This study only focused on socioeconomic factors of sorghum production. There is need for further research on the influence of other factors, such as economic and agronomic factors, and their influence on sorghum production.

REFERENCES

Commonwealth Secretariat (2001). Gender Mainstreaming in Agriculture and Rural Development. United Kingdom: Commonwealth Secretariat.

Curran S, Cook J (2009). Gender and Cropping: Sorghum in Sub-Saharan Africa. Washington: University of Washington.

Doss CR (1999). Twenty-Five Years of Research on Women Farmers in Africa*: Lessons and Implications for Agricultural Research Institutions; with an Annotated Bibliography.* CIMMYT Economics Program Paper No. 99-02. Mecico: CIMMYT.

EPZA (2005). Grain Production in Kenya. Export Processing Zones Authority.

FAO (1995). Sorghum and Millets in human nutrition. Rome: FAO.

FAO (2009). The State of Food Insecurity in the World: Economic crises – impacts and lessons learned. FAO.

FAO and ICRISAT (1996). The world sorghum and millet economies Facts, trends and outlook. Italy, India: FAO and ICRISAT.

GoK (1994). *Sessional paper No. 2 of 1994 on National Food Policy.* Nairobi: Government of Kenya.

Gujarati D (2004). Basic Econometrics, Fourth Edition. The McGraw−Hill Companies, New York.

Hamukwala PT (2010). Sorghum and pearl millet improved seed value chains in Zambia: Challenges and opportunities for smallholder farmers. The University of Zambia, Lusaka, Zambia.
Hill RC, Griffiths WE, Judge GG (2001). Econometrics, Second Edition. John Wiley & Sons, New York.
IFPRI (2009). Climate Change – Impact on Agriculture and Costs of Adaptation.
Jaetzold R, Schmidt H (2010). Farm Management Handbook of Kenya, Volume II, Part B: Natural Conditions and Farm Management Information, Central Kenya (Rift Valley and Central Provinces) 121-151:379-404.
Karugia JT (2003). A micro level analysis of agricultural intensification in Kenya: The case of food staples. Department of Agricultural Economics - University of Nairobi.
KNBS (2010). Gross Domestic Product; Third Quarter 2010. Kenya National Bureau of Statistics, Nairobi.
MOA (2007). Recipe Manual for Traditional and Underutilized Foods. Government of Kenya.
MOA (2009). Strategic Plan 2008-2012. Nairobi: Government of Kenya.
MOA (2012). Economic Review of Agriculture. Nairobi: Ministry of Agriculture.
Nambuya IS, Bashasha B, Adipala E (2005). Factors affecting adoption of improved sorghum varieties in eastern Uganda and their implication for policy intervention. *African Crop Science Conference Proceedings*, Kampala, pp. 7: 697-703.
NCAPD (2005). District Strategic Plan 2005 - 2010. National Coordinating Agency Population Development.
Nganga TKW (2009). Family Size, Economics and Child Gender Preference in the Nyeri District of Kenya. 18th Annual IAFFE Conference at Simmons College, Boston, Massachusetts, USA 26th – 28th June 2009 University of Nairobi. pp. 1-40.
Ngqangweni S, Delgado C (2003). Decisions on livestock keeping in the semi-arid areas of Limpopo Province. Working Paper, Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Pretoria.
Ogolla BD, Mugabe J (1996). Land Tenure Systems, In Land We Trust; Initiative Publishers, Nairobi Kenya.
Pallant J (2007). SPSS: A Step by Step Guide to Data Analysis using SPSS for Windows, Third Edition. New York: Open University Press.
Schmidt OG (1988). Priorities in post harvest research support for sorghum and millet in Eastern Africa. International Development Research Centre (IDRC).
UN (2009). The Millennium Development Goals Report.
UNDP (2002). Kenya Human Development Report, UNDP, Nairobi.
UNESCO (2010). Education for All Global Monitoring Report. Retrieved February 1, 2012, from UNESCO: www.efareport.unesco.org.
Waiganjo C, Ngugi EN (2001). The effects of existing land tenure systems on land Use in Kenya today. *International Conference on Spatial Information for Sustainable Development, 2–5 October 2001*, (pp. 1-10). Nairobi, Kenya.
Wakili AM (2012). Technical efficiency of sorghum production in hong local government area of adamawa state, Nigeria. Russian J. Agric. Socio-Econ. Sci. 6:1-6.
Weir S, Knight J (1999). The Effects of Education on Farmer Productivity in Rural Ethiopia. UK: Centre for the Study of African Economies, Department of Economics, University of Oxford.