academicJournals

Vol. 8(28), pp. 3735-3743, 26 July, 2013
DOI: 10.5897/AJAR12.1883
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Changes in agro-biodiversity as a result of sugarcane farming in mumias division, western Kenya

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Accepted 25 March, 2013

Sugarcane farming is a monocultural land use practice which often leads to reduction in agro-biodiversity. In Mumias division sugarcane is cultivated under small scale, large scale and nuclear estate. The study was carried out in Mumias division of western Kenya where 68% of the land is under commercial sugarcane cultivation while 32% is left for subsistence agriculture and other uses. The objectives of the study were to identify indigenous crops grown in Mumias division before the introduction of commercial sugarcane farming and to assess the effects of commercial sugarcane farming on indigenous crops. Ninety respondents were purposively selected. Data was collected using questionnaires, focus group discussion and interviews. Secondary data were obtained from documented materials. Data was analysed using means and percentages and was presented through discussions, tables and figures. With the introduction of commercial sugarcane farming in the 1970s, the land under indigenous crops declined. The research also established that sugarcane farming did not have an effect in the cultivation of groundnuts and bambara groundnuts. Our results imply that sugarcane farming is a major contributor to agro-biodiversity erosion. The results are expected to sensitize ministry of agriculture on the importance of good agricultural practices that can safeguard agro-biodiversity.

Key words: Agro- biodiversity, monoculture, indigenous crops.

INTRODUCTION

Agro-biodiversity refers to the aspects of biodiversity that affect agriculture and food production, including within-species, species and ecosystem diversity (FAO, 1999). Agro-biodiversity plays a key role in ensuring that there is increase productivity, food security, and economic returns. Monoculture is the practice of planting and cultivating crops in large tracts containing a single species. Monocultural farming involves clearing of large tracts of land to create more space for the cultivation of the single crop. Similarly in monocultural farming other subsistence crops are often abandoned with more focus and attention being given to the individual monocultural crop. At the end this is may lead to extinction of some crops that are very useful and are a source of food security to the community. Sugarcane is a monocultural crop grown in the Lake Victoria basin of Kenya and Uganda. In Kenya, sugarcane is commercially grown in Western and Nyanza provinces. Currently sugarcane occupies 107,622 ha of arable land and is grown primarily by small scale farmers followed by large-scale farmers and nucleus estates. Sixty eight percent of the land in Mumias division is put under sugarcane cultivation; this implies that a very small portion of the land (32%) in the division is left for subsistence farming. The growing of sugarcane was generally considered to alleviate poverty by expanding income generation

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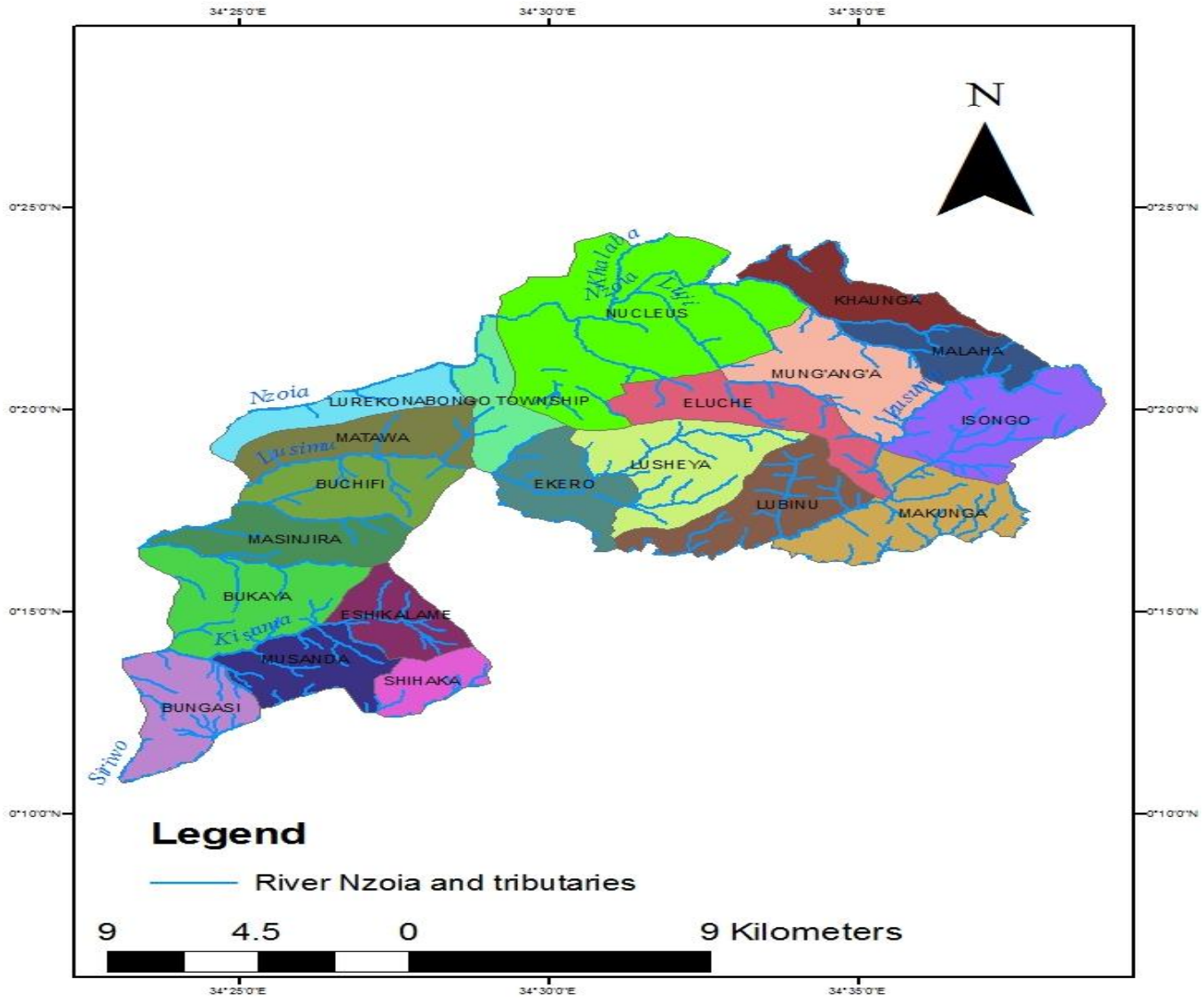

Figure 1. Map showing Mumias division.

possibilities. However statistics and observation indicate that poverty in this region remains endemic (GoK, 1999). Waswa et al. (2009) also reported that presently, sugarcane is the most widely grown commercial crop, having replaced most indigenous crops like cassava and vegetables, despite their ecological suitability and high nutritive and income value. According to World Wildlife Fund, the cultivation of sugarcane has caused a greater loss of biodiversity on planet earth than any other crop (WWF, 2004). Cheesman (2006) indicated that commercial sugarcane farming completely transformed large tracts of land especially in the coastal regions north and south of Durban, South Africa. It is widely recognized that if the remaining biodiversity is allowed to disappear as a result of socio- economic activities such as sugarcane cultivation, man's future will be at stake (Alcamo et al., 2003).

METHODOLOGY

The study was carried out in 2007 in Mumias division of Western Kenya (Figure 1). Purposive sampling techniques were used to select the respondents who included small scale, large scale farmers and key informants. The key informants included the chiefs, assistant chiefs, and District Agricultural officers. Primary data were collected using researcher administered questionnaires to 90 respondents from Mumias division and focus group discussions (FGD) involving thirty individuals who were selected with the assistance of local authorities. Both gender and age factors were put into consideration. The respondents were aged 50 years and above and were mature people who had lived in the region for more than thirty years. Secondary data on the trend in the number of farmers growing indigenous crops in the division was also acquired from Kenya Agricultural Research Institute. Data on the trend on changes in the size of land under crop species were assessed by partitioning periods into ten year intervals. Data were analyzed using descriptive statistics focusing on frequency distribution and percentages. In all cases the SPSS statistical package was used.

Table 1. Types of subsistence crops grown and acreages of land under crops in Mumias division before the introduction of commercial sugarcane farming.

Total size of land per household (acres)	Total size of land under crops (acreas)	Types of crops grown	Mean acreages per household	Percentage acreages under each crop (%)
8	7.82	Sugarcane	0.16	2
		Maize	2.34	30
		Sorghum	1.34	17
		Cassava	1.22	16
		Finger millet	0.94	12
		Ground nuts	0.64	8
		Sweet potatoes	0.56	7
		Bambara groundnuts	0.55	7
		Simsim	0.07	1

Source: Field data, 2007.

RESULTS AND DISCUSSION

Subsistence crops grown in Mumias division before the introduction of commercial sugarcane farming

In Mumias division, commercial sugarcane farming was introduced in 1972 concomitant with the introduction of Mumias Sugar Company. There are nine types of food crops that were common in Mumias division in 1960s before the introduction of commercial sugarcane farming. The field data revealed that out of the land cropped with traditional crops not all crops were given the same preference. Cereals such as finger millet, sorghum and millet together with cassava occupied a larger portion while simsim occupied the least portion. Bambara groundnuts and groundnuts were grown as intercrops with other crops such as sorghum and cassava. Subsistence crops grown in the region by the households before the introduction of commercial sugarcane farming are shown in Table 1. Maize was the dominant food crop followed by sorghum, cassava, finger millet while sugarcane was the second least grown food crop. Indigenous sugarcane was cultivated on small pieces of land of about 0.16 acres of land per household. It occupied only 2% of the total size of land under subsistence crops (Table 1). It was cultivated by about 14% of the household (Figure 2). These were the local sugarcane varieties (mikhonye cha eshinyala and mikhonye cha kampala) that were either red or green in colour and were mainly chewed raw. These varieties were commonly planted along the banks of rivers such as river Nzoia or in kitchen gardens.

Maize occupied the largest acreages per house hold with an average of 2.34 acres (Table 1). This translates to about 30% of the total size of land under subsistence crops per household in the study area. Maize, occupied the largest piece of land because 'ugali' is the stable food of the community**.** Despite maize having occupied the largest piece of land, this study established that only (51%) of the households grew it (Figure 2). The research established that this was because some households solemnly relied on other food crops such as sorghum and millet as staple food crops. The most common maize varieties grown were the unimproved landraces such as yellow maize (*shipindi)* in luhya and the white or have mixed colours (*namba nane*). Figure 2 shows the percentage number of households in Mumias division growing subsistence crops in 1960s.

Sorghum is an important crop for rural food security in Mumias division in 1960s. It occupied a mean of 1.34 acres of land per household accounting for about 17% of the land under subsistence crop and was ranked second to maize. The crop was grown by about 78% of the respondents (Figure 2). During this period, sorghum was a staple food crop in the region. Most farmers grew local land races. These varieties take 120 days to mature. Sorghum grain was utilized in preparing foods like "ugali", porridge and for making alcoholic beverages.

Cassavas were the root crop that was given the highest priority. It occupied an area of about 1.22 acres per household (Table 1) accounting for about 16% of the total land under subsistence crops and was ranked third. It was cultivated by about 73% of the household in the division. Groundnuts were grown in Mumias division in 1960s with an average of 0.64 acres per household. This was about 8% of the total size of land under subsistence crops (Table 1). Bambara groundnut was cultivated on about 0.55 acres of land per household. This was about 7% of the total size of land under subsistence crops (Table 1). The crop was cultivated by about 68% of the household in the division in the 1960s (Figure 2). Groundnuts and bambara groundnuts were often grown as intercrops with other crops such as maize, cassava and sorghum. Sixty three percent of the household interviewed in the region grew groundnuts (Figure 2).

Sweet potatoes were an important source of food to the local Wanga community of Mumias division in 1960s. It occupied about 0.56 acres of land per household. This

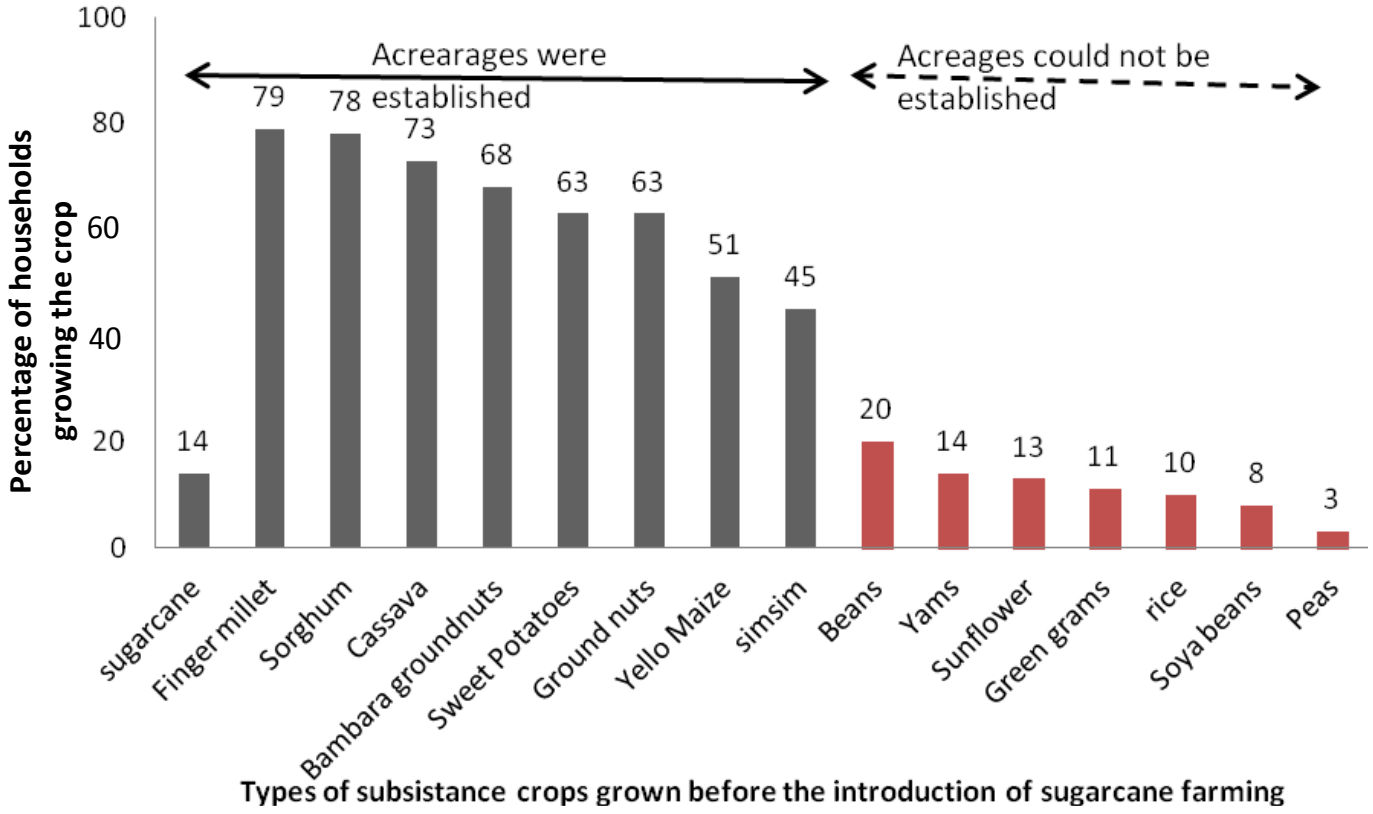

Figure 2. Percentage number of households in Mumias division growing indigenous crops in 1960s.

was about 7% of the total size of land under subsistence crops. This crop was grown by about 63% of the household in the region (Figure 2). Simsim occupied the least size of land in 1960s with 0.07 acres per household accounting for only 1% of the size of land under subsistence crops (Table 1). Despite the small size of land under simsim, it was cultivated by about 45% of the household in the division (Figure 2). Other crops that were grown in the region included, beans by 20% of the respondents interviewed, yams (14%), sunflower (13%), green grams (11%) rice (10%), soya beans (5%) and peas (3%). However, these crops occupied very small pieces of land and the acreages could not be established.

Effect of commercial sugarcane farming on subsistence crops in Mumias division in 1970s to 2000s

The study established that the average size of land under indigenous crops either decreased or remained static between 1970s and 2000s while the land under sugarcane cultivation increased over the same period. The average acreage of land per household under sugarcane increased from 1970s to 1980s when sugarcane was introduced but has tended to decline in the 1990s and 2000s. Netondo et al. (2010) reported that change in land use particularly conversion to monoculture leads to loss of agro-biodiversity.

Maize

The size of land under maize in 1970s was 1.52 (24%) acreages per household which was a 6% decline from the 2.34 (30%) acres in 1960s. The size declined to 1.12(20%) acres per household in 1980s. The size then increased to 1.3 (24%) in 1990s and increased further to 1.6 (30%) in 2000s (Figure 3). Over the same period, the size of land under sugarcane increased from 2.25 (35%) in 1970s to 2.72 (48%) in 1980s. This was an 18% increase in the size of land under sugarcane from 1970s to the 1980s. The households interviewed reported that the increase in the size of land under sugarcane was as a result of the introduction of Mumias Sugar Company which offered ready market for their sugarcane. The research findings indicated that as the size of land under sugarcane increased, the size of land under maize declined and vice versa. The respondents fifty two percent reported that in the 1970s and 1980s, much of the land that was previously under maize was transformed into sugarcane farms hence reducing the size of land available for maize cultivation.

In the 1990s and 2000s the decline in area under

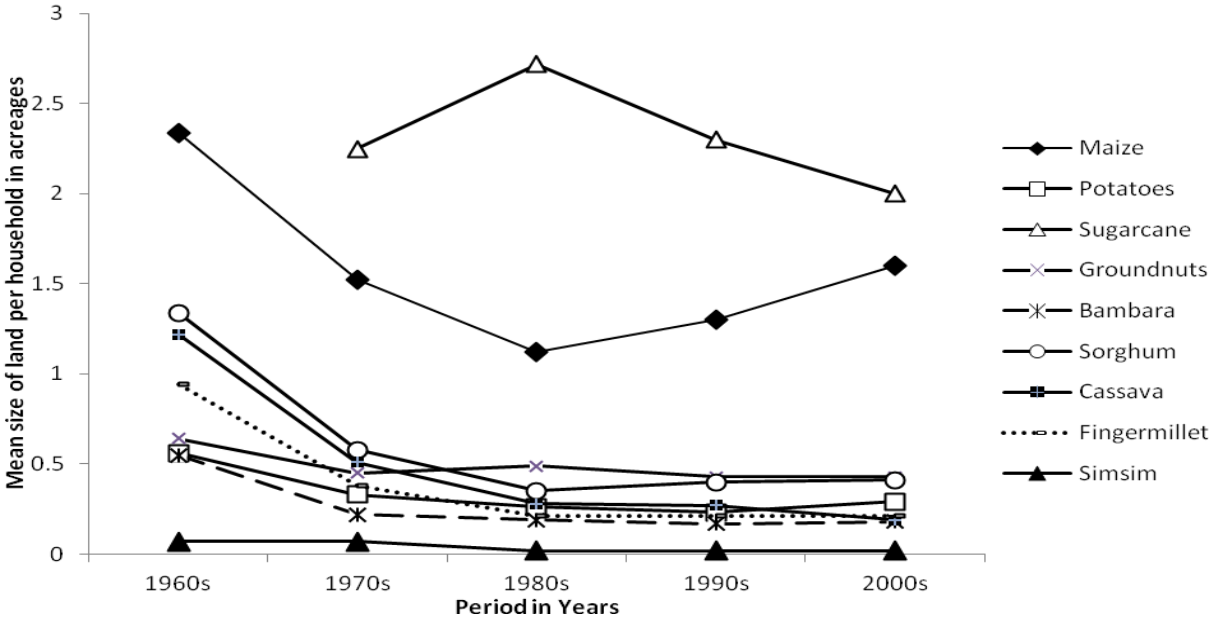

Figure 3. Size of land in Mumias division under indigenous crops between 1960s and 2000s.

individual food crops particularly maize eased. The farmers on realizing that sugarcane farming is not as profitable turned to growing some of the food crops; particularly maize which is a staple food crop. Between 1980s and 2000s, the size of land under maize increased by 10% that is from 1.12 (20%) in 1980s to 1.6 (30%) in 2000s. During the same period, the results indicated that the size of land under sugarcane declined by 0.72 (10%) acres per household that is from 2.72 (48%) in 1980s to 2 (38%) in 2000s. The research further established that in the 1970s, 1980s, 1990s and 2000s, the common maize species cultivated were the hybrid species which had replaced the local landraces that were prevalent in the 1960s. Forty eight of household interviewed indicated that land fragmentation which involves subdivision of land from father to mature sons is responsible for the decline in the size of land under maize. Previous research carried out in South Nyanza by (Eileen, 1987) revealed that as sugarcane production expands, it mainly replaces maize area. Of the plots planted in sugarcane, 95% were formerly used for maize (Eileen, 1987). Agricultural biodiversity is of fundamental importance to human survival and to the social and economic development of many countries. It supports human nutritional needs and a wide range of other crops. Pressures to develop one new species means the traditional ones are lost.

Sorghum

The land under sorghum was 0.58 (9%) acres in 1970s, it then reduced to 0.35 (6%) in 1980s. The size slightly increased to 0.4 (8%) in 1990s and 2000s (Figure 3). This implied an 8% decline in the size of land under sorghum from 1960s to 1970s, 3% decline in 1980s and a 2% increase in 1990s and 2000s. Sixty seven percent of the respondents maintained that the 7% decline in the size of land under sorghum was sugarcane farming. They reported that during this period, the size of land under sugarcane had also increased by 10% hence reducing size of land available for sorghum. Much of the land 0.99 (11%) acres per house hold that was previous under sorghum in 1960s was transformed into land for sugarcane farming in 1980s. During a focus group discussion, the respondents were asked to explain the reason for the 2% increase in the size of land under sorghum in the 1990s and 2000s. They reported that the increase experienced was as a result of the decline in the size of land under sugarcane over the same period creating more space for the cultivation of sorghum. During this period, the size of land under sugarcane had decline by 10%. The campaign encouraging people to grow more indigenous crops in Mumias was also reported to be responsible for the increased land under sorghum in the 2000s. Sorghum has starch, which makes it suitable for obese and diabetic people (Mamoudou et al., 2006). Nineteen percent of the respondents reported that the decline was as a result of maize farming whereby most farmer especially young generation aged below 40 years preferred maize over sorghum. Fourteen percent of the respondents attributed the decline to pests and diseases especially the birds that attack the crop when nearing the harvesting season. Romain (2001) reported that sorghum has lost much of its traditional area of growth in Africa to the introduced maize monoculture

which is particularly vulnerable to droughts and low soil fertility. As indicated by Upreti and Ghale (2002) and FAO (2004) commercialization of agriculture such as sugarcane monoculture farming may significantly contribute to food crop diversity loss including sorghum in the study area.

Finger millet

A mean of 0.38 (6%) acres of land per household was under finger millet in 1970s. This was a 6% decline from the 0.94 (12%) acreas under the crop in the 1960s. The size of land declined further by 2 to 0.21 (4%) of acres per household in 1980s. The mean sizes increased slightly by 1% to 0.22 acres in 1990s and 2000s (Figure 3). Eighty one percent of the respondents attributed the 0.73 (8%) acres per household decline experienced in 1970s and 1980s to the conversion of land that was previously under finger millet into commercial sugarcane farming. According to fifteen percent of the respondents, the reduced finger millet on the farms may be attributed to change of taste and preference especially by the young generation between age 5 to 18 years who prefer maize meal (ugali) made from maize other than one made from, cassava, finger millet or sorghum (National Research Council, 1996). Labour intensiveness especially during weeding was cited by four percent as a major constraint to increased agricultural production of finger millet and the most difficult and time-consuming job women face in the fields.

National Research Council (1996) pointed out that finger millet is being rejected in favour of other monoculture crops such as sugarcane, maize and sorghum, which provide more income. Results from researches carried out elsewhere are in agreement with this assertion that finger millet is being abandoned in favour of monoculture. Cagley et al. (2009) reported that some indigenous crops require more labour and this difficulty is particularly pronounced in finger millet cultivation. This research finding therefore established that the causes of decline in the size of land under finger millet were, sugarcane farming, change in tastes and preference and pests and diseases. However sugarcane farming played the greatest contribution.

Cassava

The mean size of land under cassava per household has been decreasing since 1970s with 0.51(8%) acres per household in 1970s which was a 7% declines from 1.22(15%) acres per household under cassava in 1960s. There was a further decline to 0.28 (5%) acres in 1980s and 1990s, and a further decline to 0.19(3%) acres per household in 2000s (Figure 3). The respondents reported various reasons as being responsible for the 1.03 (12%) acres per household decline from 1960s to 2000s. Fifty three percent reported that households have transformed much of the land that was previously under cassavas (1.03 acres per household) to sugarcane farming. The PRA further indicated that where farmers are growing these indigenous crops the yields are generally low. This could be attributed to poor crop husbandry occasioned by the preferential treatment given to sugarcane. The respondents Twenty five percent attributed the decline in the land and cassava in 1980s to the fact that the some cassava varieties (bitter type) were termed as poisonous and had previously caused some death among the children in the region. According to twenty two percent of the respondents, the decline in the size of land under cassava was as a result of pests and diseases that have discouraged many of the farmers from growing the crop. The respondents reported that pests such as moles had led to low output hence discouraging most farmers from growing cassavas.

FAO (2004) report cautions that the replacement of local crops with large scale monocropping might lead to the simplification of agro ecosystem such as crops that are used directly or indirectly for food, fodder, fibres, fuels and pharmaceuticals. Cassava is one such crop. The potential loss of agro biodiversity presents risks of food production as well as posing a serious threat to rural livelihood and long term food security. Waswa et al. (2009) reported that presently, sugarcane is the most widely grown commercial crop, having replaced most indigenous crops like cassavas and vegetables, despite their ecological suitability and high nutritive and income value.

Sweet potatoes

A mean of 0.33 (5%) acres of land per household was under sweet potatoes in 1970s.The size of land declined to 0.26 (5%) acres per household in 1980s and 0.23 (4%) acres in 1990s. The mean sizes then increased to 0.29 (5%) acres per household in 2000s (Figure 3). Forty one percent of the respondents pointed out that the reduced size of land under sweet potatoes in 1970s, 1980s and 1990s was due to sugarcane farming. The respondents pointed out that the land that was previous allocated to the cultivation of sweet potatoes 0.33 (3%) acres per household from 1960s was transformed to land under sugarcane farming. Over the same period, the size of land under sugarcane increased by 0.47 (13%). In 2000s, there was a slight increase of 0.06 (1%) in the size of land under sweet potatoes and a 0.3 (5%) decline in the size of land under sugarcane. Similar results have been obtained in Swaziland where it is indicated in (FAO, 2008) that establishment of sugarcane plantations leads to reduction of land under sweet potatoes and other activities. In the 1990s, fifty nine percent of the respondents pointed out that pests and diseases was the

main cause responsible for the further decline in size of land under sweet potatoes. Moles were mentioned as the main pest which attacks sweet potatoes. Woolfe (1992) reported that *Meloidogyne* spp. (root rot) and *Rotylenchus reniiformis* is the major known bacterial diseases of sweet potatoes in the tropics. Woolfe (1992) reported that the size of land and research under sweet potatoes and other root crops and tubers has been neglected in favour of more prestigious cereals and other export cash crops such as sugarcane. During the focus group discussion it emerged that the slight increase of 0.06 (1%) acres in the size of land under sweet potatoes was as a result of ready market for the crop in major towns such as Nairobi. FAO (2000) reported that sweet potato production has responded to strong urban demand and is a major traded commodity.

Groundnuts

The size of land under groundnuts in 1970s and 1980s were 0.45 (7%) and 0.49 (7%) acreages per household respectively, which was a 0.15 (1%) decline from the 1960s to 1980s. The size increased to 0.06 (8%) acres per household in 1990s and 2000s (Figure 3). On the other hand, the size of land under sugarcane increased by 0.47 (13%) acres per household between 1960s and 1980s. In the 1990s and 2000s, the size of land under groundnuts increased by 1% as the size of land under sugarcane declined by 0.72 (10%) per household. The research indicated that sugarcane farming had little effect on the cultivation of groundnuts. This was probably because groundnuts are often intercropped with sugarcane meaning that no special land is required to be set aside for the cultivation of groundnuts. This was reported by nine percent of the respondents. Apart from sugarcane farming, forty one percent of respondents attributed the decline in the sizes of land under groundnuts experienced in 1970s and 1980s to pests and diseases which led to poor crop yield and this discouraged most farmers from growing groundnuts. Groundnut rosette disease is a major constraint to productivity in both Kenya and Uganda (ICRISAT, 2010). Fifty percent of the respondents reported that the decline is as a result of the labour intensiveness involved in the production of groundnuts. They reported that a lot of labour is required in weeding harvesting and drying. During a focus group discussion it emerged that the main reason responsible for the increase in the size of land under groundnuts in 1990s and 2000s was changes in tastes and preferences. Most of the young generation aged below (40 years) in the region enjoys feeding on groundnuts which is served as a delicacy with tea. The crop is found to be delicious and rich in protein, minerals and edible oils. They can be eaten on their own or blended with other dishes such as finger millet, and simsim to improve taste and nutritional value. They can be roasted, boiled, pound using a mortar and pestle or grinding stone to form paste (KARI, 2000).

Bambara groundnuts

The mean size of land under bambara groundnut was 0.22 (3%) acres per household in 1970s. The size then declined to 0.19 (3%) acres per household in 1980s. In 1990s the mean size of land declined slightly to 0.17 (3%) acres per household. In 2000s, the size of land under the crop increased slightly to 0.18 (3%) acres per household (Figure 3). This research showed that the changes in the size of land under bambara groundnuts was neglegable. Thirty six percent of the respondents reported that land fragmentation was responsible for the slight decline in the size of land under bambara groundnuts in the 1970s, 1980s 1990s and 2000s. Fifteen percent indicated that the slight change in the size of land under bambara groundnuts was as a result of change in taste and preference with preference being given to groundnuts. Forty percent of the respondents attributed the slight change in the size of land under bambara groundnuts to cultural noms associated with the cultivation of bambara groundnuts. It was reported that poor yields were achieved if someone wearing shoes went into the field containing bambara groundnuts. Women having menstruation were also not allowed in the bambara groundnuts fields, since this could lead to low yields. Since many households could not successfully fulfill this cultural norms, they have abandoned the cultivation of this crop. However, despite the decline experienced in size of land under sugarcane in 1990s and 2000s, this did not have a great effect on the size of land under bambara groundnuts. Only nine percent of the respondents reported that sugarcane farming has had an effect on the size of land under bambara groundnuts. They indicated that the crops are grown on small scale and as intercrops with sugarcane and do not require special pieces of land to be set aside for their cultivation. The decline in the size of land under sugarcane in the 1990s and 2000s could have led to the decline of land under bambara groundnuts. Ngugi (1995) reported that bambara groundnuts is usually intercropped with crops such as maize, sugarcane and fingermillet. Andika et al. (2010) report indicate that cultivated area and production trend of oil crops like groundnuts, sunflower, soya beans, simsim, rapeseed, bambara groundnuts and castor have remained fairly constant in Mumias district. FAO (2008) reported that sugarcane farming has replaced many indigenous crops such as bambara groundnuts cassava and millets. Other findings by Ngugi (1995) indicated that bambara groundnut production is declining Kenya due to high cost of purchasing seedlings and cultural erosion with the young generation shifting from bambara groundnuts to groundnuts. In Nigeria Tanimu and Aliyu (1995) reported that bambara groundnuts cultivation has

declined due to neglect since it is not used for industrial purposes compared to other legumes such as groundnuts. However this study established that the size of land under bambara groundnut has been declining in Mumias division from 1970s to 2000s though the decline was negligible.

Simsim

The findings of this study from 1970s to 2000s clearly indicate that in Mumias division, one of the least grown crops in the region was simsim and the mean size per household is negligible. In 1970s a mean of 0.07(1%) acres of the entire land under crops per household was under the simsim. It then declined to 0.02(1%) acres per household in 1980s and 1990s (Figure 3). Out of the respondents interviewed none of them cultivated simsim in the 2000s. Forty two (42%) of the respondents attributed the decline in the size of land under simsim to the introduction of commercial sugarcane farming. They reported that the introduction of commercial sugarcane farming may have contributed to the decline in the size of land under simsim since the land is rendered infertile. The other causes reported are being labour intensive (48%) and pests and diseases (10%). Similar results have been reported by Mishra (2008) who reported that most of the oil seeds and pulses such as simsim have been neglected through monoculture of crops such as wheat, rice and maize which occupied major areas of Indian farmlands. These crops make have nodules on their root which fix nitrogen in the soil. With the decline in the size of land under simsim, farmers have to purchase more and more nitrogenous fertilizers from the markets. This results into a pressure on the national economy. The crop is labour intensive reportedly because the drying of simsim takes a long time and requires specialized skill especially by women. Such labour is scarce.

Conclusions

Indigenous crops grown in Mumias division before the introduction of sugarcane included sorghum, fingermillet, cassava, sweet potatoes, groundnuts, bambara groundnuts, indigenous sugarcane and simsim. These subsistence crops occupied various sizes of land per household. These subsistence crops were mostly landraces which had not undergone any improvement through breeding. With the introduction of sugarcane in 1970s, the size of land under most indigenous crops since most of the land that was previously under indigenous crops was dedicated to sugarcane farming. Despite sugarcane farming being the major cause for the decline, other causes for the decline include pests and diseases, changes in tastes and preference, labour intensiveness, and lack of skill and knowledge on there preparation. Crops such as bambara groundnuts, and groundnuts are not affected by sugarcane farming because they are grown as intercrops with crops such as sugarcane, maize, sorghum and cassava. The decline in cassava is majorly as a result of pests and diseases and the fact that it contains cyanide that causes death.

ACKNOWLEDGEMENT

The authors expresses their thank to VICRES for Funding Prof Godfrey Netondo, School of Graduate Studies Maseno University and Mr Gipson Masayi for having funded the research hence making it a success. They would like to acknowledge Prof. Josephine Ngaira for having tirelessly guided me throughout the entire study.

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