IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 7, Issue 4, April 2020

Subsistence Farming Activities and Food Sustainability in East Alego Location, Siaya County Kenya Crop Production and Food Sustainability

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Abstract: A lot of intervention measures have been put in place to curb the challenges faced by peasants practicing subsistence farming. However, most households still experience food unsustainability. Subsistence farmers of East Alego location, Siaya County, where the study was conducted practice subsistence farming all the year round. Even though the area is endowed with natural conditions favorable for crop production, but most households experience food unsustainability. The main objective of the study was to determine the effects of subsistence farming activities on food sustainability. Descriptive research design was used together with research instruments such as observations, interview schedules and administration of questionnaires. The study adopted stratified sampling technique and simple random sampling design with a sample size of 327 households out of 2381 targeted farm households in the study area. Data from the field was analyzed using measures of central tendencies such as mean, mode and median. Frequencies and percentages were also used to present data using tables, pie charts, bar graphs, line graphs and photographs. Tests such as Mann Whitney U-Test, Kruskal-Wallis Test and Chi- square statistics were used in analyzing data from the field. A Kruskall-Wallis Test revealed that there was a significant effect on crop production in East Alego location; Where (H (2 d.f.) = 8.07, $p < .05$). From the mean ranks Umala Sub-location had a higher mean maize production (10) than Olwa (9.25) and Ulafu (9.25) Sub-locations. Tabulated (critical) X^2 value at 0.05 and d.f. =5 was 11.070 while calculated X^2 value was 225.231 which was greater than the tabulated (critical) X^2 value (11.070) hence, the null hypothesis was rejected. Therefore, it was concluded that dependence on rain fed agriculture was significantly affecting crop production in East Alego location. A Mann Whitney U-Test value of 31 was calculated and it was above the mean and median values of 8.5 respectively and almost twice the number of the observations made (16) showing more significant effect on food sustainability in Umala/Ulafu Sub-locations than in Olwa Sub-location. Nearly 81% of the respondents suggested keeping of mixed animals for their produce and use of dung/farmyard manure as farm input to improve soil fertility so that crop production could be improved for food sustainability. There was need for mitigation measures so that subsistence farmers of East Alego location could be able to embrace clean crop husbandry practices for food sustainability.

Keywords: subsistence farming, food sustainability, diversification, intensification

I. INTRODUCTION

The American Public Health Association (APHA), defines a sustainable food system (APHA 2007) as one that provides healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come with minimal negative impact to the environment (Davids *et al.*, 2016; Foley *et al.* 2011). According to Andersen (2009), sustainable food security requires not only that all people at all times have access to sufficient food but also that this food be produced with minimal environmental impact (Godfray *et al.* 2010). There was need to create awareness to subsistence farmers of East Alego location as they work towards improved food production to consider the impacts of subsistence farming within the community over a time in order to take care of the environment for future generation thus, sustainable food production.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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Some of the characteristics of sustainable food system are based on Pothukuchi & Kaufman (1999) findings; they are energy efficient, healthy, safe and environmentally beneficial. Works towards organic farming, builds soil quality and farmland through the recycling of organic wastes. Preserves biodiversity in agro ecosystems as well as in the crop selection and has a strong education focus to create awareness of food and agricultural issues. There was need of assessing whether subsistence farmers of East Alego location takes into consideration the proposed characteristics towards sustainable food production as opposed to mere food availability. This study focused on finding out how subsistence farming activities affects food sustainability in East Alego location, Siaya County, Kenya. From the characteristics given, it could be attested that subsistence farmers of East Alego location had a lot do in order to work towards sustainable food production within the community. Food produced should not benefit only an individual family as the definition of "subsistence farming" states according to Malhi & Noev (2004). It should provide healthy food to meet current food needs, accessible and affordable to all members of the society hence, a need for intensification in sustainable food system which nurtures the people, the animals, the land, the community and the environment at large.

Globally, there are more than 1 billion overweight adults, at least 300 million of them obese (WHO, 2000). A number of countries in Asia, the Middle East, Northern Europe, the Americas, the Pacific and Sub Saharan Africa now have increasingly overweight and obese populations and the specific characteristics and quantities of foods they eat have become a serious threat to their health (Yach, 2006). This has generated a strong movement towards healthy, sustainable eating as a major component of overall ethical consumerism (Mason, 2006; Rosane, 2018). Lack of diversification and intensification in crop production in East Alego location were found to be the highest contributor to food unsustainability with majority of farmers practicing mono-cropping with maize being the staple food. The WHO (2004), recommended the Mediterranean diet which is associated with health and longevity and is low in meat, rich in fruits and vegetables. Low in added sugar and limited salt, and low in saturated fatty acids. Awareness should be created to the subsistence farmers of East Alego location, Siaya County on the nutritive values of the foods they produce so as to shift diets towards one that is more plant-based. This is because most people all over the world prefer eating meat and it is the ultimate example given representing unsustainable food (Michael *et al.* 2007).

Types of food recommended for good health by WHO (2004) are grown by subsistence farmers and therefore intervention measures on how farmers should be able to participate in clean crop husbandry for sustainable food production in the area of study was a matter of concern. Kilonzi (2011), argues that food security in Kenya is generally equated with availability of and access to adequate supplies of maize (East Africa grain council, 2008). A question subsistence farmers should ask themselves is whether growing and consummation of maize in larger quantities without considering diversification in production of other crops leads to food sustainability. Siaya County was identified as being a food deficit area (Obiero, 2013), with maize as the leading crop produced by many people. This calls for mitigation measures on diversified crop production in the area of study based on the characteristics of Pothukuchi & Kaufman, (1999) of being energy efficient, healthy, safe and environmentally beneficial.

Achieving the goal of enough food production through subsistence farming has been a global challenge even though a number of intervention measures have been put in place with many researches undertaken towards improved food production. It is estimated that over one-third of people who live in Latin America, Asia and Africa rely on subsistence agriculture for their food supply (Kostov & Lingard, 2004). Agricultural productivity levels in Sub-Saharan Africa (SSA) are still far below that of other regions in the world, and are well below that is required to attain sustainable food and poverty reduction goals (Kibaara, Ariga, Olwande & Jayne, 2009). Farmers take all the necessary steps to ensure proper nourishment of the items they raise (Schlesinger, 1977), but still food sustainability is not realized in many households. FAO (2006) emphasized on drastic measures to help the situation.

Despite the fact that low income countries such as Kenya tend to have populations in which 80% of the poor are in rural areas, and more than 90% of rural households have access to land, majority have insufficient access to sustainable food (de Janvry, 2011). There is need for proper utilization of the arable land farmers own in East Alego location in order to meet the challenges of food unsustainability. Improvements that have been made in subsistence farming have not been realized in some regions such as the area of study where farmers are engaged in farm work all the year round, but can only meet their sustainable food needs for four months in a year (Obiero, 2013). There is need for intervention measures to food unsustainability in East Alego location where natural farming conditions are favorable but food production is rarely diversified with most people producing mainly maize which is also sold to purchase other crops which could be grown in the study area.

According to Carloni (2001), subsistence farming has evolved over a time into intensive subsistence agriculture especially in high potential areas where farmers maximize food production on relatively small fields (Dixon *et al.* 2001a, 2001b). Nevertheless, most subsistence farmers of East Alego location have not achieved much as they equate increased crop production to expansive land. Bartholet, (2011) proposes that, varied technologies may help improve some of the subsistence farming pressing challenges and may offer some long-term solutions to problems that are being recognized worldwide. According to Sandra (2011), irrigation can also be used as a measure to improve productivity as Doward

(2008) puts it that, soil productivity can also be increased through the addition of chemical fertilizers as opposed to traditional and more sustainable use of cover crops and the addition of green manure. Scoones (2008) suggests collection of soil data in order to better understand soil dynamics in varying agro ecological zones and climatic conditions. Mitigation measures should be put in place for subsistence farmers of East Alego location, Siaya County, so that they can differentiate between sustainable food production and mass food production of maize crop, in order to diversify in sustainable food production.

Buck et al. (2009) points to the important role that agro ecological farming practices have in increasing yields and improving livelihoods. Farming households of East Alego location needs sensitization so that they can realize that extension work is not only meeting the technicians face to face on on-farm visits for agricultural innovations but, as Kilonzi (2011) puts it, the services can be conducted through different methods in Kenya. These could be through radios, televisions and agricultural pamphlets. Lawrence (1992) & Njenga (2007), mentioned that governments need to put more money into research specifically focused on the needs of smallholders and women farmers in order to improve their livelihoods sustainably. Resck (1998) & World Bank (2005) emphasizes long-term strategies that maximize production per unit area and diversification to higher value products on a sustainable basis.

Further suggestion is on minimal environmental degradation that will play a key role in increasing productivity of the ever diminishing land sizes of subsistent farmers in Africa. In addition, it will ensure adequate and sustainable food supplies and increase the profitability of subsistence farming. Waceke & Kimenju (2007), affirms to promoting small-scale agro-processing and value addition of farm products. Encouraging farmer-based multiplication of quality seed, promoting self-sustaining, rural micro-finance systems to cater for farmers' demand for short-term credit and strengthening the capacity of farmer associations and support farmers' field schools where they exist. Subsistence farmers of East Alego location needs to be sensitized on these good strategies to enhance sustainable food production.

II. MATERIALS STUDIED

The study involved observation of different crop farms with different farm sizes. The researcher also used questionnaires and interviews as other main research tools to collect data on the respondents' opinions and attitudes towards sustainable crop production in East Alego location, Siaya County.

2.1 Description of the study area

The study was conducted in East Alego location, Siaya County, Kenya. It covers a surface area of approximately 29.1 square km with three administrative sub-locations namely; Ulafu, Olwa and Umala (Siaya CIDP 2018-2022). The area lies within the Equator at 0.05'-0.10' and between longitudes 34.263-35 degrees to the east (Counties of Kenya maps 2012). Average land holding is 2 hectares per household. Land tenure is both communally and individually owned (Siaya CIDP, 2017). The drainage is well, soil depth ranges from deep to very deep in some areas, soil texture is fine and the fertility is average (Sombroek, Braun and Van derpouw 1982).

The location is in Low Medium (LM) Agro- ecological zone (AEZ) 1-5%- soil type being predominantly clay and sandy loam, suitable for crop production but requires incorporation of organic and inorganic manure. The region experiences a modified equatorial climate. It has a bimodal pattern of rainfall with long rains falling between March and June and short rains between September and December with average rainfall of 1000- 1500millimetres per annum (Kenya Meteorological Department, 2019). The area has an altitude of 1300-1500 meters A.S.L. The temperature ranges between 15°C and 21°C and the evaporation rate is 1800-2000 mm per year. (Siaya County Website Census Report 2009). There are few permanent streams traversing the location (GOK, 2005) namely Awach, Wang'e Jawni, Ngongo, Ogongo, Handhalo, Urewe and Kisini found in Olwa Sub-location. Achero, Mtembe and Huludhi flows through Umala Sub-location. Nyambonia and Pundo flows between Umala and Ulafu Sub-locations respectively. Majority of the farmers in the area of study use water from these streams for domestic chores. Minority of them uses the srteams for irrigating their crops for food sustainability thus low production of vegetables when the rains delay.

Farming is done throughout the year with major crops grown including maize, sorghum, beans, cassava, groundnuts, grain amaranth, sweet potatoes, kales, tomatoes, onions and bananas. The staple food is maize with the majority of farmers embracing maize farming hence, low crop diversification leading to unsustainable food.

III. METHODOLOGY

The study adopted descriptive research design (Kothari 2004). The study was carried out in randomly selected households covering crop production in relation to food sustainability within the location. Direct observations, interviews and questionnaires were used as the main tools for collecting data. These facilitated collection of data on the views, perceptions, attitudes, opinions and behavior of the respondents (Cuavery *et al*, 2007; Oso & Onen, 2005). Quantitative

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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data collected was about households practicing subsistence farming, farm sizes, crops type and crop yields (Siaya CIDP, 2017).

Direct observation was important as it provided data on what farmers actually do as opposed to what they said they did. It also allowed for first- hand information to the researcher without informants (Yuko & Owen). Observations were on the crop farms, types of crops grown, methods of planting used, topography of the farms and farms with agroforestry practice. Farms along the streams were also observed to assess the activities carried out and methods of cultivation used.

The researcher also used Chi-square test to analyze the factors affecting crop production in the study area. Kruskal Wallis Test was used in the comparison of the intensity of maize production in the location. There was need for mitigation measures as farmers associated large tracks of land with increased food production and least considered adoption of new technology for improved and diversified production resulting to food unsustainability.

A Kruskal-Wallis Test showed that there was a significant effect on crop production in East Alego location. (H (2 d.f.) = 8.07, $p < .05$). From the mean ranks Umala Sub-location (mean rank= 10) had a higher mean production than Olwa (mean rank=9.25) and Ulafu (mean rank=9.25) Sub-locations respectively. Mitigation measures for growing other crops in the area of study for food sustainability should be put in place so that mono cropping of maize crop can be balanced with growing of other crops that are suitable in the area of study. It can therefore be concluded that crop production in the three Sub-locations can do well with diversification and intensification, and thus intervention measures on clean crop husbandry in the location could lead to food sustainability.

Chi- square characteristics showed that there was a significant relationship between factors affecting crop production and food sustainability. Dependence on rain fed agriculture was statistically significant to crop production at (0.413< 9.210 d.f = 2 at 0.01). Majority of the farmers growing cereals, root tubers, legumes and fruit crops depended on seasonal rainfall unlike farmers growing vegetables where some could use irrigation along the streams and those with no farms along the streams also depended on rain fed agriculture. This meant that when the rains delayed then crop production suffered. The study further revealed that, irrigation was rarely practiced in the location a notion that had resulted into low vegetable and fruits production hence, lack of crop diversification for food sustainability.

IV. RESULTS AND DISCUSSIONS

Table I: Land acreage owned by farmers in East Alego location (N=317)

Land acreage owned	No. of respondents	percentage (%)
0-0.5	148	46.7
0.6-1	120	37.9
1.5-2	35	11.0
2.5-3	6	1.9
3.5-4	8	2.5
Total	317	100
Mean acreage owned		0.8

Source: Researcher, (2019)

Nearly half of the respondents (46.7%) owned 0-0.5 acres of land while more than a third (37.9%) owned 0.6-1 acres of land (Table 4.1). 2.5 and above acres of land was owned by negligible (4.4%) percentages of the respondents (Table 4.1). Majority of peasants (84.6%) had access to land acreage of between 0-1 which was used for both crop production and animal rearing. The mean land acreage was 0.8 with a modal value of 0-0.5 acres. Ingle & Wayazades (1989) supports that, size of land holding and annual income is positively and significantly associated with the adoption of new technology in farming.

Respondents with less than 1 acre of land (Table 4.1) cited need of more acres for extensive farming. This was in contrast to Japanese agriculture where there is shortage of farmland even though the land is intensively cultivated with paddy fields occupying much of the countryside (Hsu, 1994). There was need for mitigation measures as the peasants associated large tracks of land with increased production and least considered adoption of new technology for improved and diversified production resulting to food unsustainability.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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IV (1) Food crops grown in East Alego location

This section analyzed the diversity of crops grown by subsistence farmers in East Alego location and the intensity of production for food sustainability. The findings were as shown in Table 2.

Table II: Types of food crops grown in East Alego location (N = 317)

Characteristics	Respondents	Percentage	Characteristics	Respondents	Percentage
Vegetables			**Fruit crops**		
Tomatoes	4	1.3	Bananas	108	34.1
Onions	6	1.9	Pawpaw	32	10.1
Greens	252	79.5	Mangoes	92	29.0
Local vegetables	37	11.7	Avocado	78	24.6
Pumpkins	12	3.7	Others	7	2.2
Cabbage	6	1.9	**Root tubers**		
Cereals			Cassava	115	36.3
Maize	280	88.3	Yams	25	7.9
Sorghum	37	11.7	Potato	177	55.8
Legumes			**Legumes**		
Beans	186	58.7	Soya	22	6.9
Groundnuts	59	18.6	Green grams	10	3.2
Cowpeas	40	12.6			

Source: Researcher (2019)

Maize (88.3%) is the leading cereal crop grown by most farmers of East Alego location while sorghum (11.7%) is grown by less than an eighth of the respondents (Table 2). Most respondents preferred growing maize to sorghum. The farmers argued that maize is grown twice annually and that there were different ways maize could be put into use and also easier to process than sorghum. They did not consider that even though sorghum is grown once in a year but the nutritive value is higher than maize.

No rice and millet fields were observed during the study and the respondents cited lack of wet grounds for rice farming and unfavorable growth conditions not realizing that currently there is upland rice that can grow in any arable land. FAO, (2013) suggested that with the continuous increase in population, it is necessary to produce 70% more food to keep pace with the demand of the daily energy intake accounted for by cereals. FAO, (2014) further advised that to keep pace of food demand, global cereal production would need to increase by 40% overall or by some 900 million tons between the present and 2050. Even though maize was grown by the majority but, it could not be adequate for the population as sorghum production which would have supplemented it was low (Table 2).

Greens farming (79.5%) dominated the area of study while less than a quarter of the respondents participated in local vegetables (11.7%) farming. Tomatoes, onions and cabbages (5.1) were grown by fewer farmers (Table 2). Most pumpkins (3.7%) owned by the farmers grew wildly in the farms. In a study conducted in Australia Western Sydney, Loram (2008) suggested that, the available land areas in the individual front and rear gardens are fertile. The areas are capable of producing vegetables locally and provide most of fresh food needs without being worried of the smaller parcels of land owned. However, most of the peasants keeping livestock could not be able to use these open spaces within the homes as these spaces were also used as grazing grounds within the homesteads. Therefore they had to set aside an area of growing vegetables of which according to the land acreage owned by the majority could not be enough for cereals, tubers and vegetable farming (Table 2). A high intake of food of vegetable origin, due to the high content of functional ingredients and to the low energy load, can efficiently counteract postprandial stress (Peluso et al., 2012) and is important, as an inducer or preventer of obesity.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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Over five tenths of the respondents had grown beans (58.7%) while groundnuts (18.7%) and cowpeas (12.6%) were grown by fewer respondents (Table 2). Cowpeas (greens) grown in the location (Table 2) was used more as leafy vegetables than a legume. Soya (6.9%) and green grams (3.2%) had very low percentages (Table 2). Courty (2014) emphasized on growing of legumes because it reduces pests and disease problems when used in rotation with non-leguminous crops improving production. It also forms a very important part of the diet as well as helping in restoring soil organic matter as it is always intercropped with other plants. There were no pure strands of bean plant in the location as it was always intercropped with maize, sorghum and groundnuts.

More than half (55.8%) of the peasants had grown potatoes while slightly more than a third had grown cassava (33.6%). Yams (7.9%) were grown by a negligible percentage of respondents (Table 2). Sasson (1990) puts it that, potato has high nutritive value and high yield potential and can produce more calories, proteins, vitamins and mineral salts per surface and time unit than principal cereals or other root tubers and root crops. Despite the positive attitude portrayed by the respondents in potato farming, most respondents measured food sustainability with cereals production (Table 2).

Respondents reported that they were not actively participating in cassava farming (36.3%) because of its delay in maturity. They argued that because of the smaller portions of land owned, they (Table 2) opted for maize farming that was quite embraced in the location by the majority because of its two harvest seasons annually. Respondents who occasionally practiced cassava farming cited low production in cassava farming as a result of uncontrollable disease called Cassava Mosaic (CMD) which affects the leaves and lowers production (Timmerman's, 1994). The disease is caused by gemirai virus whose vector is sweet potato housefly (Legg & Fauquet 2004).

Mostly grown as a food source in Africa, cassava is the third largest source of carbohydrates in the world (Fragette, 1994). In recent times, cassava production has turned from subsistence to commercial production (Patil & Fauquet 2009) with the fewer peasants who grow it in Eat Alego location working towards managing the challenges. Plucknett (1983) asserts that, root tuber crops have received attention from agricultural scientists at least for over 20 years due to their tolerance to marginal conditions where farmers need to produce crops in areas where soil or climatic conditions are moderately favorable. However, major spread has been through planting of infected cuttings which causes the yield to fall by as much as 90% over time.

Nearly a third (34.1%) of the respondents practiced banana farming while almost a third grew mangoes (29.0%) and less than a quarter grew avocados (24.6%). Minority of the respondents grew paw paws (10.1%) (Table 2). Fruits such as guavas grew wildly and oranges were not grown in the location. Other fruits which comprised lemons and passion fruits (2.2%) had negligible percentages (Table 2). Most fruits were grown around the homes apart from banana plants that were observed both around the homes and along the streams. The respondents further reported that growing of the fruits around the homes were for security purposes. Kneafsey, (2008) puts it that, growing food in the home gardens generates a more transparent relationship between food, producer and consumer contributing to sustainability knowledge. Some bananas had been grown together with vegetables along the streams as a way of economizing on land use so that farmers could remain with a sizable portion for cereals production.

IV (2) Crops yield and food sustainability in East Alego location, Siaya County

The study capitalized on finding out the average yield received by the respondents per harvest/crop in relation to land acreage owned in East Alego location. To get information on whether the peasants were food sustainable or not, respondents were interviewed about their previous harvests per crop during the long rainy season. The responses were as stated in figure 1 below.

Almost quarter of the respondents in the three sub-locations had maize harvests of between 0-1 bags, while respondents with 2-3 bags almost doubled respondents with 0-1 bags harvest (Fig.1). Umala Sub-location had more respondents with between 2-3 bags of maize harvests. Peasants who could count on good harvests of 6 to more than 10 bags were very few to make the whole location realize food sustainability. The other crops had the majority of farmers with harvests of between 0-1 bag to 4-5 bags apart from sorghum which had almost more than a quarter (27.1%) with 2-3 bags which was to be used for two seasons.

Most respondents rarely quantified crops such as fruits, vegetables and root tubers and legumes apart from beans. This could be attributed to different times of maturity of the other crops. According to the respondents, their main outstanding crop was maize. Crops such as beans, groundnuts, cassava, fruits, vegetable and soya were rarely harvested more than 4-5 bags (Fig.1). Study findings further revealed that most farmers depended on mono cropping of maize which was later sold to access other crops which could as well be produced from the same farms if diversification and intensification on subsistence farming was embraced for food sustainability. The study therefore adopted Kruskal- Wallis Test to compare the intensity of maize production in the three Sub-locations which was practiced by the majority of respondents (Table 3).

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

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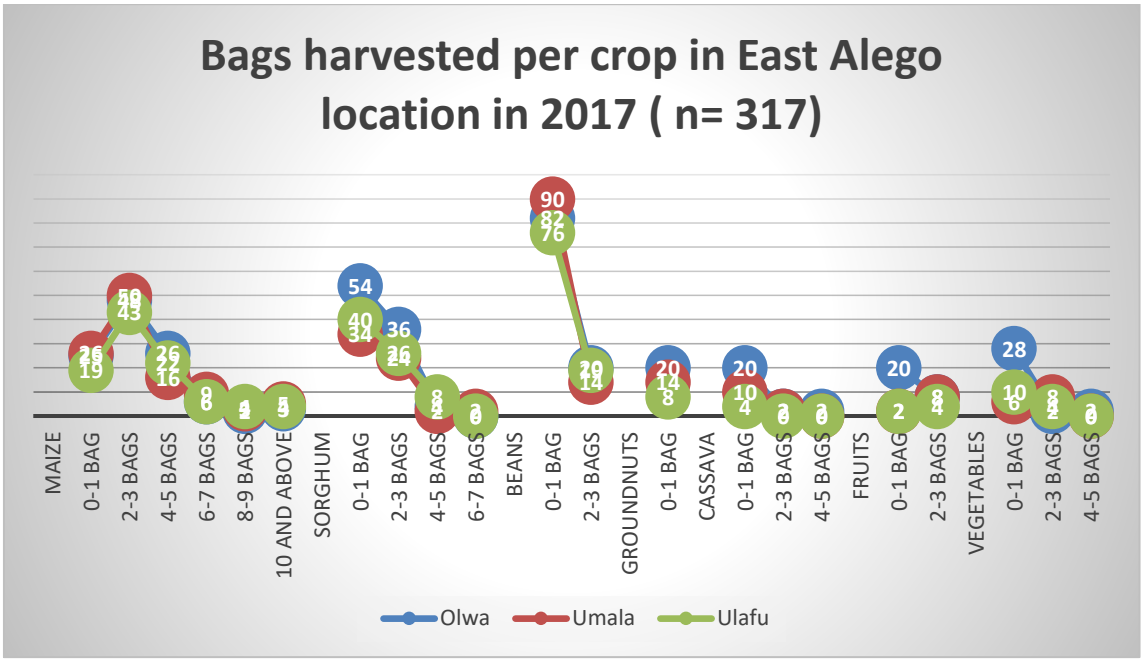

Fig. 1 A bar graph showing the quantity of crops harvested in the long rainy season 2017.

Source: Researcher, (2019)

Table III: Kruskal-Wallis Test on the comparison of the intensity of maize production in East Alego location (Olwa, Umala and Ulafu Sub-locations) (n=317)

	C1 (Olwa)	C2 (Umala)	C3 (Ulafu)
	25 (13)	26 (14.5)	19 (11)
	48 (17)	50 (18)	43 (16)
	26 (14.5)	16 (10)	22 (12)
	6 (7.5)	9 (9)	6 (7.5)
	2 (1)	3 (2.5)	4 (4.5)
	3 (2.5)	5 (6)	4 (4.5)
Mean rank	9.25	10	9.25
(SD)	6.61	5.60	4.57
Sum of ranks (Tc)	55.5	60	55.5

From Table 3, Kruskal –Wallis Test was used to analyze the differences in the intensity of maize production in East Alego location which was grown by majority of the respondents. Source: Researcher, (2019)

Formula for kruskal Wallis Test

$$\boldsymbol{H = \left[\frac{12}{N(N+1)} \times \sum \frac{Tc^2}{nc}\right] - 3 \times (N+1)}$$

Where N is the total number of participants- all groups combined together are 18

Tc is the rank total for each group; Tc1, Tc2, Tc3

nc is the number of participants in each group; where nc1=6, nc2=6, nc3=6

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ISSN (Online) 2393-8021
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International Advanced Research Journal in Science, Engineering and Technology

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$\sum \frac{Tc^2}{nc}$ Means the following:

First – each group rank total is squared and then the result is divided by the number of participants in that group. Then the results are added together.

Thus $\sum \frac{Tc^2}{nc} = \frac{Tc1^2}{nc1} + \frac{Tc2^2}{nc2} + \frac{Tc3^2}{nc3} = \sum \frac{Tc^2}{nc}$

$$H = \left[\frac{12}{18(18+1)} \times \sum \frac{T_{C^2}}{nc}\right] - 3 \times (18+1)$$

H= $12/342$ ×55.5/6+ 60/6 + 55.5/6

H= 0.04×513.75 + 600 + 513.75= 65.07- 57= 8.07 at 2d.f

If there are more than 5 participants per group then H is treated as Chi Square. There are six participants per group and therefore H is treated as a Chi-Square. H is 8.07, with 2 d.f. H should not be equal to or larger than the critical value. The critical value for H is 9.21. 9.21 will occur by chance one time in a hundred with a p of .01. Our H of 8.07 is likely to occur with a probability of 0.01.

Conclusion: There is a difference of some kind between the three sub-locations in crop production. The likelihood of obtaining a value of H as large as the one we've found, purely by chance is somewhere between 0.05 and 0.01.

A Kruskal-Wallis Test revealed that there was a significant effect on crop production in East Alego location. (H (2 d.f.) = 8.07, p < .05). From the mean ranks Umala Sub-location (mean rank=10) had a higher mean production than Olwa (mean rank=9.25) and Ulafu (mean rank=9.25) Sub-locations respectively. Mitigation measures for growing other crops in the area of study for food sustainability should be put in place so that mono cropping of maize crop can be balanced with growing of other crops that are suitable in the area of study. It can therefore be concluded that crop production in the three Sub-locations can do well with diversification and intensification of crop production, and thus intervention measures on clean crop husbandry in the location could lead to food sustainability.

IV (3) Factors affecting crop production in East Alego location Siaya County

This was concerned with finding out some of the factors affecting crop production that causes food unsustainability in East Alego location. Table 4 shows the respondents responses. The study adopted Chi-Square test to find out the relationship between the respondents perceptions on subsistence farming activities and factors affecting crop production in East Alego location.

Table IV: Factors affecting crop production in East Alego location Siaya County (N=317)

Characteristics	Observed	Expected	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Dependence on rain fed agriculture	123	52.83	70.17	4923.83	93.201
Low use of organic manure	104	52.83	51.17	2618.37	49.56
Wildlife crop interference	31	52.83	-21.83	476.55	9.02
Poor soil fertility	30	52.83	-22.83	521.21	9.87
Low provision of extension work	29	52.83	-23.83	567.87	10.75
Persistent drought	0	52.83	-52.83	2791.01	52.83
$\sum$	317	317			225.231

Source: Researcher, (2019)

Therefore;

$$\text{Chi} - \text{square} = \frac{(01-E1)2}{E1} + \frac{(02-E2)2}{E2} + \frac{(03-E3)2}{E3} + \frac{(04-E4)2}{E4} + \frac{(05-E5)2}{E5} + \frac{(06-E6)2}{E6} = 225.231$$

Determination of tabulated (critical) X^2 value:

i) Significance level=5% (0.05)
ii) Degree of freedom (df) = n-1
= 6-1=5

Tabulated (critical) X^2 value at 0.05 and df= 5 is 11.070.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 7, Issue 4, April 2020

From Table 4, the calculated X^2 value (225.231) is greater than the tabulated (critical) X^2 value (11.070) hence, the null hypothesis was rejected. Therefore, it was concluded that dependence on rain fed agriculture was significantly affecting crop production in East Alego location. Majority of the farmers growing cereals, root tubers, legumes and fruit crops depended on seasonal rainfall unlike farmers growing vegetables where some could use irrigation along the streams and those with no farms along the streams also depended on rain fed agriculture. This meant that when the rains delayed then crop production suffered.

4.4 Intensification of crop production in East Alego location Siaya County

This section looked into how the respondents were planning to intensify crop production for food sustainability in the location. Figure 2 shows the responses of the respondents.

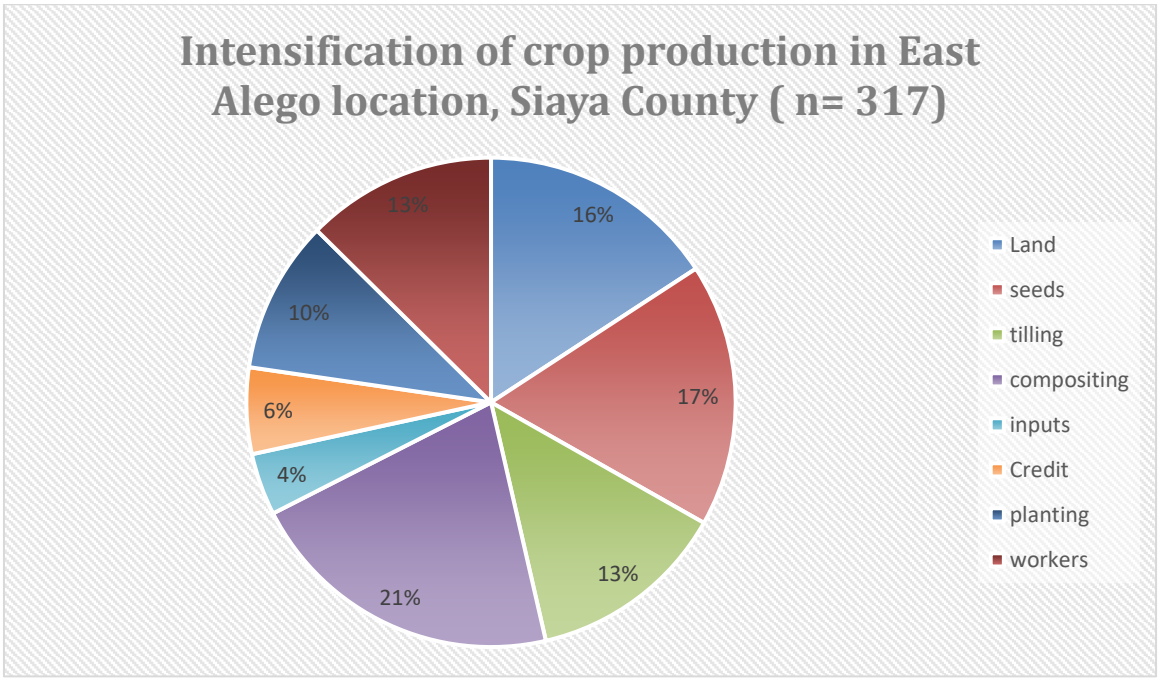

Fig. 2: Pie chart showing the respondents' perception on intensification of crop production in East Alego location. Source: Researcher, (2019)

Majority of the respondents in the area of study owned 0-1 acres of land (Table 1) which most of the peasants said was not enough for all their farm undertakings. This therefore made some of the respondents to suggest increase in land acreage (16%) as a way of diversifying on crop production (Fig.2). The respondents also realized that accessing credit (6%) if people were not in farming groups was not easy and therefore acquisition of inputs was a farmers own initiative thus, a challenge in improving food sustainability (Fig.2). 21% of the respondents were for knowledge in compositing as a way of improving soil fertility to intensify food production while 4% of the farmers were for improved acquisition of inputs to enhance sustainable food (Fig. 2). Respondents who cited diversified methods of planting (10%), improved methods of tilling (13%) and diversification of seeds (17%) emphasized on extension services (Fig.2) as a way of imparting modern farming technologies on agricultural production. According to Bonabana-Wabbi (2002), agricultural extension support is vital to compliment the farmer's formal education for improved farming techniques. There was low provision of extension work coverage in East Alego location hence inadequacy of modern farming technologies for improved food production leading to food unsustainability. There was need for intervention measures so that farmers could acquire new farming methods to improve food production for sustainable food.

V. CONCLUSION

Crop production could lead to food sustainability if mitigation measures were put in place so that growing of maize could be balanced with other crops suitable in the area of study. In regard to crop production Umala Sub-location had a mean rank of (10) while, Olwa and Ulafu Sub-locations had a mean rank of (9.25) each respectively with dependence on rain fed agriculture. Need for mitigation measures was cited as a way of working towards clean crop husbandry for sustainable food. Effects of food sustainability were more significantly effective in Umala/Ulafu Sub-locations with a rank of (U= 31) than in Olwa Sub-location with a rank of (U=34). On barriers to adaptation to food sustainability, lack of information about weather on timing of planting, lack of appropriate seeds and need for sensitization by extension workers was emphasized by respondents as a concern of working towards sustainable food in East Alego location. The study

demonstrated the importance of diversification and intensification of crop farming. It pointed to growing of drought resistant crops such as sorghum, cassava and potatoes which could result into food sustainability in East Alego location. The study revealed that diversification of seeds, knowledge on compositing, improved acquisition of inputs and increase on farm workers could be used by peasants as a way of intensifying crop production.

VI. RECOMMENDATIONS

Farmers should be encouraged to diversify and intensify on crop production to avoid mono-cropping of maize. Farmers should also be urged to embrace irrigation of horticultural crops for improved food sustainability. The study strongly emphasizes on farmers encouragement to practice clean crop husbandry so as to work towards food sustainability. The study highly recommends on-farm visits by extension workers so that farmers can be equipped with modern technology necessary for sustainable food production

ACKNOWLEDGEMENT

I am gratifying the Lord's name for His protection and care to attend to this work. I would like to express my sincere thanks to my supervisors, **Otieno, A. Charles (Ph.D.)** and **Warkach Kipkorir Tonui (Ph.D.)** for their valuable comments, guidance and suggestions in the course of attending to this work. Appreciation to my university lecturers **Professor Ang`awa** and **Mr. Maurice Odhiambo** who gave thoughtful insights during my preparations for this course. I acknowledge the efforts of my classmates who made sure that we consulted as a team for success. Special thanks to my beloved husband for his encouragement and understanding while undertaking this study. My children's support in editing and typing of the work is highly appreciated. They took it as a challenge in their academic endeavors. I also wish to thank Mrs. Jayne Ochieng` who was very close to me and through her advice, encouragement and material support the end result has been realized. I thank Jaramogi Oginga Odinga University of Science and Technology for giving me the chance to study at the institution and the university support staff that facilitated me during the entire course. Thanks to National Commission on Science Technology and Innovations NACOSTI-(Kenya) for their permission to carry out a research on subsistence farming activities and food sustainability in East Alego location, Siaya, Kenya. I am indebted to everyone who touched my life spiritually or physically during this course.

God bless you all.

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