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Research Article

Spatial Analysis of Food Crop Diversification in Busia County-Kenya: Implications on Household Food Security

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Abstract

Food insecurity is a major problem in Busia County as studies show that 54 percent of households face food insufficiency and child malnutrition. This problem is compounded by small land holdings per household, with just 155,990 acres under food crops. Studies that have been done in the County to show the major food crops that are cultivated, however, no single one has been done showing the variations of these food crops within regions, while it is well known that diversity in terms of space has a bearing in food security at household level. This research sought to find out how food crops are diversified within space and its implications on household food security. Mixed design approach was used (descriptive and correlational). Nine research assistants were involved to collect data in the cropping season using interview schedules and observation schedules. Primary data was collected in one cropping season using interview and observation schedules. Gibbs and Martins Index of crop diversification was applied to determine crop diversification. Household Dietary Diversity Score (HDDS) was used to determine food security status. Multi-stage mixed sampling techniques involving purposive, simple random stratified proportionate was used. Qualitative data was used to address research questions while quantitative data addressed the hypotheses. The results showed that there was a wide range of food crops grown in the County with cereals taking the largest portion while oils and miscellaneous crops had the lowest acreage. The study further revealed that Busia County had household food security index of 3.52 in the range of 1 to 6. It also found no statistically significant difference in regional diversification of food crops (p= .126). Finally, it revealed a very low negative correlation (r= -.080) with an insignificant relationship (p= .13) between crop diversification and household food security.

Keywords

Spatial Analysis, Crop Diversification, Food Crops, Food Security, Busia County

1. Introduction

1.1. Background to the Research

Agriculture remains to be the cornerstone of economic development in Kenya. It provides the junk of employment in the country, directly or indirectly hence the largest contributor to the Gross Domestic Product (GDP) at 33 percent [1]. Aside from this, it is the primary source of food for many households, especially for the rural dwellers who rely on agricultural produce to meet their nutritional requirements. To this extent,

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agriculture is the sector that is meant to spur Kenya towards achieving the second objective in the Sustainable Development Goals (SDGs); that is zero hunger within the populations. This calls for coming up with means to upscale the disposable incomes as well as assets of the rural folks in the developing countries [2]. Fighting the insecurity of food and nutrition in the Sub-Saharan Africa (SSA) is still a government-policy issue. Food shortage has become a global challenge for policy makers where population growth rate exceeds the ability of the available food (in quantity and quality) to meet the nutritional needs of the population [3].

Majority within the poor Kenyan population depends on subsistence agriculture as the mainstay of their livelihoods because through this, they are able to defray the impacts of food insecurity and rural poverty. Subsistence farmers are key to attaining food and nutrition security as well as sustainable rural economic growth. Kenyan households are exclusively involved in agricultural ventures and contributed 31.4 percent to rural poverty reduction, and agriculture remains the largest income source for both poor and non-poor households in those areas [4]. This is so because poverty in Kenya is mostly concentrated in rural areas. It is estimated that over 75 percent of Kenya's estimated 52 million people live in rural areas, where around half of the population face dire poverty [5].

In Busia County for example, agriculture is the most significant sector as it provides more than 65 percent of the total earnings. Most residents of the County are employed either directly or indirectly in this sector. Part of the available farmland is taken up by sugarcane farming as a cash crop leaving little room for food crops [6]. In the County, little land is left for food crops hence cubing food insecurity remains a mirage. The main food crops grown in the County includes cereals, (maize, sorghum, finger millet) legumes (cowpeas, green grams, beans, bambara nut (indigenous and local), oil crops (sesame –simsim-, oil palm); tubers (cassava, sweet potato, taro); fruits (jackfruit, pineapple, pawpaw, mango, guava, passion fruit, gooseberries, bananas, sambarao); nuts (ground nuts); vegetables (indigenous vegetables, kale, tomato, cabbage, pepper) [7].

Even though agriculture-related growth has been pivotal in cubing food and nutrition insecurity as well as transforming the developed world economies, majority of African nations are yet to meet the criteria for a successful revolution agricultural sector. Agricultural risks and uncertainties are the major features of agricultural production in developing countries [8]. Subsistence farmers face a myriad of challenges including the small farm sizes, civil (political) strife, poor post-harvest storage, poor farm tools, failure to access fertilizers, use of poor farming methods, poor soils, diseases and pests, climatic changes and marginal provision of extension services [9].

Consequently, many rural farmers are facing declining agricultural productivity, food and nutrition insecurity and income declines, negatively impacting on their livelihoods. Of these challenges, the food and nutrition insecurity and income variability are the major components of smallholder farmers' livelihoods [3]. Crop diversification has been identified as one of the ways to develop a resilient agricultural system, especially where communities depend largely on agricultural produce for their income and livelihood [10]. Similarly, crop diversification is considered to be one of the most ecologically, feasible, cost-effective and rational ways to reduce risks and uncertainties in agriculture among small-holder farmers. Additionally, diversification brings about higher spatial-temporal biodiversity on the farm and increases ecosystem resilience [11]. Cultivating multiple crops can also help subsistence farmers in the management of prices and production-related risks [12]. In soils that are moisture-stressed, the practice can also be a strategy to upscale crop productivity at the farm level. In its entirety, crop diversification can bring about improved harvests for the small-scale farmers which could result into more quality food for family consumption and sale to earn revenues for the farming households.

In the context of Busia County, households' access to food is hugely dependent on what they grow, either because they consume what they grow, or they make food purchases with the income obtained from the harvests. Additionally, because of high production costs, many rural households are pushed into reliance on the produced crops to meet their nutritional needs. To that extent, crop diversification can be a crucial means to reduce food insecurity in rural farming community [13].

Food crop diversification is a concept that can be viewed in terms of space hence the spatial concept. Crop diversification per say, means production of different varieties of crops in the same cultivated land, in other words, farmers harvest varied crops, and not a single one from a plot of land or a farming unit [14]. Crop diversification is the practice of cultivating more than one crop belonging to similar or different families in a given area in the form of rotations and or intercrops [10]. The practice brings a shift from low-value to high-value agriculture which is a significant way to upscale agricultural output. Cropping pattern implies the proportion of an area under various crops at a time. A shift in cropping pattern or crop diversification means an alteration in the proportions of areas under different crops. The magnitude to which a crop is diversified is largely influenced by several factors including geo-climatic condition of an area, socio-economic and cultural conditions of the farmers, availability of tools and implements for mechanization, requirements of more returns from limited cropped area among other factors [15]. Spatial crop diversification is achievable by growing various crop types differently configured at the same time in a given farm land. On the other hand, temporal crop diversification involves the practicing of rotational cropping or growing a sequential set of crops in the same piece of farm land [16]. Spatial diversity refers to the variations in crops grown in terms of space or farm lots. On the other hand, temporal diversity is defined as the variation of crop species at a single or different time periods. These two scenarios can be used to

describe diversity hence determining whether the benefits of crop diversification are being attained. The main difference between temporal and spatial crop diversification is that temporal diversification refers to the diversity in kind or arrangement of component crops in the farm across time while spatial diversification is the diversity in kind or arrangement of crops across space [17].

Reducing food insufficiency within rural farming community is one of the biggest challenges of agricultural policies in Kenya. Up-scaling agricultural production with fewer inputs, while improving and enhancing the livelihoods of small-scale and family farmers, remains an issue for the future [18]. Researches on the crop diversification have been done especially in Kenya, with attempts to link it to household food security. For example, diversifying agricultural production towards non-traditional crop varieties can be a means to improve agricultural productivity, stabilize output, and reduce food insecurity, as well as mitigate the risks and effects of climate change [19]. It is further pointed out that agricultural diversification has the potential of expanding the number of crop types for markets as well as contributing significantly to household nutritional requirements.

Food security exists when all people, at all times have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life [20]. There are three main dimensions of food security. These are: physical availability, which addresses the supply side of food security, taking into account the degree of food production, stock levels and balance of net trade; economic and physical access to food, which addresses the income levels, expenditure as well as market prices; and food utilization which refers to the way the body makes use of the various nutrients from the food. For households to be food secure therefore, they must be able to physically access it, afford it and utilize it in a manner that the most of the required nutrients are obtained from it.

Attempts have been made to create a link between food crop diversification and household food security. For example, an examination of the link between farms crop diversity and dietary diversity among households in central Kenya and northern Tanzania [21]. In both countries, the number of crops grown by a household was positively related to the dietary variety of the household, and in the Republic of Tanzania, crop diversity was associated with the diversity of food groups in households and individual children's diets. Enhanced biodiversity conservation and use of diverse crops, which evidently improves farm productivity and therefore food security and household nutrition, could be applied as a means to solve this problem [22]. The widening of the inter-specific and intra-specific crop diversity contributes to dietary diversification and nutrition as well as improves the resilience of production systems to biotic and abiotic shocks emanating from climate variations.

Studies have been done focusing of crop diversification and relationship with food security and evidences show a positive link between the two. For example, it has been identified as a viable option for smallholder farmers to ensure establishment of resilient agricultural systems that can contribute hugely to food security for households [10]. Other studies have been done to describe both spatial and temporal diversification and their impacts on crop yields. For example, spatio-temporal variations in observed yields allowed interpretation of potential determinants that are important for food policy formulation [22].

1.2. Statement of the Problem

Food insecurity is a major problem in many Kenyan Counties, Busia included. In the County, only 20 percent of children are reported to be getting adequate dietary requirements. It is estimated that about 64 percent of the population in Busia County lives below the poverty line and approximately 54 percent face food insecurity with skyrocketing cases of child malnutrition [23]. This problem is compounded by low acreages of farm lands, estimated to be at an average of 1.71 acres per household, with just 155,990 acres under food crops [6]. This means that food insecurity is still a problem in the County. Studies that have been done in the County to show the major food crops that are cultivated, however, no single one has been done showing the variations of these food crops with regions, while it is well known that diversity in terms of space has a bearing in food security at household level. It is on this backdrop that the research was set to find out how food crops are diversified within space and how their implications on household food security within Busia County.

1.3. Purpose of the Study

The purpose of this study was to find out the spatial diversification of food crops and determine their implications on food security of households in Busia County.

1.4. Objectives of the Study

The objectives of the study were:

1. To determine the range of food crops grown in Busia County.
2. To prepare a ranking of the identified food crops in Busia County.
3. To determine a food security index for Busia County.
4. To study the regional diversification of the food crops within Busia County.
5. To determine the relationship between regional diversification of food crops and household food security in Busia County.

1.5. Research Questions and Hypotheses

1.5.1. Research Questions

1. What is the range of food crops grown in Busia County?

2. How do the food crops grown in Busia County rank?
3. What is the Busia County food security index?

1.5.2. Research Hypotheses

1. There is no statistically significant difference in regional diversification of food crops within Busia County.
2. There is no statistically significant relationship between regional diversification of food crops and household food security in Busia County.

1.6. Significance of the Study

Many African nations, including Kenya face high levels of food insecurity. Busia County has always registered high levels as shown by various studies. This study revealed how food crops are diversified with respect to regions. This is important for policy making so that the County government and policy makers can understand and address issues of concern in relation to food security.

1.7. Justification of the Study

Household food insecurity is a problem faced by many Counties in Kenya. In Busia, with the estimated 54 percent of households being food insecure, it is apparent that key tenets of ensuring food security have to be properly addressed. Food crops diversification has been identified as one of the ways to improve this situation; however there is no clear understanding of how food crops production is diversified in Busia County and how it relates to household food security. This study therefore was necessary to address the gap.

2. Methodology

2.1. Description of Study Location

Busia County is located on the Western end of Kenya. It borders Uganda to the West, Lake Victoria and Siaya County to the South, Kakamega County to the East and Bungoma County to the North. It covers an area of 1,694.5 km^2. The County comprises of 7 Sub-Counties, 35 Wards, 60 Locations and 181 Sub-locations. The County vastly falls within the Lake Victoria Basin with undulating altitude that rises from about 1,130m above sea level on the shores of Lake Victoria to a maximum of about 1,500m in the Samia and North Teso Hills. The County is served by River Malakisi to the extreme North, Malaba in the Northern entry of the central region and River Sio crisscrossing Funyula and Nambale Sub-Counties. River Nzoia terminates into Lake Victoria via Budalang'i Sub-County [6]. Busia County has a climate that is conducive for agriculture, but it continues to register low agricultural productivity as a result of deteriorating soil fertility and extreme climate events especially occasional droughts and floods [23]. The map of Busia County is shown in Figure 1.

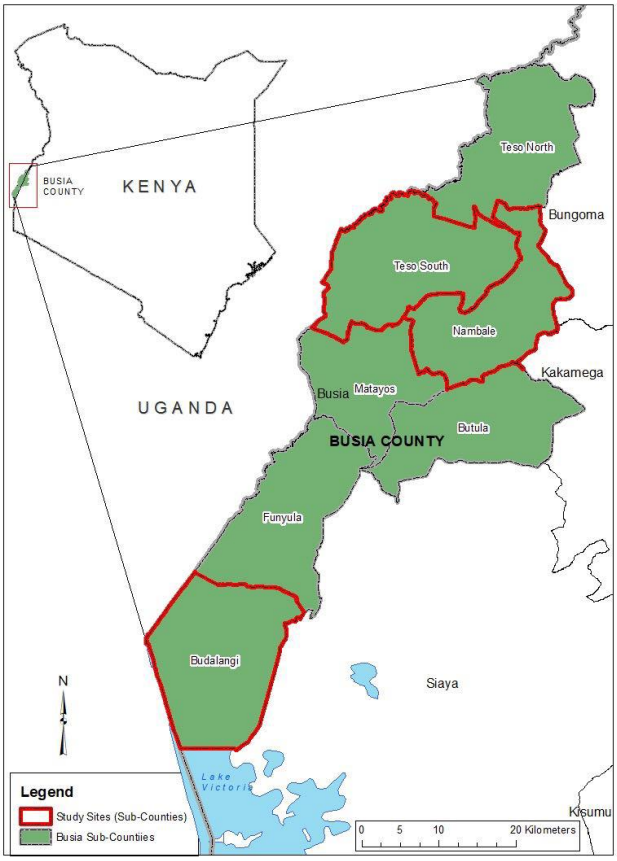

Figure 1. *Map of Busia County.*

2.2. Research Design and Execution

This study employed mixed research design (descriptive as well as correlational research designs). Descriptive design allows the observation and description of what the subjects do without an influence on them [24]. In this research, the researchers were able to observe and give detailed description of the food crops grown by the farming households, as well as asking and recording details of food types consumed. Correlational design allows the examination of the relationships between variables without any intervention in the process [25]. Food crop diversification and food security indices were examined and relationships established without any intervention.

This study was based on primary data gathered from the field plots for August-December 2023/2024 cropping season. Descriptive data was obtained to describe the nature and distribution of food crops in the research area. Gibbs and Martins Index of crop diversification were applied to find crop diversification index as follows:

$$\text{Crop Diversification Index (CDI)} = 1 - \{(\sum x2) / (\sum x) 2\}$$

Where; Where X = percentage of total cropped area occupied by each crop or acreage under individual crop.

X = (total area covered by individual crop/total cultivated area under all the crops cultivated)

The values of CDI range from 0 to 1.0, with the implication that the higher the value of the diversification index, the higher the degree of crop diversification and vice versa.

To determine household food security index, the Household Dietary Diversity Score (HDDS) were applied. The HDDS is described as the number of food groups consumed by a household over a given reference period [26]. The HDDS indicator shows a picture of a household's ability to access food as well as its socioeconomic standing basing on the previous 24 hours. Based on these scores, household food security was classified further into three ranks: poor, borderline or acceptable.

2.3. Instrumentation and Execution

Observation schedules were used to collect data on the range of food crops grown in the study area to help in determining crop diversification index while an interview schedule was used to gather information that was used to determine food security index.

2.4. Sampling Techniques

The County has 7 Sub-Counties and 35 Wards. The Wards formed the sampling units. Multi-stage mixed sampling technique was used. Purposive sampling was used to select 3 Sub-Counties with the highest food insecurity, simple random sampling applied to select 3 Wards in each of the 3 Sub-Counties, giving a total of 9 Wards. 384 farming households were purposively, stratified and proportionately sampled from the 9 Wards, using the formula by Cochran (1977) for determining sample size as shown below:

Unlimited population

$$N = \frac{z^2 \text{ x } \hat{p}\,(1-\hat{p})}{\varepsilon^2}$$

Where;

z = the z score

ε = the margin of error

N = population size

$\hat{p}$ = the population proportion

95% confidence and a margin of error of 5% was used, assuming a population proportion of .5, and unlimited population size. z for a 95% confidence level is 1.96 from the z-table. The formula substituted gives;

$$N = \frac{1.96^2 \text{ x } 0.5\,(1-0.5)}{0.05^2} = 384.16 \textit{ or } 384$$

2.5. Data Collection

Nine research assistants identified from the undergraduate class were trained on data collection. Each was assigned to gather data from each of the 9 Wards. Data was collected during the cropping season. The research assistants visited the identified households during the end of the first and second months of the planting season to collect data on the types of food crops grown as classified under: cereals; roots and tubers; vegetables; fruits; pulses, legumes and nuts; and oils and miscellaneous crops. This data was used to calculate the CDIs. During the same period, interview schedules were used to collect data on the food groups used by the households. These interview schedules were administered once in the second month, then in the third month of the cropping season.

2.6. Data Analysis

Data was analyzed using SPSS Version 20.0. Descriptive statistics (means, modes, medians and frequencies) were used to analyze data on the block distribution of food crops. This data was used to address objective one and two. To determine the food security index, HDDS was used. Interview schedules were used to gather information on food consumption where each of the 6 food groups was assigned a score of 1 (if consumed over the previous 24 hours) or 0 (if not consumed in the same period). The household food security index scores ranged from 0 to 6, equal to the total number of food groups consumed by the household. The number of consumed food groups out of the 6 is the resulting HDDS for the household. The house hold HDDS averages was used to compute the Ward (lot) averages, which shall eventually be used to compute County HDDS averages.

In determining the household food crop diversification, Gibbs and Martins Index of crop diversification was applied. The values of CDI range from 0 to 1.0, with the implication that the higher the value of the diversification index, the higher the degree of crop diversification and vice versa. If the total cropped area in a region is wholly under one crop, the index value is zero; and if it is equally distributed among all crops, the index value approaches 0.9. These indices were classified in range categories as: above 0.65 (high), 0.55-0.65 (medium), 0.45-0.55 (low) and below 0.45 (very low). The spatial diversification of food crops were measured as variations in crops grown per lot. To determine the differences or similarities, one-way analysis of variance (ANOVA), at .05 level of significance was used. To determine the relationship between food crop diversification and food security, Spearman's rank correlation coefficient was used, with values ranging from -1 to 1. This implies that the lower the values, the lower the relationship and vice versa. 0 correlations would mean no relationships.

2.7. Expected Findings

This study was expected to reveal the level of diversification of cropping patterns in Busia County with limited reference to food crops. It was also expected to reveal the level of household food security within the County as well as the positive or negative relationship between crop diversity and household food security.

3. Results and Discussions

3.1. Socio-Economic Characteristics

The socio-economics of the respondent are as shown in Table 1.

Table 1. *Socio-economic characteristics.*

Characteristic	Frequency	Percent
Sub-county (n=384)		
Butula	129	33.6
Bunyala	129	33.6
Teso South	126	32.8
Total	384	100.0
Ward (n=384)		
Kingandole	43	11.2
Marachi Central	43	11.2
Elugulu	43	11.2
Bwiri	43	11.2
Ageng'a Nanguba	43	11.2
Nangina	43	11.2
Chakol South	43	11.2
Chakol North	43	11.2
Ang'orom	40	10.4
Total	384	100.0
Household head (n=380)		
Father	279	73.4
Mother	89	23.4
Child-headed	12	3.2
Total	380	100.0
Level of education of household head (n=384)		
Didn't complete class 8	89	23.2
Kenya Certificate of Primary Education (KCPE)	213	55.5
Kenya Certificate of Secondary Education (KCSE)	67	17.4
College graduate	9	2.3
University graduate	6	1.6
Total	384	100.0
Household size (n=384)		
1-3	82	21.4
4-6	188	49.0
7-10	81	21.1

Characteristic	Frequency	Percent
> 10	33	8.6
Total	384	100.0
Family land size in acres (n=384)		
< 0.49	23	6.0
0.5-1.49	95	24.7
1.5-2.99	100	26.0
3-4.49	79	20.6
> 4.5	87	22.7
Total	384	100.0
Land size on food crops (n=380)		
< 0.25	24	6.3
0.25-0.49	19	5.0
0.5-0.99	82	21.6
1-1.25	14	3.7
>1.25	241	63.4
Total	380	100.0
Land ownership (n=374)		
Collective/communal	23	6.1
Individual	351	93.9
Total	374	100.0
Land registration status (n=368)		
Titled	222	60.3
Not titled	146	39.7
Total	368	100.0

In this study, wards were used as sampling units. From the results, it can be seen that all the wards contributed equal number of respondents (11.2%) except Ang'orom that proportionately had lower number of farmers and consequently had 10.4 percent of those who took part in the study.

The study sought to find out who heads the farming households. The results show that most (73.4%) of the households are father-headed, 23.4 percent are mother-headed while 3.2 percent are headed by children. The implication of this is that the 3.2 percent represent families where children are fully orphaned complicating the situation of having a head that can properly fend for the families.

Educational levels are important in influencing the type and levels of farming ventures households engage in. The study sought to determine the level of education of the household head. It can be seen from the results that almost a quarter (23.2%) of the household heads did not complete Class 8, whereas the majority (55.5%) went to school up to Class 8, holding KCPE certification. On the other hand, those holding KCSE, Middle level college and University degree certificate were 17.4 percent, 2.3 percent and 1.6 percent respectively. This implies the average level of education of the farming household in Busia County is KCPE Certificate. This is a low level of education bearing in mind that agricultural production requires farmers who are properly educated and have the understanding of the knowledge and bear skills needed to incorporate technology in agricultural production.

Household size is a key factor in determining sufficiency of food in any meal. The number of family members in each of the households was determined. It is apparent that about one-fifth (21.4%) of the households in the study area are small (1-3 members), while almost half of them (49%) are composed of 4-6 members. On the other hand, 21.1 percent of the households are composed of 7-10 members and the rest (8.6%) are

made up of more than 10 members. From the results, it can be said that most farming families in the County are larger than the average Kenyan family size of 3.8 per household [27]. This is likely to put more pressure on the available food resources within the County even as the land size continues to diminish.

The total family land size as per the results showed that 6 percent of the households posses very little parcels less than half an acre (< 0.49) while about a quarter (24.7%) of them posses 0.5-1.49 acres. Likewise, slightly more than a quarter (26.0%) of the households in the county hold 1.5-2.99 acres while about a fifth (20.6%) have 3-4.49 acres. On the other hand, only 22.7 percent have more than 4.5 acres of land under their possession.

Despite the total land holdings families have, it is the quantity placed under food crops cultivation that will impact on food security. Land size under food crops data revealed that a small percentage of respondents (6.3%) had < 0.25 acres of their land on food crop production another small number (5%) had 0.25-0.49 acres under the same practice. Moreover, slightly more than a fifth (21.6) of the households had 0.5-0.99 acres on food crops while just 3.7 percent had 1-1.25 acres put aside for production of food crops. On the positive side it can be seen that majority (63.4%) of farmers put aside more than 1.25 acres to produce food crops. This is something good with respect to addressing the challenge of inadequate food despite the fact that the land holdings are still below the national average.

In terms of landownership type, very little land in the study area is collectively owned (6.1%) while most of it (93.9%) is individually owned. This is a good scenario especially when it comes to individual decision-making with the type of agricultural enterprises to engage in on the farm. This research further dug into information on land registration status. Land registration shows whether he land has got title deed or not. Upon registration at the ministry of land, a land owner is issued with this crucial document which is a proof of ownership. The nature of land registration is important because it determines the extent and types of land uses by farmers. Most (60.3%) of the land in the County is titled whereas the rest (39.7%) is not. It can be said therefore that most farmers in the County have already embraced the benefits of having land registered. As previously said, the farmers can be reported to be reaping the benefits of land registration.

3.2. Information on Household Food Security

Several items were developed to measure the household food security and the results are as shown in Table 2.

Table 2. *Household food security status (n=varied).*

Item		Response				Likelihood	Response			
		No	Not sure	Yes	Total		Rarely	Sometimes	Often	Total
In the past 24 hours, did you worry that your household would not have enough food?	n	203	-	181	384	How often it happened	99	70	-	177
	f	52.9		47.1	100		59.9	39.5	4.5	100
In the past 24 hours, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	n	174		210	384	How often it happened	92	100	18	210
	f	45.3		54.7			43.8	47.6	8.6	100
In the past 24 hours, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	n	234		150	384	How often it happened	68	77	5	150
	f	60.9		39.1	100		45.3	51.3	3.3	100
In the past 24 hours, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	n	282		102	384	How often it happened	45	52	5	102
	f	73.4		26.6	100		44.1	51.0	4.9	100
In the past 24 hours, did you or any other household member have to eat fewer meals in a day because there was not enough food?	n	198	10	169	377	How often it happened	78	100	8	186
	f	52.5	27	44.8	100		41.9	53.8	4.3	100
In the past 24 hours, was there ever no food to eat of any kind in your household because of lack of resources to get food?	n	286		86	372	How often it happened	4			4
	f	76.9		23.1	100		100			100

The respondents were required to indicate the level of worry about not having enough food in the previous 24 hours. As shown, slightly more than half (52.9%) of the respondents were not worried of insufficient food. On the other hand, 47.1 percent were worried that they would not have sufficient food to sustain their families over the same period. These results mean that most of the farming households in the study area had sufficient food to sustain their households in the period under review.

On the likelihood of the worry on insufficient food, 177 had responses of which 59.9 percent indicated that it was rare while 39.5 percent showed that this would occur sometimes. From this result, it can be reported that most of the households were not likely to be worried about insufficient food in that period.

The research sought to determine the level of inability to get preferred food due to resources inadequacy in the previous 24 hours of the study. As can be seen, 45.3 percent were not faced with this challenge. On the contrary, majority (54.7%) were unable to eat preferred food because they lacked the money to purchase them. These results mean that most of the farming households we enabled by the resources at their disposal to eat the food they preferred.

On the likelihood of inability to get preferred food due to resources inadequacy, 210 gave responses. Of this 43.8 percent indicated that it was rare for them to worry about resources being hindrance towards eating preferred food while 47.6 percent showed that this would occur sometimes. Furthermore, only 8.6 percent indicated that they would often worry about eating preferred food to lack of money to purchase them.

The research sought to determine respondents ate unpreferred food due to resources inadequacy in the previous 24 hours. It can be said that most (60.9%) were not faced with this problem. However, 39.1 percent ate unpreferred foods since they did not have enough money to purchase foods of their preference. This suggests that most of the farming families were able to acquire and eat preferred foods because the resources were available.

On the likelihood of consuming unpreferred food due to resources inadequacy, 150 respondents responded of whom 45.3 percent indicated that it was rare for them to consume unpreferred food while majority (51.3%) showed that they would sometimes eat the foods they did not prefer due to shortage of money. Furthermore, only 3.3 percent indicated that they would often eat foods they did not like because they lacked money to purchase what they liked.

The research sought to find out if the respondents ate less food due to its inadequacy in the study period. A huge number (73.4%) did not eat less food compared to their required amounts due to food inadequacy. It can also be seen that 26.6 percent ate less food since there was not enough in the family. It can be seen therefore that majority of the respondents were able to eat preferred foods.

On the possibility of consuming less food due to food inadequacy, 102 of respondents replied whereby 44.1 percent indicated that this rarely happened to them while majority (51.0%) showed that they would sometimes eat less food since they did not have enough. Furthermore, only 4.9 percent showed that they would often eat less food because they lacked enough in the family.

It was of interest to determine if the households spent a day with no food at all due to lack of resources to acquire it. Most (76.9%) of the households did not spend the day with no food at all. Equally, 23.1 percent spent a day with no food at all due to lack of resources to acquire the precious human need. It can be seen therefore that majority of the households were able to put something on the table however little. For the 4 respondents who did not eat anything at all due to lack of resources, all of them indicated that this problem would rarely occur.

Different classes of food consumed by household in the previous 24 hours (in the category of: cereals, roots and tubers, vegetables, fruits, pulses, legumes and nuts, oils and miscellaneous). The research sought to determine the variations in the food types households consumed in the previous 24 hours of this study. This is an indicator of household dietary diversity and food security. The results are shown in Table 3.

Table 3. *Variations in food classes consumed (n=365).*

Food class variation	Frequency	Percent
4 types	154	42.2
3 types	79	21.6
2 types	65	17.8
5 types	55	15.1
1 type	9	2.5
All (6) types	3	.8
Total	365	100.0

From the table, 42.2 percent of the households had consumed 4 different classes of food in the previous 24 hours while 21.6 percent had consumed 3 classes. Furthermore 17.8 percent consumed 2 types while 15.1 percent utilized 5 types of food in the stated period. A meagre 2.5 percent had consumed 1 type of food while a further 0.8 percent had taken food from all the 6 classes considered in this study. From this outcome, it is possible to say that a good number (42.2%) of households were taking a balanced diet.

3.3. Land Acreage under Various Food Crops

Table 4. Acreage under various food crops.

Area under various crop types	Count	Response range (land size in acres)					Total
		< 0.25	0.25-0.49	0.5-0.99	1-1.25	>1.25	
Cereals (e.g. maize, sorghum)	n	25	28	93	54	126	326
	f	7.7	8.6	28.5	16.6	38.7	100
Roots & tubers (e.g. cassava, yams, sweet potatoes)	n	105	78	82	45	18	328
	f	32.0	23.8	25.0	13.7	5.5	100
Vegetables (e.g. cowpeas, onions, pumpkins, pigweed)	n	195	78	22	-	-	295
	f	66.1	26.4	7.5	-		100
Fruits (e.g. bananas, mangoes, pawpaw, jack fruit)	n	183	41	15	13	-	252
	f	72.6	16.3	6.0	5.2	-	100
Pulses, legumes and nuts (e.g. groundnuts, soybean, beans)	n	92	41	53	24	7	217
	f	42.4	18.9	24.4	11.1	3.2	100
Oils and miscellaneous (e.g. simsim)	n	17	11	-	-	-	28
	f	60.7	39.3	-	-	-	100

From the data, it can be seen that for the cereals including maize, sorghum and millet, 326 farmers out of the total 384 taking part in the research were practicing cereals farming. Of this number, 7.7 percent had planted < 0.25 acres, 8.6 percent had 0.25-0.49 acres, 28.5 percent had 0.5-0.99 acres, 16.6 percent planting 1-1.25 acres while the highest percentage (38.7%) had >1.25 acres of land under cereal crops. This affirms the position of cereal crops as staple food for most families in Kenya and Busia County generally. This is consistent with the Agriculture and Food Authority (2024) report that says that cereals form the main component of food crops for Kenyan families.

With reference to roots & tubers (e.g. cassava, yams, sweet potatoes among others), 328 farmers reported to be farming them. From this number, 32.0 percent had planted < 0.25 acres, 23.8 percent had 0.25-0.49 acres, a quarter (25.0%) had 0.5-0.99 acres, 13.7 percent planting 1-1.25 acres while only 5.5 percent had >1.25 acres of land planted with root and tuber crops. This is consistent with other findings that reiterated that the production of main root crops like cassava, sweet potato and yams remains below potential posing a challenge to policymaking, research, and other value chain processes in order to upscale their competitiveness in our agri-food systems for a healthy nation [28]. Root and tuber crops are an important source of carbohydrates in Kenya, only second to cereal crops [29]. This therefore means efforts should be up-scaled to ensure that they take their rightful position in ensuring food and nutrition security.

On vegetables (e.g. cowpeas, onions, pumpkins, pigweed), 295 farmers were reported to be actively growing them. Out of this number, more than half (66.1%) had just grown < 0.25 acres, about a quarter (26.4%) had 0.25-0.49 acres whereas very few (7.5%) had 0.5-0.99 acres with acres of land planted with vegetable crops. It can therefore be seen that vegetable crops are grown in very smallholdings as consistent with the dietary requirements. These foods are not usually consumed in large quantities. Fruits and vegetables supply an abundant, cheap source of fibre and several vitamins and minerals [30]. Generally, they contain the highest nutritional value when freshly eaten. Persons involved in production of fruits and vegetables can assure their households' food security, and cases of anaemia for women of childbearing age are expected to go down. Vegetables provide a cheap source of essential vitamins hence it is recommended nutritionally that they are incorporated in every meal.

With respect to fruits, it can be seen that majority (72.6%) of farmers who practiced this kind of farming had < 0.25 acres while 16.3 percent had put 0.25-0.49 acres under the same crop. Furthermore, small fractions (6.0% and 5.2%) had 0.5-0.99 acres and 1-1.25 acres respectively under vegetables. Fruits do not form part of the main diet hence they are planted in very small holdings.

There were 217 farmers who had included pulses, legumes and nuts (e.g. groundnuts, soya bean, beans) in their farming

ventures. Out of this number, 42.4 percent had planted < 0.25 acres, 18.9 percent had 0.25-0.49 acres, about a quarter (24.4%) had 0.5-0.99 acres, 11.1 percent planted 1-1.25 acres while just 3.2 percent had >1.25 acres of land planted with pulses legumes and nuts. This category of food crops supply the main source of dietary protein, a component needed for body building. Pulses are rich in the essential nutrients including fibre, foliate, calcium, iron, and vitamin C [31]. Therefore, they are essential for human growth and development. Legumes, apart from being rich in dietary proteins have been cited for many other benefits. Oils and other crops considered miscellaneous for this study were not significantly grown in this County, as only 28 respondents reported to have grown them. These crops have no major place in the human dietary needs as can be witnessed from the results of this study.

3.4. Answers to Research Questions and Test for Hypotheses

3.4.1. Research Question 1: What Is the Range of Food Crops Grown in Busia County

The study found out that Busia County is diverse with reference to the types of food crops grown. It further found out that cereals took the major proportion, being staple foods for this part of the country.

3.4.2. Research Question 2: How do the Food Crops Grown in Busia County Rank

Various crops under any agricultural system can be grown to different levels based on various factors including the usefulness of the crop to the farmer. This is as shown in Table 5.

Table 5. *Ranking of food crops by acreage.*

Crop type	Area under cereals (e.g. maize, sorghum)	Area under roots & tubers (e.g. cassava, yams, sweet potatoes)	Area under pulses, legumes and nuts (e.g. groundnuts, soya bean, beans)	Area under fruits (e.g. bananas, mangoes, paw-paw, jack fruit)	Area under vegetables (e.g. cowpeas, onions, pumpkins, pigweed)	Area under Oils and miscellaneous (e.g. simsim)
Acreage	3.6994	2.3689	2.1382	1.4365	1.4136	1.3929

From the data, it can be said that cereals were the highest ranking in terms of size of cultivated area taking about 3.69 acres. This was followed by roots and tubers (2.26 acres) followed by pulses, legumes and nuts (2.13 acres), fruits (1.44 acres), vegetables (1.41) and the smallest acreage was taken by oils and miscellaneous crops at 1.39 acres of the entire area under food crops.

3.4.3. Research Question 3: What is the Busia County Food Security Index

The food security levels were measured by indices generated from the various food types households consumed in the previous 24 hours of conducting the study. The number of consumed food groups out of the 6 gives the HDDS. The County HDDS is as shown in Table 6.

Table 6. *HDDS index for the County.*

	N	Minimum	Maximum	Mean
How many types of food did your household consume in the last 24 hours (in the category of: cereals, roots and tubers, vegetables, fruits, pulses, legumes and nuts, oils and miscellaneous)	365	1.00	6.00	3.5205
Valid N (list wise)	365			

Based on the data, it can be seen that the household food security index was 3.52 in the range of 1 to 6. This shows that the County is performing above average. It equally implies that households were consuming between 3 and 4 different types of food classes in every meal. This is contrary to the findings of [32] which showed that 93% of the households in the County had a low food diversity comprising a maximum of two food groups. This implies that the situation has been

improving over the years as households get to know the necessity of balanced diet. This is also contrary to [33] which revealed that household food insecurity 88.7 was percent among the households in Busia County.

3.4.4. Null Hypothesis 1: There Is No Statistically Significant Difference in Regional Diversification of Food Crops within Busia County

To determine if there was a difference in food crop diversification between the sampling units (Wards), a one-way ANOVA was conducted and the results areas shown in Table 7.

As the table shows, there is no statistically significant difference in regional diversification of food crops (p= .126) which is greater than the significance level (.05). It can therefore be said that the food crops diversification indices did not vary significantly among the 9 wards in Busia County.

Table 7. One-way ANOVA results.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.885	8	15.043	2.351	.126
Within Groups	2361.097	369	6.399		
Total	2376.140	377			

3.4.5. Null Hypothesis 2: There Is No Statistically Significant Relationship Between Diversification of Food Crops and Household Food Security in Busia County

To determine the relationship between diversification of food crops and household food security, Pearson correlation was conducted and the results are shown in Table 8.

Table 8. Pearson's correlation for diversification and household food security.

Diversity index	Pearson Correlation	1	-.080
	Sig. (2-tailed)		.131
	N	371	356
Household food security	Pearson Correlation	-.080	1
	Sig. (2-tailed)	.131	
	N	356	365

As can be seen there was a very low negative correlation (r= -.080) with an insignificant relationship (p= .13) between crop diversification and household food security in Busia County. This is to mean that to a small extent, crop diversification would reduce household food security and vice versa. This is contrary to Mango (2018) which found out that diversification of crops is one of the many viable option in smallholder farming that can ensure establishment of resilient agricultural systems that can contribute by a large margin to food security in households.

4. Conclusions and Recommendations

The study set out to find out how food crops are diversified within space and their implications on household food security. The findings showed that there was a range of food crops grown in the County with cereals were the most grown and oils and miscellaneous crops being the least grown. The study further revealed that the food security level in the County was slightly above average. It was also found out that there was no statistically significant difference in regional diversification of food crops. Finally, it revealed a very low negative correlation between crop diversification and household food security. The study therefore recommends that further research be done to determine the number of food crops farmers should keep within their diversification programme in order to ensure a significant positive link between diversification and household food security.

Abbreviations

HDDS	Household Dietary Diversity Score
GDP	Gross Domestic Product
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
CDI	Crop Diversification Index
ANOVA	Analysis of Variance
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education

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Author Contributions

Ongang'a Peter Odhiambo: Conceptualization, Software, Formal analysis, Funds acquisition, Invesigation, Methodology, Writing of Draft, Project Administration

Ngugi Margaret Njeri: Data curation, Methodology, Project administration, Writing – review & editing

Mwatu Morris Maingi: Conceptualisation, Formal Analysis, E Investigation, Validation, Writing – review & editing

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Data Availability Statement

The data is available from the corresponding author upon justifiable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

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