East African Scholars Journal of Agriculture and Life Sciences
Abbreviated Key Title: East African Scholars J Agri Life Sci
ISSN 2617-4472 (Print) | ISSN 2617-7277 (Online) |
Published By East African Scholars Publisher, Kenya
OPEN ACCESS
Volume-2 | Issue-11 | Nov-2019 |

Research Article

Crop Diversification, a Potential Strategy to Building Resilience through Reduction of Costs of Farming among the Small holder Farmers

Catherine Nyongesa[1*], Prof. Boniface Oindo[1] and Dr. Esnah Bosire[1]
[1]Masters Student in the School of Environment and Earth Sciences of Maseno University, Kenya

*Corresponding Author
Catherine Nyongesa

Abstract: Globally, due to rapid population growth and continual urban sprawl, average arable land per household is shrinking hence crop diversification is gaining increased importance in the quest for solutions to the perennial food security problems in most of Sub-Saharan countries. This study sought to examine the relationship between crop diversity and costs of farming among the farmers. A cross-sectional descriptive research design was adopted for the study. The target population for the study was small holder farmers with a total population of 26,617, from which a representative sample of 384 participants was drawn using Simple random sampling. Data was generated through secondary and primary data; primary data was collected through designed and administration of questionnaires. Hypothesis were generated and tested. Data was analysed using both descriptive (means, standard deviation, frequencies and percentages) and inferential statistics (simple linear regression analysis). All the tests of significance were conducted at $\alpha = 0.05$. The study revealed that crop diversification reduces the labour costs among the small holder farmers in the region, that is; an increase in crop diversification lead to a drop in the total cost of farming among the small holder farmers in Bungoma South Sub-county by 67.2% (as indicated by Standardized Beta coefficient = 0.672). The results are indicative of the importance of crop diversification as ecologically feasible, cost- effective and climate smart agriculture practice in rural smallholder farming systems. Therefore, we recommend wider adoption of diversified cropping systems notably those currently less diversified for resilient and affordable agricultural practise.
Keywords: Crop Diversification, Food Crops, Costs of Farming, resilience, Crop Diversification Index (CDI).

INTRODUCTION:

Globally, the idea of building resilience has been studied in a broad range of ecosystems, from coral reefs to forests (Altieri, 1999). However, this idea has not been well studied in an especially important system to human society: the agro ecosystem (Nyström *et al.*, 2000). In addition to that, many agriculture based economies have few other livelihood strategies (Brenda, 2011), and small family farms have little capital to invest in expensive adaptation strategies, which increases the vulnerability of rural, agricultural communities to a changing environment. The challenge for the research community therefore is to develop resilient agricultural systems using rational, affordable strategies such that ecosystem functions and services can be maintained and livelihoods can be protected (Brenda, 2011). Crop diversification could provide a solution because it is meant to give a wider choice to a farmer in production of a variety of crops in a given area and this helps a farmer avoid risks and uncertainties due to climatic and biological vagaries so as to expand production on various crops (Heal, 2000). While many of these studies recognise the fact that diversity can reduce the costs in agricultural system, adoption of increased diversification has been slow because of mistaken belief that biomass production is substantially greater in monocropped systems than in multispecies systems that must be addressed in order to hasten the implementation of this strategy.

Most governments in SSA are faced with the dilemma of achieving food security, while reducing poverty in the face of increasing population, climate change and the associated environmental consequences (Teklewold *et al.*, 2013; Vanlauwe *et al.*, 2014; Kuivanen *et al.*, 2016; Binswanger-mkhize & Savastano, 2017). Although smallholder farmers in these developing countries depend on rain-fed

Quick Response Code

Journal homepage:
http://www.easpublisher.com/easjals/

Article History
Received: 28.10.2019
Accepted: 08.11.2019
Published: 18.11.2019

DOI: 10.36349/easjals.2019.v02i11.004

agriculture, they continue to contribute to improvement of rural and urban livelihoods. For instance, in SSA, agriculture employs over 50% of labour force and contributes to an average of about 15% of the total gross domestic product (GDP) (OECD-FAO, 2016). Agricultural diversification is one of the strategies for income generation, poverty and food insecurity reduction and improvement of nutritional status of rural population (Makate *et al.,* 2016).

However, food crop production, the primary income generating enterprise in rural areas in SSA, is inadequate to enhance the well-being of smallholder farmers. In addition, its contribution to rural livelihoods is hampered by high cost of production (Gautam & Andersen, 2016). This is attributed to low input use, low mechanization and poor soil fertility which lead to low agricultural output (Barrett, 2000; Asfaw *et al.,* 2018). Although agricultural diversification reduces production-related risks and increases farm earnings, few farmers diversify their agricultural activities in SSA. The lack of access to agricultural inputs, equipment and other factors of production as well as institutional constraints are important obstacles to diversification (Asfaw *et al.,* 2018). Studies in the African continent point out the role of a small holder farmer in economic development, the overall benefits of diversification to small holder farmers and the constraints they face in adopting crop diversification. However, these studies have failed to explain the extent to which crop diversification will make agricultural land production to the small holder farmer's cost-effective.

Darnhofer (2010) observed that Kenyans have a mistaken belief that biomass production is substantially greater in mono cropped systems than in multispecies systems. Tutwiler (2011) also notes that majority of the Kenya's food insecure population lives in rural areas in the country and many are subsistence producers who may not grow enough to meet their families' needs. According to FAO (2013), discussions of food security in Kenya usually revolve around maize, since the country's food security is overwhelmingly dependent on it, despite a continued structural deficit in maize production that has resulted in an increase in food prices. This therefore makes the development of resilient agricultural systems an essential topic of study because many communities greatly depend on the provisioning ecosystem services of such systems (food, fodder and fuel) for their livelihoods (Tilman *et al.,* 2002).

Bungoma South Sub-County's cropland is diversified into four major food crops namely maize, beans, sweet potatoes and finger millet (Wachiye, 2013). However, the potential effects of this crop diversity on costs of farming in the region remain unknown. While monoculture farming in the Sub-County has advantages in terms of efficiency and ease of management, the loss of the crop in any one year could put a farm out of business and/or seriously disrupt the stability of a community dependent on that crop (Oloo, 2013). By growing a variety of crops, farmers spread economic risk and are less susceptible to environmental risks (Wachira, 2014).While these studies address the cost-effectiveness of crop diversification, it's uncertain if these crop diversification projects embraced by small scale farmers in the Sub- County can effectively promote resilience of agricultural land production by reducing the costs of farming.

Gunasema (2012) in a research report on intensification of crop diversification in the Asia-Pacific region defined that crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking in to account the different returns from value added crops with complementary marketing opportunities. Gunasema (2012), further identified 7 advantages of crop diversification (1) comparatively high net returns per unit of labor, (2) high net returns per unit of labor, (3) optimization of resource use, (4) higher land utilization efficiency, (5) increased job opportunities, (6) disease and pest suppression, (7) climate variability buffering and mitigation. This can be justified by the study conducted by Brenda 2011) who observed that intercropping coconut with cassava, maize, cashew nut, sorghum and pineapples were the alternatives used by farmers to cope with declining coconut production caused by coconut mite and lethal yellowing disease due to climate variability in Tanzania. On the other hand, Makate *et al.,* (2016) asserts that, crop diversification increases resilience and brings higher spatial and temporal biodiversity on the farm. While these studies point out all these advantages to justify the cost- effectiveness of crop diversification farming among the farmers, they don't tell us how crop diversification make a small holder farmer resilient through a reduction in the costs of farming.

Statement of the Problem

Globally, the idea of building resilience has been studied in a broad range of ecosystems. However, this idea has not been well studied in an especially important system to human society: the agro ecosystem. While many of the studies carried out worldwide recognize the fact that diversity can improve the resilience of agricultural system, adoption of increased diversification has been slow because of mistaken belief that biomass production is substantially greater in monocropped systems than in multispecies systems that must be addressed in order to hasten the implementation of this strategy.

In SSA, most of the governments are faced with the dilemma of achieving food security, while reducing poverty in the face of increasing population, climate change and the associated environmental consequences. Agricultural diversification is one of the strategies embraced by small holder farmers for income generation, poverty and food insecurity reduction and improvement of nutritional status of rural population. However, these small scale farmers often do so without clearly referencing the theoretical literature on resilience. As a result of this, it's uncertain if this crop diversification can be cost-effective in promoting resilience of agricultural land production of small holder farmers.

Studies carried out in Kenya reveal that high poverty rates, dependence of a large proportion of the population on maize-based diets and the lack of policy focus on diversification of food availability and affordability at household level in the country leaves many households vulnerable to the effects of unstable weather and unreliable marketing. This therefore makes the development of resilient agricultural systems an essential topic of study because many communities greatly depend on the provisioning ecosystem services of such systems for their livelihoods.

Bungoma South Sub-County's cropland is purely rain-fed and diversified into four major food crops namely maize, beans, sweet potatoes and finger millet. By growing a variety of crops, farmers spread economic risk and are less susceptible to environmental perils. However, this does not highlight the extent to which there are synergies between crop diversification and the resilience of agricultural production. Therefore the purpose of this study is to establish the effects of crop diversification in building the resilience of agricultural land production among the small holder farmers in Bungoma South Sub- County.

Purpose of the paper

The purpose of this paper was to explore the effects of crop diversification on the resilience of agricultural land production among the small holder in Bungoma South Sub- County. The specific objective of the study was to: establish the effects of subsistence crop diversity on costs of farming among smallholder farmers in Bungoma South Sub- County. The null hypothesis arising from the stated objective of the study was: Diversification of subsistence food crops has no significant effect on costs of farming among the small-holder farmers. The findings of the study would be of importance in the following ways: Firstly, the findings will add to the existing conceptual and empirical evidence that crop diversification influences resilience of agricultural land production. Secondly, the findings will help develop a resilient agricultural systems using crop diversification such that ecosystem functions and services can be maintained and livelihoods of small holder farmers can be protected. Thirdly, the findings of this study will help to improve the understanding of the reasons for the benefits obtained by using crop diversification so that the design and management of crop diversity in practical farming can be improved.

Theoretical Framework

This study is based on Resilience theory which was first described by Holling (1973), who studied how populations function within ecological systems, particularly after some sort of ecological stress. The resilience theory is a theoretical perspective that provides a framework and tools for addressing and enhancing households, capacity to deal with changes, slow or abrupt. Small holder farmers are strongly influential in shaping their landscapes and are at the same time affected by changes at all levels. Therefore, they have been developing coping strategies to address changes in their surrounding leading to further adaptation and transformation of their systems. One rational and cost-effective method they are using may be the implementation of increased agricultural crop diversification. However, the idea of resilience has not been well studied in an especially important system to human society: the agro ecosystem (Nyström et al. 2000). This makes the development of resilient agricultural systems an essential topic of study because without clearly referencing the theoretical literature on resilience thinking, it's uncertain if this crop diversification can effectively promote resilience in agricultural land production.

RESEARCH METHODOLOGY

This research adopted a cross-sectional descriptive research design (Mugenda, 1999). This was considered appropriate method for this study since data that was collected didn't need a long time frame for studies. Data collected at a single instant would be enough to accomplish the objectives of the study. Therefore, the effects of crop diversity indices on cost of farming were evaluated in order to determine the status of resilience of small holder farmers. Crop farmers in the region were used as units of analysis.

The target population of the study consisted of 26617 small holder farmers in Bungoma South sub-county. Moreover, 5 local chiefs, 5 agricultural service providers in each location and 1 sub county agricultural officer were also considered. The list of small holder farmers was obtained from Bongoma South Sub-County Agricultural office. Simple random sampling technique was employed to select proportionate number of small holder farmers from the 10 sub- locations in the Sub-County. This technique was considered appropriate because it ensures that all smallholder farmers have an equal chance of being included in the study sample. Besides, simple random sampling gives random samples which yield data that can be generalized within margins of error that can be determined statistically (Borg, 1987; Mugenda &Mugenda, 1999). Simple random sampling was used to select the groups of these farmers from a list of farmers provided by the Sub-County ministry of agriculture. However key informants were selected purposively from the region. The study used questionnaires, interview schedules and observation schedule to collect the data for the study.

The study instruments were pilot tested to detect weaknesses in the design and implementation of a questionnaire and to provide proxy for data collection of a probability sample (Cooper &Lybrand 1993). Other scholars argue that the purpose of pilot testing is to establish the accuracy and appropriateness of the research design and instrumentation (Saunders *et al.*, 2007). Pilot testing has dual advantages; first, is to catch potential problems, costly mistakes, provide an indication of time required for actual field work and possible modifications of the instrument and modality of data collection, second, enhancing the training of field staff, review of the instrument, prevention of wasteful expenditures on a full blown survey whose results may not be acceptable (Star, 2008). Thus, to check the validity and reliability of the questionnaires in gathering the data required for the purposes of the study, a pilot study was carried out. Baker (1988) argues that the size of a sample for the purpose of pilot testing can range between 5% and 10%. However, Mugenda and Mugenda (2003) argue that the pretest sample should be between 1% and 10% depending on the size of the sample, the larger the sample, the smaller the percentage. In this study, the questionnaire was pilot tested on 10% of the sample to ensure that the instrument is relevant and reliable. The questionnaire was tested on forty (40) small holder farmers in the region, who were not involved in the main study. The responses from the 40 respondents were used to determine the existence of ambiguities in the items and also to establish whether they could elicit the type of responses sought. The items that were not clearly understood and that evoked unanticipated responses were subsequently modified to improve their clarity.

Validity is the degree to which the results obtained from analysis of the data actually represent the phenomenon under study (Robinson *et.al* 2014). Pilot testing and expert opinion (opinion from supervisors, and other research experts in the school of environment and earth science) were used to determine the validity of the research instruments during the pilot study. This study assessed validity of the study instrument using content and construct validity. Content validity was determined by first discussing the items in the instrument with the supervisors (expert opinion) and pilot testing. To ensure content validity, the questionnaire was subjected to thorough examination by two independent resource persons (supervisors), from the school of environment and earth science of Maseno University. They evaluated the statements in the questionnaire and confirmed them relevant, meaningful and clear. On the other hand, Saunders et al (2007) explains construct validity as the extent to which the measurement questions actually measure the presence of those constructs one intended to measure. In this study and for the purpose of construct validity, the questionnaire was divided into several sections to ensure that each section assesses information for a specific objective, and also ensure that the same is closely tied to conceptual framework of the study.

Joppe (2000) defines reliability as the extent to which results are consistent over time and an accurate representation of the total population under study. If the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. The consistency levels of the research instruments are vital in determining whether the data to be generated from the instruments are reliable. A reliable coefficient of not less than 0.7 is recommended for consistency levels (Fraenkel and Wallen, 1993). In this study, reliability was measured using Cronbach's Alpha of coefficient. The standard reliability coefficient is taken from Nunnally (1978), who suggests that in the early stages of research on predictor tests or hypothesized measures of a construct, reliabilities of 0.7 or higher will be sufficient. Table 3.3 below shows a summary of reliability analysis.

Table 3.3: Summary of reliability analysis

Variable	**Measures**	**Cronbach's Alpha**	**Cronbach's alpha Standardized**	**No. of items**
Crop Diversity	• Crop diversification Index (CDI)	0.82	0.82	10
Resilience of agricultural land production	• Costs of farming	0.79	0.80	10

The results in Table 3.3 show that Cronbach's alpha coefficient ranged between .79 (Resilience of agricultural land production) to .82 (Crop diversity). This was an indication that measurement scales used in the study were sufficiently reliable and adequately measured the variables for the study. The Cronbach's alpha coefficients exceeded the 0.6 lower levels of acceptability (Croncbach, 1970) and within the 0.7 and above as suggested by Nunnally (1978) and therefore this implies that the data set was reliable and acceptable for further analysis.

The study was carried out at the farm level hence there was need for the researcher to observe ethical issues as far as data collection was concerned. The researcher had to seek permission from the local administration and the Sub-County Agricultural Officer to carry out research in their area of jurisdiction. In addition to that, the researcher also had to seek the consent of farmer respondents. The respondents were informed about the purpose of the study and the benefits of this research to the community. In part, the researcher informed the respondents about the procedures of the study which they had to participate and the expected duration of participation. The researcher also assured the respondents of privacy and confidentiality for any information collected from them. Numbers were used for identification to maintain anonymity of the respondents.

This study generated both qualitative and quantitative data that were analysed using descriptive and inferential statistics. Standardized data was summarised using means, standard deviations, frequencies and percentages. To determine strength and direction of the relationship between CDI index visa viz costs of farming, the study used Pearson moment correlation coefficient (r). In order to establish significance difference in the proportions, Chi Square analysis was performed at 5% level of significance. To test for the research hypothesis, the study used simple linear regression at α = 0.05. The simple linear regression model adopted was:

$$Y = \beta_1 + \beta_i x_i$$

Where;

Y = CDI Index
β_1 = Constant
β_i = Regression coefficient for the x_i
x_i = Costs of farming.

Crop Diversification Index (CDI), was calculated using Bhatia's technique (Bhatia, 1965), that is:

$$CDI = \frac{Percent\ of\ the\ total\ harvested\ area\ under\ k\ crops}{Number\ of\ k\ crops}$$

Where k crops are those crops that individually occupy 10 per cent or more than 10 per cent of the total cropped area in the study region. This formula is inversely related with the magnitude of diversification. Here, the higher is the value of the index (positive); the lower will be the degree of diversification and vice versa. Moreover, all the quantitative data collected were analysed on computer using the Statistical Package for Social Sciences (SPSS) software version 23 and summarized in tables. However, qualitative data from the interviews was presented in text around themes and according to the objective of the study. Details on how data collected were analysed in terms of qualitative and quantitative descriptions are presented below.

FINDINGS AND DISCUSSIONS

Costs of farming are believed to be incurred in terms of labor costs (hired labor) and other input variable costs (cost of buying seeds and fertilizers).

Input Variable Costs

Input variables include the inputs bought from farm input retail shops. The study included seeds and fertilizers as the basic input variables used by farmers in the region. This was summarized in table 3.4 below

Table 3.4: Average input variable costs (Ksh.) incurred by a crop farmer on approximately 1.5 acre piece of land

	Maize		Bean		Millet		Total variable costs
	Seed	Fertilizer	Seed	Fertilizer	Seed	Fertilizer	
Response count	189	189	178	75	43	31	189
Mean (Ksh.)	2900.49	9567.5	2864.89	2706.67	1351.86	3738.71	23130.12
Std. Error of Mean	6.96	8.49	4.69	8.27	9.22	9.62	6.68
Std. Deviation	95.71	116.69	62.61	71.58	60.49	53.55	91.90
Skewness	3.01	3.15	-.10	3.63	3.44	3.66	3.28
S.E of Skewness	.18	.18	.18	.28	.36	.42	.18

A farmer who practice crop diversification (plant maize, beans and finger millet) in the region incur a total variable cost of approximately Ksh.23, 100.00 on approximately 1.5 acre piece of land as shown in table 3.4 above. However it should be noted that a farmer practicing Potato farming in the region doesn't incur any variable cost since farmers neither buy the planting stems nor apply fertilizers.

4.5.2. Labour Costs

Labor costs are incurred during land preparation, weeding and harvesting of the crops. The study reveals that farmers in Bungoma South Sub-County either use family labor or hired labor as shown in figure 1 below.

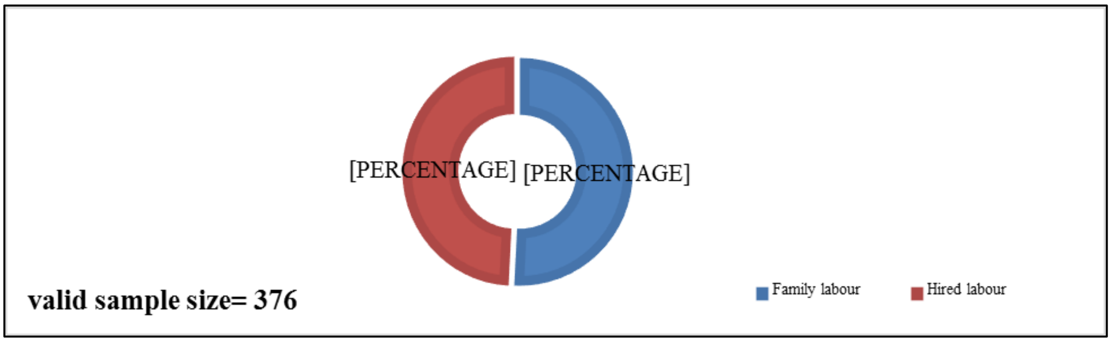

Figure 1: Type of labor used by famers in the region

A Chi-square test, $x_1^2 = 0.096$, $\rho = 0.057 > 0.05$, indicates that there is no significant difference between farmers using hired labour and those using family labour in the region as shown in figure 1 above. In addition to that, for those small holder farmers who use family labor, there are no costs incurred apart from costs of buying seeds and fertilizers. But for the farmers who use hired labour, they incur both labour costs and costs of buying seeds and fertilizers. This was summarized in table 3.5 below.

Table 3.5: Average labor costs (Ksh.) incurred by small holder farmers who use hired labor in crop farming

Average costs incurred	N	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
land preparation costs	189	7015.52	6.25451	85.98531	3.915	.177
weeding costs	189	4799.21	3.4589	47.55180	4.514	.177
Harvesting costs	188	6558.60	5.3494	73.34750	3.994	.177
Total labour costs	189	18338.62	7.2163	99.20740	1.623	.177

A small holder farmer in the region incur a total labour cost of approximately Ksh.18, 300.00 (as shown in table 3.5) on an average of approximately one and half (1.5) acre piece of land. In details, a farmer incurs approximately Ksh.7000.00 on land preparation, Ksh.4800.00 on weeding and Ksh.6600.00 on crop harvesting as shown in table 5.4. However, to get the gross margin that a small holder farmer earns out of the crop farming, the costs were subtracted from the revenue as indicated in table 3.6 below.

Table 3.6: Distribution of average costs and revenue generated from crop farming in the region

	Total variable costs	Total labour costs	Total cost of farming	Total revenue	Gross margin
N	379	189	189	189	189
Mean (Ksh.)	23,100.09	18,338.62	41,438.71	103,290.13	51851.42
Std. Error of Mean	11.2003	7.0842	15.0344	31.7297	20.4061

Keeping other factors constant, the study reveals that majority of farmers use a total cost of Ksh.41, 400.00 in growing crops in a season and gains a profit of approximately Ksh.51900.00 out of the yields as detailed in table 3.7 above. Note that every farmer incurs input variable costs but only those who use hired labor do incur labor costs. In addition that, farmers practicing intercropping also cut on labour and fertilizer costs because intercropped crops are weeded once at ago and fertilizer application is also done once.

The study also used scatterplot fitted with the best line of fit to show the relationship between Crop Diversification on the cost of farming (see figure 2).

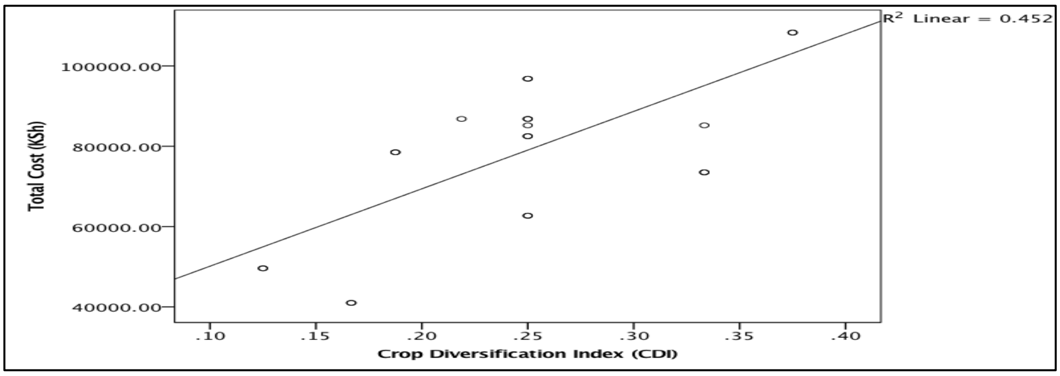

Figure 2: Scatterplot between Crop Diversification on the cost of farming

The scatterplot in figure 2 shows a linear relationship between crop diversification index and the cost of farming. The line of best fit is in the positive direction; an indication that an increase in the CDI leads to an increase in the cost of farming. Since the CDI is inversely proportional to the magnitude of crop diversification, our results in figure 2 implies that the cost of farming reduces with an increase in the magnitude crop diversification.

To find out if diversification of subsistence food crops does influence the cost of crop farming in the region, farmers' awareness on the impact of crop diversification on the cost of crop farming was sought. Their responses were as indicated in table 3.7 below.

Table 3.7: Farmers' awareness on the impact of crop diversification on the cost of crop farming

Number of crops planted in a season		Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Total
One crop	Count	0	0	4	1	0	5
	Row N %	0.0%	0.0%	80.0%	20.0%	0.0%	100.0%
More than one crop	Count	246	100	24	0	0	370
	Row N %	66.5%	27.0%	6.5%	0.0%	0.0%	100.0%
Total	Count	246	100	28	1	0	375
	Row N %	65.6%	26.7%	7.5%	.3%	0.0%	100.0%

From table 3.7 above, none of the farmers who plant one crop does realize that crop diversification minimizes farming expenses per given crop season. Of all the valid sampled farmers (375), a significant proportion of them, 7.5%, do not realize the same impact of crop diversification on the costs of crop farming. However, the study reveals that planting more than one subsistence food crop on the same piece of land actually reduces the general cost of crop farming as shown in table 3.7 above. This is evident by the 65.5% of the responses who strongly agreed that crop diversification reduces the cost of farming.

Secondly, the relationship between crop diversity and input variable costs was done and the results were as shown in table 3.8 below.

Table 3.8: Correlation Analysis crop diversification and the cost of farming

		Crop Diversification Index (CDI)	Total Cost (KSh)
Total Cost (KSh)	**Pearson Correlation Coefficient (r)**	.672**	1
	p-value	. 001	
	N	22	
**. Correlation is significant at the 0.01 level (2-tailed).			

The results of table 3.8 shows that the Pearson Correlation coefficient (r) was 0.672 with p-value = 0.001< 0.05; this indicates a significant strong positive relationship between Crop Diversification Index (CDI) and the total cost.

However, the hypothesis of the study was;

H_0: Crop Diversity has no significant effect on total cost of farmimg among small holder farmers in Bungoma South Subcounty.

To test the H_0 and achieve the set objective, the study adopted the use of simple linear regression as shown in table 5.7 below.

Table 3.9 Simple Linear Regression of Crop Diversification on the cost of farming

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.672[a]	.452	.424	15437.20365

a. Predictors: (Constant), Crop Diversification Index

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3928224034.855	1	3928224034.855	16.484	.001[b]
	Residual	4766145130.599	20	238307256.530		
	Total	8694369165.455	21			

a. Dependent Variable: Cost of farming

b. Predictors: (Constant), Crop Diversification Index

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		β	Std. Error	Beta		
1	(Constant)	30864.202	12163.080		2.538	.020
	Crop Diversification Index (CDI)	192715.955	47466.606	.672	4.060	.001

a. Dependent Variable: Cost of farming

From the ANOVA results as shown in table 3.9, it is evident that the model well fitted the dataset [F (1, 20) = 16.484, P = 0.001< 0.05]. The model explained 42.4% of the variation in the efficient cost of farming among the farmers in Bungoma South Sub-County (Adjusted R Square = 0.424). The results of coefficients in Table 3.9 show that Crop Diversification had a statistically significantly influence in the cost of farming in Bungoma South Sub-County, (β = 192715.955, t = 4.060, $p=0.001<0.05$); thus we reject the null hypothesis and conclude that Crop Diversification has a significant influence on cost of farming in Bungoma South Sub-County. CDI had a positive standardized beta coefficient = 0.672 in the coefficients results of table 3.9; an indication that a Unit change in the CDI is likely to result to an increase in the cost of farming in Bungoma South Sub-County by 67.2%. Since the CDI is the inverse of the situation of crop diversification, such that lower CDI indicates increased crop diversification (Bhatia, 1965), then we conclude that a decrease in crop diversification indicated by (a positive standardized beta coefficient = 0.672 in the coefficients results of table 3.9) is likely to lead to increased costs of farming in Bungoma South Sub-County and vice versa. Therefore, our regression results imply that increase in the magnitude of crop diversification (lower CDI) by one unit results to a decrease in the costs of farming by 67.2%.

The linear regression model to predict cost of farming in Bungoma South Sub-County given Crop Diversification Index (CDI) was as follows:

Cost of Farming = 30864.202+ 192715.955 CDI

These findings concurs with other researches done globally who postulates that the development of resilient and affordable agricultural systems is especially vital in sub-Saharan Africa (SSA), where many communities depend largely on agricultural products (food, fodder, fuel) for their livelihoods (Altieri, 1999). The majority of farmers here are smallholders owning less than 5 acres (2 hectares) of land (which is likely to be further reduced due to current land fragmentation and unregulated urban center expansion) and practicing "low-resource" agriculture (Altieri, 1999). These farmers are more vulnerable to the overall effects of climate change since they have limited resources to invest in expensive coping strategies (Brenda, 2011). Crop diversification is seen as one of the most ecologically feasible, cost-effective, and rational ways of reducing uncertainties in agriculture especially among small-scale farmers.

CONCLUSIONS AND RECOMMENDATIONS

From the findings of this study, increased diversification of subsistence food crops increased total variable costs but lead to reduced labour costs and some input costs such as fertilizer. This is attributed to the fact that most small holder farmers use family labour and do intercropping. In a addition to that, those that use hired labour and practise crop diversification do minimises labour especially when weeding and fertiliser costs because they do the weeding and fertiliser application at once for all the intercropped plants. This reduces the costs of farming altogether to a small holder farmer. Therefore, since the Sub- County's food insecure population lives in rural areas where many are subsistence producers who may not grow enough to meet their families' needs; embracing crop diversification could be the better option to assist them cut down on farming costs.

Based on this conclusion, the study recommends that, the findings of this study will add to the existing conceptual and empirical evidence that crop diversification influences resilience of agricultural land production. That small- holder farmers in the Sub-County and beyond should embrace crop diversification because it helps reduces costs of farming among the small holder farmers. That the findings will help in shaping a policy framework on crop diversification farming in enhancing the resilience of agricultural land production among smallholder farmers in Bungoma County and beyond.

REFERENCES

1. Altieri, M. A. (1999). The Ecological Role of Biodiversity in Agro Ecosystems. *Agriculture,Ecosystems & Environment*, 74(1–3), 19–31.
2. Nyström, M., Folke, C., & Moberg, F. (2000). Coral Reef Disturbance and Resilience in a Human- Dominated Environment. Trends in Ecology and Evolution 15:413–417.
3. Brenda L. B. (2011). Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental Change. *BioScience*, *61*(3), 183-193.
4. Heal, G. (2000). Nature and the Marketplace: Capturing the Value of Ecosystem Services. Island Press.
5. FAO, (2016).Sustainable Crop Production Intensification; Twenty- Third Session. Rome.
6. Makate, C., Wang, R., Makate, M., & Mango, N. (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change. *SpringerPlus*, *5*(1), 1135.
7. Gautam, Y., & Andersen, P. (2016). Rural livelihood Diversification and Household Well-Being: Insights from Humla, Nepal. *Journal of Rural Studies*, *44*, 239-249.
8. Barrett, B.C., Bezuneh, H., & About, M. (2000). The response of income diversification to macro and micro policy shocks in Cote dÍvoire and Kenya.

9. Asfaw, S., Pallante, G., & Palma, A. (2018). Diversification strategies and adaptation deficit: Evidence from rural communities in Niger. *World Development*, *101*, 219-234.
10. Darnhofer, I. (2010). Strategies of Family Farms to Strengthen their Resilience. *Environmental Policy and Governance*, 20(4), 212-222.
11. Tutwiter, A. (2014). Agricultural Biodiversity: *The Foundation of Resilient FamilyFarms*. Biodiversity International, Rome Italy. Retrieved from www.biodiversityinternational.org.
12. FAO, (2013). Sustainable Crop Production Intensification: Twenty Third Session. Rome.
13. Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural Sustainability and Intensive Production Practices. *Nature*, *418*(6898), 671.
14. Oloo, G. (2013). Evaluation of Climate Change Adaptation Strategies and their Effect on Food Production among Small holder Farmers in Bungoma County, Kenya
15. Wachira, K., Nyangweso, A., Mutunga, J., & Nderitu, J.(2013). Policy Makers Guide to CropDiversification: *The Case of the Potato in Kenya*.
16. Gunasena, H. P., & Pushpakumara, D. K. N. G. (2015). Chena cultivation in Sri Lanka. Shifting cultivation and environmental change: indigenous people, agriculture and forest conservation. Routledge, New York, 199-220.
17. Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*(1), 1-23.
18. Nyström, M., Folke, C., & Moberg F. (2000). Coral Reef Disturbance and Resilience in a Human-Dominated Environment. Trends in Ecology and Evolution 15:413–417.
19. Mugenda, M.O., & Mugenda, A. G. (1999). Research Methods: Quantitative and Qualitative - Approaches. Nairobi: Acts Press.
20. Borg R.W. (1987). Applying Education Research: A Practical Guide for Teachers. New York: Macmillan Publishing Company
21. Coopers & Lybrand. (1993). Factors Affecting the Supply of Capital for Small Company Growth, New Zealand Ministry of Commerce, Wellington.
22. Saunders, A., & Cornett M. M. (2007). Financial Markets and Institutions*: An Introduction to the Risk Management Approach* (3rd Ed.). McGraw Hill.
23. Barker, I. (2008). Challenges and opportunities for improving availability of quality potato seed in Eastern and Central Africa. Paper presented at Global Potato Conference, 9–12 Dec. 2008, CIP. 2011. Tackling the food price crisis in Eastern and Central Africa with the humble potato: Enhanced productivity and uptake through the "3G" revolution Final Project Report of the USAID-funded 3G Project. New Delhi.
24. Robinson, O. C. (2014). Sampling in Interview-based Qualitative Research: A theoretical and Practical Guide. *Qualitative research in psychology*, *11*(1), 25-41.
25. Joppe, M. (2000). The Research Process, as Quoted in Understanding Reliability and Validity in Qualitative Research NahidGolafshani.*The Qualitative Report- 8.*
26. Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). How to Design and Evaluate Research in Education. New York: McGraw-Hill Humanities/Social Sciences/Languages.
27. Nunnally, J. C. (1978). Psychometric Theory (2nd ed.). New York: McGraw-Hill.
28. Croncbach, L.J.(1971).Test Validation in Educational Measurement, R.L. Thorndike (Ed.) (1970) Washington D.C: American Council on Education.
29. Bhatia, S.S. (1965). Patterns of Crop Concentration and Diversification in India "EconomicGeography", 14. p.41-56.