

## FARMER'S ADOPTION OF CROP DIVERSIFICATION IN VARIOUS AGRO ECOLOGICAL ZONES OF EMBU COUNTY

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### Abstract

Crop diversification has and continues to play an important role in promoting climate change adaptation. Moreover, crop diversification reduces the risk crop failure. Despite its importance, very little has been documented on the agro ecological zone perspective. The objective of this study is to investigate the adoption crop diversification by farmers in different agro ecological zones. The study also investigated the factors influencing farmers to diversify their cropping patterns. The study is based on a sample of 96 randomly selected smallholder farming households from different agro ecological zones of Embu County. Data was collected through observation and use of questionnaires. Chi square test was used to analyse farmers' adoption to crop diversification. The results reveal that 57% of the farmers have adopted crop diversification while 43% have not. Additionally, the results divulge different factors that influence crop diversification. Gender and agro ecological zones significantly influence diversification with chi square value and p values of 0.556; 0.456 and 5.270; 0.042 respectively. On the other hand, education level ( $X^2=0.538$ , P value= 0.982), age ( $X^2=0.596$ , P value = 0.891) and land size ( $X^2=0.284$ , P value=0.594) do not influence crop diversification. Based on these findings the study recommends the government to consider undertaking policies that will encourage few farmers who have not adopted crop diversification. Promotion campaigns should also be carried out in order to reduce the spatial variations in adoption of crop diversification across the entire study area.

**Keywords:** Crop diversification, agro ecological zones, household, adoption, small holder farmers, climate smart agriculture

### INTRODUCTION

Adoption occurs when there is need to address a problem (Rodgers, 2003). According to Bwire (2008), adoption is a process that depends on the nature of the innovation, farmers' level of understanding of the innovation and effectiveness of communication systems. Pannel (2006) further stamps this by pointing out that any new innovation carries both risks and opportunities and therefore farmers are likely to try out a new cropping pattern that is less risky and is expected to yield higher benefits. Among the farmers' characteristics, empirical evidence shows that the sex, age, education and perceptions of the farmers are key determinants of adoption (Baumgart-Getz, 2012). A number of farmers have adopted crop diversification. Neltin (1993) noted prevailing diversified cropping systems in various Sub-Saharan locations. A study by Joshi (2007) too showed that Indian agriculture was gradually diversifying in favor of high value commodities in particular fruits vegetables, milk, poultry and fish. Some countries also like Ethiopia have not practiced diversification (Mesfin 2015, Sibhah 2015 and Mussema 2015). More than 2000 farmers in Uasin Gishu County have embraced diversification of high value crops such as coffee, grafted avocados, tissue culture bananas and macadamia in

order to realize economic stability instead of relying solely on maize (Kenya News Agency, 2021).

Different studies including Fittien (2009), Mandal and Bezbaruah (2013) and World Bank (2018) have identified that crop diversification is shaped by various factors within the farming household. These include available inputs such as farm experience, availability of seeds, prices, government policy, access to extension services and household characteristics as well as environmental factors such as climatic and soil conditions. Kankwamba (2012) conducted a study on the determinants of crop diversification in Malawi which used the Herfindahl Index. The agricultural sector in Malawi is highly undiversified, with maize and tobacco being the dominant staple and export crops, respectively. Despite this, the government had since the 2005/06 cropping season implemented the Farm Input Subsidy Program aimed primarily at increasing maize productivity and output. They found that, although crop diversification had deteriorated nationally and regionally, beneficiaries of the subsidy program had become more diversified in their cropping practices.

Farmers diversify their cropping patterns for different reasons. A number of governments in Sub-Saharan Africa have identified crop diversification as being important in climate change adoption strategies. Crop diversification is thought to enhance climate change adaptation in a number of ways: First, by spreading agricultural production has led to crop loss and market conditions (Hahn Riederer and Foster, 2009; Dercon 1996). Secondly, crop diversification entails adopting commercial oriented crops that thereafter increases households' income. (Krupinsky JM, Bailey KL, Mc Mullen MP, Gossen BD, Turkington TK 2002). Finally crop diversification provides agronomic benefits such as differential nutrients uptake and disease management which may stabilize crop productivity in a case of climate change. (King and Hofmockel, 2017). Generally, from the perspective of managing risk and associated vulnerability of rural households, and in some cases from a desire to increase incomes, crop diversification makes sense as a policy goal (Kimenju and Tschirley, 2009). Crop diversification through the cultivation of a diverse collection of crop species and or varieties well suited to local conditions and that meet farmers' preferences make up an important strategy used by farmers in Sub-Saharan Africa to cope with and adapt to socio economic and environmental risks and shocks (Lin, 2011). Bobojonor 2012, Mc Cord (2015) and Huang (2014) have pointed out that farmers diversify their crops to curb risks and negative impacts from extreme weather events. SK Sharma (2005) also found out that diversification towards selection of high value crops including fruits and off season vegetables, compatible with the comparative advantage of the region is suggested as a viable solution to stabilize, raise farm income and increase land productivity. In agriculture, crop diversification is an important instrument for its growth, particularly for food and nutrition security, growth of income and employment, poverty alleviation, judicious use of land, water and other resources, sustainable agricultural progress as well as for sustainable environmental management (Singh 2001, De, 2003).

In Kenya, Ruthenberg and Janke (1985) points out diversification as a pillar in subsistence production. This brings out an important distinction between small holder farmers producing at a subsistence level and those that grow for both subsistence and cash. More specifically are records from Nzoia and Matungu that indicate a wide range of ecologically suitable crops where farmers growing maize commercially particularly on small plots under conventional management regimes are likely to make losses from the investments. Tea farmers' to be specific have been urged alternative crops to avoid frequent complaints about low bonuses (Kenya Fisheries, 2019). Wambugu, S.K and J.T Karugi (2014) have not been left behind either. In their study, they

clearly outline that household in Nyeri and Kakamega counties are diversifying rather than specializing their agricultural activities. Moreover, low agricultural productivity is still a challenge which may be attributed to the limited adoption of crop diversification especially by female farmers (M. Belay and Mengiste, 2021).

In as much as a number of scholars have looked into crop diversification, very little has been documented on agro ecological perspective. Msangya (2015) conducted a study on the influence of agro ecological factors and cultural practices on heifer in trust schemes in Njombe and Shinyanga regions in Tanzania. The study adopted a cross sectional design. Agro ecological factors of interest to the study were attitude, and rainfall patterns (unimodal or bimodal). The study sought to evaluate the influence of these factors on availability of pasture, milk production and income from milk sales, pasture and fodder. These findings showed that both regions Njombe (highlands) and Shinyanga (semi-arid) there was variability in rainfall amounts. Drought, abnormal temperatures and natural disasters have put pressure on sustainable agricultural production. On the other hand, Mugwane (2011) while conducting a study on factors influencing adoption of dairy goats in Meru County, Kenya. He revealed that agro ecological zones had no effect on the probability of dairy goat adoption. With such an evaluation on the past literature, there is controversy on literature concerning the effect of agro ecological conditions on spatial variations on crop diversification, hence the need of this study.

This paper will also look into different factors that influence farmers to diversify their cropping patterns. Some scholars try to explain why it is easier for males to adopt crop diversification as opposed to females. In Nigeria for example, research has shown that some socio-cultural norms and values give control over land and productive resources to men. Men are able to diversify their crops as compared to women (Obisesan, 2014). Benzer (2017) confirms this by saying that women face significant obstacles to achieving equal status with men in terms of land ownership. Gebre (2019) also tried to explore the role of gender-based decision making in the adoption of improved maize varieties. He also found out that the intensity of improved maize varieties adopted on plots managed by male, female and joint decision making households are significantly different. However, there are scholars who have data that shows women stand a chance of adopting crop diversification as compared to men. An example of F.Belay and Oljira (2016) point out that the 85% of the labour force employment with half being women. Deere, Alvarado and Twyman, (2009) also found women in make headed households make production decisions after jointly reasoning out with their spouses.

There is controversy in literature concerning the effect of education on adoption of crop diversification. According to Cramerm, J.S (2003) and Hosmer, D.W and Lemeshow S. (2000) an increase in the level of education increases the probability of diversifying their cropping patterns. The educational attainments of farmers are important for their capacities in the acquisition of this information that is necessary in adopting new idea (Namara, 2013). According to Mwawuli (2016), education has a higher bearing on adoption of new ideas in the sense that farmers have more capacity to internalize information than uneducated farmers. Education of the farmers has been assumed to have a positive influence on farmers' decision to adopt new technologies. This is because the education level of a farmer increases their ability to obtain information relevant to adoption of new idea (Mignouna, Manyong, Rusike, Mutabazi and Senkondo, 2011). Contrary to the above findings other scholars have reported otherwise. Results by Geethu and Sharma (2008) evidence that the degree of literacy can reduce crop diversification. Khanna (2001) also reported insignificant or negative effect of education on the rate of adoption.

A study that touched on sorghum farmers within Guinea as well as Burkina Faso revealed that farmers who are younger stand higher chances at employing new ideas than older farmers (Adesina and Forson, 1995). From this, the younger farmers are seen to adopt crop diversification because of their level of education, their desires in taking up potential risks, as well as the foreseeable long-run plans that they may have compared to the older generation (Akudugu, 2012). On the other hand, the older generation may employ new ideas in view of their access to credit facilities as a result of their long-term capital accumulation (Boateng, 2003). On contrary, age has been

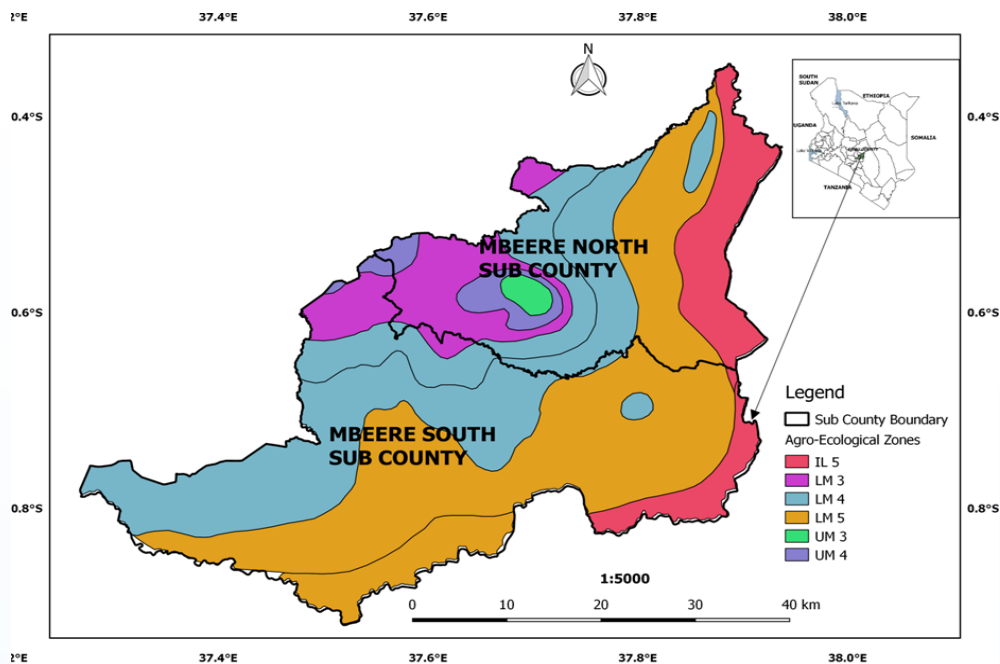
found to have a negative relationship with adoption of crop diversification. This is confirmed by Maurer, Alwang, Norton and Barrera (2005) who stated out that as farmers grow older, there is an increase in risk aversion and a decreased interest in long time investment in the farm. According to a study by Nhembo (2003), older ages may negatively influence adoption of new ideas due to conservatism.

Many studies have reported a positive relationship between farm size and adoption of crop diversification (Uaine and Wiggins, 2009). Bhattacharyya (2008) shows that land is necessary if Indian farmers are to diversify. Infact Birthal (2013) considers that large scale farmers are often better able to bear the risks associated with the production and marketing of high value commodities than small scale farmers. Assefa and Gezaheg (2010) say that each additional hectare of land decreases the probability of farmers' crop diversification by 25.4%. In Kenya, farmers with a larger portion of land would be more likely to allocate land area to a new crop (sugar beet) by reducing the land area of some of their current crops (Mandere, 2011). Such conflicting findings on the adoption of crop diversification calls for further empirical investigation.

## MATERIAL AND METHODS

### STUDY AREA DESCRIPTION

The research was conducted in Embu County that is 120km North-East of Nairobi. Embu County was purposively selected as it is endowed with a number of agro ecological zones. The county is divided into five sub counties namely; Embu West, Embu North, Embu East, Mbeere North and Mbeere South. The study was majorly based on Mbeere North and Mbeere South as shown in the figure below:



**Figure 1: A Map Showing the Area of Study**  
Source: Fieldwork, 2021

**Sampling and data collection**

The study used cluster sampling where the natural agro-ecological areas constituted clusters from which random sampling of farmers was done. To ensure distribution of samples across the wards, proportionate allocation was done. Data was collected from farmers that were randomly picked from IL5, LM3, LM4, LM5, UM3 and UM4. Households were obtained through lists from resident agricultural offices. A sampling technique was used to draw a sample of 96 households. Determination of the sample size was based on the proportionate to size sampling formula. According to the 2019 National Population Census; the cumulative households of the Mbeere North and South were over 10,000. Since the total number of households is greater than 10,000, an ideal sample size was determined using the following formula by Mugenda and Mugenda (2003).

$$n = \frac{Z^2 pq}{d^2}$$

where,

N= the desired sample size (if the target population is greater than 10,000)

Z= the standard normal deviation at the required confidence level (standard value of 1.96)

P=the proportion in the target population estimated to have characteristics being Measured (0.5)

q=1-p

D=the level of statistical significance (per cent margin error)

In the case of the study,

$$n = \frac{1.96^2 \times 0.5(1 - 0.5)}{0.12}$$

n = 96 Sampling size

On sampling 96 households, households were randomly picked from each of the earlier on selected agro ecological zones that is, IL5, LM3, LM4, LM5, UM3 and UM4.

Interviews were administered to different selected households. These households helped to obtain data on whether there are significant variations in crop diversification. This data was obtained on posing question like whether the farmers have adopted crop diversification, if yes what factors triggered them to diversify their cropping patterns. The data included information on the socio-economic characteristics of farmers and comments on agro ecological zones. Farmers were asked to state their demographics (age and gender) and their socio-economic characteristics such as farm size and their level of education.

**Data analysis**

A total of 96 questionnaires were distributed and delivered to the respondents but only 90 questionnaires were filled and returned. This presented 94% response rate which is quite suitable to make a finale for the study. According to Mugenda and Mugenda (2003), a response rate of 50% and above is considered adequate for reporting and analysis, 60% good and 70% and above response is very good for analysis and reporting. SK Sharma (2005) who defines crop diversification as movement towards selection of high value crops. Table 1 shows how the respondents have adopted crop diversification in the selected areas of data collection.

**Table 1: Crop Diversification in Embu**

Do you diversify crops?	Frequency	Percent
Yes	57	63.3
No	33	36.7
Total	90	100.0

Among the 90 farmers that were sampled for diversification, 63.3% of the respondents said that they had adopted crop diversification as a strategy of farming while 36.7% had not yet adopted crop diversification. These findings closely relate with Wambugu S.K and Karugia J.T (2014) that most households are diversifying rather than specializing their agricultural activities. Farmers who were interviewed reported to have introduced crops such as millet and sorghum in their farms. However, there

are farmers who had opted not to diversify as they preferred to use their large tracts of land in growing a single crop in large scales.

**Gender and crop diversification**

This variable was coded with one if male and two if female. Gender and its influence on crop diversification were subjected to the chi square as shown in the table 2.

Gender	Female				Male				X <sup>2</sup>	df	p
	Yes	%	No	%	Yes	%	No	%			
	31	34.5	4	4.4	35	38.9	20	22.2	.556	1	.456

The data obtained on table 2 above, it is therefore right to say that the gender of the household significantly influences the decision on whether the farm would adopt crop diversification (X<sup>2</sup>=0.556, P=0.456). The findings align with Lin (2011) who believes that gender differences in planting of diverse crops are affected by multiple crops including attitudes towards crop diversification.

women and the elder to manage small farms and therefore can switch to crop diversification as a cropping pattern.

Of the value of 35 females who were interviewed 4 of them had not adopted diversification in their cropping patterns. On the other hand, 20 males out of 55 had not diversified their crops. From the analysis above, males diversified as compared to females. This could be explained by a number of reasons. To begin with, in most farms the decision on the crops to grow and the cropping pattern was majorly made by the males. This aligns with earlier findings by Benzer (2017) that women face significant obstacles to achieving equal status with men in terms of land ownership. However, these findings contradict those of Li (2020) that given the high demand for labour, many male and young farmers have immigrated to urban areas living

Many females who were house heads had opted to grow multiple crops in their farms as they were mainly growing for food consumption. Males on the other hand, had stuck to a single crop as most of them were into the business of growing crops that are cash oriented thus many of them grew crops on large scale. Few scholars have put gender into consideration when analysing its impact on crop diversification. For instance, a study by Food and Agricultural Organization 2016 indicates that smaller holder female-headed households diversify significantly less compared to man-headed households. This therefore conflicts with the above results thus calls for further research.

**Education and Crop Diversification**

Farmers were expected to comment on their level of education which was later used to determine whether it influences their decision on their cropping patterns. This data is represented in the table 3

**Table 3: Influence of Education Level on Crop Diversification**

Education level	Yes	%	No	%	X <sup>2</sup>	df	p
Tertiary level	16	17.8	3	3.3			
Secondary level	21	23.3	4	4.4			
Primary level	20	22.2	14	15.6			
Other	9	10	3	3.4			
Total	66	73.3	24	26.7	.538	1	.982

From the data on table 8 above, was no significant relationship between education level and their cropping patterns ( $X^2=0.538$ ,  $P=0.982$ ). This is contrary to research that has been made on the effect of level of education on crop diversification. This is because few researchers have mentioned that the likelihood of farmers' participation in crop diversification increases with an increase in farmers' level of education. Education contributes to increased awareness of varieties of high yielding crops. Besides, it effectively improves the prospects of crop diversification by boosting the ability to absorb new information related to crop diversification and especially the complex art of management of diversified crop systems. These results correlate with previous studies done by Cramerm, J.S (2003) and Hosmer, D.W and Lemeshow S. (2000) who observed that education significantly and positively influenced farmers' participation in diversified farming. These findings contradict with

Geethu and Sharma (2008) who evidence that the degree of literacy can reduce crop diversification. The data further contradicts with Mwawuli (2016) who believes that education has a higher bearing on adoption of a cropping pattern in the sense that educated farmers have more capacity to internalize information than uneducated farmers.

On the other hand, these results relate with Ngulu (2014) who states that there is a negative relationship between adoption of improved mango varieties because whose education level is below secondary level adopt more. According to table 3, farmers who have levels of education of secondary and primary levels of education have a high diversification of 23.3% and 22.2% respectively. This finding particularly on the secondary level contradict with Bett (2006) who noted that education could lead to a household having more occupations thus have less time to attend to farm activities.

### Age and crop diversification

Moreover, age was also computed against crop diversification as in the table 4 below:

**Table 4: How Age Influences Diversification**

Age	Yes	%	No	%	$X^2$	df	P value
30-40	13	14.4	4	4.4			
41-50	14	15.5	7	7.9			
51-60	25	27.7	6	6.7			
61-70	14	15.5	7	7.8	.596	1	.891

Referring to table 4 ( $X^2=0.596$ ,  $P=0.891$ ) it can be deduced that there is no relationship between the age of the farm manager and the decision to diversify their cropping patterns. This contradicts the findings by FAO (2012) that young farmers may be more inclined to look at farming as a business opportunity for family sustenance thus may diversify more. From the data in table 9 it is clear that farmers aged 51-60 had the highest diversification rate of 27.7%. These findings contradict with FAO (2012) that young farmers may be more inclined to look at farming as business opportunity for farming sustenance thus may diversify more. Findings by Lighton (2016) also contradict this finding as he pointed out that farmer' risk bearing ability reduces as his or her age increases. However, the findings

align with Boateng (2003) who said that older generation may diversify due to their access to credit facilities as a result of their long term capital accumulation.

The tabulated data also shows that the younger farms had the least level of diversification. This data contradicts with Sidibe (2005) who outlined that young farmers in a society have a greater chance of absorbing and applying new knowledge and thus are better placed for adoption.

### Land size and crop diversification

Data on the size of the lard of the farmers was computed against the decision to diversify just as shown in the table 5 below:

**Table 5: How Land Size Influences Crop Diversification**

As shown in table 10 above ( $X^2=0.284, P=0.594$ ) it can be deduced that land size does not influence the decision of a farmer to diversify. Most farmers with large tracts of land who were interviewed had opted to grow single crops. Actually, most of them were miraa farmers as opposed to them that small portions of land had wanted multiple options in case of a failure of certain crop. These results contradict with earlier study by Bhattacharyya (2008) who alluded that land is necessary if farmers are to diversify. This data however, correlates with Assefu and Gezaheg (2010) who said that each additional hectare of land decreases the probability of farmers by 25.4%. This data however, does not match with Solomon Y, Andrias O (2018) whose research states that farmers with large sized farms are likely

to adopt new cropping pattern as they can afford to devote part of their land for such without necessarily suffering losses.

**Agro ecological zones and crop diversification**

An agro ecological zone is an area of a land that is defined in terms of climate, landform and soils having a specific range of potentials for land use. Crop diversification was investigated from one agro ecological zone to another as shown in table 6 below. Thereafter agro ecological zones were computed against the diversification as shown in the table 6 below:

**Table 6: Crop Diversification across Agro Ecological Zones**

Agro ecological zone	Yes	%	No	%	$X^2$	df	P value
Lower Midland 3	14	26.9	7	18.4			
Lower Midland 5	32	61.7	8	21.1			
Upper Midland4	1	1.9	6	15.8			
Upper midland 3	2	3.8	7	18.4			
Lower Midland 4	2	3.8	6	15.8			
Inland Midland 5	1	1.9	4	10.5	5.270	2	.042

There is a significant relationship between agro ecological zones and the decision to diversify ( $X^2=5.270, p=0.042$ ). This data matches a few scholars who have tried to measure crop diversification in an agro ecological perspective. For example, Msangya (2015) pointed out that farm characteristics such as soil properties, access to irrigation water and agro ecological conditions of the area where the farm is located have been found to affect adoption. Mugwane (2011) who also conducted a study on factors influencing adoption of dairy goats in Meru County doesn't agree with the above finding. He concluded that agro ecological zones have no effect on the probability of adoption. From the data above too, LM 5 had the highest level of diversification. Few farmers who were interviewed attributed the decisions to diversification to favorable climate. This will add to the body of knowledge as very few researchers have commented on the influence of agro ecological zones on crop diversification.

**Conclusion**

Ffarmers' adopted of crop diversification in various agro ecological zones of Embu County. Education level of the farmer, age and land size did not account for the adoption of crop diversification as a cropping pattern. Gender and agro ecological conditions had relationship with crop diversification that was statistically significant. The study revealed that education had no significant influence on adoption of crop.

**Recommendation**

Drawing from the research findings and conclusions discussed herein, the study a recommendation that government, extension officers, farmers and other stakeholders can organize trainings on the significance of crop diversification in farming so as to have more members adopting crop diversification.

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