Influence of Agro-Ecological Zones on the Application of Extension Approaches in Kenya

W.A. Ochola[1], P.O.[2] and Osewe, D.O.[3]

1. Department of Agricultural Extension and Education, Kisii University, P. O. Box 408 Kisii, Kenya, Email; woadede@gmail.com

2. Department of Animal Science, School of Agriculture and Food Security, Maseno Univiersity, P.O. Box 333 - 40105, Maseno, Kenya, Email: olwandepo@yahoo.com

3. Department of Extension Education, Mahatma Phule Krishi Vidyapeeth (Agricultural University), Rahuri – 413 722, India

Corresponding author: Tel: +254722630849; +91 74209 31062; Email: danosewe@gmail.com

ABSTRACT

The effectiveness of agricultural extension approaches in improving farming practices among smallholder farmers depend on different aspects. This study assessed the influence of Agro Ecological Zones (AEZ) on implementation of agricultural extension approaches implemented by agricultural institutions among smallholder farmers. A cross-sectional survey that combines both quantitative and qualitative data collection methodologies was used to gather relevant information on extension approaches used among the smallholder farmers in different Agro Ecological Zones (AEZ). The study sampled out 12 agricultural institutions operating within the six counties of the former Nyanza province: Kisii, Nyamira; Migori; Homa-bay; Kisumu and Siaya. A multi stage random sampling technique was used to identify a total sample size of 492 respondents comprising; 12 key informants, 120 agricultural extension personnel and 360 farming household heads. AEZ positively influenced the implementation; number of groups of persons participating in identifying the most dominant extension problem; those involved in coming up with the purpose; level of education of extension agents; reward to extension agents; the frequency of extension agents visit to farmers. Agro ecological zone negatively influence, number of groups of persons involved in programme planning and number of extension agents representing a given number of smallholder households.

Keywords: *Smallholder farming practices; Agro-Ecological zones; Extension approaches; Agricultural institutions.*

INTRODUCTION

In Kenya, Agriculture is the mainstay of the economy, contributing up to 26% of Gross Domestic Product (GDP) directly, and 27% indirectly through linkages with manufacturing, distribution and other service-related sectors . The sector also accounts for 65% of Kenya's total exports and provides more than 18% of formal employment and more than 80% of informal employment is in the rural areas . More than 80% of Kenya's population live in rural areas and entirely depend on rain-fed smallholder agricultural practices . This group of farmers accounts for 75% of total agricultural produce and 70% of total marketed produce in Kenya (Government of Kenya, 2009). Therefore, improving the productive capacity of these smallholder farmers through effective extension systems not only improves their food security and livelihood but also contributes towards national economic growth. There has been however, a decline in the productive capacity of the smallholder farmers in Kenya and the decline is attributed to ineffective smallholder extension services (FAO, 2012 and 2015).

Agricultural extension can be defined as a service or system which assists farm people, through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, bettering their standard of living and lifting social and educational standards . Agricultural extension not only provides smallholder farmers with information on improved and better farming systems, but also provides mentorship and guidance.

Smallholder farmers in Africa can be

categorized depending on; the agro-ecological zones they operate in; their socio economic status in terms of capital invested and size of land owned; or annual revenue generated from farming activities. An agro-ecological Zone is a land resource mapping unit, defined in terms of climate, landform and soils, and/or land cover, and having a specific range of potentials and constraints for land use . Jaetzold, Schmidt, Hornetz, and Shisanya, (2009) identifies the essential elements used in defining the agro-ecological zones as the temperature regime, growing period, and soil attributes.

Kenya is divided into seven major AEZs in terms of temperature regimes including Tropical Alpines (TA) Upper Highland (UH) Lower Highland (LH) Upper Midland (UM) Lower Midland lowland (LL) and Coastal Lowland (CL). Each of the seven AEZs are further divided into at least five sub-zones in terms of other climatic factors such as precipitation, growing period, land cover, soil type and landform.

In high potential areas, smallholder such as UH or LH farmers own and use less than one hectare of land, which may increase up to 10 ha or more in low potential semi-arid areas. They may also include livestock production of up to 10 animals . Smallholder farmers' production range from subsistence farming (those producing for family consumption) to those whose annual income from farming activities reach up to Ksh. 500, 000 in developed countries . Family is the main centre of operations, planning, decision-making and implementation in smallholder farming systems.

Although Kenya experienced improved growth of the agricultural sector after the year 2000 with the formulation of the National Agricultural Extension Policy (NAEP) with the objective to support participatory and pluralistic approach to extension delivery , thereby bringing on board many players. This sectorial growth after 2000 does not match the growth of smallholder agriculture. The growth is attributed to highly commercialized agriculture in medium to large scale agricultural production while small holder agricultural production continues to decline .

On the other hand, the decline in the smallholder contribution to agricultural growth has been largely attributed to ineffective agricultural extension and innovation, climate change and variability, poor infrastructure, access to input and output markets, access to credit and agricultural financing, and land tenure and access . While focusing on the ineffective agricultural extension and innovation systems, it would be worthwhile discussing how the Kenyan extension system is applied under different Agro Ecological Zones. This study therefore assessed the influence of AEZ on the implementation of agricultural extension approaches by various agricultural institutions.

METHODOLOGY

A cross-sectional survey that combines both quantitative and qualitative study approaches was used to gather relevant information on extension approaches as applied by various institutions in different AEZs.

The study was conducted within the geographical mandate area of 12 agricultural institutions located in six counties: Nyamira, Kisii, Homa-bay, Migori, Kisumu, and Siaya counties. These counties are located in South Western part of Kenya. The area has a total population of 5,442,711 persons comprising 1,186,398 households, with 43% of them living below poverty line as per the 2009 censors Kenya National Bureau of Statistics (KNBS) 2010) .

This study used a proportionate stratified random sampling method to select at least 12 institutions engaging in agricultural extension spread across the 6 counties. The agricultural institutions were grouped according to the agricultural extension approaches they use to disseminate the agricultural technologies. The agricultural extension approaches include: Commodity Extension Approach; Private -Profit Institutions; Farming Systems Research Extension

Approach; Input Suppliers Approach; Project Extension Approach; and Government Extension Approach. At least ten agricultural extension officers affiliated to each institution were randomly identified and interviewed. Three farmers affiliated to each agricultural extension officer were also randomly identified and interviewed. This brought a total of 30 farmers per agricultural institution. At least one key informant was identified from each agricultural institution resulting into a total of 12 key informants who were mainly the top managers of agriculture in the respective institutions. A total sample size of 492 respondents comprising; twelve key informants, 120 agricultural extension personnel and 360 farming household heads were interviewed. AEZ was not considered in the sampling frame, however the agricultural institutions, farmers and the extension agents were asked to indicate their AEZs.

Desk top reviews, key informant interviews and focus group discussions (FGDs) guided by checklists were used to gather qualitative data. Structured questionnaires were used to collect quantitative data from 120 farming households. One FGD was organized involving the 10 extension workers, and another 2 FGDs made up of at least 10 smallholder farmers affiliated to each agricultural institution was conducted A total of 36 FGDs (12 for extension workers and 24 for smallholder farmers) made up of at least 10 participants were conducted. Hence a total of 120 extension workers and 240 smallholder farmers took part in the FGDs. The study triangulated the information collected from both the extension personnel and farming households by collecting information from the 12 key informants and focus group discussion (FGD) organized for each group of farmers and extension agents from each agricultural institution.

Data were analyzed using both descriptive and inferential statistics. For inferential statistics, Analysis of Variance (ANOVA) was used to test significant differences at 0.05. Where there was significant difference, Tukey post hoc test was used to distinguish the differences among groups of institutions implementing the extension approaches.

FINDINGS AND DISCUSSION

Difference in approaches as applied by institutions in various agro ecological zones

The study found out that there were significant differences in the application of extension approaches by agricultural institutions in different AEZs as presented in Table 1.

Identification of the most dominant problem to be solved by the extension approach

Participation of different stakeholders in situations analysis, diagnosis, programme formulation, and priority setting enhances technology uptake and adoption. A research conducted by on research-extension-farmers linkage system on banana and plantain (Musa spp.) in Nigeria, indicated that farmers productivity improved more when there was a joint problem identification. However, Various stakeholder participation in different stages of extension program development could be influenced by various factors such as socioeconomic variables and climatic conditions . The study therefore looked at the influence of AEZ on level of participation of different stakeholders on problem identification.

Analysis using Tukey post hoc test on who participates in identifying the most dominant problem to which the approach is applied as a strategic solution by agro-ecological zone indicated that, at Lower Midland 3-5 AEZ, an average of two group of persons (institutional staff and farmers) were involved the identification of the most dominant problem to which the approach is applied as a strategic solution. While at the Upper Midland 1-2, institutional staff, farmers, Subject Matter Specialist (SMS) and other stakeholders were involved in identifying the most dominant problem to which the approach is applied as a strategic solution.

Table 1
ANOVA results on different aspects of extension approaches on agro-ecological zones

Sr. No.	Extension Approach Aspects	ANOVA	
		F	Sig.
1	Who were involved in the identification of the dominant problem to which the approach is to be applied as a strategic solution	49.284	.000
2	Rate target group participation in coming up with purposes the approaches are designed to achieve	10.367	.000
3	Who are involved in the extension programme planning	15.816	.000
4	Frequency of conducting the planning meetings	2.654	.023
5	The general level of education of extension agents involved in the extension programme	3.438	.006
6	How well the extension agents involved in the extension programme rewarded	4.785	0.0001
7	The distribution of the programme extension agents in the programme location	21.980	.000
8	Ratio of female to male extension agents	1.954	.085
9	Frequency in which the extension agents working in the programme transferred to different location	1.004	.415
10	Frequency of refresher training to the extension agents working the programme	4.452	.001
11	Level of funding available to achieve the set extension programme objectives	9.229	.0001
12	Frequency in which the extension agents meet farmers	10.195	.000

A further analysis using spearman rho correlation coefficient two tailed test indicate that there is a strong positive relationship (rs=0.620, p value = 0.0001) between the Agro-ecological zone and number of group of participants involved in identifying the most dominant problem to which the approach is applied as a strategic solution. This means that the higher one get up the agro-ecological zone the more the number of the group of participants involved in identifying the most dominant problem to which the approach is applied as a strategic solution. This finding conforms the earlier finding by Ochola Basweti, Ogendi, Onyango and Ochola (2014) on the level of participation of researchers, extension agents and farmers on on-farm research trails conducted in Kisii - Kenya, indicating a relationship between participation and agro-ecological zones.

Participants involved in coming up with purposes of the extension approaches

One of the key characteristics of an agricultural extension approach is the process of identifying the key extension purpose, of which the number of different stakeholders involved in the process is pertinent. As indicated earlier, participation of different stakeholders in the initial stages of extension program development, improves technology uptake and adoption. However, participation of these stakeholders could be influenced by various factors such as AEZ. The study analysed the influence of AEZ on the number of group of different stakeholders participating in identifying extension purpose.

A Tukey post hoc test result indicated that, extension approach as applied in the lower midland 1 AEZ, involved at least two groups of participants (farmers and institutional staff) in designing the extension purpose. While, extension approach as applied in the lower midland 3-4 involved an average of four group of persons (institutional staff,

farmers, SMS, and other stakeholders) in designing the purpose of extension purpose.

Further analysis using spearman rho correlation coefficient (two tailed test) indicated that, there was a weak positive correlation (rs= 0.269, p value = 0.0001) between the mean number of groups involved in designing extension purpose and AEZs. This means that the higher the AEZ, the extension approach involves more groups of persons in designing extension purpose.

Participants involved in the extension programme planning

Success of any agricultural extension program largely depends on its program planning process. Involving different stakeholder during this crucial stage is as important as conducting the process. How, the process is conducted and the number of groups of persons involved is used as a distinguishing feature of Agricultural extension approaches. The number of persons involved in the program planning process could be influenced by other factors such as AEZ. Therefore, the study analysed the influence of AEZ on the number of group of persons involved in program planning process.

Tukey post hoc test on the number of group of persons involved in planning extension program and extension approach as applied in different agro-ecological zones indicates that, extension approaches as applied in the lower midland 1 AEZ, involved an average of one group of persons (farmers or institutional staff) in extension programme planning. While the agricultural extension approach as applied in the lower midland 3-5 involved up to an average of four group of persons in planning extension programme.

Further analysis using spearman correlation coefficient (two tailed) test resulted into a weak negative correlation (rs= -0.154, p value =0.0001). This Means that the average number of group of persons participating in program planning reduces as one moves to higher AEZs. This is in line with the argument that farmer participation is influenced by their situation . However, it conflicts in the direction of the level of farmers' participation. As most publications indicate that the level of stakeholder participation in extension increases with the increase in farmers' situation, this finding provides the reverse. This could be unique because it singled out only stakeholder participation in planning process of agricultural extension program. Which according to agricultural extension programs rarely involved different stakeholders including the target group in the early stages of extension programme planning.

Frequency of conducting extension programme planning meetings

Frequency of conducting extension program planning meetings is also a key factor in distinguishing extension approaches. More planning meetings provide the participants the opportunity to review the plans for better result delivery. The frequency of conducting planning meeting is dependent on several factors such as availability of all the stakeholders, socio-economic factors, institutional factors and many more. The study analysed the frequency of holding planning meetings as conducted in different AEZ.

Agricultural extension approaches were applied significantly differently (F= 2.654, p value 0.023) in different AEZs in terms of the frequency at which different stakeholder involved in the extension programs hold their planning meetings. Tukey post hoc analysis result indicate that extension stakeholders implementing extension approaches in upper midland 3-4 hold their planning meetings at least every six months which was significantly different with frequency at which extension stakeholders implementing extension approaches in lower highland AEZ, who hold their planning meetings at least annually or when it is very necessary. However, there was no significant difference in the frequency at which stakeholders in the other AEZs hold their extension programme planning meetings.

Analysis by Spearman correlation coefficient result indicates that, there was no significant

correlation (rs= -0.036 p value =0.497) between the frequency of holding extension program planning meetings and AEZs. Meaning the frequency of holding extension program planning meetings does not follow any pattern in relation to AEZs.

General level of education of extension agents involved in the extension programme

Level of education of extension workers is considered to be one of the most important factors in determining the effectiveness of extension workers. The study analysed the education level of extension workers in different AEZs. There was a significant difference (F= 3.438, df = 119, p value = 0.006) on the general level of education of extension agents implementing extension approaches in different AEZs. Tukey post hoc analysis result indicate that, extension agents implementing extension approaches in the lower highland AEZ were significantly more educated than the extension agents implementing extension approaches in lower midland 1 and lower midland 2 AEZs. Further interrogation revealed that, the extension agents in the high potential areas were able to upgrade their studies to meet the challenges they are exposed to daily and also that they were highly motivated by the farmers they interact with in the course of their work.

Analysis by Spearman correlation coefficient (two tailed test) result indicated that, there was a weak positive correlation (rs =0.294, p value = 0.001) between the level of education of extension agents and AEZs they work in. This could also be explained by the fact that extension agents implementing agricultural extension approaches at higher AEZs are more motivated and face challenges that would motivate them to further their education. This finding is also supported by research conducted on Integrated pest management in Honduras by Wyckhuys and O'Neil (2007) .

Institutional reward system for agricultural extension agents

Reward has been considered one of the most important factors influencing the productivity of extension agents or any other employee . The other factor that could also influence the performance of agricultural extension agents is the farmers' response. Farmers in different AEZs could reward agricultural extension agents by responding differently to agricultural advice. The study therefore analysed the influence of AEZs on perceived rewards to agricultural extension agents.

There was a significant difference (F = 4.785, p value = 0.0001) on how the agricultural extension agents implementing extension approaches in different AEZs are rewarded. Tukey post hoc test result indicate that, extension agents implementing extension approaches in lower midland 2 AEZ is significantly rewarded lower that the agricultural extension agents implementing extension approaches in upper midland 3-4 and lower highland AEZs.

Analysis using spearman correlation coefficient results indicate that, there is a week positive correlation (rs=0.200, p value = 0.0001) between the rewards for the extension agents implementing extension approaches and AEZs. That is the higher the AEZ the higher the reward. This conforms the earlier finding that extension agents implementing extension approaches in the lower highland are significantly more educated than those implementing the extension approaches in lower midland 1 and 2 AEZs. Further analysis using spearman correlation coefficient indicate that there is a weak positive correlation (rs=0.229, p value = 0.0001) between level of education of extension agents and their reward systems. It can therefore be argued that the extension agents implementing extension approaches are rewarded according to their level of education.

Distribution of the programme extension agents in the programme location

The work load of agricultural extension agents can be determined by the number of households they are supposed to reach. Others determine the work load in terms of the geographical area the extension agents are supposed to cover. However, the population density of Kenya is largely

dependent on AEZ. ANOVA result indicated a significant difference (F=21.980, p value = 0.0001) in the distribution of extension agent per given number of households by AEZs. A Tukey post hoc analysis indicated that, upper midland 3-4 and upper midland 1-2 had a significantly higher number of extension agent per given number of households compared to the other AEZs. Spearman correlation coefficient two tailed test result indicates a weak negative correlation (rs= -0.241, p value = 0.0001) between the agro ecological zones and number of extension agent per given number of household. This means that the higher the AEZs the lesser the number of extension agents representing a given number of households. A further inquiry into the matter reveals that the extension agents are employed as per the region not the number of households covered. Population density of the households are higher at high agro ecological zone, that means that a given area in terms of size in a higher AEZ will have more households than the same area in a lower AEZ Kenya National Bureau of Statistics (KNBS), 2010).

Frequency of refresher training to the extension agents working the programme

ANOVA result indicates that there is a significant difference in the frequency at which extension agents implementing extension approaches in different AEZs are retrained (refresher trainings) (Table 1). A Tukey post hoc test results indicate that, extension agents implementing extension approaches in upper midland 1-2 are retrained significantly more frequently compared to extension agents implementing the extension approaches in upper midland 3-4, lower midland 3-5 and lower highland. Spearman correlation coefficient two tailed test indicate that, there was no significant correlation between the AEZs and the frequency of refresher training for agricultural extension agents implementing extension agents in the zones. This means that the frequency of refresher training provided to extension agents implementing extension approaches follow no pattern. The refresher trainings are provided to the extension agents when it is necessary. This conflicts with the earlier findings that extension agents implementing extension approaches in higher AEZs are significantly more educated. However, it can be argued that more education of the extension agents implementing extension approaches in higher AEZs is absolutely their individual efforts to better themselves, while refresher trainings are organized by the institutions to improve service delivery.

Level of funding available for extension programs

As indicated in Table 1, the ANOVA result (F= 9.229, p value = 0.0001) indicates that there was a significant difference in the level of funding available to implement extension approaches in different AEZs. A Tukey post hoc test result indicates that, extension approaches as implemented in upper midland 3-4 had significantly lower funding available, than lower midland 1 with significantly moderate funding available and lower highland with significantly higher funding available for the implementation of the extension approaches. Spearman correlation coefficient two tailed test indicated that, there was no significant correlation between the AEZs and funding available to implement extension approaches. This means that availability of funding do not depend on the AEZs.

Frequency at which the extension agents meet farmers

ANOVA result (F=10.195, p value =0.0001) indicates that, there was a significant difference in the frequency at which extension agents implementing extension approaches in different AEZs meet their farmers (Table 1). A Tukey post hoc analysis indicates that, extension agents implementing extension approaches in lower highland visited their farmers significantly more frequently compared to extension agents implementing extension approaches in the other AEZs. Analysis using spearman correlation coefficient two tailed test indicated that, there was a weak positive correlation (rs=0.224, p value =0.0001) between the frequency at which extension agent visit their farmers and AEZ. This could mean that the extension agents in higher AEZs visit their

farmers more frequently compared to extension agents implementing extension approaches in lower AEZs. This confirms the earlier results indicating that, more groups of persons participate in designing extension purpose in the higher AEZs as compared to the lower AEZs. This supports the argument that there are more agricultural activities in the higher AEZs thus forcing the extension agents to be more visible compared to the lower AEZs (Agrell, Stem and Fischer, 2004; Seo, 2014; GOK, 2006) .

Difference in Improved agricultural practices by the small holder farmers by AEZs

The level at which the farming households were able to improve their agricultural practices was used to determine the performance of agricultural extension. ANOVA result (F=37.791, p value = 0.0001) indicated that there was a significant difference in the level of improved of agricultural practices by farmers in different AEZs (Table 2). This could mean that agricultural approaches as implemented by agricultural institutions in different AEZs resulted in the farmers improving their agricultural practices at different levels.

Influence of AEZs on the level of improved agricultural practices by small holder farmers

Spearmen correlation coefficient two tailed test was used to determine the correlation between the level of improved agricultural practices as implemented by small holder farmers and AEZs. The test result (rs= 0.568, p value = 0.0001) indicated that, there was a significant positive correlation between AEZs and the level of improved agricultural practices as implemented by the farmers in these AEZs. This, therefore means that the AEZs influenced the way the agricultural approaches were implemented which in turn influenced level of improved agricultural practices by the farmers in these AEZs. That is the higher the agro ecological zone the more the small holder farmers improved their agricultural practices.

Table 2
ANOVA results of improved agricultural practices by farmers in different AEZs

Particulars	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	641.828	5	128.366	37.791	.000
Within Groups	1202.436	354	3.397		
Total	1844.264	359			

Table 3
Tukey post hoc test result on level of improved agricultural practices by small holder farmers in different AEZs

AEZ	N	Subset for alpha = 0.05		
		1	2	3
Lower Midland 3-5	40	3.825		
Lower Midland 2	70	4.029	4.029	
Lower Midland 1	90		5.022	
Upper Midland 1-2	80			6.813
Upper midland 3-4	40			7.100
Lower Highland	40			7.225
Sig.		.993	.063	.858

CONCLUSION

It can therefore be concluded that, agro ecological zone influenced the way agricultural institutions implemented the extension approaches. Agro ecological zones positively influenced the implementation of the following aspects, number of group of persons participating in identifying the most dominant extension problem; the number of group of persons involved in coming up with the purpose of extension approaches; level of education of extension agents implementing extension approaches; level of reward provided to extension agents implementing the extension approaches; the frequency at which extension agents implementing extension approaches visit their farmers. Agro ecological zone negatively influence the number of group of participants involved in extension programme planning and number of extension agents representing a given number small holder households.

Due to these influences on the implementation of extension approaches, agro ecological zones influenced the output of the extension approaches by influencing the level at which small holder farmers were able to improve their agricultural practices. The finding of this study could be related to finding of other studies on the effect of agro – ecological zones on agricultural productivity such as.

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