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Assessing the Effectiveness of Selected Aspects of Extension Approaches Across Different Agro Ecological Zones

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: Understanding how different agricultural organisations implement extension approaches across different Agricultural Ecological Zones is very critical for the success and impact in agricultural sector. This paper therefore assessed the effect of Agro-Ecological Zones on implementation of agricultural extension approaches to provide an insight into how to improve dissemination of improved technologies.
Study Design: A cross-sectional survey combining quantitative and qualitative data collection methodologies was used.
Place and Duration of Study: The study was conducted in six counties of western Kenya: Nyamira, Kisii, Homa-bay, Migori, Kisumu, and Siaya counties. The study was conducted between September to December 2019.
Methodology: 12 agricultural institutions within the study area were sampled. A multi stage random sampling technique was used to identify 492 respondents comprising; 12 head of agriculture in the

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institutions, 120 extension personnel and 360 household heads across different Agricultural Ecological Zones (AEZs). Data was analysed using both descriptive and inferential statistics. The inferential statistics were set at the 0.05 level for significance. Kruskal Wallis test and Dunn-Bonferroni Post Hoc test were used to test significant differences on the implementation aspects of the extension approaches across the different AEZs.

Results: Climatic conditions, average age, land size, and value of household assets as factors of AEZs influenced how various aspects of agricultural extension approaches were implemented. Level of implementation of aspects influenced uptake of agricultural technologies. Kruskal Wallis test result (H (5) = 126.679, p value < 0.001) indicated that there were significant differences in the level at which smallholder farmers improved their agricultural practices in different AEZs.

Conclusion: For effective dissemination of agricultural technologies, farmer situation, specifically agro ecological zone must be taken into consideration when recommending extension dissemination approaches to be used. Multivariate analysis needs to be done to inform how to implement various aspects of extension approaches to achieve optimum results in terms of farmer behaviour change.

Keywords: Agro ecological zones; extension approaches; technology uptake.

1. INTRODUCTION

Improving the productive capacity of smallholder farmers through effective extension systems not only improves their food security and livelihood but also contributes towards national economic growth [1]. There has been however, a decline in the productive capacity of the smallholder farmers in South Asia and Sub-Sahara Africa which has been attributed to ineffective smallholder extension services [2].

Agricultural extension is 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 [3]. It does not only provide smallholder farmers with information on improved and better farming systems, but also provides mentorship and guidance through extension approaches, models and methods [4]. Extension approach is the style of action within an extension system, which implies that the extension approach informs, stimulates and guides various aspects of the extension system such as its structures, leadership, programmes, resources and its linkages [5].

These agricultural extension approaches are categorized in terms of various implementation aspects, which are also used to measure the effectiveness of the approaches [4]. The implementation aspects considered in this study include; the dominant identified problem to which the approach is to be applied as a strategic solution; the purpose which the extension approach is designed to achieve; the system which controls program planning, and the relation of those who control program planning to those who are the program's main target group; the characteristics of field personnel including the ratio of extension personnel to smallholder farmers, their level of training, rewards system, origin, gender and transfers; resources required and various cost factors; implementation techniques; and how it measures success.

Smallholder farmers in Africa are faced with myriad and unique situations depending on their topological locations, thus inhibiting the success of different extension approaches and methods [6]. The diverse farming conditions include; the agro-ecological zones (AEZs) they operate in; their socio economic status in terms of capital invested and size of land owned; or annual revenue generated from farming activities [7]. An Agro-Ecological Zone (AEZ) 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 [8,9] identifies the essential elements used in defining the agro-ecological zones as the temperature regime, growing period, and soil attributes. The factors used to identify the AEZs have also been shown to influence farmers' ability to adopt agricultural technologies [10].

Kenya is divided into seven major AEZs in terms of temperature regimes including: Tropical Alpines (TA), which is characterised by no direct importance in agricultural production other than being the source of rain and some rivers/streams. It is confined to mountains and immediate surrounding such as Mt. Kenya and Mt Elgon. Upper Highland (UH) is generally restricted to the highlands of Kenya between

1980 and 2700 m above sea level. It has forests or open grasslands. The minimum rainfall is 1000 mm. Lower Highland (LH), occurs mainly at elevations between 900-1800 m with annual rainfall between 950 and 1500 mm. This zone is the most significant for agricultural cultivation. It is also the most resettled by human. Upper Midland (UM), occupies more or less the same elevation (900-1800 m) as the previous or may be at times lower. However, it has lower rainfall of about 500-1000 mm. Lower Midland (LM) zone is much drier than UM Zone and occurs at lower elevations. Annual rainfall is 300-600. Low Land (LL), zone is considered as semi desert and is the driest parts of Kenya. Annual rainfall is 200-400 mm and is quite unreliable. Finally, Coastal Lowland (CL) is represented by coastal strip and mangrove forests as the only vegetation found. 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 [11,8,7].

In high potential areas, 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 [12]. They may also include livestock production of up to 10 animals [13]. 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 [13]. Family is the main centre of operations, planning, decision-making and implementation in smallholder farming systems.

Decline in smallholder contribution to agricultural growth has been largely attributed to ineffective agricultural extension and innovation, among other factors including; climate change and variability, poor infrastructure, access to input and output markets, access to credit and agricultural financing, and land tenure and access [13]. This study therefore assessed the effect of various aspects of agricultural extension approaches on the success of agricultural extension approaches used across different AEZs.

1.1 Theoretical Underpinning of the Study

The conceptual framework developed for this study was based on the two premises; effective communication strategy and adoption. Communication is the dissemination processes that involve a multidisciplinary group of participants; including the smallholder farmers, extension agents, policy makers and other stakeholders including agricultural research institutions, input suppliers, and Agro-processing farms. Effective communication of agricultural technologies does not only depend on the communication process, it also depends on the timely formation of coalitions of key actors with common interests and need such that they can focus their resources and efforts on achieving change in agricultural systems [14]. This entails coming up with an agricultural technology dissemination strategy or approach. This study identified this collective effort and use of resources towards effecting change, or technology dissemination strategy as the agricultural extension approach. Without proper communication channels adoption is affected [15].

The second premise is the adoption process. Most researches on farmer adoption of new agricultural technologies explain the adoption as taking up and using the technologies. This has been expressed as inherently individual decision or a mental process, which is exhibited through technology implementation [16]. However, farmer decision-making is generally more complex than this implies. Farmers' decisions are complicated more by the sustainable livelihood aspects including food security, adequate cash income, a secure asset or resource base, social security [17]. The objectives of smallholder farmers to improve their livelihood and the available resources vary between farmers and change over the life-cycle of the farm household such that some farmers at sometimes may rely on off-farm work as a major source of livelihood, restricting their capacity to invest in labour-intensive technologies [18]. Thus, farmers in the same environment may have different objectives and livelihood strategies. The most effective agricultural extension approach should therefore be able to provide the farmers the opportunity to select livelihood strategies to pursue these objectives with the resources available to them [19].

To establish the effectiveness of extension approaches, this study synthesized the extension approaches into implementation aspects, then linked the implementation aspects of extension approaches to the smallholder farmers' ability to improve their agricultural practices. The level of application of the implementation aspects to support the farming household improve their agricultural productivity was studied as the dependent variables while smallholder farmers' situation (AEZs), including, factors influencing farmers' decisions to change their agricultural practices, was studied as independent variable.

2. METHODOLOGY

2.1 Study Area

The study was conducted in six counties: Nyamira, Kisii, Homa-bay, Migori, Kisumu, and Siaya counties. These counties are located in south western part of Kenya. The counties cover AEZs ranging from Lower Highland to Lower Midland. The area has a total population of 5,442,711 persons comprising of 1,186, 398 households, with 43% of them living below poverty line as per the 2019 censors [20].

2.2 Study Design

A cross-sectional survey that combines both quantitative and qualitative study approaches was used to gather relevant information on implementation of various aspects of extension approaches as applied in different AEZs. This study first identified different aspects used to distinguish extension approaches. The success of the extension approaches in each AEZ was then pegged on these implementation aspects. These aspects include; the dominant identified problem to which the approach is to be applied as a strategic solution; the purpose which the extension approach is designed to achieve; the system which controls program planning, and the relation of those who control program planning to those who are the program's main target group; the characteristics of field personnel including the ratio of extension personnel to smallholder farmers, their level of training, rewards system, origin, gender and transfers; resources required and various cost factors; implementation techniques; and how the extension approach measures success.

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. Each FGDs were organized comprising of 10 extension workers or at least 10 smallholder farmers. A total of 36 FGDs (12 FGDs for extension workers and 24 FGDs for smallholder farmers) were conducted across the six AEZs. The FGDs were used to triangulate information collected through questionnaires and Key Informant Interviews.

2.3 Sampling Design and Procedure

This study used a multi stage sampling procedure, in which proportionate stratified random sampling method was used to select at least 12 institutions engaging in agricultural extension spread across the 6 counties. Purposive, proportionate sampling technique was then used to identify respondents in each agro ecological zone depending on the extension approaches used by the agricultural institutions in the AEZs. Table 1, indicate the number of smallholder farmer-respondents in each AEZs by the extension approaches implemented in the zones. The agricultural extension approaches considered were: Commodity Extension Approach; Private -Profit Institutions; Farming Systems, Research Extension Approach; Input Suppliers Approach; Project Extension Approach; Government Extension Approach. At least ten agricultural extension officers affiliated to each institution was 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 agricultural managers 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.

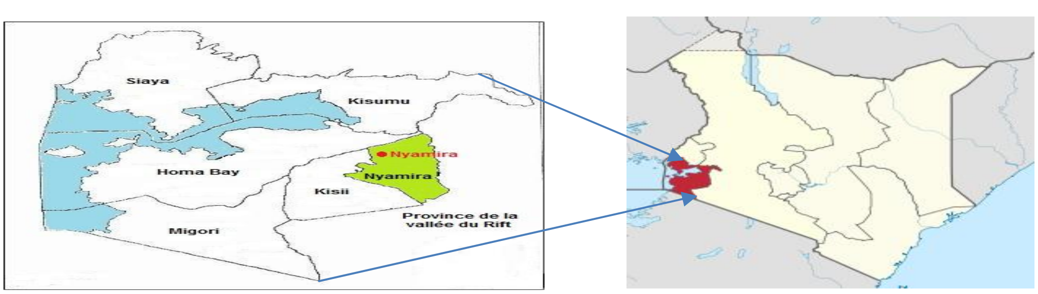

Table 1. Number of Smallholder Respondents in AEZ by Agricultural Extension Approaches

Agricultural Extension Approaches	Agro-Ecological Zone						Total
	Lower Highland	Upper Midland 1-2	Upper midland 3-4	Lower Midland 1	Lower Midland 2	Lower Midland 3-5	
Commodity Specialised Approach	0	40	30	10	10	0	90
Private-Profit extension Approach	0	20	10	10	20	0	60
Farming System Research Approach	0	0	0	30	20	10	60
Input Suppliers Approach	10	10	0	20	10	10	60
Integrated Project Approach	30	10	0	0	10	10	60
Government Extension Approach	0	0	0	20	0	10	30
Total	40	80	40	90	70	40	360

2.4 Data Analysis

Data was analysed using both descriptive and inferential statistics. The inferential statistics were set at the 0.05 level for significance. Kruskal Wallis test and Dunn-Bonferroni Post Hoc test were used to test significant differences on the implementation aspects of the extension approaches as used across different AEZs. Spearman correlation coefficient two tailed test was used to establish the strength and direction of the relationship among the variables.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Socio economic characteristics of the respondents

Majority (66.9 percent) of the households interviewed were male headed with the few female headed (33.1%) being widows (Table 2). This might be explained by the fact that in African rural set up, men are the main owners of productive assets and also control the utilization of these assets [21]. However, women carry out the majority of work related to agricultural activities [22]. The majority of the farmers were above 35 years old, while those with 19-35 years (32.5 percent), while those below 18 years were only 1.4 percent. Most of the households (47.5 percent) had a total of 3-5 persons per household followed by 6-9 persons per household at 39.7 percent, households with ten or more persons were 7.2 percent, and households with two or less persons were only 5.6 percent (Table 2). The average household size in Kenya is 3.9 persons, with the six counties having an average household size ranging from 3.8 in Kisumu to 4.6 in Migori [20]. Members of the household provide the much-needed labour, unless they are too young, sick or living with disability. There was also a positive correlation (rs =0.484, *P* =.001) between the age of the household head and the size of the household. This means that the older the household head the bigger the size of the household. Bigger household size could provide the needed labour and could also be disadvantageous if the majority of the members are of the school going age.

The main sources of income for the families were smallholder farming (80.6 percent), petty trade and grants from friends and relative (6.9 percent each), while 5.6 percent relied on part time employments. A higher proportion of the smallholder farmers interviewed (37.2 percent) owned one or less of an acre of land, followed by 2-4 acres (33.6 percent), 5- 10 acres (23.1 percent), while those owning more than 10 acres were only 6.1 percent. A cross tabulation of the size of land owned by the smallholder farmers by Agro ecological Zone indicate a relationship (Chi-square = 80.699, df = 15, *P* = .001) between size of land owned and Agro Ecological zone. This means that the higher the AEZ, the smaller the size of land owned by smallholder farmers. The size of land available for the smallholder farmers for agricultural practices influences their decisions on how to improve their agricultural production [23].

Majority of the household heads valued their assets at one million Kenya shillings and below (51.4 percent), followed by Ksh. 2-4 million (30.3 percent) while those valued at Ksh. 5-10 million were only 18.3 percent. None of the respondents valued their assets to be more than Kshs.10 million. The size of the farm owned by a household, the value of its livestock, off-farm income, family labour supply, and level of education were found to be the major factors affecting adoption of technologies [24].

A higher proportion of the households indicated that their main sources of labour as both hired and family labour (52.2 percent), followed by only family labour (43.6 percent), and the households who relied on only hired labour were only 4.2 percent. On the other hand, more than half of the households (51.9 percent) indicated that they had at least a family member who could not provide the much needed labour.

A higher proportion of the household heads interviewed had at least secondary level of education (66.8 percent), household heads with post-secondary level of education comprised 23.6 percent, those with higher primary level of education at 23.3 percent, and household heads with lower primary level of education were only 10 percent.

The socioeconomic attributes that were found to be significantly different across the AEZs include average age of household heads (K (5) 33.939, *P* = .001), land sizes (K (5) 28.121, *P* =.00) and value of assets (K (5) 100.781, *P* = .00) across different AEZs. These socio-economic attributes were also found to have a significant relationship with AEZs, average age of household heads rs = -228. *P* = .00, size of household land rs = -0.0144, *P* =.006 and value of assets rs = 0.492 *P* = 0.00).

Table 2. Socio economic characteristics of the respondents by Agro-Ecological Zones (AEZ)

Characteristic / Percentage (%)	Agro-ecological zones						
	LH	**UM1-2**	**UM3-4**	**LM 1**	**LM 2**	**LM 3-5**	**Mean**
Age (years) <18	2.5	0	0	0	2.9	5.0	1.4
19 – 35	32.5	25	17.5	27.8	40.0	60	32.5
36 – 50	40.0	48.8	52.5	45.6	50	27.5	45.3
	25.0	26.3	30	26.7	7.1	7.5	20.8
>50							
Education level:							
Lower Primary	5	10	10	11.1	10	12.5	10
Primary graduate	25	25	25	24.4	22.9	15	23.3
Secondary	40	43.8	45	43.3	45.7	37.5	43.1
Post-secondary	30	21.3	20	21.1	21.4	35	23.6
Household size (numbers)							
<2	0	10	5	8.9	2.9	0	5.6
3-5	55	41	37.5	41.1	54.3	65	47.5
6-9	32.5	42.5	47.5	42.2	40.0	27.5	39.7
>10	12.5	6.3	10	7.8	2.9	7.5	7.2
Household head:	70	65	77.5	66.7	64.3	62.5	66.9
Male	30	35	22.5	33.3	35.7	37.5	33.1
Female							
Source of income:							
Farming	92.5	73.8	85	76.7	81.4	85	80.6
Petty trade	0	11.3	7.5	10	5.7	0	6.9
Grants	2.5	10	5.0	8.9	5.7	5.0	6.9
Employment	5.0	5	2.5	4.4	7.1	10	5.6
Asset value:							
<1Million	7.5	37.5	40	55.6	82.8	70	51.4
2-4Million	25	32.5	35	43.3	12.9	27.5	30.3
5-10Million	67.5	30	25	1.1	4.3	2.5	18.3

Table 3. Kruskal Wallis result on level of implementation of different aspects of extension approaches in different AEZs

Extension Approach Aspects	Σ2 Value	Mean Ranking BY AEZs						Sig.
		LH	UM1-2	UM3-4	LM1	LM2	LM3-5	
Level of participation in identifying the Dominant problem	151.47	248.58	250.53	248.3	152.99	110.17	89.55	0.000
Level of target group participation in designing the Purpose	49.392	192.81	232.55	218.48	138.65	162.38	151.99	0.000
Level of participation in extension programme planning	56.336	192.81	232.55	218.48	138.65	162.38	151.99	0.000
Frequency of conducting planning meetings	13.7	227.64	172.52	150.7	174.11	183.09	188.98	0.018
*Level of education of extension agents	15.514	81.42	71.54	66.46	48.9	49.23	58.36	0.008
Level of rewards to extension agents	24.794	226.75	183.69	196.38	190.19	136.43	167.31	0.001
Ratio of extension agents to smallholder farmers	85.816	229.43	115.16	111.04	208.75	194.57	243.53	0.000
Gender representation of extension agents	12.598	214.41	164.08	212.6	164.89	185.04	166.49	0.027
Transfer/ relocation of extension agents	5.555	160	181.38	177.25	183.67	184.64	188.12	0.352
Frequency of refresher trainings to the extension agents	16.473	204.51	150.19	205.29	188.98	166.43	197.85	0.006
*Amount of funding available to extension programmes	32.425	98.29	53.39	29.08	63.32	51.48	75	0.000
Frequency in which the extension agents meet farmers	44.493	268.18	186.69	135.05	177.62	171.22	148.61	0.000
Level of improved agricultural Practices	126.679	258.63	236.71	249.68	155.06	110.28	100.9	0.000
N		40	80	40	90	70	40	
N*		12	28	13	31	22	14	

3.1.2 Aspects of Extension Approaches by Agro-Ecological Zones (AEZs)

The study found out that there were significant differences in the level of implementation of different aspects of extension approaches across different AEZs as presented in Table 3.

3.1.3 Level of participation in identifying the Dominant problem

There were significant differences in the level of participation in identifying the most dominant problem, at P = .05 level, in different AEZs [H (5) = 151.47, P = .00] (Table 3) The mean ranking of the level of participation in identifying the most dominant problem by AEZs is listed in Table 3. This indicated that the respondents from different AEZs participated at different levels when identifying the most dominant problem to be solved by an extension approach. Analysis using Dunn's post hoc test result on level of participation in identifying the most dominant problem to which the approach is applied as a strategic solution in different AEZs indicated that, at Lower Midland 3-5 AEZ, the level of participation was significantly lower than all the AEZs except for Lower Midland 2. While Upper Midland 1-2, exhibited the highest level of participation, but not significantly different from Lower Highland and Midland 3-4.

A further analysis using spearman rho correlation coefficient two tailed test indicate that there was a strong positive relationship (rs=0.620, $P < 0.001$) between the Agro-ecological zone and level of participation in identifying the most dominant problem to which the approach is applied as a strategic solution. This means that, the higher the AEZ, the higher the level of participation in identifying the most dominant problem. Higher level of participation gives the farmers the opportunity in highlighting the most dominant problem affecting their production hence improving the effectiveness of an extension approach.

3.1.4 Level of target group participation in designing the Purpose

There were significant differences in the level of participation in designing extension purpose at the p<.05 level in different AEZs [H (5) = 49.392, P =.00]. Table 3 presents Kruskal Wallis test result on the mean ranking on the level of participation in designing extension purpose by AEZ. This indicate that the respondents from different AEZs participated at different levels when designing the purpose of the extension approach. A Dunn's post hoc test result indicated that, extension approach as applied in the Lower Midland 1 AEZ, had a significantly lower level of participation compared to UM 3-4, and UM 1-2. That is, it involved lower number of group of participants in designing the extension purpose. While, extension approach as applied in the UM 1-2 involved significantly the highest number of group of participants compared to LM 1, LM 3-5, and LM 2 in designing the purpose of extension.

Further analysis using spearman rho correlation coefficient (two tailed test) indicated that, there was a weak positive correlation (rs= 0.269, P = .00) between the level of participation 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. This also improves the effectiveness of extension approach as one move to higher AEZs.

3.1.5 Level of Participation in extension programme planning

There were significant differences in the level of participation in extension programme planning at the P = .05 level for different AEZs [H (5) = 56.336, P =.00] (Table 3). This indicated that the respondents from different AEZs participated at different levels in extension programme planning. Dunn's post hoc test result revealed that extension approaches as applied in the Lower Midland 1 AEZ, had a significantly lower level of participation in extension programme planning compared to LM 3-4 and UM 1-2. While the agricultural extension approach as applied in the UM 1-2 -5 had significantly the highest level of participation in planning extension programme planning compared to LM 3 -5, LM 1 and LM2.

Further analysis using spearman correlation coefficient (two tailed) test resulted into a weak negative correlation (rs= -0.154, P =.00). This Means that the average number of group of persons participating in program planning reduces as one move to higher AEZs. This conflict with the level of participation in designing extension purpose and identifying extension problems in the way the extension approaches. This means that more farmers in higher AEZs participate in identifying extension problem and designing the purpose but refuse to participate in the initial planning sessions to solve the identified problems. Failure to participate in programme planning result in lack of harmony during programme implementation.

3.1.6 Frequency of conducting extension programme planning meetings

There were significant differences in the frequency of conducting extension programme planning meetings at the P=.05 level in different AEZs [H (5) = 13.700, P = 0.02] (Table 3). This indicates that the respondents from different AEZs participated at different frequencies of conducting programme planning meeting.

Dunn's post hoc analysis results indicated that extension stakeholders implementing extension approaches in upper midland 3-4 was ranked to have held significantly the lowest frequency of planning meetings compared to LH. However, there was no significant difference in the ranking of the frequency of planning meetings held by the other AEZs.

Analysis by spearman correlation coefficient result indicates that, there was no significant correlation (rs= -0.036 *P* =.497) between the frequency of holding extension program planning meetings and AEZs. Meaning the frequency of holding extension program planning meetings occurred at different levels at different AEZs but does not follow any pattern in relation to the AEZs.

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

There were significant differences (H(5) = 15.514, *P* = .01) on the general level of education of extension agents implementing extension approaches in different AEZs . Table 3, presents the Kruskal Wallis test result on the mean rankings on level of education of extension agents. Dunn's post hoc analysis result showed 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, Lower Midland 2 and Lowland 3-5 AEZs. However, there was no significant differences in the ranking of education of extension agents implementing extension approaches in the other AEZs.

Analysis by spearman correlation coefficient (two tailed test) result indicates that, there was a weak positive correlation (rs =0.294, *P* = .001) between the level of education of extension agents and 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.

3.1.8 Institutional reward system for agricultural extension agents

Kruskal Wallis test results (Table 3) indicated that, there were significant differences (H (5) = 24.794, *P* = .00) on how the agricultural extension agents implementing extension approaches in different AEZs are rewarded. Table 3 present the mean rankings on the level of reward to extension agents. Dunn's post hoc test result revealed that, extension agents implementing extension approaches in Lower Midland 2 are rewarded significantly lower than the agricultural extension agents implementing extension approaches in Upper Midland 3-4, Lower Midland 1, and Lower Highland AEZs. While the level of reward in the other AEZs remain the same.

Analysis using spearman correlation coefficient results indicate that, there is a week positive correlation (rs=0.200, *P* =.00) between the rewards for the extension agents implementing extension approaches and AEZs. That is, the higher the AEZ the higher the reward. This confirms 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 indicated that there is a weak positive correlation (rs=0.229, *P* = 0.00) 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.

3.1.9 Distribution of the programme extension agents in the programme location

Kruskal Wallis test result (Table 3) indicated significant differences (H(5) = 85.816, *P* = .00) in the distribution of extension agent per given number of households by AEZs. The result of Kruskal Wallis on the rankings of the distribution is presented in table 3.

Dunn's post hoc result 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 indicated 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 households. This means that the higher the AEZs the lesser the number of extension agents representing a given number of households. This could be due to higher population in higher AEZs while the extension agents are employed in terms of geographical location.

3.1.10 Frequency of refresher training to the extension agents working the programme

Kruskal Wallis result indicated that there were significant differences H (5) = 16.473, *P*=.006] in the frequency at which extension agents implementing extension approaches in different AEZs are retrained (refresher trainings) (Table 3).

Dunn's post hoc test results revealed 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, while the other AEZs indicated no significant differences. Analysis by Spearman correlation coefficient two tailed test showed 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.

3.1.11 Amount of funding available for extension programs

Kruskal Wallis result (F (5) = 13.514, *P* = .019) indicated that there were significant differences in amount of funding available to implement extension approaches in different AEZs (Table 3). Dunn's post hoc test result indicated that, extension approaches as implemented in Upper Midland 3-4 had significantly lower amount of funding, compared to Lower Midland 1, LH, and LM 3-5. Lower Highland, had a significantly higher amount of funding available for the implementation of the extension approaches compared UM 3-4, LM 2, UM 1-2. Spearman correlation coefficient two tailed test indicates 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.

3.1.12 Frequency at which the extension agents meet farmers

Kruskal Wallis result (H (5) = 44.493, P=.001) indicates that, there were significant differences in the frequency at which extension agents implementing extension approaches in different AEZs meet their farmers (Table 3). Dunn's post hoc test result indicated 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* =.001) 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.

3.1.13 Improved Agricultural Practices by the Smallholder Farmers by AEZs

The level at which smallholder farmers improved their agricultural practices after being exposed to different extension approaches, was used to determine the overall effect of extension approaches used in different AEZs. Kruskal Wallis test result (H (5) = 126.679, *P* value = .001) indicated that there were significant differences in the level at which smallholder farmers improved their agricultural practices in different AEZs (Table 3). This could mean that agricultural approaches as implemented in different AEZs resulted in the farmers improving their agricultural practices at different levels. The level at which the farming households were able to improve their agricultural practices was used to determine the performance of agricultural extension approaches.

Dunn's post hoc test result indicated that, farmers in Lower Highland, had the highest level of improved agricultural practices and significantly higher than LM 3-5, LM 1, and LM2. LM 3-5 had the lowest level of improved agricultural practices and significantly lower than LH, UM 1-2, and UM 3-4. While UM 1-2 had a medium level of improvement on their agricultural practices and significantly higher than LM 3-5, LM 2, and LM1.

Spearmen correlation coefficient two tailed test result (rs= 0.568, *P* = .001) indicated that, there was a significant positive correlation between AEZs and the level of improved agricultural practices as implemented by the farmers. This therefore means that the AEZs influenced the effectiveness of the agricultural approaches, 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 smallholder farmers improved their agricultural practices.

4. DISCUSSION

One key characteristic of agricultural extension approaches is the participation of different stakeholders in situations analysis, diagnosis, programme formulation, priority setting which enhances technology uptake and adoption. There were significant differences on how various aspects of agricultural extension approaches were implemented in different AEZs. This might have been due to different climatic and socio-economic attributes in different agro ecological zones. The socio economic attributes that were found to be significantly different across the AEZs included average age of household heads, land sizes and value of assets across different AEZs. These socio economic attributes were also found to have a significant relationship with AEZs. These attributes coupled with climatic factors influenced how various aspects agricultural extension approaches were implemented in different AEZs. The size of land owned by the households have a positive influence on adoption of technologies such as farm mechanization [25]. The more the estimated value of assets owned by the households the more they are likely to improve their agricultural technologies or take up technologies disseminated to them through various agricultural approaches. This finding is in line with other findings by [24]. [25, 26] that the value of assets owned by households such as cattle, crop in the field, capital assets and food in store positively influence the level of uptake of agricultural technologies. The level of assets owned by the households allows the households the freedom to take risk or access to capital to enable them to be innovative hence improving their agricultural practices.

The level of change of agricultural practice by smallholder farmers due to implementation of various aspects of agricultural approaches was significantly different across the different AEZs and there were also significant relationships between the change in agricultural practices and the AEZs. This means that the implementation of these aspects had significantly different effects across different AEZs. The implementation of the aspect resulted into a higher positive change in agricultural practices in higher AEZs compared to lower AEZs. This therefore means that the aspects as implemented in higher AEZs resulted into a greater change in agricultural practices. These findings confirm the earlier findings [27] 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 AEZs. A research conducted by [28] 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 [29]. The various implementation aspects of agricultural approaches that were influenced by AEZs include, level of participation in identifying the most dominant problem, designing the extension purpose, level of education, level of rewards to extension personnel, level of participation in planning meetings, frequency of extension visits and ratio of extension staff to farming households. The other aspects that were not influenced by AEZs included, level of funding available for agriculture, refresher training for extension personnel.

There was a significant relationship between the level of education of extension agents and AEZs they operate in. This could 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 [30]. However, there were no significant relationship between the number of refresher trainings and AEZs. It can be argued that more education acquired by 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 education has a positive influence on up take and adoption of technologies [31,32,33]. Other studies such as [34,35] support this argument that, packaging technologies and technology attributes coupled with farmers' personality factors such as levels of education influence uptake of technologies.

Reward to extension agents should be considered as one of the most important factors influencing the productivity of extension agents or any other employee [36]. 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 ratio of extension agents to the number of farmers was not significantly different in all the AEZs. A further inquiry into the matter reveals that the extension agents are employed as per the region not the number of households covered. While, the population density of the households is 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 [37]. The extension agents in higher AEZs will be covering more farmers, hence the need for the extension agents to be more active compared to their colleagues in lower AEZs.

5. CONCLUSION

It can therefore be inferred that, climatic conditions, average age of household, size of household land, and value of household assets as factors of AEZs influences how various aspects of agricultural extension approaches are implemented. The implementation of the aspects of extension approaches influences level uptake of agricultural technologies. The implementation aspects of extension approaches were implemented differently in different AEZs such that there were positive correlation between the AEZs and the following aspects; the number of groups of persons participating in identifying the most dominant extension problem; the number of groups 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 groups of participants involved in extension programme planning and number of extension agents representing a given number small holder households. Therefore, for effective dissemination of agricultural technologies, farmer situation, specifically agro ecological zone must be taken into consideration when recommending extension dissemination approaches to be used.

FUTURE RESEARCH

There is need to carry out a multivariate analysis model to inform how to implement various aspects of extension approaches to achieve optimum results in terms of farmer behaviour change.

CONSENT

As per the university standards, the respondents' consent was sought and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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