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Influence of Selected Alternative Extension Approaches on the Acquisition of Knowledge, Skills for Agricultural Productivity in the Lake Victoria Region, Kenya

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Abstract

The role of agricultural extension is vital to the diffusion of new technologies, but extension is currently not very effective in many African nations, with traditional extension approaches having minimal impact. In Kenya, there have been gaps on the availability of studies and documentation of the specific extension approaches and their influence on the acquisition of knowledge, skills and productivity for household food security despite the various extension efforts and resources put in place in many parts of the country. This study therefore investigated the influence of three selected alternative extension approaches on the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region, Kenya. The main objective of the study was to compare the individual and collective influence of Farmer Field Schools, On-Farm Research and Focal Area approaches on the acquisition of knowledge, skills and farm productivity for enhanced household security in the Lake Victoria region of Kenya. A cross sectional survey design was adopted in order to develop a detailed account of the effect of the three approaches. The total population of the study area was 188,661 households from which a random sample of 396 was selected comprising of small-scale farmers from three sub counties: Bondo, Rachuonyo and Nyamira. Data was analyzed using both descriptive and inferential statistics with the aid of Statistical Package for Social Sciences (SPSS 18.0) at 5 percent level of significance.

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Findings revealed that Farmer Field School contributed to the acquisition of knowledge and skills in various agricultural production activities and an increase in farm productivity. Results on On-Farm Research revealed that it contributed to knowledge and skills as well as improvement of farm productivity. However, a hypothesis test showed no significant influence on knowledge, skills and productivity for household food security. Findings about Focal Area approach revealed that it contributed to the acquisition of knowledge, skills and productivity for household food security. Focal Area approach proved to be the most effective of the three approaches in the acquisition of knowledge, skills and productivity for household food security ; followed by Farmer Field Schools and lastly On-Farm Research. It is hoped that the findings of this study will contribute to greater understanding of agricultural extension approaches especially in policy formulation and design of the provision of extension services to communities in Kenya.

Key Words: Extension approach; Farmer Field Schools; Conventional Extension ;On- Farm Research knowledge and skills.

1.0 introduction

1.1 Background information

Agricultural extension is considered to be an important service in increasing agricultural productivity and attaining sustainable development [1] . Its role is to help people identify and address their needs and problems. There is a general consensus that extension services if successfully applied should result in outcomes which include observable changes in attitudes and adoption of new technologies and improved quality of life based on indicators such as health, education and housing. It has been recognized that agricultural extension accelerates development in the presence of other factors such as markets, agricultural technology, and availability of supplies, production incentives and transport.

Eradication of extreme poverty and hunger is given top priority by the United Nations and is listed as Millennium Development Goal Number One [2]. The role of agricultural productivity in alleviating poverty in developing countries as presented in some empirical results suggest that there are significant relationships between productivity growth and both poverty and nutrition [3] . These studies have shown that the empirical estimates of this relationship appear to be robust and that regardless of the differences in data and formulation, the results showed that a one percent increase in yields leads to a reduction in the percentage of people living on less than one US dollar per day of between 0.6 percent and 1.2 percent.

In Kenya, agriculture is the leading economic sector, accounting for 25 percent of the Gross Domestic Product (GDP), employing 61 percent of Kenyans; predominantly small scale mainly in the high potential areas and accounting for 75 percent of the total agricultural output and 70 percent of agricultural produce [4]. According to the Central Bureau of Statistics [5] (2003), more than half of Kenya's population is poor with 7.5 million people living in extreme poverty and over 10 million people suffering from chronic food insecurity. There are about two million people who are permanently on food relief; the number of people on food relief increases rapidly to over five million during drought years and over four million live below the absolute poverty line[6] .

It has been documented that the low level use of farm inputs amongst the small scale farmers has often resulted in sub-optimal levels of production [7].

The past half-century has seen marked growth in food production, allowing for a dramatic decrease in the proportion of the World's people that are hungry, despite a doubling of the total population [8]. Nevertheless, more than one in seven people still do not have access to sufficient protein and energy from their diet, and even more suffer from some form of micronutrient malnourishment [9]. The World is facing a new set of intersecting challenges, with the global population continuing to grow and likely to plateau at some 9 billion people by roughly the middle of this century [10]. A major correlate of this population growth is increased wealth, and with higher purchasing power comes higher consumption and a greater demand for processed food, meat, dairy, and fish, all of which add pressure to the food supply system. At the same time, food producers are experiencing greater competition for land, water, energy and the need to curb the many negative effects of food production on the environment is becoming increasingly clear [11] .

In developing countries, the root causes of food insecurity include: poverty, war and civil conflict, corruption, national policies that do not promote equal access to food for all, environmental degradation, barriers to trade, insufficient agricultural development, population growth, low levels of education, social and gender inequality, poor health status, cultural insensitivity, and natural disasters [12] . Many farmers in Sub-Saharan Africa countries face declining crop yields, which has constrained economic growth [13]. The underlying constraints are caused by low and unreliable rainfall, pests and diseases, and inherently infertile soils. The soil infertility is related mainly to the low nutrient status of the soils while the qualities of some soils have declined as a result of continuous cultivation without returning enough nutrients back to the soil [14].

The critical challenge facing Kenya is to raise the rate of economic growth to levels incorporating broad-based improvement in the standards of living and well-being of Kenyans in order to reduce poverty which has increased rapidly in the recent past [15] . Kenya's economic growth rate declined dramatically from an average of 6.6 percent in 1970s to 4.2 percent in 1980s to an average of 2.1 percent in the 1990s. The living conditions of the vast majority of Kenyans were deteriorating rapidly with a marked increase in the number of people unable to access clean water, clothing, shelter, health services and education. There have been growing disparities in access to services which further undercut the living conditions of low-income households, school enrolments; infant mortality and life expectancy have deteriorated [16]. It has been documented that about a half of Kenya's estimated 38 million population are poor with some 7.5 million people living in extreme poverty. It is likely that over 10 million suffer from chronic food insecurity and poor nutrition with an estimated 2million people requiring food assistance at any one time [17].

Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seed varieties, crop management, marketing; exposure to such activities is intended to increase farmers' ability to optimize the use of their resources and causing awareness of existing technologies to generate effective demand by providing a critical signal to input distribution systems[18] . Thus, extension systems and input distribution systems are mutually reinforcing – the contribution of extension to agricultural productivity growth depends on functioning input distribution systems, and vice versa, besides providing a feedback from farmers to

research centres. The World's expansion beyond the global village is a reality that has strongly affected public sector extension. Globalization is inextricably linked to privatization, and countries are finding themselves confronted by a new and highly competitive global market. Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seed varieties, crop management, and marketing. Exposure to such activities is intended to increase farmers' knowledge and skills that would optimize the use of their resources and increase farm productivity [19]. The study involved three selected alternative extension approaches namely: Farmer Field Schools, Focal Area and On-Farm Research. As a benchmark, Conventional or Public Extension approach was used for comparison. Each approach is discussed in turn.

In this study three extension approaches were studied, with Conventional Extension acting as a benchmark. The first was On Farm Research (OFR). On-Farm Research (OFR) is a tool for developing and validating technology. It is research carried out on farmer's fields and in a farmer's environment [20]. OFR is commonly used as a means to ensure that technologies developed on-station will be relevant to the problems and priorities of the targeted client adopters. To validate on-station results, OFR is carried out to assess the performance of particular systems or technologies on-farm, with the farmer's involvement. Such research will likely lead to the observation of yield gaps or shortfalls, and consequently research is then initiated to address the gaps and eliminating or narrowing the gaps [21].

The second extension approach in the study was Farmer Field Schools. One of the pluralistic education and extension programme practised worldwide is the Farmer Field Schools (FFS) approach, being implemented in at least 78 countries [22]. The main objective of a Farmer Field School is to bring farmers together in a learning situation to undergo a participatory and a practical season-long training in a particular topic/technology. The focus is field observation, hands-on activity and season long evaluation of technologies demonstrated for scaling-up [23]. Farmers are facilitated to conduct their own research, diagnose and test problems, and come up with solutions. FFS training programmes help farmers develop analytical skills, critical thinking, and creativity, and learn to make better decisions [24]. Such an approach, in which the trainer is a facilitator rather than an instructor, reflects a paradigm shift in extension [25]. Through group interactions, attendees sharpen their decision making abilities and their leadership, communication, and management skills [26]. Three major learning tools of FFS include discovery-based learning exercises, group experiments, and agro-ecosystem analysis [27] .

The third approach in the study was Focal Area. Focal Area is an approach implemented by the National Agricultural and Livestock Extension Programme (NALEP) and focuses in one geographical area called the Focal Area, usually a location or sub-location, whereby resources and efforts are concentrated for one year before moving to another area [28] . The programme is anchored on the principle that extension staff members in collaboration with other stakeholders mobilize the Focal Area community to spearhead their area development. The strategy entails strong collaboration, participation and partnership between the extension staff and other stakeholders. The mobilization involves creating awareness, training, empowering and development of action plans.

Conventional extension also referred to as general extension approach or public extension in contrast to several other approaches is also called Ministry-Based General Extension. Extension conventionally comprises several of the following functions [29]: First, diagnosis of farmers' socio-economic and agro-ecological conditions and of their opportunities and constraints; secondly, message transfer through direct contact between extension agent and farmer or indirect contact involving intermediaries such as 'contact farmers' or voluntary organizations; through training courses and through mass media. Messages may comprise advice, awareness creation, skill development and education; thirdly, feedback to researchers on farmers' reactions to new technology to refine future research agenda; fourthly, development of linkages with researchers, government planners, NGOs, farmers' organizations, banks, and the private commercial sector. In remote areas, extension agents have taken on a number of these functions directly; and lastly monitoring of the extension system, and evaluation of its performance at farm level.

1.2 Statement of the problem

Improving agricultural extension services is critical in addressing the existing knowledge and skills gaps in agricultural production in many parts of the World. It has been documented that extension services may improve returns to agricultural production by between 34 and 84 percent. In Kenya, there exist gaps on the availability of studies and documentation of the specific extension approaches and their influence on the acquisition of knowledge, skills and productivity for household food security. Despite the various extension efforts and resources put in place in many parts of Kenya including the Lake Victoria region, there still exist wide gaps in knowledge, skills and productivity for household food security. This study therefore investigated the influence of Farmer Field Schools, On Farm Research and Focal Area as alternative approaches on the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region, Kenya.

1.3 Objectives of the study

The objectives of the study were to:

i) Determine the status of changes in food production under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya.

ii) Compare individual influence of Farmer Field Schools, On-farm Research and Focal Area extension approaches on the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

1.4 Hypotheses of the study

The following were the null hypotheses of the study:

$Ho_{(1)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between the farmers exposed to Farmer Field Schools Extension approach and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

$H_{O\,(2)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between the farmers exposed to Focal Area Extension approach and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

$H_{O(3)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between the farmers exposed to On-Farm Research Extension approach and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

$H_{O(4)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between farmers exposed to Farmer Field School, On-farm Research, Focal Area Extension approaches and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya

2. STUDY METHODOLGY

2.1 Research Design

The research adopted a cross sectional design. This design involves collecting data from a predetermined and specific population [30]. It allows the researcher to collect data at one point in time, thus enabling the respondents to describe a phenomenon, in this case selected extension approaches and their effect on agricultural knowledge, skills and household food production. This design allows for comparison of groups without manipulating the independent variable [31]. In this study, knowledge, skills and productivity for household food security in the study districts were determined in relation to the extension approaches used to provide services. Chance differences were however minimized by using a large sample and randomization [32].

2.2 Study Location

The study was carried out in three districts in the Lake Victoria region basin of Kenya. Lake Victoria basin is located in the upper reaches of the Nile River basin and occupies an area of about 251,000 km^2 of which 69,000 km^2 is the lake area [33] and is shared by Kenya, Uganda, Tanzania, Rwanda and Burundi. The study was carried out in three sub counties in the Lake Victoria region namely: Bondo, Nyamira and Rachuonyo. The following criteria formed the basis for sampling the 3 sub counties:

a) The sub counties portrayed a national or regional extension delivery system
b) They were fairly accessible based on available funds and time
c) They had representation in terms of diverse climatic conditions, agro-ecological zones, agricultural practices and communities.

The sub counties were purposively selected since they were representative of the larger Lake Victoria Region of Kenya. Nyamira, located in the Kisii highlands represent a high potential region for agricultural production, receiving rains most of the year, with rich arable soils. Rachuonyo on the other hand represent a medium potential region especially the Southern part with moderate rains, with fairly rich soils. Bondo Sub County is

typically low potential with low rains and poor soils, with the main economic activity being fishing in Lake Victoria.

2.3 Population of the Study

The target population for this study consisted of small-scale farmers drawn from the three districts: There are approximately 865,923 persons in the three study districts represented by 188,661 households [34]. The small-scale farmers in the study sub county practice subsistence agriculture, involving cultivation of food crops and keeping few heads of cattle mainly for household consumption with little surplus for sale. In Nyamira sub county the small scale farmers grow bananas, small acreages of tea and coffee. In Bondo Sub County, the farmers are involved in fishing, growing of maize and sorghums for subsistence and keeping of local cattle. In Rachuonyo Sub- County the farmers grow bananas, maize, sweet potatoes and keep grade cattle. The demographic characteristics of these Sub- Counties are as shown in Table 1

Table 1: Population distribution of the study Sub- Counties

S/N	Sub- County	Male	Female	Total	Households	Area (Km^2)	Density
1	Bondo	76468	81054	157522	37296	593.0	266
2	Rachuonyo	182,967	199744	382711	81426	950.7	403
3	Nyamira	155808	169882	325690	69,939	398.3	818
	Total	415243	450680	865923	188661	1942	

Source: GoK (2009)

2.4 Sampling Procedure and Sample Size

The study adopted multi stage sampling technique, first of the Sub- Counties and secondly of the households. For the selection of sample Sub- Counties, purposive sampling technique was used. This technique allows the researcher to use cases that have the required information with respect to the objectives of the study, cases of subjects are therefore handpicked because they are informative or they possess the required characteristics [31] Then within the selected Sub- County, proportionate random sampling was applied to obtain the desired cases [32] The sample frame for this study comprised of small-scale farmers who had practiced agriculture over the years. The sampling unit was the household. In order to sample the households, proportional stratified random sampling technique was used. This technique ensures that all subgroups in the population are represented. Equal allocation was then used to sample the households.

2.5 Sample Size

The probability formula was adopted to determine the sample size [31] as follows, whereby a sample size was selected as shown in Table 2.

Table 2: Study Sample

Extension Approach	Sample	
	F	%
Farmer Field Schools	46	11.6
Focal Area	105	26.5
On Farm Research	55	13
Conventional Extension	190	48
Total	396	100
N=396		

The increase in the number of farmers in the study was due to the fact that extension approaches focus on farmer groups hence some respondents had invited their group members to join them during the interviews. The researcher had to include them in the study to avoid discrimination.

2.6 Instrumentation and Data Collection

An interview schedule was used to collect data from the sampled farmers in the study area. Validity of the instrument was done to test if results obtained from the analysis of the data actually represent the phenomenon under study. Based on the comments offered by the experts, appropriate adjustments were made on the instrument before it was taken to the field for data collection. Reliability of the instrument was computed using Cronbach alpha . A reliability coefficient threshold of 0.7 is recommended for survey research to be adopted. For this study the final reliability was 0.72, which was above the recommended threshold. Face-to- face administration of the interview schedule was done. Focus group discussions were held to further verify the information gathered from individual respondents, and to be able to triangulate it within the themes of the study.

Qualitative or non-numerical data was used in describing the various aspects of the study. Quantitative data was however analyzed using inferential statistics. Descriptive statistics involved computing frequencies, percentages, means and standard deviations to summarize data from the objectives. The purpose was to enable the researcher to meaningfully describe a distribution of scores of measurements using a few indices or statistics. The inferential statistics used in the study were F test using ANOVA and independent t-test.

3.0 Results and Discussions

3.1 Introduction

This chapter presents and discusses the results of the study based on the study objectives and the set of hypotheses.

3.2 Socio- Economic Characteristics of the study respondents

The socio – economic characteristics of the respondents include: gender, education level, land tenure system, family size, family farm income and changes in family incomes.

3.3 Gender of the respondents

Gender remains one of the key factors in agricultural production hence the need for collection of gender desegregated data. Table 3 shows the study sample desegregated by gender.

Table 3: Extension approaches by gender of respondents

Extension Approach	**Male**		**Female**		**Total**	
	F	**%**	**F**	**%**	**F**	**%**
FFS	21	45.7	25	54.3	46	100
FA	58	55.2	47	44.8	105	100
OFR	30	54.5	25	45.5	55	100
CE	97	51.1	93	48.9	190	100
Total	206	52.0	190	48.0	396	100
	N=396					

The findings show that there were more males in the study (52. 0%) than females (48%).In terms of extension approaches there were more males than females in Focal Area. There were more female farmers (54.3%) who were exposed to Farmer Field Schools as compared to the other two approaches. The findings also agree with [36] which shows that whereas women are normally excluded from extension services, Farmer Field Schools attract more women than men. Overall, the results of the study point to the fact that quite a large number of women (48%) did not participate in the three extension approaches as depicted by those who only participated in Conventional Extension.

3.4 Farm family incomes of respondents

Family income is an important factor in determining the livelihoods of the family. According to the 1997 WMS, the poverty line per person per year was defined as Kenyan shillings (Ksh) 21,848 (US$288) in rural areas and Ksh46, 693 (US$615) in urban areas, both expressed in 2003 prices and unadjusted in US dollars [37].

Table 4 shows the family farm incomes of the respondents. On average, a majority of families (41.7%) earn incomes of over Ksh. 10000 followed by incomes of between Ksh. 5000-10000 represented by 38.6 percent; while less than19.7 percent earn below Ksh. 5,000.00.

Table 4: Extension approaches by family farm incomes

	Less than Ksh.5000		Ksh.5000-10,000		Over Ksh.10,000		Total	
	F	%	F	%	F	%	F	%
FFS	10	21.7	25	54.3	11	23.9	46	100
FA	24	22.9	46	43.8	35	33.3	105	100
OFR	15	27.3	23	41.8	17	30.9	55	100
CE	29	15.3	59	31.0	102	53.7	190	100
Total	78	19.7	153	38.6	165	41.7	396	100

N=396

The results show that most of the respondents (58.3%) have an income of below Kenya Shillings 10,000. This implies that they live below the poverty line. Farmers with Farmer Field Schools exposure farmers had slightly higher number of farmers (54.3%) with an income of between 5000-10000.The results concur with studies by [38] , which documented that Farmer- to -Farmer diffusion effects of FFS are expected to bring about cost effectiveness in knowledge diffusion and financial sustainability.

4.5 Family incomes over the last 5 years

Despite their higher output per hectare and the significant contribution they make to food production, small-scale farmers often have low incomes and are poor.

Results in Table 5, show the trends in farm family income over the last five years in the study area.

Table 5: Extension approaches by trends in the family incomes over the last 5 years

Extension Approach	Increased		Remained constant		Decreased		Total	
	F	%	F	%	F	%	F	%
FFS	35	76.1	4	8.7	7	15.2	46	100
FA	43	41.0	14	13.3	48	45.7	105	100
OFR	10	19.6	17	33.3	24	47.1	55	100
CE	51	26.8	24	12.5	115	60.5	190	100
Total	139	35.1	59	14.9	194	50	396	100

N=396

The Results revealed that over the last five years, 50 percent of the respondents had their family incomes decreased; 35.1percent of them indicated that their incomes had increased whereas 14.9 percent stated that their incomes remained constant. The findings however showed that FFS participants had a majority (76.1%) of the farmers having increased incomes, while Conventional Extension had the highest number with decreased

incomes (60.5%) over the last five years. Overall, only 35 percent had their incomes increased while 65 percent of the farmers had their incomes decreased or remained the same over the last five years. The results concur with a study by [39] who documented that in a survey of smallholder households, 55 per cent in Kenyans and 75 per cent and Ethiopians, respectively, fell below the poverty line.

3.6 Analysis of Objective I

Objective 1: To determine the status of changes in food production under the influence of Farmer Field Schools, On-farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya.

This section provides a description of the status of changes in food production in the study area under the influence of the selected alternative extension approaches including: the period of participation, the activities, causes of food shortages, amount of food consumed and stored and contribution to food productivity.

3.7 Extension Approaches and their contribution to food productivity

Figure 1 shows the contribution of the three extension approaches to farm productivity as reported by the respondents. Respondents were asked to indicate whether the extension approaches had contributed to their farm productivity. According to the findings all the three approaches had contributed to the improvement in farm yields.

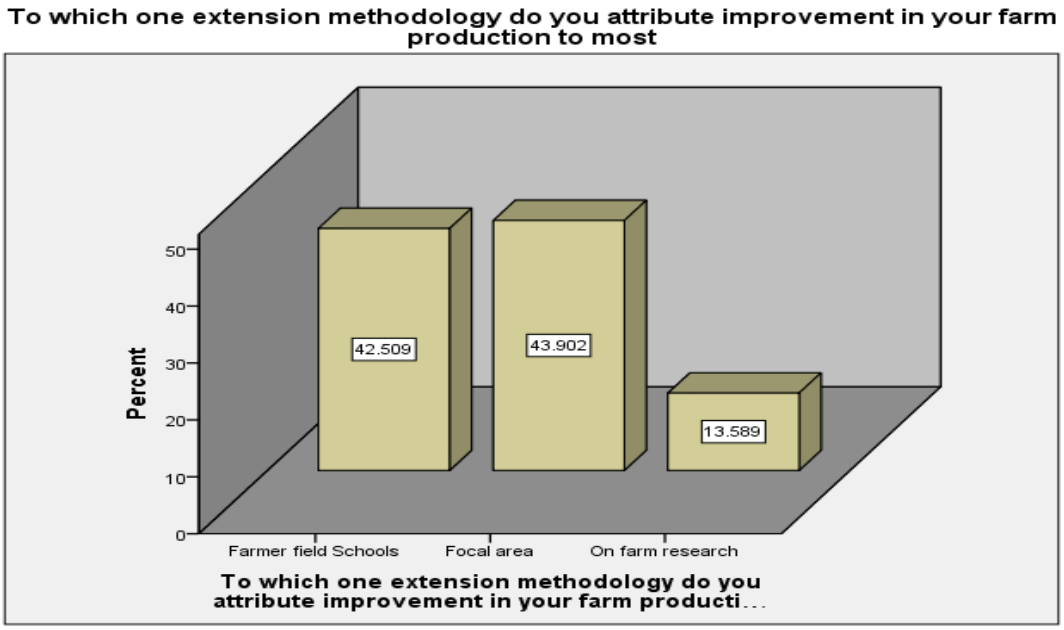

Figure 1: Contribution of extension approaches to farm productivity

Results indicate that Focal Area Approach contributed to 43.9 percent, of the 396 respondents in the study followed by Farmer Field School at 42.5 percent while On -Farm Research contributed to 13.6 percent.

Analysis of Objective 2

Objective II : To compare the influence of Farmer Field Schools, On-farm Research and Focal Area Extension approaches on knowledge, skills and farm productivity for household food security in the Lake Victoria region of Kenya.

3.8 Knowledge and skills on the use of fertilizers and manures

Enhancement of farmers' knowledge and skills on fertilizers and manure use is an important aspect in enhancing soil fertility improvement. Table 6 shows the results on the knowledge and skills on the use of fertilizers and manures.

Table 6: Extension approaches by knowledge and skills on fertilizers and Manures

Exten App	Very know		Somewhat Know		Not sure		Very little Know		No Know		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
FFS	2	4.3	32	69.6	5	10.9	6	13.0	1	2.2	46	100
FA	7	6.7	55	52.4	20	19.0	20	29.1	3	2.9	105	100
OFR	1	1.8	29	52.7	7	12.7	16	29.1	2	3.6	55	100
CE	1	0.5	96	50.5	19	10.0	18	9.5	56	29.5	190	100
Total	11	2.7	212	53.5	51	12.9	60	15.2	98	24.7	396	100

N=396

The results show that 53.3 percent of the farmers had knowledge and skills on the fertilizers and manures. The fertilizers and manures examined in the study were: inorganic fertilizers, green manures, compost and farmyard manure. Farmers exposed to Farmer Field Schools had the highest (69.6%) knowledge and skills on the use of fertilizers and manures; followed by OFR (52.7%); FA (52.4%), and CE (50.5%). According to the results 56.2% of the farmers in the study were knowledgeable on the use of fertilizers and manures. Recommendations by the Kenyan Ministry of Agriculture have documented that the use of fertilizer and hybrid seeds may increase yields from 40 percent to 100 percent [40]. The study findings concur with [41] that only about 60 percent of Kenyan farmers use fertilizer and hybrid seed and that many farmers switch back and forth between using and not using fertilizer from season to season.

3.9 Farmers knowledge and skills on soil testing

In order to determine the type and amount of fertilizer, soil testing is a useful activity so as to establish the nutrient content of specific soils in the farm. Table 7 provides results of responses of participants on the knowledge and skills on soil testing.

Table 7: Extension approaches by knowledge and skills on soil testing

Exten App	Very know F %	Somewhat Know F %	Not sure F %	Very little Know F %	No Know F %	Total F %
FFS	6 13.0	29 63.0	10 21.7	1 2.2	0	46 100
FA	11 10.5	58 55.2	22 21.0	14 13.3	0	105 100
OFR	0	34 61.8	5 9.1	16 29.1	0	55 100
CE	4 2.1	18 9.5	115 60.5	62 4.2	0	190 100
Total	21 5.3	139 35.1	152 38.4	83 21	0	396 100

N=396

The findings show that 40 percent of the participants were very knowledgeable and on soil testing. This means that about 60% no knowledge on soil testing. Although studies have shown that soil testing is a useful tool in the characterization of the topsoil as well as addressing soil fertility constraints [42].Results from this study show that most farmers do not carry out soil testing on their farms. The results indicate that FFS participants had knowledge and skills on soil testing (63%) under the somewhat knowledgeable category, followed by On Farm Research (61.8%), Focal Area (55.2%); while Conventional (9.5%). Respondents cited lack of resources and awareness as the main reasons for not testing their soils. The cost of soil testing ranged from Ksh.250.00 to Ksh.800 per sample, which farmers found to be unaffordable.

3.10 Knowledge and Skills on crop post- harvest handling techniques

Post harvest operations for cereal grains follow a chain of activities starting in farmers' fields and leading eventually to cereals being supplied to consumers in a form they prefer. During post harvest operations there are often considerable losses of both cereal quantity and quality. The losses result from two main factors: (i) grain scattering, dispersal or crushing, at harvesting, handling, processing and during transportation and (ii) grain is subjected to bio deterioration by insects or pathogenic organisms. In most cases, post harvest losses start from the field and are transferred along the chain after harvest, to the store and to the processor/and or consumer [43] . Among the major causes to loss of grain are moulds, mycotoxins and storage insect pests. Table 8 shows the Knowledge and skills on crop post harvest handling techniques per extension approach.

Table 8: Selected extension approaches and farmers knowledge and skills on crop post- harvest handling techniques

Exten App	Very know		Somewhat Know		Not sure		Very little Know		No Know		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
FFS	1	2.2	21	45.7	14	30.4	10	21.7	0	0	46	100
FA	1	1.0	56	53.3	27	25.7	18	17.1	3	2.9	105	100
OFR	2	3.6	28	50.9	10	18.2	14	25.5	1	1.8	55	100
CE	1	0.3	71	17.2	28	7.1	39	9.8	51	26.8	190	100
Total	5	1.3	176	44.4	79	19.9	81	20.5	55	13.9	396	100

N=396

Findings reveal that on crop post harvest techniques, Farmers exposed to Focal Area approach had some knowledge and skills (53.3%), under the somewhat knowledgeable category; Farmers exposed to On- Farm Research (50.9%); Farmers exposed to Farmer Field Schools (45.7%) and Conventional Extension (17.2%). With regard to post-harvest storage, simple technologies with small investments can make a big difference. Small holder farmers with limited access to dry and sanitary storage and cold chain facilities often suffer post harvest food losses that can range from 20 per cent to more than 30 per cent of their crop yields. Furthermore, without crop storage systems, farmers are usually compelled to sell their entire crop immediately at the time of harvest when market prices are much lower than levels possible several months after harvest [44].

3.11 Knowledge and skills on livestock production

Livestock production is useful in the provision of meat, milk and hides and skins among other products. Appropriate technologies to improve dairy production and household food security are crucially needed and that smallholder dairying is clearly a positive activity in a food security programme [45]. Knowledge and skills on various aspects helps to boost livestock productivity among farmers. In the research the knowledge and skills on livestock feeding, disease control, breeding management and population statistics were studied.

3.12 Farmers Knowledge and skills on livestock breeding management

Knowledge and skills in livestock breeding is an important tool in ensuring that there is replacement of existing old stock but also serves as a means of improving or maintaining the genetic make-up of future cows. Table 9 shows the knowledge and skills on livestock breeding management.

Table 9: Knowledge and skills on livestock breeding management

Exten App.	Very know		Some what Know		Not sure		Very little Know		No Know		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
FFS	1	2.2	20	43.5	9	19.6	15	32.6	1	2.2	46	100
FA	5	4.8	29	27.6	31	29.5	37	35.2	3	2.9	105	100
OFR	0	0	22	40.0	8	14.5	24	43.6	1	1.8	55	100
CE	2	1.1	31	16.3	40	21.1	67	35.3	50	26.3	190	100
Total	8	2.0	102	25.8	88	22.2	143	36.1	55	13.9	396	100

N=396

Overall the Knowledge and skills on livestock breeding is fairly low among the farmers (2%) and (25.8%) in the very knowledgeable and knowledgeable categories, implying that 72.2 percent of the farmers had little or no knowledge and skills at all.

3.13 Knowledge and skills on farmers own experiments

This section provides findings of knowledge and skills on farmers own experiments. The specific experiments investigated included: new crop/livestock varieties, use of fertilizers and Indigenous Technical Knowledge (ITK). Studies have shown that farmers carry out experiments sometimes by evaluating the performance of different technological options in a similar environment by conducting controlled experiments that compare techniques, referred to as adaptive experiments [46] .

3.14 Knowledge and skills on experiments involving the use of fertilizers

Assessment was done on the knowledge and skills involving fertilizers included the use of applying varying rates of fertilizers. For example, chicken manure combined with DAP; compost combined with DAP at varied rates; and Farm Yard Manure used solely with topdressing of CAN. Table 10 shows the results of knowledge and skills on fertilizers experiments. The results show that 21.7 percent of the farmers had knowledge and skills on experiments involving fertilizer trials, while about 78.3 percent had little or no knowledge.

3.15 Knowledge and skills on experiments involving ITK

Experiments assessed under ITK involved the use of plant extracts, ash of certain tree species and their effectiveness in controlling insect pests like stalk borer in maize and vegetables. Results in Table 11 show the

Knowledge and skills on carrying out experiments involving Indigenous Technical Knowledge (ITK) by extension approach.

Table 10: Knowledge and skills on experiments involving fertilizer trials by Extension approach

Exten App	Very know		Some what Know		Not sure		Very little Know		No Know		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
FFS	6	13.0	7	15.2	21	45.7	9	19.6	3	6.5	46	100
FA	2	1.9	36	34.3	23	21.9	36	34.3	8	7.6	105	100
OFR	1	1.8	12	21.8	11	20.0	26	47.3	5	9.1	55	100
CE	1	0.5	21	11.0	48	25.3	67	35.3	53	27.9	190	100
Total	10	2.5	76	19.2	103	26.0	138	34.8	69	17.4	396	100

N= 396

Table 11: Knowledge and skills on experiments about ITK by Extension approach

Exten App	Very know		Somewhat Know		Not sure		Very little Know		No Knowledge		Total	
	F	%	F	%	F	%	F	%	F	%	F	%
FFS	1	2.2	26	56.5	7	15.2	8	17.4	4	8.7	46	100
FA	6	5.7	32	30.5	24	22.9	30	28.6	13	12.4	105	100
OFR	2	3.6	11	20.0	14	25.5	26	47.3	2	3.6	55	100
CE	6	3.2	18	9.4	48	25.3	53	27.9	65	34.2	190	100
Total	15	3.8	87	22	93	23.5	117	29.5	84	21.2	396	100

N=396

Results show that only 29.6 percent were knowledgeable on experiments involving ITK, while 74.2 percent had no knowledge. However when a comparison was made among the extension approaches, Farmer Field Schools had the highest (56.5%).

3.16 Analysis of Hypotheses

In comparing the influence of the three extension approaches, four hypotheses were derived from objective as stated herein:

Objective 2:

To compare the influence of Farmer Field Schools, On-farm Research and Focal Area extension approaches on the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

Hypotheses I, II and III were tested using independent *t*- test, while Hypothesis iv was tested using F- test for ANOVA. One-way ANOVA refers to the analysis of variance where groups were being compared on only one variable but at different levels. The hypotheses were tested at probability $\alpha = 0.05$ significance level.

3.17 Test of Hypothesis I

$Ho_{(1)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between the farmers exposed to Farmer Field Schools Extension approach and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

Table 12 presents the results of a comparison between Farmer Field Schools and conventional extension regarding the influence on acquisition of knowledge, skills and productivity for household food security.

Table 12: Independent t-test results for the comparison of Farmer Field Schools and Conventional Extension

Source	Means	N (236)	df	Std. Error Difference	T	Sig. (2-tailed)
FFS	2.7823	46	2	.06951	-1.587	0.014
Conventional Extension	2.9053	190		.03788		

From the Results in Table 33, $p = 0.014$ is less than alpha 0.05. This indicates therefore that, there is a significant difference in the means of farmers exposed to FFS and Conventional Extension approaches. We therefore reject the null hypothesis. This implies that Farmer Field Schools extension approach significantly influences the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya. The findings mean that when a comparison was made between farmers exposed to FFS and

Conventional Extension, those exposed to FFS had more knowledge , skills and productivity that those of Conventional Extension.

The findings mean that farmers exposed to FFS had more knowledge on farm operations including: the use of fertilizers and manures, soil testing, the choice of type and varieties of seeds to plant, weed control and crop spacing. The results also mean that farmers exposed to FFS had higher knowledge and skills on credit facilities, had higher family farm incomes and higher farm productivity as compared to those exposed to Conventional Extension approach. On experiments farmers exposed to FFS had higher knowledge and skills involving crop/livestock varieties as well as livestock breeding.

On experiments the findings mean that farmers exposed to Farmer Field Schools had the higher knowledge and skills on experiments involving crop/livestock varieties and Indigenous Technical Knowledge (ITK) as compared to those exposed to Conventional Extension.

3.18 Test of Hypothesis II

$H_{O(2)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between the farmers exposed to Focal Area Extension approach and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

Table 13 presents the results of a comparison between Focal Area and Conventional Extension regarding the influence on acquisition of knowledge, skills and productivity for household food security.

Table 13: Independent t-test results for the comparison between Focal Area and Conventional Extension approaches

Source	Means	N (295)	Df	Std. Error Mean	t	Sig. (2-tailed)
Focal Area	3.0611	105	2	.07809	2.000	0.047
Conventional Extension	2.9053	190		.03788		

The results show that p=0.047 which is less than alpha, meaning that there is a statistically significant difference in the means of farmers exposed to the Focal Area approach and Conventional approach hence we reject the null hypothesis. This implies that Focal Area extension approach significantly influences the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya. The findings mean that when a comparison was made between farmers exposed to Focal Area and Conventional Extension, those exposed to Focal Area had more knowledge , skills and productivity that those of Conventional Extension. The farmers exposed to Focal Area were more knowledgeable than those exposed to Conventional Extension on farm operations including: ploughing, crop post harvest handling techniques, marketing of produce and experiments involving fertilizers trials.

3.19 Test of Hypothesis III

$H_{O\,(3)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between the farmers exposed to On- Farm Research approach and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

Table 14 presents the results of a comparison between On Farm Research and Conventional Extension regarding the acquisition of knowledge, skills and productivity for household food security.

Table 14: Independent t-test results for the comparison between On -Farm Research and Conventional extension approaches

Source	Means	N (245)	df	Std. Error Mean	t	Sig. (2-tailed)
On -Farm Research	2.8568	55	2	.05273	-.767	0.44
Conventional Extension	2.9053	190		.03788		

From the Results, $p = 0.44$ which is greater than alpha. Meaning, there is no significant difference in the means of farmers exposed to On-Farm Research extension approach and the conventional extension approach; hence we fail to reject the null hypothesis. This implies that On-Farm Research extension approach does not necessarily influence the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya. Although the findings show farmers exposed to On-Farm Research approach had higher knowledge on certain farm operations such as livestock feeding, livestock management and control of livestock diseases, when farmers On-Farm Research were compared to those exposed to Conventional Extension the former did not have statistically higher knowledge and skills than the latter.

3.20 Test of Hypothesis IV: Multiple comparison

$H_{O(4)}$ There is no statistically significant difference in the acquisition of knowledge, skills and productivity between farmers exposed to a combination of Farmer Field Schools, On-farm Research, Focal Area Extension approaches and those exposed to Conventional Extension approach in the Lake Victoria region of Kenya.

a) An F-test with ANOVA was done to find out the statistical significance when all the three approaches were combined against conventional extension approach.

From the results it can be seen that (p=0.000). This p value is less than 0.05 (p=0.000), meaning the difference is strongly significant, which implies that there is a statistical significance difference between means of all the three approaches combined and Conventional Extension. We therefore reject the null hypothesis. This implies that all the three approaches combined may significantly influence the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

Table 15: F-test with ANOVA results for the comparison between the three selected approaches combined and Conventional Extension

Source	Means	N (396)	df	Std. Error Mean	f	Sig. (2-tailed)
More than One approach	2.4975	206	2	.08237	-5.025	.000*
Conventional Extension	2.9053	190		.03788		

The study findings revealed the following:

3.21 Findings of the study

This section provides major findings to this study, starting with knowledge and skills related to crop production; knowledge and skills related to livestock production; knowledge and skills related to farmers own experiments; knowledge and skills related to agricultural support services; and lastly findings based on the analysis of the to the study hypotheses.

3.22 Status of changes in Farm productivity

Findings revealed that all the three extension approaches had contributed to the improvement in farm productivity to some extent, however Farmer Field Schools contributed most to family farm income (54.3%) compared to the other two Extension approaches.

3.23 Knowledge and skills on various farm operations

a) Findings based on the knowledge and skills related to crop productivity

Findings revealed that: first that farmers exposed to Focal Area Extension approach had the highest (56.2%) knowledge and skills on ploughing. Secondly, Farmer Field Schools contributed most to the acquisition of knowledge and skills on the use of fertilizers and manures manure (69.6%) compared to the other two Extension approaches. Thirdly, farmers exposed to Farmer Field Schools had highest knowledge and skills on soil testing (63%) as compared to the other two approaches; Fourthly, farmers exposed to Farmer Field Schools had the highest knowledge and skills on the choice of type and varieties of seeds to plant (58.7%) as compared to the other two approaches; fifthly, on weed control results showed that farmers exposed to Farmer Field Schools was highest (73.9%) as compared to the other two approaches; Sixthly, for knowledge and skills on crop spacing, farmers exposed Farmer Field Schools was highest (58.7).seventhly, on crop post harvest handling techniques farmers exposed to Focal Area approach had the highest knowledge and skills (53.3%) as compared to the other

two approaches; and lastly, farmers exposed to On- Farm Research had the highest knowledge and skills on the use of commercial chemicals towards the storage of crops.

b) Findings based on the knowledge and skills related to livestock production

Findings revealed that on livestock feeding: firstly, farmers exposed to On- Farm Research had the highest knowledge and skills (54.5%) as compared to the other two approaches; Secondly, farmers exposed to On- Farm Research had the highest knowledge and livestock for the management and control of livestock diseases; Thirdly on livestock breeding management Farmer Field Schools had the highest knowledge and skills (43.5%) as compared to the other two approaches.

c) Findings based on the knowledge and skills related to farmers own experiments

Findings revealed: first that farmers exposed to Farmer Field Schools had the highest knowledge and skills (32.6%) on experiments involving crop/livestock varieties; secondly that farmers exposed Focal Area had highest knowledge and skills (34.3%) on Experiments involving fertilizers trials. Thirdly, that farmers exposed to Farmer Field Schools had the highest (56.5%) knowledge and skills on experiments involving Indigenous Technical Knowledge (ITK) as compared to the two approaches.

d) Findings based on the knowledge and skills related to agricultural support services

Findings revealed that knowledge and skills on marketing of produce was highest (55.2%) among farmers exposed to Focal Area approach; and secondly farmers exposed to Farmer Field Schools had the highest knowledge and skills on credit facilities as compared to the other two approaches.

3.24 Findings based on the study hypotheses

a) Influence of Farmer Field Schools

The results indicate that there was a statistically significant difference between the means of farmers exposed to Farmer Field Schools and those exposed to Conventional Extension at alpha 0.05 ($p < 0.05$), meaning that the null hypothesis was rejected. This implies that when the knowledge and skills of farmers exposed Farmer Field School extension approach may significantly contribute to the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

b) Influence of Focal Area approach

The results indicate that there is a statistically significant difference between the means of farmers exposed to Focal Area and farmers exposed to Conventional Extension at alpha 0.05 ($p < 0.05$), meaning that the null hypothesis was rejected . This implies that Focal Area extension approach may significantly contribute to the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

c) Influence of On Farm Research

The results indicate that there is no statistically significant difference between the means of On- Farm Research farmers and Conventional Extension at alpha 0.05 ($p < 0.05$). This implies that On Farm Research extension approach may not significantly contribute to the acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

d) Comparison of all the three extension approaches

When farmers exposed to a combination of the three alternative approaches in the study were compared to those exposed to Conventional Extension and analysis done using F- test with ANOVA, the results show that $p<0.000$ meaning that the p value is less than 0.05 ($p>0.05$), hence the null hypothesis was rejected and that the difference in the means was strongly significant.

3.25 Conclusions

The following conclusions may be drawn from the study:

i- That Farmer Field Schools approach is useful as revealed in the study. It may contribute to the acquisition of knowledge and skills in various agricultural production activities but more significantly to an increase in farm productivity. The study concludes that Farmer Field School influences agricultural knowledge, skills for household food production in the Lake Victoria region of Kenya. The findings showed that the approach contributed to knowledge and skills on seven technologies, which was the highest among the three approaches.

ii- That although On- Farm Research approach contributed to some knowledge and skills for household food productivity, a hypothesis test showed no significant influence. The study concludes that On-Farm Research does not influence agricultural production knowledge, skills for household food production in the Lake Victoria region of Kenya. The approach only contributed to the acquisition of knowledge and skills on two technologies namely livestock feeding and livestock diseases, but did not contribute to other variables.

iii- That findings showed that Focal Area approach contributed most to the acquisition of knowledge and skills in various agricultural production activities. Hypothesis test also showed significant contribution towards knowledge and skills for farm productivity. The study concludes that Focal Area Approach influences acquisition of knowledge, skills and productivity for household food

security in the Lake Victoria region of Kenya. From the results it can be seen that knowledge and skills such as on marketing of farm produce was highest among farmers exposed to Focal Area approach, meaning that such farmers will not only produce crops and livestock but will produce for specific markets niches. Secondly, they will look for value in their produce, thereby undertake in terms of value addition thereby embrace the concept of farming as a business.

iv- That findings show that when all the farmers were exposed to a combination of all the three Extension approaches there was a highly significant difference in the means. The study concludes that a combination of the three alternative approaches influences acquisition of knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya. When all the three alternative approaches were used in combination, the results revealed that there was some synergy in their contribution to acquisition of knowledge and skills on the agricultural technologies.

3.26 Recommendations

The following recommendations may be drawn from the study:

1. Since all the three extension approaches enhance knowledge, skills and productivity for household food security there is need to use them in agricultural technology development and transfer. Nonetheless employing specific extension approaches to carry out specific technologies taking into cognizance their strengths as demonstrated in the study is recommended.
2. Results of this study revealed that Farmer Field Schools approach enhances experimentation skills of farmers. The study recommends the use this Extension approach by researchers in the verification and validation of proven agricultural technologies; test new ones and use it to disseminate research outputs to other farmers.
3. On -Farm Research proved that it enhances knowledge and skills in such activities such as ploughing and livestock production, it may be recommended that it be used for such technologies, nonetheless use of the approaches singly may not be very productive in the acquisition of knowledge, skills and productivity for household food security.
4. Study findings revealed that Focal Area Approach enhances acquisition of knowledge and skills on several activities and technologies including crop post harvest handling technologies. The study therefore recommends the use of this approach in the acquisition of knowledge and skills improving agricultural productivity.

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References

[1] J.K. Kibet, M.E. Omunyinyi, M. E. & J. Muchiri . Elements of Agricultural Extension Policy in Kenya. Challenges and Opportunities. African Crop Science Conference Proceedings. 7: 1491 - 1494.2005.

[2] A.Haines & A.Cassels. Can The Millennium Development Goals Be Attained? BMJ: British Medical Journal, Vol. 329, No. 7462 (Aug. 14, 2004), pp. 394-397.2004.

[3] C.Thirtle . Producer Funding of R&D: Productivity and the Returns to R&D in British Sugar, 1954-93, *Journal of Agricultural Economics*, Vol.50, No.3.2001.

[4] GoK. (2005). *Draft National Agriculture Sector Extension Policy* (NASEP).Ministry of Agriculture and Rural Development. Nairobi. July 2005.

[5] Central Bureau of Statistics .(2003) *Statistical Abstract 2004*. *Ministry of Finance and Planning.* Government Printers, Nairobi.

[6] GoK. (2001). Poverty Reduction Strategy Paper for the Period 2001-2004. Ministry of Finance and Planning, Government Printer, Nairobi. Kenya.

[7] R. Joetzold, H. Schmidt, H. Brethold, & C. Shisanya, C. (2006). Farm Management hand Book of Kenya, Vol II: Part B. Rassdorf, Nairobi.

[8] World Bank. *World Development Report: Agriculture for Development* (World Bank, Washington, DC,). 2008.

[9] FAO . *State of Food Insecurity in the World 2009* .FAO, Rome, 2009.

[10] A. Evans. *The Feeding of the Nine Billion: Global Food Security* (Chatham House, London. 2009.

[11] D. Tilmanet . *Forecasting agriculturally driven global environmental change. Science* 2001.

[12] Food & Agriculture Organization. "Rome Declaration on World Food Security." Proceedings from the World Food Summit, November 13–17, 1996. Rome, Italy.

[13] R.M. Hassan. *Maize Technology Development Transfer*: A GIS Application for Research Planning in Kenya. CABI Publishing, Wallingfors, UK. 1998

[14] GoK. Poverty Reduction Strategy Paper (PRSP) 2000-2003. Nairobi: Government Printers.2000.

[15] UNDP . Kenya Human Development Report. Nairobi: UNDP. 2002

[16] GoK . Kenya Integrated Household Survey (KIHBS, 2005/6). Ministry of Planning & National Development, Nairobi: Government Printer.2006

[18] A.P. Davidson, A. Munir & A.Tanvir . *Dilemmas of agricultural extension in Pakistan: Food for thought.* Agricultural Research and Extension Network. Network Paper No. 116. Overseas Development Institute.2001

[19] Katz, E. (2002). *Innovative Approaches to Financing Extension for Agriculture and NaturalResource Management*: Conceptual considerations and analysis of experience. LBL,Swiss Center for Agricultural Extension, Eschikon 28, CH-8315 Lindau, Switzerland.

[20] D. Rocheleau, F.Weber & A. Field-Juma. Agroforestry in Dryland Africa (ICRAF, Nairobi).1998

[21] Kang, B.T., L. Reynolds, and A.N. Atta-Krah. . Alley Farming. Advances in Agronomy. 1990.

[22] A.Braun, J.Jiggins, N. Ro¨ ling, H.Van den Berg & P.Snijders . A global survey and review of Farmer Field School experiences. Nairobi: International Livestock Research Institute .2006

[23] A.Abate &, D. Duveskog *Applications of the Farmer Field School Approach in Kenya,* A Report of The Farmer Field School Stakeholders forum Held on 27th March 2003 At ILRI, Nairobi, Kenya, 2003. Pp. 11-15.

[24] P. Kenmore. Integrated pest management in rice. In: Persley, G.(Ed.), Biotechnology and Integrated Pest Management. CAB International,Wallingford, pp. 76–97.1996.

[25] N. Ro¨ ling, N. (1995). The changing role of agricultural extension. In agricultural extension in Africa: Proceedings of an international workshop. Yaounde, Cameroon, January 1994. Technical Center for Agricultural and Rural Cooperation, Wageningen, The Netherlands.1995.

[26] Van de Fliert, E. (1993). Integrated pest management: Farmer field schools generate sustainable practices. A case study in central Java evaluating IPM training. Published Doctoral Dissertation, Wageningen University, Wageningingen.

[27] D.Duveskog . Theoretical perspectives of the learning process in farmer field schools. Nairobi: FAO Working Paper .2006.

[28] Ministry of Agriculture, Livestock & Fisheries Development. NALEP Operational Manual, Kilimo House Nairobi.2004.

[29] J. Morris. *Extension Alternatives in Tropical Africa*. Overseas Development Institute: London.1991.

[30] J.R. Fraenkel, J.R. & N.E. Wallen, N.E. How to Design and Evaluate Research in Education: New York, NY: Mcgraw-Hill Publishers Co. Pp 2-483.2000.

[31] O. Mugenda & A.G. Mugenda, A.G. *Research Methods*: *Quantitative and Qualitative Approach*, African Centre for Technology Studies, Nairobi, Kenya.1999.

[32] V. H.Borg & Gall, M.E. . *Education Research: An Introduction*, Pp 257-265). New York, NY:Longman. Inc. 2003.

[33] UNEP (2006a). Lake Victoria Environment Outlook: Environment and Development. UNEP,Nairobi, Kenya.

[34] GoK . Demographic and Health Survey (KDHS, 2008/2009). Ministry of Health, Nairobi: Government Printer.2009.

[35] K. Davis, & N. Place. Non-governmental organizations as an Important Actor in Agricultural Extension in Semiarid East Africa. Journal of International Agricultural and Extension Education, 10(1),31–36.2003.

[36] Feder, G., Murgai, R., & Quizon, J. (2004a). Sending farmers back to school: The impact of farmer field schools in Indonesia. Review of Agricultural Economics, 26(1), 45–62.

[37] GoK. Development Plan 1997-2000. Nairobi: Government Printing Press.1997

[38] G. Feder, R. Murgai, & J. Quizon . Sending farmers back to school: The impact of farmer field schools in Indonesia. Review of Agricultural Economics, 2004a .26(1), 45–62.

[39] T.S. Jayne, T. Yamano, M. Weber, D. Tschirley, R. Benfica, A. Chapoto & B.Zulu. "Smallholder income and land distribution in Africa: implications for poverty reduction strategies." Food Policy 28: 253–275. Research Foundation for Science, Technology and Ecology.2003.

[40] Kenya Agricultural Research Institute . Fertilizer Use Recommendations Program, Vol. 1-23 . Nairobi, Kenya: KARI.1994.

[41] Suri, T. (2007). "Selection and Comparative Advantage in Technology Adoption" working paper, MIT Sloan School.

[42] FAO (1998). Topsoil Characterization for Sustainable Land Management. Rome: Food and Agricultural Organization of the United Nations, Land and Water Development Division.1998.

[43] A.F.Adisa. Estimating field loss of a developed rice stripper harvester in Nigeria. International Journal of Science and Technology, 2013. 2: 353-358.

[44] Kader, A and Rolle, R. (2004). "The role of post-harvest management in assuring the quality and safety of horticultural produce." FAO, Rome.

[45] G. Mbagaya, M. Odhiambo & R. Oniango. .*Dairy production: A nutrition intervention in a sugarcane growing are in Western Kenya.* African Journal of Food Agriculture, Nutrition and Development. Volume 4 No1 2004.

[46] R.Rhoades & A.Bebbington. 'Farmers As Experimenters' in B. Haverkort, J. Van Der Kamp and A.Waters-Bayer (Eds) *Joining Farmer.1,'Experiments: Experience*!, in *Participatory Technology Development*. London; Intermediate Technology Publications.1991.