THE EFFECTIVENESS OF FARMER FIELD SCHOOLS' EXTENSION METHODOLOGY IN CONSERVING SOIL AND WATER USING CONTOUR PLOUGHING, UNPLOUGHED STRIPS AND FARM YARD MANURE

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Abstract

Land degradation, characterized by bare ground, wanton destruction of vegetation and poor farming practices, still threatens food production in Africa where poverty and insufficient resources for income generation impacts negatively on the population. The Farmer Field Schools' (FFS) Extension and Non-Farmer Field Schools' (NFFS) Extension Methodologies have been used to teach farmers how to minimize the problem in both Bondo and Rarieda districts of Kenysa through soil and water conservation. However, it is not yet clear whether FFS are more effective than NFFS in enhancing adoption of Contour Farming, Un-ploughed Strips and Farm Yard Manure Application. This study sought answers to this question using a cross-sectional survey design to collect data from 150 FFS-trained and 150 NFFS-trained farmers randomly selected from both districts. Ten extension experts ascertained the questionnaire's content validity whose reliability was 0.85α at 0.05 confidence level. A t-test was used to determine the presence of significant differences between mean scores of FFS-trained and NFFS-trained farmers in adopting the three conservation techniques. The FFS-trained farmers' adoption rate of the three conservation technologies was significantly higher than that of the NFFS-trained farmers. The FFS extension methodology was more effective than the NFFS extension methodologies. Extension providers should consider using the FFS extension methodology more in their daily extension work because it is interactive and more effective than the NFFS.

Key words: *effectiveness, farmer field schools, conservation of resources, Bondo and Rarieda districts, Kenya.*

Introduction

Globally, the problem of land degradation, which is a major threat to food security and farm productivity, is worse now than ever before and according to the United Nations Secretary General, Ban Ki-moon, land degradation has made approximately 30% of the world's cropland unproductive over the past 40 years (Block, 2008, Ki-moon, 2010). In Bondo and Rarieda districts of Western Kenya, land degradation manifested itself in gullies, bare ground and wanton destruction of ground vegetation cover that led to losses of soil and water and increased inability of the land to support agricultural production. It makes land use unsustainable and harder for Kenya to achieve her Vision 2030 that targets a 10% annual economic growth aimed at creating sufficient funds for improving the country's infrastructure and reducing unequal distribution of resources, poverty and unemployment (Daily Nation, 2009). It negatively affects Kenya's ability to achieve the Millennium Development Goal (MDG) 7 whose objective is to ensure environmental sustainability by integrating the principles of sustainable development into policies and programs intended to reverse the loss of environmental resources (GTZ, 2006, Ki-moon, 2010). Effective conservation of the natural resource was greatly needed to address problems of land degradation. Extension providers in Bondo and Rarieda districts were using the Farmer Field Schools (FFS) extension methodology and the non-Farmer Field Schools (NFFS) extension methodologies to promote contour ploughing, use of unploughed strips, and farm yard manure application as conservation measures. A Farmer Field School is a capacity building extension methodology that uses adult education principles in farmers' groups. it is best described as 'a school without walls' in which farmers learn improved technologies and farming practices aimed at high and sustained production as well as environmental conservation in their farms through observation and experimentation (District FFS Coordinator, 2006, Groeneweg, 2006, Mungai, Nakhone, Lagat, Opiyo, & Mumera, 2008, Wright, 2007). Non-Farmer Field Schools (NFFS) extension methodologies involved use of neighbours, friends, farm visits, focal area approach, seminars, letters and brochures, telephone, contact farmers, mass media, agricultural shows, on-farm trials, demonstrations or field days to communicate with farmers.

This study sought to determine the effectiveness of Farmer Field Schools (FFS) extension methodology in enhancing the adoption of contour ploughing, use of unploughed strips and farmyard manure application. The study's specific objectives were to determine the effectiveness of the FFS extension methodology when compared to NFFS extension methodologies in enhancing the adoption of contour ploughing, use of unploughed strips and farmyard manure application in Bondo and Rarieda districts. The results of the study were intended to provide answers to the following research questions: Is FFS extension methodology more effective than NFFS methodologies in enhancing the adoption of contour farming, use of unploughed strips, and farm yard manure application by small-holder farmers in Bondo and Rarieda districts?

Knowing the effectiveness of an extension communication method enables an extension provider to choose correctly an appropriate method that is effective in a particular situation. The correct choice and use of the right extension communication method is likely to enhance adoption of conservation technologies. The ability to choose the correct extension method was particularly important in Bondo and Rarieda districts because over 80% of the households in the two districts engaged in subsistence farming, were food insecure in at least part of the year, 74.1% of them lived below the poverty line and experienced surface runoff of 40% in their farms and development of gullies affected 30% of their available arable land (District Agricultural Officer, 2006, Mungai, Nakhone, Lagat, Opiyo, & Mumera, 2008).

Problem of Research

Extension providers in the two districts had insufficient knowledge on whether the FFS extension methodology was more effective than the NFFS extension methodologies in addressing problems of land degradation. Lack of this information made it harder for them to choose and apply the more effective extension methodology in resources conservation. This study was intended to provide the missing information to enable extension providers to choose correctly an appropriate extension method that would more effectively improve their dissemination of appropriate conservation technologies to farmers. Better interaction with farmers would then enhance farmers' adoption of sustainable farming practices in the two districts. The results from this study were also intended to help other educators in encouraging frequent use of the more effective extension communication methodology in all their interactions with farmers on issues related to environmental conservation.

Research Focus

Land degradation - largely caused by land clearance, deforestation and poor farming practices – is becoming worse in severity and extent and is a major threat to food security and farm productivity in African countries and Kenya in particular (Block, 2008). It manifested itself in declining biodiversity; soil erosion leading to loss of soil fertility and productivity with negative impacts on livelihoods and the economy; increased sedimentation; long-term loss of ecosystem function due to disturbances from which the land cannot recover unaided; reduced crop and pasture productivity; diminished fuel wood and non-timber forest products closely linked to poverty and food insecurity; increased salinity; scanty ground vegetation cover and low carrying capacity of pastures; farmer migration; and ecosystem failure (Block, 2008, Muchena 2008). Uncontrolled land degradation made it harder for Kenya to achieve the MDG 7 whose objective is to ensure environmental sustainability by integrating the principles of sustainable development into policies and programs intended to reverse the loss of environmental resources. Within the 40 years that approximately 30% of the world's cropland became unproductive, involuntary migration, disintegration of communities, political instability and armed conflict occurred as a result of social strains caused by drought, famine, unsustainable farming practices that remove ground vegetation cover exposing top soils to erosion, and deepening poverty (GTZ, 2006, Ki-moon, 2010).

Land degradation made it harder for Kenya to achieve her goals of increasing farm productivity, food self-sufficiency, better nutrition and poverty reduction without increasing cultivated land. Achievement of MDG 1 and 2 was particularly important for Bondo and Rarieda districts whose poverty level was 71% implying that it is was important to eradicate extreme poverty and hunger, as per the objectives of MDG 1 (DDO, 2007). Because degraded farms needed more resources to than average farmers could afford, using effective extension methods to disseminate research-based technologies to farmers was desirable and extremely essential (Block, 2008, Groeneweg, 2006, Prager, Schuler, Helming, Zander, Ratinger & Hagedorn, 2010, Wright, 2007). To conserve the natural resource, extension providers promoted three conservation technologies to cut down the speed of ground runoff namely, *contour ploughing* and use of *stone lines* or *unploughed strips*. In contour ploughing, farmers plough the land across the slope to create stepped-up ridges for planting crops. The ridges reduce the speed of water runoff, which causes soil erosion. Unploughed strips usually 1-2 m wide, left along the contours prevent or minimize soil erosion by slowing down the flow of surface water down the slope. Soil erosion was also controlled by constructing stone lines using stones or boulders (Government of Kenya, 2002).

Contour ploughing ensures that rainfall and surface runoff is spread over a field by making furrows parallel to the contours. It is effective on slopes less than 10% steep and can reduce soil erosion by 50% while increasing water infiltration and soil retention, limited release of nutrients, disruption of wind currents, reduced loss of nutrients and increased speed of ox ploughing since the equipment moves along the same elevation (Nyagaka, Mwer, Shiribwa, & Kaumbutho, 2001, Posthumus, Hewett, Moris, Quinn, 2008). However, improperly laid contour lines increase the risk of soil erosion; stepped topography may hinder mechanized farming; and maintenance of contours is labour-intensive (Nyagaka *et al.,* 2001). *Unploughed strips*, usually 1-2m wide, left to run along the contours act as a barrier that slows the speed of surface runoff down the slope while *farmyard manure* is a good source of plant nutrients. Some farmyard manures provide 70%-80% nitrogen, 60%-85% phosphorus and 80%-90% potassium (Quedraego, 2005). Proper management of the top soil creates an organic soil cover that may enhance growth of soil organisms that improve soil structure (Wright, 2007). A cover or mulch prevents the ground from being directly impacted on by rainfall and adoption conservation practices could facilitate accumulation of soil organic matter, which maintains soil physical, chemical and biological properties that are important for crop production (Michemi, Kihanda, Irungu, 2004, Theodore, 2008).

Extension providers were promoting adoption of contour ploughing as well as the use of unploughed strips and farm yard manure application in Bondo and Rarieda districts using the Farmer Field Schools (FFS) extension methodology and non-Farmer Field Schools (NFFS) extension methodologies. The purpose of using FFS extension methodology was to empower farmers, through education, to independently make day-to-day, on-farm decisions and to bring farmers with common problems together to conduct collective and collaborative inquiry (Buttanya, 2004, Makori, 2004). The FFS extension methodology initiates community action in problem solving using experimental learning techniques developed for non-formal adult education. Farmer Field Schools were first used in South East Asia in 1989 to disseminate Integrated Pest Management technologies among small-scale rice farmers and have since been used to educate farmers on soil fertility management in the Philippines, Vietnam and China; and in disseminating dairy production technologies in Kenya (Groweneg, 2006). A farmer field school has 20-30 farmers who meet regularly to share information and interact with researchers and extension workers on a demand-driven basis (Groeneweg, 2006, Soniia, Agordorku, Bassanga, Guloud, Kumi, Okuku, & Wandiji, 2006). Participants learn problem-solving skills by participating in practical farmer-led learning activities on the farmer's field with the help of competent extension facilitators who guide them systematically through discovery learning (Groeneweg, 2006 & Khisa, 2004, Sonii *et al.,* 2006). The number of FFS in both crop and livestock production in Bondo district increased from 18 in 2002 to 187 in 2010 involving 4500 farmers (District FFS Coordinator, 2007).

Figure 1 shows the relationship between the independent variable *types of extension methodologies* and the dependent variable *effectiveness*. To control the Intervening variable *experimental learning*, all farmers taught through FFS used the same curriculum while those taught through NFFS used various models. To control the variable *contact hours*, completed hours of learning was 80 hours for all FFS-trained farmers but varied for NFFS-trained farmers depending on the method used. The variable *funds availability* was controlled by ensuring that all FFS-trained farmers received 80,500/= Kenya shillings (US$ 1.00= Ksh. 1,000) of which 40,000/= (US$ 500) was for capacity building and the remaining 40,500/= for enterprise development. NFFS-trained farmers had received no funds or varying amount that could not be easily quantified. The intervening variable *policy environment* was controlled by the fact both FFS-trained and NFFS-trained farmers worked under the same policy environment. Farmers were free to decide whether to adopt or not. Therefore, differences in adoption of the three resource conservation technologies between the two groups could be attributed to factors other than policy environment. To control the variable *facilitators,* both the FFS-trained and NFFS-trained farmers were taught by extension agents with equivalent training, qualifications and experience. Therefore, any changes in the dependent variable were more likely to be due to the extension methodology used.

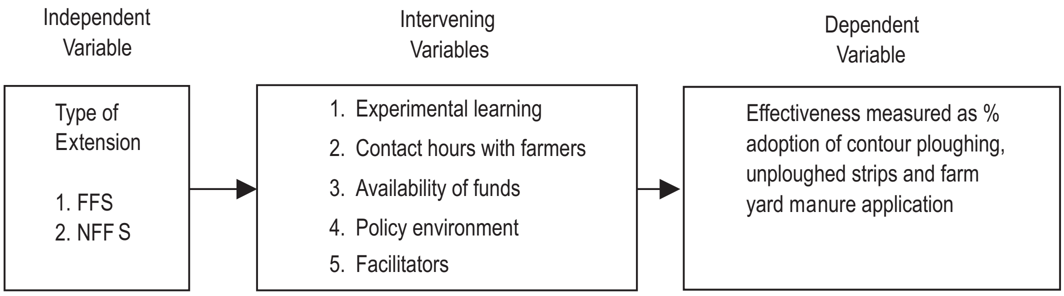

Figure 1: A conceptual framework for determining the effectiveness of the type of extension delivery method in the farmers' adoption of three resource conservation techniques.

Methodology of Research

General Background of Research

The study used a cross-sectional survey design (Kombo & Tromp, 2007) to collect data from 150 FFS-trained and 150 NFFS-trained farmers in Bondo and Rarieda districts. This design is suitable for determining respondents' feelings, attitudes, opinions and practices. Bondo district is 1328 km^2 and has a population of 144,780 while Rarieda district is 644 km^2 and has a population of 133,886 (District Agricultural Officer, 2008, District Livestock Production Officer, 2008). The rainfall in both districts is bimodal and ranges from 800-1600mm per year with a mean of 1200mm. The long rains fall between March and May while the short rains fall between October and November. The temperature ranges from 15^{0}C-32^{0}C with a mean of 24^{0}C while the annual evaporation rate is 2000-2200mm. The districts are 1140m-1400m above sea level and have soils that vary from black cotton, sand loams, to red volcanic. Small-scale farmers account for 80% of total agricultural production. On average, their farms are 2-3ha. Their annual consumption of cereals is 350,000 bags but production is 201,080 bags indicating a big food deficit that is responsible for the prevailing poverty index of 70.6% (Central Bureau of Statistics, 2000, District Development Officer, 2008).

Sample of Research

Purposive sampling was used to select FFS-trained farmers and proportional random sampling to select respondents from each division based on the number of farmers in the division. Divisions with more farmers had a higher representation in the sample. In order to minimize problems of attrition, migration out of the study area, and non-response or refusal to participate, a sample of 300 was selected from 4500 farmers, which included 150 FFS-trained farmers and 150 NFFS-trained farmers. This number was above the minimum of 100 subjects recommended for survey research analysis in each major sub-group by Kathuri and Pals (1993) and Fraenkel and Wallen (1990). An equal number of NFFS-trained farmers (150) were selected proportionately from a list obtained from District Agricultural Officers of both districts. These officers had kept records of all farmers trained through FFS and NFFS. It was therefore possible to distinguish FFS-trained from NFFS-trained farmers.

Instrument and Procedures

A structured closed-ended questionnaire, developed by the researchers and found to be content valid by a panel of extension experts, was used to collect primary data while reports and pamphlets were used to collect secondary data (Kombo & Tromp, 2007, Kothari, 2007). The questionnaire for data collection was pilot tested with 35 FFS-trained and 35 NFFS-trained farmers in the neighbouring Busia district. Its reliability was found to be 0.85α, which was above the 0.70 threshold for acceptable reliability (Bryman & Cramer, 1997). For data collection, five enumerators, trained on questionnaire administration and issues of confidentiality assisted the researchers in collecting primary data from both FFS-Trained and NFFS-trained farmers in their farms. This was preceded by prior appointments made through Divisional FFS Coordinators. The three conservation techniques that farmers had adopted were measured in meters. Each respondent completed the questionnaire and handed it over to the researchers or to enumerators who checked to ensure that there were no uncompleted items. Where necessary, respondents with inadequate writing skills were assisted to record their responses in the questionnaire. The size of farms was calculated in square meters to obtain the proportion of land conserved through the three land conservation technologies.

Data Analysis

Data were entered in the computer and analyzed using the Statistical Package for Social Sciences (SPSS). For each technique (contour ploughing, unploughed strips and farmyard manure application), the mean, mode and standard deviations were calculated while a t-test was used to determine whether there was a statistically significant difference in mean scores between FFS-trained and NFFS-trained farmers. The extension methodology (FFS or NFFS) associated with a higher adoption rate than the other was considered more effective.

Results of Research

Unlike NFFS- trained farmers, all FFS-trained farmers followed a well defined resource conservation training program linked to a specific enterprise from land preparation to harvesting. Depending on the enterprise, farmers were trained for 2 hours per day once a week for a maximum of 40 weeks or 80 contact hours with extension staff. The curriculum for NFFS-trained farmers was not well defined since the training was largely informal and therefore, it was difficult to ascertain the number of times they interacted with extension providers. The fact that adoption of the three resource conservation technologies was higher for FFS-trained than for NFFS-trained farmers implies a positive and significant relationship between farmers' contact hours with extension providers and adoption.

Table 1 shows the farmers' percentage adoption of the three conservation technologies by age. None of the respondents was below 20 years and although percentage adoption tended to increase with age, it was relatively higher for FFS-trained than for NFFS-trained farmers.

Table 1. Percentage adoption of conservation technologies by age in years (N=300).

Type of technology and extension method	Age				
	< 20	21 - 30	31 - 40	41 - 50	>50
Contour Ploughing					
FFS	0	10	18	26	37
NFFS	0	10	13	15	26
Unploughed Strips					
FFS	0	6	13	20	24
NFFS	0	2	5	5	14
Farm Yard Manure Application					
FFS	0	10	19	24	42
NFFS	0	4	8	17	19

The percentage adoption was higher for females than for males irrespective of the type of technology being promoted and the training methodology used (Table 2).

Table 2. Percentage adoption of conservation technologies by gender (N=300).

Type of technology and extension method	Gender	
	Male farmers	Female farmers
Contour Ploughing		
FFS	29	71
NFFS	31	69
Unploughed Strips		
FFS	17	83
NFFS	19	81
Farm Yard Manure Application		
FFS	23	77
NFFS	24	76

Table 3 shows higher adoption rates among farmers with primary school level of education irrespective of the training methodology used

Table 3. Farmers' percentage adoption of conservation technologies by education level (N=300).

Type of technology and extension method	Education level				
	N	P	S	T	AE
Contour Ploughing					
FFS	2	51	34	2	0
NFFS	2	35	18	5	1
Unploughed Strips					
FFS	2	29	17	1	0
NFFS	2	25	10	0	0
Farm Yard Manure Application					
FFS	1	46	28	1	0
NFFS	1	28	14	5	0

Key: N=Nil, P = Primary, S = Secondary, T = Tertiary, AE = Adult Education

Farmers learned the three conservation technologies from NFFS extension methodologies that included public meetings, on-farm trials, farm visits and tours, residential and non-residential training, and field days. Their adoption of these technologies remained low probably due to the limited contact they had with extension providers and insufficient hands-on experience except where on-farm demonstrations were used. Adoption of the three technologies for FFS-trained farmers was higher than for NFFS-trained farmers implying that use of FFS in promoting the use of these technologies may lead to higher adoption. Plates 1-3 show the three conservation technologies on FFS-trained farmers' farms in Usigu division of Western Kenya.

Plate 1: A Contour Ploughed Field in Western Kenya

Plate 2: Unploughed Strip of a Farm in Western Kenya

Plate 3: Ground Rock Exposed by Water Erosion in Western Kenya

The first research question was: Is the FFS extension methodology more effective than NFFS methodologies in enhancing adoption of contour ploughing in Bondo and Rarieda districts? Table 8 shows that the mean score of land covered by contour ploughing was higher at 1.32 (with a standard deviation of 0.69 and standard error of 0.06) for FFS-trained than for NFFS-trained farmers, which was at 1.27 (with a standard deviation of 1.26 and standard error of 0.10) at 0.05α. Table 9 indicates a statistically significant difference between mean scores of FFS-trained and NFFS-trained farmers in adoption of contour ploughing with a combined mean of 0.20, standard deviation of 1.14 and standard error of 0.07 ($t = 3.09$, $p < 0.05$, df=299).

Table 8. Paired samples statistics for FFS and NFFS-trained farmers on contour ploughing in Bondo and Rarieda Districts (N=300).

		Mean	N	Std Deviation	Std. Error Mean
Pair 1	FFS Test Scores NFFS Test Scores	1.32 1.27	150 150	0.69 1.26	0.06 0.10

Table 9. Paired samples test for FFS and NFFS-trained farmers on contour ploughing in Bondo and Rarieda Districts (N=300).

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FFS Test Scores NFFS Test Scores	0.20	1.14	0.07	0.07	0.33	3.09*	299	0.00

Legend: (*) Significant at 0.05 levels

The second research question was: Is FFS the extension methodology more effective than NFFS methodologies in enhancing the adoption of unploughed strips in Bondo and Rarieda districts? Table 10 shows that the mean score of land covered by unploughed strips was higher at 0.74 (with a standard deviation of 0.85 and standard error of 0.07) for FFS-trained than for NFFS-trained farmers, which was at 0.53 (with a standard deviation of 0.08 and standard error of 0.07) at 0.05 confidence level. Table 11 indicates a statistically significant difference between mean scores of FFS-trained and NFFS-trained farmers in adoption of unploughed strips with a combined mean of 0.86, standard deviation of 1.02 and standard error of 0.06 ($t = 14.65$, $p < 0.05$, df=299).

Table 10. Paired samples statistics for FFS and NFFS-trained farmers on unploughed strips in Bondo and Rarieda Districts (N=300).

		Mean	N	Std Deviation	Std. Error Mean
Pair 1	FFS Test Scores NFFS Test Scores	0.74 0.53	150 150	0.85 0.08	0.07 0.07

Table 11. Paired Samples Test for FFS and NFFS-Trained Farmers on Unploughed Strips in Bondo and Rarieda Districts (N=300).

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FFS Test Scores NFFS Test Scores	0.86	1.02	0.06	0.75	0.98	14.65*	299	0.00

Legend: (*) Significant at 0.05 levels

The third research question was: Is FFS the extension methodology more effective than NFFS methodologies in enhancing the adoption of farmyard manure application in Bondo and Rarieda districts? Table 12 shows that the mean score of land covered by farmyard manure application was higher at 1.15 (with a standard deviation of 0.69 and standard error of 0.06) for FFS-trained than for NFFS-trained farmers, which was at 0.83 (with a standard deviation of 0.76 and standard error of 0.06) at 0.05 confidence level. Table 13 indicates a statistically significant difference between mean scores of FFS-trained and NFFS-trained farmers in adoption of farmyard manure application with a combined mean of 0.51, standard deviation of 0.98 and standard error of 0.06 ($t = 8.93$, $p < 0.05$, $df = 299$).

Table 12. Paired samples statistics for FFS and NFFS-trained farmers on farmyard manure application in Bondo and Rarieda Districts (N=300).

		Mean	N	Std Deviation	Std. Error Mean
Pair 1	FFS Test Scores	1.15	150	0.69	0.06
	NFFS Test Scores	0.83	150	0.76	0.06

Table 13. Paired samples test for FFS and NFFS-trained farmers on farmyard manure application in Bondo and Rarieda Districts (N=300).

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	FFS Test Scores NFFS Test Scores	0.51	0.98	0.06	0.40	0.62	8.93*	299	0.00

Legend: (*) Significant at 0.05 levels

Discussion

Since FFS-trained and NFFS-trained farmers worked under the same farming conditions and were trained by extension agents with similar qualifications and experience, any difference in adoption between then was attributed to the type of extension methodology. The two methodologies differed in practical approach, participatory nature and contact hours. Adoption rate for FFS-trained farmers was higher than for NFFS-trained farmers on all the three conservation technologies, implying that the FFS extension methodology was more effective.

Adoption was higher for older than for younger farmers. This was probably because older farmers had bigger family responsibilities and therefore tended to adopt new technologies that improved the productivity of their farms. This finding is supported or contested by the work of other researchers. For example, Anyango (2000) found no relationship between age and adoption while Rahman (2007) reported a positive relationship. Our results support Rahman's (2007) work but differ with the work of Mohammed and Singh (2003), who found a negative relationship, between age and adoption. Rogers' (1983) had earlier argued that younger farmers were more likely to adopt new technologies. In general adoption of the three conservation technologies (contour ploughing, unploughed strips and farmyard manure application) was higher for FFS-trained than for NFFS-trained farmers implying that the FFS extension methodology was more effective than the NFFS extension methodologies in resource conservation due to its practical and interactive orientation.

Adoption was higher for female than for male farmers. On average, the mean adoption of the three conservation technologies among farmers in the two districts was higher for FFS-trained than for NFFS-trained farmers. This difference could be attributed to the FFS' group learning and learning by doing approach. Adoption of the three conservation technologies was higher for farmers with primary education followed by those with secondary school education and tertiary education. Since education for FFS-trained farmers and NFFS-trained farmers was not significantly different, the higher adoption for farmers with primary education was probably due to their availability for meetings and group composition aspects rather than education. It should be noted that proportional random sampling was based on geographical division rather than education. This may explain why this particular finding differed with the findings of Rahman (2007), Chitere (1995), Ndiema (2002) and Childress (1994) who found that adoption of agricultural technologies increased with education.

Unlike NFFS- trained farmers, all FFS-trained farmers followed a well defined resource conservation training program linked to a specific enterprise from land preparation to harvesting. Depending on the enterprise, farmers were trained for 2 hours per day once a week for a maximum of 40 weeks or 80 contact hours with extension staff. The curriculum for NFFS-trained farmers was not well defined since the training was largely informal and therefore, difficult to ascertain the number of times they interacted with extension providers. The fact that adoption of the three technologies was higher for FFS-trained than for NFFS-trained farmers implied a positive and significant relationship between farmers' contact hours with extension providers and adoption.

Farmers learned the three conservation technologies from NFFS extension methodologies that included public meetings, on-farm trials, farm visits and tours, residential and non-residential training, and field days. Their adoption of these technologies remained low because of their limited contact with extension providers and limited hands-on skills except where farm demonstrations were used. Adoption of the three technologies for FFS-trained farmers was higher than for NFFS-trained farmers. This implied that use of the FFS extension methodology led to higher adoption of the three conservation technologies.

Since FFS-trained and NFFS-trained farmers worked under the same farming conditions and were trained by extension agents with similar qualifications and experience, any difference in adoption between them was attributed to the type of extension methodology. The two methodologies differed in their practical approach, participatory nature and contact hours. FFS-trained farmers had a higher adoption rate than NFFS-trained farmers on all the three conservation technologies, implying that its use in promoting conservation agriculture led to higher adoption rates.

Since the FFS extension methodology was more effective than the NFFS extension methodologies in promoting adoption of the three conservation technologies, the researchers recommended that given a choice, extension providers should use the FFS extension methodology to encourage farmers to practice conservation agriculture in their farms due to its interactive and learning by doing principle. The Kenya Government, through the Ministry of Agriculture, and the private sector should continue to encourage farmers to pay greater attention in ensuring that they ploughed along the contours, leave unploughed strips whose number and length should depend on the slope of the land; and should allocate more funds for FFS training. They should further make a regular follow up of the FFS-trained farmers after graduation. Since adoption rates of contour ploughing, and use of unploughed strips and farm yard manure application were significantly higher for FFS-trained than for NFFS-trained farmers, further research should be done to determine whether the use of FFS in promoting resource conservation technologies is cost effective.

Conclusions

Age influenced the adoption of contour ploughing, use of unploughed strips and farmyard manure application for both FFS-trained and NFFS-trained farmers. Farmers with more years in farming had a better understanding of the usefulness of conservation agriculture and were more likely to adopt conservation technologies that improved the productivity of their land per unit area. The FFS extension methodology was more effective than the NFFS extension methodologies in promoting conservation agriculture. Adoption of the three conservation technologies was independent of gender though it could play a role where physical strength is required to apply farmyard manure or plough along the contour using heavy farm machinery. Education did not influence the adoption of the three conservation technologies probably because they were fairly simple and their benefits easy to understand. However, education may play a significant role in adoption if the technology is more complex and challenging to understand, interpret and use.

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