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THE IMPACT OF GROUP BASED TRAINING APPROACHES ON CROP YIELD, HOUSEHOLD INCOME AND ADOPTION OF PEST MANAGEMENT PRACTICES IN THE SMALLHOLDER HORTICULTURAL SUBSECTOR OF KENYA

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ABSTRACT

The recent group-based training approaches such as Farmer Field School (FFS) and Common Interest Group (CIG) have been promoted in Kenya to accelerate dissemination of new technologies among farmers. The acceleration of technology adoption is, in turn, expected to have positive impacts on yield, income and adoption of pest management practices. Yet, no conclusive evidence exists to confirm that this might be the case. Using a data from random sample of 495 FFS, CIG and individual farmers this paper evaluated the impact of FFS and CIG participation on yield, income and pest management practices among smallholder horticulture farmers in Kenya. A propensity score matching method was used to determine the average treatment effect on FFS and CIG participation against farmers who operate individually. From the analysis results, FFS and CIG participation had a positive impact on yield and adoption of pest management practices respectively suggesting the importance of farmer groups.

Keywords: FFS and CIG group-based training, integrated pest management, Impact assessment, Kenya

INTRODUCTION

Agricultural extension services provide farmers with information and training new technologies and management practices. It is the process of introducing farmers to knowledge, information and technologies that can improve their productivity, income and welfare (Purcell and Anderson, 1997). The knowledge is introduced through various channels including trainings and demonstrations. The service provides a mechanism for important feed back as well. In addition, agricultural training and education indirectly impacts agricultural productivity since the ultimate goal of any farmer training is to help farmers acquire knowledge of the technology thus enable the farmer to make informed decisions on what technology to adopt. In sub-Saharan Africa 60-80% of the population is employed in agriculture, producing 30-40% of GDP (Staatz & Dembele, 2008; World Bank, 2007a). Out of this proportion smallholder's account for the majority of these agricultural workers (World Bank, 2007b). In Kenya, smallholder horticulture farmers generate 40 to 50% of total exports and 90% of the commodities consumed locally (Wasilwa, 2008). Nonetheless, the horticulture industry is the major consumer of pesticides (Rhoda *et al.,* 2006).

Farmers in developing countries heavily rely on the use of pesticides to control insects and diseases (Thrupp *et al.,* 1995). Cooper (1999) has shown that half of the smallholder producers in Kenya used more than three times the recommended volume of pesticides. Tomato producers in Nakuru district also used 3-7 times the recommended amount of pesticides (Lagat *et a*l., 2007). The use of excessive pesticide is perceived as a loss aversion factor by farmers (Antle, 1988) and caused serious environmental problems in Indonesia (Oka, 1991). Besides, the negative impact of pesticides on health and environment call for an intervention. Previous studies have shown that agricultural extension programs such as farmer training are considered an investment to the agriculture sector and farmers at large (Feder *et al*., 2003). Recent study by Yan (2006) demonstrated that farmers in China witnessed the highest annual income increase in 2005 due to training of young farmers.

However, despite the importance that farmer training holds, the previous extension systems in Kenya failed to deliver effective extension services to farmers. In early 1980s the government of Kenya adopted the training and visit (T&V) system of extension. In this method of extension the contact farmer approach was used. The approach was supported by the World Bank through the First and Second National Extension Projects (NEP-I and II). The training and visit extension approach was financially costly yet the resultant impact on agricultural production was limited (Gautam, 1999). Due to the weaknesses in the previous extension systems the government of Kenya through the Ministry of agriculture and other stakeholders embraced participatory and demand driven extension systems (ROK, 2005). These extension approaches focus on the group based training approaches such as FFS and CIG. These approaches promote participatory method of training and farmers in these groups are trained collectively in order to share their experiences, learn and understand different technologies. According to van de Fliert *et al*., (2007) experiences gained by farmers through FFS training are more effective; it is more attractive to farmers since they are able to benefit from learning how to gather information and how to better manage their farms within the context of rapid changes in a liberalizing and development climate.

Recently one strategy that has led to improved crop production and pest management knowledge while protecting the environment is the integrated pest management technology. This technology has been found one suitable for smallholder production in export and domestic market crops (Nyambo and Nyagah, 2006) since it keeps pests below the economic damaging level and subsequently improve horticultural production. The integrated pest management was perceived by the Indonesian government as an alternative national pest control strategy to sustain environmentally friendly agricultural production while minimizing the risks associated with pesticide use (Röling *et al*., 1994; van den Berg, 2004).

Nevertheless, the IPM technology is a complex technology, it requires farmers to integrate different pest control methods including varietal resistances, cultivation, mechanical control, biological control and chemical control according to their specific field conditions" (Yang *et al*., 2008). Furthermore, the technology requires sufficient knowledge acquisition for successful implementation to occur (Mauceri, 2004). The group based training approaches have been considered as the most effective way to learn a certain technology. The implementation of integrated pest management practices through group based farmer training approach is the best way for achieving good agricultural practices while protecting the environment. Thus farmers need skills in pest monitoring and knowledge of pest ecology (Lewis *et al.*, 1997; Matthew, 1999; Ruttan, 1999; Atkinson *et al*., 2004). In this respect various stakeholders, including NGOs' and government of Kenya through ministry of agriculture, offer training opportunities to farmers in agricultural production and integrated pest management practices (IPM). However, the impact of IPM training among smallholder horticulture farmers in Kenya is partially unknown and if known, it is inconclusive. This study aims to fill this knowledge gap.

EMPIRICAL ASSESSMENT OF TRAINING

Agricultural extension services provide farmers with important information such as training in new technologies, management practices with respect to production and marketing, and market information. Generally extension services improve the knowledge base of farmers, through various means, which include trainings and demonstrations, and provide a mechanism for important feedback. Given that the extension services cannot reach all farmers, the working of the system is largely dependent on the assumption that messages will spread through the farming community through a diffusion process (Feder et al., 2003).

In addition, agricultural training and education indirectly impacts agricultural productivity. A number of papers have examined the effect of training on productivity by using econometric measures on farm-level data, focusing largely on contributions of training to harvested yield. Barrett and O'Connell (2001) regressed the level of training intensity on the change in productivity and found out that the effect of training, days/total employment, was positive and significant on changes in labor productivity. Black and Lynch (1996) estimated a standard Cobb–Douglas production function including training intensity, three specific types of training activities, and several controls for other workplace practices. However, estimating productivity of training using econometric models such as the Cobb-Douglas production function is likely to be biased because of the endogeneity of the training variable.

Establishing the impact of training is difficult using observed data from the survey because of the observed and the unobserved farmers' attributes that are likely to be correlated with training frequency and content and the farmers' characteristics influence on the training approach. Farmers who are trained are likely to be more productive, apply inputs nearer to the economic optimal levels thereby causing a problem in separating the impact of training in production from that of use of more productive inputs. The decision to attend training may also be influenced by some intrinsic farmer characteristics that are not obviously observable. An appropriate methodology for such analysis should consider the selection bias by controlling for farmers' differences when examining the impact of training on productivity.

METHODOLOGY

Study area

The study was conducted in five districts in Kenya, namely Muranga, Thika, and Maragua in Central Province, and Makueni and Embu in Eastern Province, which are major horticulture production areas. Central Province covers an area of 13,176 km2 with a population of 3.7 million. The area has 965,000 ha of potential agricultural land of which 78% is devoted to agricultural activities. The province is characterized by both intensive and extensive agricultural activities involving cash and food crops, including horticulture, dairy, poultry, and pig production. The areas receive an average annual rainfall of 2600 mm and have a mean annual temperature of 20^0C. Soil characteristics include humic nitisol, eutric nitisol, ando-humic and nitisol, nito-rhodic ferralsol.

Eastern Province covers an approximate area of 3952 km2 with a projected population of 5,587,781 (Republic of Kenya, 2006b) and receives rainfall ranging from 190 mm to 390 mm (Republic of Kenya, 2010). The mean temperature is 26^0Cand much of the district is characterized by a loamy sand soil type.

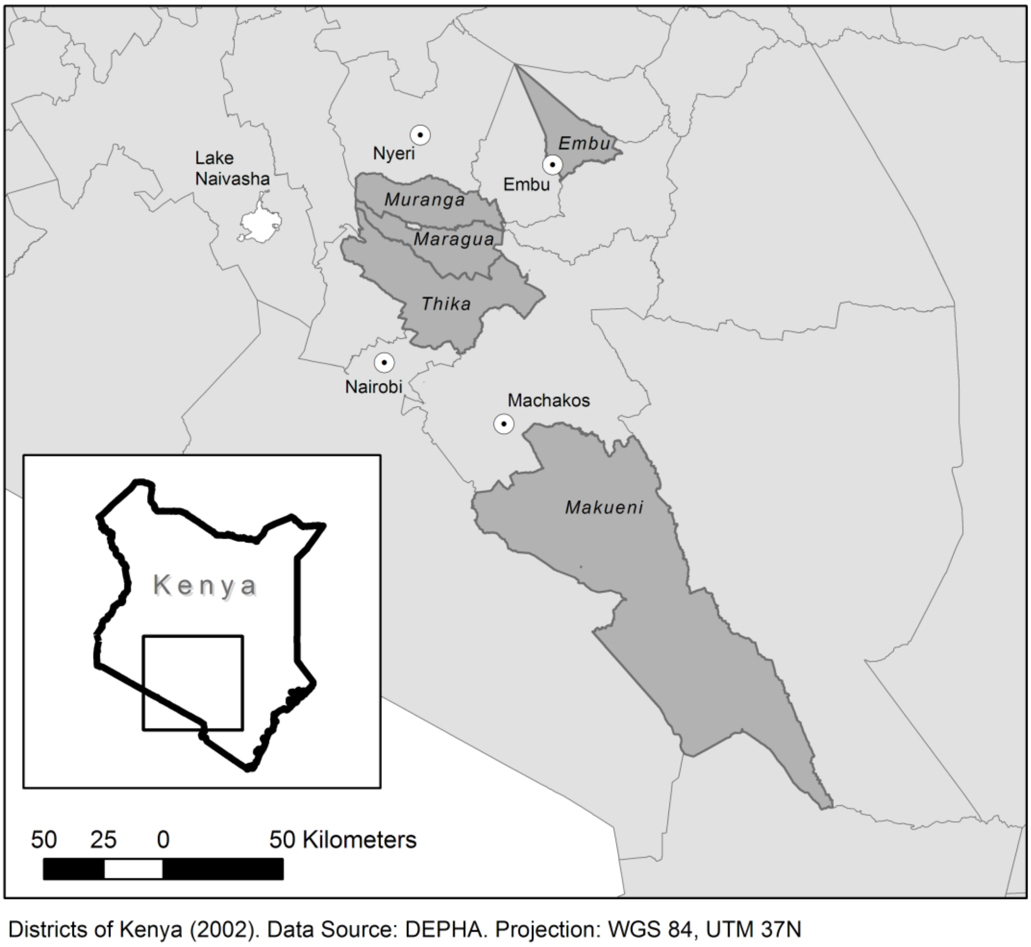

Figure1. Study area.

Survey Design and Data

Data were collected from May to July 2008 focusing on active smallholder vegetable and fruit producers grouped in three categories: FFS members, CIG members and control farmers. The control farmers are not members of the two group-based training approaches. They were sampled from the same village as the FFS and CIG farmers.

The five study districts were purposely selected. A sampling frame containing all active FFS and CIG horticulture groups and their members was compiled during the formal or informal meetings held in 2007 by district and divisional horticulture extension officers. The sampling units, consisting of small-scale FFS and CIG horticultural producers, were selected from the sampling frame using systematic random sampling. CIG and FFS farmers were selected first, and then a sampling frame for control farmers was compiled for the sub-locations selected. From each district, 50% of the sub-locations were randomly selected to get the representative sample. For this study, the sample size was determined following Rea and Parker (1997) as

$$n = \left(\frac{Z_{\alpha} \sqrt{p(1-p)}}{Cp} \right)^2 \qquad (1)$$

The sample size is given by n; Cp is the confidence interval in terms of proportions and was set at 5% as this was enough to remove 95% bias in sampling. $Z\alpha$ is the Z score for various levels of confidence (α) and Z =1.96. The proportion of the population containing the major attribute or the population is p, which was assumed at 0.5. Control farmers were selected following the same procedure as for the group farmers. Overall, 33 FFS, 33 CIG and 33 control farmers were selected per district to give a sample of 99 farmers, giving a total sample of 495 horticulture farmers in five survey districts from the two provinces.

To avoid respondent bias, 20 field research assistants who were conversant with the local language of the respondents undertook a three-day intensive training session on the data collection techniques prior to the survey. During the survey, each of the 20 research assistants completed an average of 25 questionnaires. The survey covered demographic information on farmers such as a farmer's age, total number of years of schooling, land size, household size and on-farm labour. In addition, information on assets and wealth, a farmer's main farm and off-farm income sources, pesticide and fertilizer application, horticulture crop portfolio, a farmer's horticultural training, information access and knowledge of IPM was solicited. Information on group membership, social capital, and the diffusion of information among farmers was also gathered.

Data analysis

Empirical specification of propensity score

The propensity score is the conditional probability of assignment to a particular treatment given a vector of observed covariates (D'Agostino, 1998). The purpose of matching is to select a subset of the control sample that has covariate values similar to those in the treated group. Matching on all covariates (pretreatment measurements) may be difficult when the set of covariates is large. In order to reduce the matching problem, Rosenbaum and Rubin (1983) suggested an alternative method which is based on matching on the propensity score $P(X)$ that solves the problem of selection bias.

Using the propensity score, participants from the treatment group with participants from the control group can be matched, so that the treatment group and control group can be balanced.

The model is appropriate for addressing the problem of possible occurrence of selection bias. The selection bias problem arises because the aim is to determine the difference between the participant's outcome with and without a programme. Nonetheless, with cross sectional data it is impossible to observe the participants and non participant's outcome for a given household simultaneously. This is because participants and non-participants usually differ even in the absence of the programme. This is the problem of selection or selectivity bias. However, the propensity score approach can significantly reduce bias in observational studies (Rosenbaum, 1987, 2004; Rosenbaum and Rubin, 1985; Rubin and Thomas, 1992) through identification of non-participants who are similar to participants in all relevant pre-participation characteristics.

A number of studies have tried to capture the effect of training on productivity by using econometric measures on farm-level data, focusing largely on contributions of training to harvested yield. Barrett and O'Connell (2001) analyzed the effects of the level of training intensity on productivity changes and found out that the effect of training, days/total employment, was positive and significant on changes in labor productivity.

Other studies, like Godtland *et al*., (2004) used propensity score matching method to analyze the impact of FFS participation on farmers' IPM knowledge by creating a comparison group similar to the FFS participants in observable characteristics. Davis *et al.*, (2010) used propensity score matching method to evaluate the impact of FFS on crop productivity, farmers' empowerment and poverty. Praneetvatakul and Waibel (2006) used Difference in Difference (DD) estimator to evaluate the impact of FFS participation on crop yield and pest management practices and found significant impact on pesticide reduction and environment. Feder *et al*., (2004) used DD to evaluate the impact of the FFS participation on yields and pesticide use before and after the program. An appropriate methodology for such analysis should consider the selection bias arising from non random selected samples by controlling for farmers' differences when examining the impact of a programme. To address the self-selection bias problem, we make use of a variety of propensity score matching methods.

The first step in a propensity score analysis is to estimate the individual scores using logistic or probit regression. However, for this study a logit model was chosen for its computational simplicity. The conditional probability that the individual assigned to treatment 1 i.e. the propensity score of vector *X* can be defined as:

In this study the estimation of propensity score is analyzed using the logit model. Due to its computational simplicity, the logit model is used when there is a non-normal distribution. The logit model for our analysis is expressed as:

$$P(X) = \Pr(D = 1 \mid X) = F(\beta_1 \mathrm{X}_1 + \dots\dots\dots\dots + \beta_i \mathrm{X}_i) \qquad (2)$$

Where D is the indicator of participation, $D = 1$ if a farmer is a participant in FFS and 0 otherwise. X_i represents a set of covariates of the observed farmer characteristics which are same across all FFS farmers.

$$P(X) = \Pr(Z = 1 | X) = F(\beta_1 X_1 + ... + \beta_i X_i) \quad (3)$$

where Z is the set of indicators of participation with $Z = 1$ is if a farmer is a participant in CIG and 0 otherwise. X_i represents covariates of the farmer characteristics which are same across all CIG farmers'. Then, followed by options that commands for generation of propensity score index '*mypscore*', generation of variable '*myblock'* for the identification of blocks of propensity score , and *'comsup'* option that generates a dummy variable, which identifies household that meet the matching condition. The common support variable attaches numerical '1' corresponding to the subjects that meet the matching condition and '0' to those that do not meet the condition.

However, this study was to estimate the average treatment effect on the treated. In order to achieve this and following Rosenbaum and Rubin (1983), we established two conditions: the balancing hypothesis and the conditional independence assumption. The balancing hypothesis dictates that the propensity score must be a precondition for the evaluation of effect of the program. And the distribution of pre-treatment characteristics must be the same across control and treated groups and thus

$$D \perp X | P(X) \quad (4)$$

This means that the pre-treatment characteristics of the treated and control group must be the same it is conditional on the propensity score and each individual has the same probability of assignment to treatment. This ensures that persons with the same *X* values have a positive probability of being both participants and non-participants (Heckman *et al.*, 1999). This implies that the probability of FFS and CIG participation is conditional on farmer's socio-economic and institutional factors. Rosenbaum and Rubin (1983) have shown that if potential outcomes are independent of participation conditional on covariates they are also independent of participation conditional on a balancing score (*X*) or Average Effect of the programme (AEP). The balancing assumption dictates that the propensity score of participation *P*(D=1 for FFS , Z=1 for CIG)= *P*(X) must be conditional for the evaluation of the effect of the programme.

On the other hand, the conditional independence assumption (CIA) requires that the independent variables are independent of participation but conditional on propensity score. It also assumes that selection is exclusively based on observable characteristics and the model is expressed as:

$$Y_1 Y_0 \perp D | P(X) \quad (5)$$

where, $Y_1 Y_0$ are the potential outcomes with or without program, *D* is the participation variable and *P(X)* the propensity score. For a given propensity score, exposure to the program is random and therefore participants and non - participants smallholder farmers should be on average observationally identical (Caliendo and Kopeinig, 2005). Once the propensity score has been computed the Average effect of participation (AEP) can be estimated as follows:

$$
\begin{aligned}
AEP &= E\{Y_{1i} - Y_{0i} \setminus D_i = 1\} \\
&= \mathrm{E}\{\mathrm{E}\{Y_{1i} - Y_{0i} \setminus D_i = 1, P(X_i)\}\} \\
&= \mathrm{E}\{\mathrm{E}\{Y_{1i} / D_i = 1, P(X_i)\} - \mathrm{E}\{Y_{0i} \setminus D_i = 0, P(X_i)\} \setminus D_i = 1\}
\end{aligned} \qquad (6)
$$

where (*AEP*) is the average effect of participation, Y_{1i} is the potential outcome if farmer is an FFS or CIG participant, and Y_{0i} is the potential outcome if the farmer is neither a participant in FFS nor in CIG.

The average treatment effect on the treated ATT indicates the mean differences between the scores among participants and non-participants who are identical in observable characteristics. In order to see the effect of the treatment of the propensity score technique, Becker and Ichino (2002) proposed different matching methods that include Nearest Neighbor Matching, Radius Matching, Kernel Matching and Stratification Matching. These methods are discussed as follows:

In estimating the average treatment effect of FFS and CIG participation commands in STATA, such as *attnd* for nearest neighbor, *attr* for radius matching, *attk* for kernel matching and *atts* for stratified matching methods were used. The general formula of the empirical model is as follows:

Command: $y = \beta_0 + \beta D + \beta_i \mathrm{X}_i + \varepsilon, pscore(mypscore), com\sup, \log it$ (7)

where *command* denote the matching estimators such as *attnd, attr, attk and atts. While y* is the outcome of interest, X_i is a vector of participation covariates followed by the propensity score option, then the common support option. The two options are important in the sense that the average effect of participation (AEP) is computed from propensity score index (eg. the difference in outcomes for participants and non-participants who are similar in personal characteristics as possible). Common support also mandatory option to ensure matching is done only on controls that are similar to participants.

Variables in the Model

Variables included in the logit model are indicated in Table1. Independent variables that were hypothesized to explain FFS and CIG participation include: other groups that farmers belongs to (grpnumber), the total number of school years of the farmer (household head) (scholyrs), gender, age, household size (hhsize), distance to extension services (distextn), land size (loghectare), the number of casual labourers (hwmcaslb), the frequency of listening to horticulture production programmes on the radio (freqradio), the frequency of reading about horticulture production and pest management in the newspaper (freqnewspaper), and the farmer's locality (district). District is a dummy variable equaling 1, if a farmer lived in a particular district (Muranga, Thika, Maragua or Makueni) and 0 otherwise, with (Embu) being a reference district.

Table 1: Description of variables and expected signs.

Variable	Description	FFS participation	CIG participation
Dependent			
FFS	FFS participation (1=yes, 0=no)		
CIG	CIG participation (1=yes, 0=no)		
Independent			
Control	Base, not being FFS or CIG member		
grpnumber	Number of groups farmer belongs to, excluding FFS and CIG (number)	-	-
Scholyrs	Total number of school years (number)	+	+
Gender	Gender of the farmer (1= male, 0=female)	_	_
Age	Age of the farmer	_	_
Hhsize	Number of household members (number)	_	_
Distextn	Distance to extension services (km)	-	-
Loghectare	Total land under horticulture farming (log) (ha)	+	+
Hwmcaslb	Number of casual labourers (number)	+	+
Embu	Base/reference district		
Maragua	Maragua (1=yes, 0=otherwise)	+	+
Makueni	Makueni (1=yes, 0=otherwise)	_	_
Thika	Thika (1=yes, 0=otherwise)	+	+
Muranga	Muranga (1=yes, 0=otherwise)	+	+

It was hypothesized that belonging to other groups could have a negative influence on FFS and CIG participation. This is possibly because framers' who belong to other groups are less likely to join another group due to limited time and other household responsibilities.

Education was also hypothesized to positively and significantly influence FFS and CIG group participation. This might be that education enhances the ability of a farmer to comprehend and process information that in turn affect farmer decision making. Educated farmers are likely to have the motivation to participate in farmer groups since they are aware of the benefit of farmer groups in improving farming practices.

Gender is a dummy variable that refers to the sex of the farmer. It was hypothesized to influence FFS and CIG participation since women farmers are likely to have fewer opportunities for farmer group participation due to household responsibilities. However, Davis et al., (2004) findings indicated that women tended to participate more in merry-go-rounds, church groups, and women's groups, while men participated more in clan and water groups. This finding confirms the notion that gender plays a major role in farmer group participation.

The age of the farm decision maker was also expected to influence FFS and CIG participation. We hypothesize that younger farmers' are more likely to participate in farmer groups. However, the older farmers tend to be cautious when it comes joining farmer since they are risk averse. . The findings of Davis et al., (2004) in Kenya indicated that age could have an effect on group membership since people may feel more comfortable in groups that are comprised of leaders of their same gender, age set, or wealth level.

Household size was another important determinant that was expected to affect FFS and CIG participation. We hypothesized that larger households positively affect group membership activities since such households had more contacts and a wider social network which was a prerequisite for group participation.

Farm size was hypothesized to affect group participation. We assume that the bigger the land size the more farmers' join groups. This is possibly because the farmer might be interested to learn good farming skills through group. This notion is in agreement with Davis et al., (2004) who reported that land size influence group participation.

The availability of labour was expected to influence FFS and CIG participation. A farmer with a farm labourer was more likely to be in a position to join a farmer group and interact with other farmers due to sufficient manpower and time.

The distance to extension services was hypothesized to have an influence on the probability of FFS and CIG participation. This is possibly because farmers who resided closer to extension services were at a greater advantage when it came to joining farmer groups. On the other hand, the farther a farmer resided from extension services, the lesser he/ or she participates.

RESULTS AND DISCUSSION

Descriptive results

Table1: descriptive summary of sample farmers before treatment

Variable	Non FFS farmers		FFS households		Difference in means		t-value
	Mean	STD	Mean	STD	Mean	STD	
grpnumber	2.094	1.352	2.032	0.964	0.062	0.388	0.472
Scholyrs	9.298	3.583	8.964	4.069	0.063	0.486	1.429
Gender	1.239	0.428	1.656	0.476	-0.416	-0.048	-8.332***
Age	45.099	13.166	49.312	11.628	-4.212	1.538	-3.060***
Hhsize	5.370	3.681	5.943	3.134	-0.211	0.547	-0.558
Distextn	6.190	5.631	8.210	8.888	-2.020	-0.644	-2.479**
Landsize	2.904	2.624	3.274	3.421	-0.369	-0.797	-1.103
Hwmcaslb	2.544	3.061	2.407	3.705	-0.144	0.644	-0.364
Trialradio	2.631	1.226	2.490	1.398	0.141	-0.172	0.973
Trialnwspr	4.035	1.354	4.00	1.484	0.035	-0.130	0.223
Permtlbr	0.051	0.019	0.037	0.015	0.014	0.024	0.608

*** and ** indicate statistically significant at 1% and 5% probability level

The status of general agricultural training among FFS, CIG and control farmers is presented in Table 2. Nearly 87%, 63% and 49% the majority of FFS, CIG and control farmers received agriculture training. The results also showed that nearly 85%, 62% and 48% of FFS, CIG and Control farmers applied the technique that they have learnt. The findings also indicated that farmers who undergo training are aware about the benefit of training. Nearly 87%, 62% and 48% of FFS, CIG and control farmers respectively cited the benefit of Agricultural training

Table 2: Status of agricultural training among FFS, CIG and control farmers

Variable	FFS (N=157)	CIG (N=159)	Control (N=171)	χ^2	P-value
	%	%	%		
Agricultural training					
Yes	86.84	62.42	48.73	51.11	0.000***
No	13.16	37.58	52.43		
Application of technique learnt					
Yes	84.87	61.74	48.73	45.3970	0.000***
No	15.13	38.26	51.27		
Benefit of agricultural training					
Yes	86.84	61.74	47.47	54.01	0.000***
No	13.16	38.26	52.53		
Family members training					
Yes	23.03	14.77	15.19	5.53	0.104
No	76.97	85.23	84.81		
Do you advice farmer to go for training					
Yes	92.76	85.23	81.01	9.24	0.010**
No	7.24	14.77	18.99		
Are you willing to train others					
Yes	88.82	78.52	74.05	11.20	0.004***
No	11.18	21.48	25.95		

*** and ** indicate statistically significant at 1% and 5% probability level

Source: Computed from own survey data, 2008

Furthermore, these trained farmers are in a better position to apply the techniques they have learnt as it is demonstrated in this paper. This suggests the important role that farmer group-based IPM training plays in improving the knowledge base of farmers and subsequently enhances adoption of IPM technology.

Propensity score of FFS and CIG participation using the logit model

The logit model results on participation of FFS and CIG are presented in Table 3. The results showed that memberships to other groups, casual labour and listening to radio on horticultural information positively influenced participation in FFS. On the other hand, gender and belonging to other groups influenced participation in CIG. This suggests that farmers' socio economic characteristics are important in determining farmers' participation in extension programs.

Table 3: Logit model to predict the probability of FFS and CIG participation conditional on selected observables

Variable	FFS participation		CIG participation	
	Odds ratio	Marginal effect	Odds ratio	Marginal effect
Other groups	1.156**	0.284**	-0.734**	-0.182**
Total number of school years	-0.058	-0.014	0.072	0.018
Age	-0.066***	-0.016***	0.019	0.004
Gender	-2.564***	-0.631***	0.192**	0.226**
Household size	0.388	0.095	0.197	0.049
Land under horticulture farming (log ha)	-0.224	-0.055	0.129	0.032
Casual labourers employed	0.690**	0.170**	-0.288	-0.071
Number of meetings for different social gatherings	-0.437**	-0.017	-0.043	-0.010
Distance to extension services	-0.295	-0.072	0.155	0.038
Frequency of listening to radio on horticulture production and pest management information	0.245*	0.060*	-0.119	-0.029
Frequency of reading news paper on horticulture production and pest management information	-0.050	-0.012	-0.077	-0.019
Permanent labour	-0.754	-0.185	0.050	0.012

*** and ** indicate statistically significant at 1% and 5% probability level

Source: Computed from own survey data, 2008

Table 3: Logit model to predict the probability of FFS and CIG participation conditional on selected observables continued

Variable	FFS participation		CIG participation	
	Odds ratio	Marginal effect	Odds ratio	Marginal effect
Number of observations	231		232	
Log likelihood	-117.83741		-150.02037	
LR chi2(12)	83.31		20.48	
Prob > chi2	0.0000		0.0586	
Pseudo R2	0.2612		0.0639	

*** *and* ** indicate statistically significant at 1% and 5% probability level

Source: Computed from own survey data, 2008

The odds in favor of FFS and CIG participation among farmers belongs to other groups increased and decreased by 1.156 and 0.734 percentage points respectively. The significant and negative results of other groups not participating in FFS and CIG could be that farmers join any group if they gain economic benefit rather than to learn new farming skills.

Average treatment effect of FFS and CIG participation on yield, income and pest management practices

Average treatment effect of FFS

We evaluated the treatment effect of FFS and CIG participation on horticultural crop yield that is measured as kilogram per hectare (kg/ha), income (from sale of fruits and vegetables and pest management practices.. Using different matching techniques the average treatment effect result for FFS participation is presented in Table 4. The Nearest Neighbor Matching (NNM) shows that 124 participants matched with 40 non-participants with average effect of program participation. The results showed that participation in FFS has a positive effect on yield with a t-value of 2.774 suggesting the importance of FFS in improving horticultural productivity. This finding is in agreement with Davis et al., (2010) and Van de Flirt (1993) who reported about the positive impact of FFS on yield in East Africa and Central Java, This result is however contrary to Bentley (2009) and Feder *et al.,* (2003) studies who reported the non-significant impact of FFS participation on yield in Indonesia and in the tropics respectively. According to Bentley (2009) “FFS may be better suited to stimulating collaborative research with farmers than for extension itself”.

The lack of CIG impact on crop yield might be attributed also to the IPM substitutes for chemical inputs that may also cause the yield to remain constant for some time. Furthermore, the system may also take sometime to show effects which the study could not yet trace. The impact of the program on crop yield may also fluctuate between years and not be traceable with cross sectional data. In addition, farmers’ lack of confidence on the IPM concept as well as the training methodology used might also be instrumental here.

Thus, this study recommends the need to review aspects of the CIG training methodology and boost farmers' confidence through encouragement of use of IPM technology. This may help farmers overcome the risk that is associated with trying out new technologies. On the other hand, the negative impact of FFS participation on income might be attributed to lack of product and price differentiation among horticultural crops that are available in the market. Because, horticultural crops that are grown using IPM practices are not identified in the marketplace like organic horticulture crops. Therefore, farmers who use IPM or conventional methods sell their products at the same price. This calls for an intervention.

Table 4: Average effect of FFS program participation on yield, income and pest management practices

Horticulture yield					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	124	40	0.649	0.234	2.774
Kernel matching	124	97	0.467	0.215	2.177
Stratified matching	124	196	0.472	0.246	1.916
Income					
Matching Method	Participant	Non-participants	ATT	Std.Err	t-value
Nearest neighbor	124	18	-0.099	0.317	-0.311
Kernel matching	124	97	-0.013	0.325	-0.039
Stratified marching	124	196	-0.130	0.200	-0.649
Adoption of pest management practices-					
Matching Method	Participants	Non-participants	ATT	Std.Err	t-value
Nearest neighbor	124	41	-1.591	0.588	-3.318
Kernel matching	124	97	-1.953	0.466	-4.187
Stratified marching	124	196	-1.871	0.458	-4.081

Source: Computed from own survey data, 2008.

The results in Table 4 show no significant and positive impact on adoption of more pest management practices. This may be that FFS farmers used selected pest management practices that are effective in their farming. On the other hand, CIG participation has a positive effect on adoption of more pest management practices as compared to FFS. This results suggest, the important role that group based training approaches play in facilitating adoption of IPM practices.

Average treatment effect of CIG

The average treatment effect results of CIG participation on horticulture yield and farmers' income are presented in Table 5. The results show a non-significant impact of CIG participation on horticultural crop yield. They are in contrast to those by Cuellarl *et al*., (2006) and Githaiga (2007) findings on the impact of CIG participation on yield. Similarly, CIG participation also did not show any significant impact on farmers' income. The lack of impact on yield might be attributed to farmers' lack of confidence in using the IPM strategy and lack of understanding on the IPM implementation process. In addition, the lack of impact of a CIG program on income might be attributed to lack of information on price for the different horticulture products that are grown using the IPM and conventional methods.

Table 5: Average effect of CIG participation on yield, income and pest management practices

Horticultural yield					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	108	60	0.336	0.248	1.356
Radius			-0.047	0.161	-0.294
Kernel matching	108	124	0.158	0.197	0.801
Stratified matching	107	229	0.102	0.209	0.487
Income					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	114	35	0.233	0.267	0.874
Radius matching					
Kernel matching	114	133	-0.059	0.224	-0.264
Stratified marching	156	315	-0.017	0.104	-0.161
Pest management practices					
Matching method	Participants	Non-participants	ATT	Std.Err.	t- value
Nearest neighbor	108	60	0.944	0.429	2.203
Radius matching					
Kernel matching	108	124	0.646	0.405	1.595
Stratified marching	107	229	0.714	0.348	2.049

Source: Computed from own survey data, 2008

Heterogeneous treatment effect

Heterogeneity treatment effect analysis was carried out to determine variation in farmers' characteristics in relation to FFS participation. The outcome or the dependent variable is crop yield. The treatment effect variable for crop yield was generated using the matching exercise and were regressed on farmer characteristics. The result (Table 6) indicated that more educated, older farmers as well as small land holdings were benefited from FFS participation.

Table 6: Regression analysis of variation in FFS individual household treatment effects by farmers' characteristics.

Variables	Coefficient
Other groups	-0.265
Total number of school years	0.098**
Age	0.040***
Gender	-0.394
Household size	0.068
Land under horticulture farming (log ha)	-0.599***
Casual labourers employed	0.001
Number of meetings for different social gatherings	0.118
Distance to extension services	-0.172
Frequency of listening to radio on horticulture production and pest management information	-0.104
Frequency of reading news paper on horticulture production and pest management information	-0.049
Permanent labour	0.451
Constant	-1.588
Number of observations	123
F	(12, 110) 3.21***
Adjusted R^2	0.18

**** and *** indicate statistically significant at 1% and 5% probability level

Source: Computed from own survey data, 2008

This study also looked at the heterogeneity treatment effect (variation) of farmers characteristics in relation to CIG participation. The dependent variables is pest management practices. The treatment effect variable was generated using the matching exercise and were regressed on farmer' socio economic characteristics. The result shows that farmers belong to more groups and farmers who are far from extension services are beneficiary in adopting more pest management practices than those farmers who are a member of one group.

Table 7: Regression analysis of variation in CIG farmer's treatment effects by farmers characteristics.

Variables	Coefficient
Other groups	1.913***
Total number of school years	0.107
Age	0.017
Gender	0.729
Household size	0.331
Land under horticulture farming (log ha)	0.231
Casual labourers employed	-0.176
Number of meetings for different social gatherings	0.053
Distance to extension services	-0.494*
Frequency of listening to radio on horticulture production and pest management information	-0.100
Frequency of reading news paper on horticulture production and pest management information	-0.142
Permanent labour	-1.297
Constant	-4.068***
Number of observations	107
F	(12, 94) =3.20***
Adjusted R^2	0.20

**** and *** indicate statistically significant at 1% and 5% probability level

Source: Computed from own survey data, 2008

Sensitivity analysis

Rosenboum bound sensitivity method was used to test the potential effects of unobservable factors. In order to analyze the hidden bias we generated a dummy variable for yield by taking the value above and below the median. The Γ was increased to 1.6 to see the potential effects of FFS participation. On testing the potential hidden bias on crop yield, our result in Table 8 showed that the estimated effect is not sensitive to unobserved selection bias confirming the true impact of FFS program participation that was reported on Table 4.

Table 8: Rosenboum bound sensitivity tests to check the influence of unobservable factors on the effect of FFS participation on crop yield

Level of hidden bias (Γ)	P-critical
1	0.002
1.05	0.003
1.1	0.005
1.15	0.008
1.2	0.013
1.25	0.018
1.3	0.026
1.35	0.035
1.4	0.047
1.45	0.060
1.5	0.076
1.55	0.095
1.6	0.115

Source: Computed from own survey data, 2008

CONCLUSIONS AND POLICY IMPLICATION

The recent group-based training approaches such as Farmer Field School (FFS) and Common Interest Group (CIG) have been promoted in Kenya to accelerate dissemination of new technologies among farmers through various learning and communication networks. The acceleration of technology adoption is, in turn, expected to have positive impacts on horticultural yield, income and adoption of pest management practices. Data were collected from random sample of 495 farmers who had been either a member of FFS, CIG or who operate individually (control,). Using propensity score matching method, we analyzed the average treatment effect on FFS and CIG participation on horticulture yield, income and adoption of pest management practices among smallholder horticultural farmers in Kenya. Results from the propensity score method indicated that FFS participation has shown a positive and significant impact on horticultural yield suggesting the importance of FFS participation in improving horticultural productivity. In contrast, the lack of CIG impact on horticultural yield in the study area might be attributed to lack of effective training methodology combined with lack of proper understanding of IPM implementation process among CIG horticulture farmers.

Furthermore, Integrated Pest Management (IPM) substitutes for chemical inputs may also cause the yield to remain constant for some time. And the system may also take sometime to show effects, which the study could not yet trace. The impact may also fluctuate between years and not be traceable with cross sectional data. In addition, farmers' lack of confidence in the IPM strategy might also be instrumental here. Correspondingly, the non-significant impact of FFS and CIG on income might be attributed to lack of market access among smallholder horticulture farmers. The results on the impact of CIG participation on adoption of a range of pest management practices show a positive and significant impact.

Heterogeneity treatment effect results also indicated that impact of FFS participation varies depending on farmer characteristics. Farmer characteristics such as more educated and older farmers as well as small land holdings were benefited from FFS participation in improving horticultural yield. On the other hand, farmers belong to more than one group and reside far from the extension services are beneficiary in adopting more pest management practices than those farmers who are a member of one group.

Based on our findings, we conclude that farmer groups are important to improve horticultural production and facilitate adoption of a range of pest management practices that are crucial components of food security. Therefore, we recommend that farmer groups to be given a lot of emphasis especially in areas where farmer groups are not introduced. It is also necessary to review the training curriculum of the FFS and CIG approach for better understanding and boost farmers confidence in adopting IPM technology while helping them overcome the risk associated with trying out new technologies. The study also recommends, the relevant bodies in the government to come up with price differentiation between the two different products that are grown using IPM method and conventional method or the benefit of the farmers

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