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Research Paper

Do Farmers Acquire Agricultural Knowledge from Neighbors? The Case Study of Farmer Field Schools in Anuradhapura District

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Abstract

Group extension techniques are widely used in agricultural extension outreach programmes, often in developing countries. The techniques involve demonstrating novel cultivation methods and technologies for local communities. However, many extension models have been implemented with limited success only. One of the popular group extension models, the farmer field schools (FFS) approach, is based on adult education principles such as experiential learning. Therefore, to understand the effectiveness of FFS on information diffusion to neighbors, a randomized field experiment and a field survey was conducted using 379 randomly-selected maize farmers in Anuradhapura District during February 2023. Data were analyzed using a logistic regression and found that FFS participation is more than three times (any figure or % better to include.) as effective in promoting the adoption of high-density planting and reducing pesticide application compared to other control variables. The overall results pose a vital policy implication for agriculture extension in Sri Lanka, where the FFS technique can serve as an effective tool for agriculture extension approaches, mostly in programs seeking to spread the new knowledge or skills across small population or groups. Findings further revealed that, FFS can increase knowledge of farmers on Integrated Pest Management, Integrated Plant Nutrient Management Systems, and crop agronomy, leading to an approximate 7% increase in yield. Moreover, FFS participants should be selected cautiously for effective and efficient transmission of key messages in the information delivery. However, there is a little evidence (any figure of %) that lessons learned are passed to nonparticipants or that an FFS is a likely basis for sustained group activity.

Keywords: Agriculture extension, Farmer field school, Technology diffusion

Introduction

Agricultural extension services are a one of the main important social services addressing rural development, because the establishments of agriculture extension are mandated to support learning, and assist farmers in skill development (Conley & Udry, 2001). However, key challenges are raised with the expansion of agricultural technologies. The first issue was that poor farmers being left behind, as many were not reached at by modern approaches (Feder & Savastano, 2006). In addition, those technologies promoted were not appropriate to the challenges facing smallholders, particularly women farmers (Valente *et al*., 1999; Vasilaky 2012; Nakano *et al*., 2018). Second, modernization was also associated with adverse environmental and plant health problems, relating to water pollution, declining soil quality, soil erosion, pest resistance and loss of biodiversity. Moreover, the environmental and health consequences of chemical pesticide use place significant pressure on the implementation of organic agricultural policies in Sri Lanka. Chemical pesticides have been heavily promoted and publicly subsidized under the modernization agenda to such an extent that their overuse led to insect pests becoming resistant and causing major outbreaks of insect pests. In addition, prolonged exposure to pesticides was associated with chronic and acute health problems among rural residents (Bandara *et al*., 2010). Therefore, finding an extension approach that adequately addresses these issues is a special challenge in the Sri Lankan context, with poverty growing and productivity declining on the continent.

One popular education and extension approach, using worldwide is the farmer field schools (FFS) approach, currently practicing in many countries. The FFS is a participatory method of learning, technology adaptation, and dissemination based on adult learning principles such as experiential learning (Rogers, 1995). Farmers are facilitated to conduct their own research, diagnose and test problems, and come up with solutions. FFS training programs help farmers develop analytical skills, critical thinking, creativity, and learn to make better decisions. Three major learning tools of FFS include discovery-based learning exercises, group experiments, and agroecosystem analysis (Feder *et al*., 2004). The FFS approach supports current interest in participation, empowerment, and decentralization for rural development, and it provides an attractive package for agriculture extension projects to manage (Mekonnen *et al*., 2018).

However, according the literature, these impacts have not translated into changes beyond the locality. Several studies suggest that FFS are having limited or no effect on the agricultural sector's economic performance, sustainable use of the environment, on rural health, and on dissemination of information by FFS participants to other farmers (Tripp *et al*., 2005). There are also many questions about their sustainability. Therefore, this study examines the FFS approach focusing on the degree to which FFS participants gain new skills, the type of farmer that participates in FFS, the transmission of skills to non-participants, the breadth of skills amenable to the FFS approach, and the degree to which FFS contributes to building social capital.

Material and Methods

The study was based on field experiment and subsequent survey using stratified sampling method. The Department of Agriculture (DOA), with support from Japan International Cooperation Agency (JICA) and other donors (UNDP), have conducted a program on FFS for high-density planting and fall army worm control Integrated Pest Management (IPM) program in maize from 2022 August to 2023 March. The program has conducted 256 FFS throughout the country. Figure 1 explains the selection of FFS and farmers in the district. In order to explore the effectiveness of the FFS concept, 16 FFS out of 82 FFS (treatment) were randomly selected in the district and 2 control villages from remaining maize cultivating villages in Anuradhapura district. In selecting the two villages for the control, the study team ensured that farmers have not exposed to FFS for last five years, to remove the spillover effect of the FFS experience. The selected villages are presented in Table 1.

In each of the sites, an FFS has been conducted for farmers in a single maize farming *Yaya* (30-50 acres of uplands) with the participation of 25- 30 farmers. In each sample of FFS *Yaya*, consisted of a randomly selected of 10 participant farmers, representing 30% approximately from the total, 10 non-participant neighbors from the same *Yaya*, and these 10 control farmers from a nearby *Yaya* where no FFS has been already conducted. In the second control group, 60 farmers were selected, with 30 farmers chosen from each village. In the control group, *Yaya* conditions particularly in term of size and irrigation quality were as similar to those of the FFS *Yaya*. The total sample was thus consisted of 379 farmers and informal interviewing's were conducted with individual farmers for data gathering. [1] The questionnaire was pre-tested and validated for data collection.

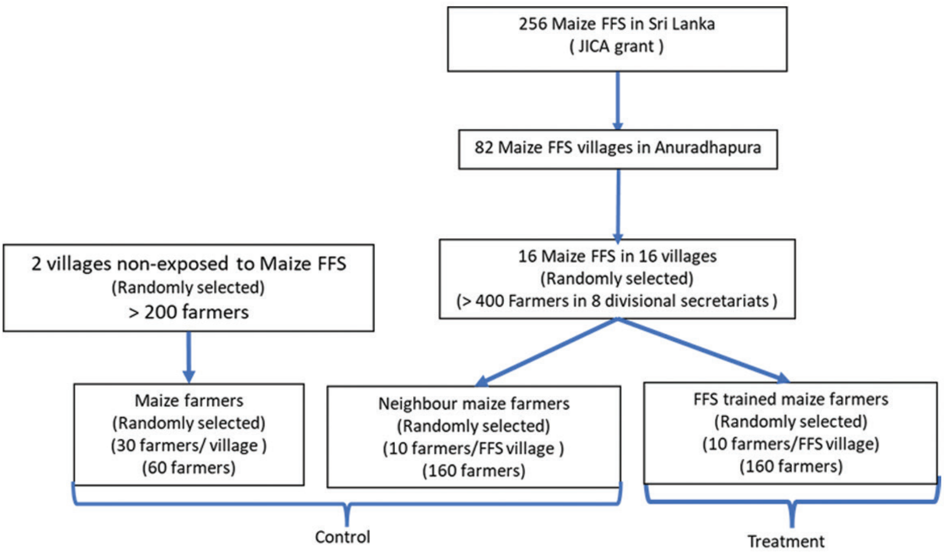

Figure 1. Selected FFS farmers and control farmers in the field experiment

[1] *Due to the passing away of one farmer, data from only 59 farmers in control group 2 were collected.*

Table 1. Villages selected for the FFS and for the control in the experiment

Nos	Village	Agrarian service center	Divisional secretariat	Treatment
1	Randuwa	Mahavillachiya	Nuwaragam Palatha Central	FFS/Control
2	Mailagaswewa	Galenbidunuwewa	Galenbidunuwewa	FFS/Control
3	Madagama	Rabewa	Rabewa	FFS/Control
4	Higuruwelpitiya	Adiyagala	Palagala	FFS/Control
5	Mannewa	Ipologama	Ipologama	FFS/Control
6	Malawa	Kakirawa	Kakirawa	FFS/Control
7	Korakahawewa	Thalawa	Thalawa	FFS/Control
8	Rotawewa	Eppawala	Eppawala	FFS/Control
9	Kuda Rabewa	Palugaswewa	Palugaswewa	FFS/Control
10	Kadawthgama	Madawacchiya	Madawacchiya	FFS/Control
11	Meegassegama	Siwalakulama	Thirappane	FFS/Control
12	Periyankulama	Thirappane	Thirappane	FFS/Control
13	Nikawewa	Horowpthana	Horowpathana	FFS/Control
14	Kapugollewa	Kapugollewa	Horowpathana	FFS/Control
15	Mahagalkandegama	Kahatagasdigiliya	Kahatagasdigiliya	FFS/Control
16	Olukkulama	Mihinthale	Mihinthalae	FFS/Control
17	Helabodugama	Negampaha	Galnewa	Control
18	Periyankulama	Thirappane	Thirappane	Control

Notes: The villages and divisional secretariates of Anuradhapura District conducted FFS on maize from August 2022 to mid-March 2023.

The questionnaire was administered in February 2023 after 2022/23 *Maha* season. Prior to the introducing of FFS discussions, maize production details were given more emphasis like agronomic practices adopted in the cultivation focusing particularly on the previous 2022/23 *Maha* season.

The FFS technique has been adopted to train the farmers continuously and give awareness on agronomic package of maize including high density planting, IPNS, and IPM technologies during the 2022/2023 *Maha* season by well-trained agriculture instructors. The FFS trainings have commenced from first week of August 2022 and terminated at the end of March 2023, with an average participation rate of 81%. Subsequent to the FFS intervention, all the selected households were surveyed to identify knowledge gathered regarding maize agronomy, spacing, IPM, and IPNS in April 2023[2].

The treatment in this experiment was whether the farmers received training in FFS, which were held at the village level. Since farmers and FFS were randomly selected for this experiment, it is expected that the treatment status is independent from observed and unobserved household characteristics. However, this issue needs to be verified carefully because the sample consists of only 18 villages, and the village-level heterogeneity might confound the treatment status by coincidence (Greene, 2008).

To check this possibility, a balancing test is conducted to compare several key characteristics between the treatment and control groups. [3] The treatment exogeneity is verified and result are presented in Table 2 showing the comparison between the treatment and the control on household observed characteristics. [3]The result shows no significant differences ($p<0.05$) in the demographic characteristics considered (Panel A), housing condition and ownership of durable consumer goods (Panel B), cultivated extent (Panel C), and network connections (Panel D). Thus, the balancing test confirmed that the households in the three groups are adequately homogeneous.

Afterwards, the field experiment data was analyzed by comparing the treatment and control group's means using STATA to identify the effectiveness of FFS on information delivery and the extent to technology diffusion with spillover effects to their neighboring farmers. In addition, the factors affecting the adoption of high-density planting and agrochemical reduction was explored using Ordinary Least Square (OLS) method. The simple regression is:

$$D_{ij} = \beta_0 + \beta_1 T_{ij} + \mathrm{x}_i\gamma + \delta_j + u_{ij} \quad \text{....... (01)}$$

Where dependent variable D_{ij} is the binary variable of households that household i has adopt the high-density planting of maize cultivation or number of application of pesticides after the intervention of FFS in village *j*. Independent variable T_{ij} is an indicator variable that takes value 1 if household i participated in the FFS in village *j*, otherwise (control group) is equal to 0. x*i* controls for a wide variety of household head and household characteristics. δ_j denotes village fixed-effects and u_{ij} captures unobserved components. The β_0 , β_1 and γ are parameters need to be estimated.

[2] *The questions used to test the farmer's knowledge in the surveys are; 1. Do you know about soil health? 2. What are the main reasons for degraded soil health? 3. What are the main elements plants need for their growth? 4. What are the trace elements plants need for their growth and name 4 trace elements? 5. Do you know limiting nutrients does not allow the full expression of other nutrients? 6. Do you think soil organic matter content is one of the key parameters influencing soil fertility? Do you know natural enemies of pest in maize? 7. What are the main pest and disease in maize farming? 8. Can you identify fall army worms? If yes, what are the characteristics of larva and adults? 9. What is the time you decided chemical application for pest control? 10 Do you know the aflatoxin in maize seeds and if yes how did you manage it?*

[3] *Balancing Test is a statistical method used to evaluate the similarity in the distribution of covariates between treatment and control groups in a study (Greene, 2008).*

Table 2. Balancing test of household, agriculture production and network characteristics.

	Treatment (FFS villages trained farmers)	Control-1 (FFS villages non trained farmers)	Difference	Control-2 (Farmers in non-FFS villages)	Difference
	Mean /% (Std. dev.) N=160	Mean /% (Std. dev.) N=160	1 – 2 (Std. err.)	Mean /% (Std. dev.) N=59	1– 4 (Std. err.)
	1	2	3	4	5
Panel A: Household head's characteristics					
Age (# of years)	50.7	52.1	-1.4	53.4	-2.7
	(12.1)	(13.1)	(1.4)	(11.5)	(1.8)
Female (yes =1)	18.1%	20.1%	-2%	10.1%	8%
	(0.38)	(0.41)	(0.04)	(0.31)	(0.05)
Years of education	8.7	8.4	0.3	9.6	-0.9
	(3.8)	(5.5)	(0.4)	(2.8)	(0.5)
Full time farming (yes =1)	26.8%	31.2%	-4.3%	20.3%	6.5%
	(0.44)	(0.46)	(0.05)	(0.41)	(0.06)
Panel B: Household characteristics					
Household size (# of members)	3.3	3.2	0.1	3.2	0.1
	(1.44)	(1.38)	(0.15)	(1.21)	(0.21)
# of sleeping rooms	3	2.9	0.1	3.1	-0.1
	(1.17)	(0.99)	(0.11)	(0.91)	(0.16)
TVs availability (yes=1)	91.8%	90%	1.8%	96.6%	-4.7%
	(0.27)	(0.31)	(0.03)	(0.18)	(0.04)
Mobile phones (yes =1)	91.8%	91.5%	0.3%	100%	- 8.2%**
	(0.27)	(0.26)	(0.03)	(0)	(0.04)
Panel C: Agricultural production					
Maize land cultivated (acre)	0.94	0.91	0.03	0.96	-0.02
	(0.51)	(0.62)	(0.06)	(0.47)	(0.07)
Panel D: Network characteristics					
Connections to AI before FFS (yes=1)	20%	27.5%	-7.5%	29.6%	
	(0.41)	(0.44)	(0.05)	(0.49)	(0.07)
Connections to ARPA before FFS (yes =1)	56.8%	66.2%	-9.3%	76.2%	
	(0.49)	(0.47)	(0.06)	(0.41)	(0.07)

*Notes: Columns 1, 2, and 4 of the table report the mean of the observed characteristics of households in the Treatment, Control 1, and Control 2 groups, respectively. The standard deviations are presented in parentheses. Columns 3 and 5 report the difference in means between the treatment and control groups, with the corresponding standard errors (SE) presented in parentheses. Statistical-significance indicated by the asterisk, ***p<0.01,**p<0.05,*p<0.1 respectively.*

Results & Discussion

The first section of the results discusses the role of the FFS in information and technology diffusion specially focusing on farmer-to-farmer information and knowledge transferring (Table 3). The results show that farmers trained in the FFS achieved a yield approximately 7% higher compared to those who did not participate in the FFS. The results further indicate that the technologies gained from the FFS have not effectively transferred to the neighboring villages as expected.

Table 3. Knowledge and skill transfer to trained farmers and neighbors through FFS

	Treatment (FFS villages trained farmers) Mean / % (Std. dev.) N=160	Control-1 (FFS villages non-trained farmers) Mean / % (Std. dev.) N=160	Difference 1– 2 (Std. err.)	Control-2 (Farmers in non-FFS villages) Mean / % (Std. dev.) N=59	Difference 1 – 4 (Std. err.)
	1	2	3	4	5
Yield after FFS training (Mt/Ac)	1.67 (0.25)	1.62 (0.21)	0.05*** (0.02)	1.55 (0.02)	0.12*** (0.03)
IPM, IPNS and agronomy knowledge (max=10)	3.4 (1.13)	2.7 (1.21)	0.7*** (0.13)	2.2 (1.09)	1.2*** (0.17)
Know fall-army worm damage (yes =1)	90.6% (0.29)	88.1% (0.32)	2.5% (0.04)	83.1% (0.37)	7.5% (0.05)
Identification of fall army worm (yes =1)	70% (0.46)	30% (0.45)	40 %*** (0.05)	13.50% (0.34)	56.4 %*** (0.06)
2' X 2' or 2' X1' planting space know (yes =1)	100% (0)	100% (0)	0% (0)	94.9% (0.22)	5.1 %** (0.012)
1.5' X 1' high density planting space know (yes =1)	65.6% (0.48)	23,1 % (0.42)	42.5%*** (0.05)	6.7% (0.25)	58.8 %*** (0.06)
1.5' X 1' high density planting space practice (yes =1)	25.6% (0.43)	9.3% (0.05)	16.2%*** (0.04)	3.3% (0.25)	22.2%*** (0.06)
Urea used (kg/Ac)	165.5 (23.41)	190.6 (24.43)	-25.1*** (2.67)	183.3 (23.09)	-17.7*** (3.55)
Organic fertilizer used (kg/ac)	173.4 (484.01)	98.1 (351.54)	75.3 (47.29)	181.3 (512.75)	-7.9 (74.91)
Insecticide applied (yes =1)	29.3% (0.45)	28.1% (0.45)	1.2% (0.03)	40.6% (0.49)	-11.3% (0.07)
# of times insecticide applied	0.9 (0.67)	1.8 (0.84)	-0.9*** (0.08)	2.1 (0.71)	-1.2*** (0.11)

Table 3. (continued) Knowledge and skill transfer to trained farmers and neighbors through FFS

Pheromone trap use (yes =1)	18.7%	6.8%	11.8%***	6.70%	11.90%
	(0.39)	(0.25)	(0.04)	(0.25)	(0.05)
# of hours monitoring the field	6.7	6.5	0.2*	6.6	0.1
	(1.31)	(1.07)	(0.13)	(1.06)	(0.19)
Apply insecticides after counting insects or damaged plants (yes =1)	64.3%	20.6%	43.7%***	20.3%	44.1%***
	(0.48)	(0.41)	(0.05)	(0.41)	(0.07)

*Notes: Columns 1, 2, and 4 of the table report the mean of the observed characteristics of households in the Treatment, Control 1, and Control 2 groups, respectively. The standard deviations are presented in parentheses. Columns 3 and 5 report the difference in means between the treatment and control groups, with the corresponding standard errors (SE) presented in parentheses. Statistical-significance is indicated by the asterisk, ***p<0.01, **p<0.05, *p<0.1 respectively.*

As expected IPM, IPNS, and agronomy knowledge of trained farmers is significantly different compared to the neighbors and farmers those who have not exposed to the IPM FFS. Although all the farmers (trained and non-trained) have identified the damages of the recent outbreak of the fall-armyworm, the farmers those who have trained at FFS have correctly identified the pest with their morphological characteristics. All famers have had good knowledge on planting spaces of maize. However, recently introduced high-density planting technologies have sown slow diffusion rates to maize-growing farmers. These results further explore that whether farmers who have awareness on the high-density planting actually adopted the technology in their fields. Results indicate that FFS trained farmers have almost practice high-density planting technique compared to non-trained farmers. However, the results of the high-density planting decision (row 7) opposed to the awareness on the same (row 6) indicated that, although farmers have awareness on the high-density planting technology, the awareness itself has not influenced the decision on the adoption[4].

In case of the fertilizer application by the farmers, the results indicated that farmers trained at FFS have applied limited quantity in the applications of urea fertilizer than other farmers during 2022/23 *Maha* season. This is further illustrated in Figure 2. In the plant nutrient management with the application of organic fertilizer with inorganic fertilizer, the results (row 9) did not show a significant difference between the two groups. However, farmers have very rarely used organic fertilizer for maize farming (Figure 3).

[4] *Decision to adopt is not purely based on knowledge. But other factors as well*

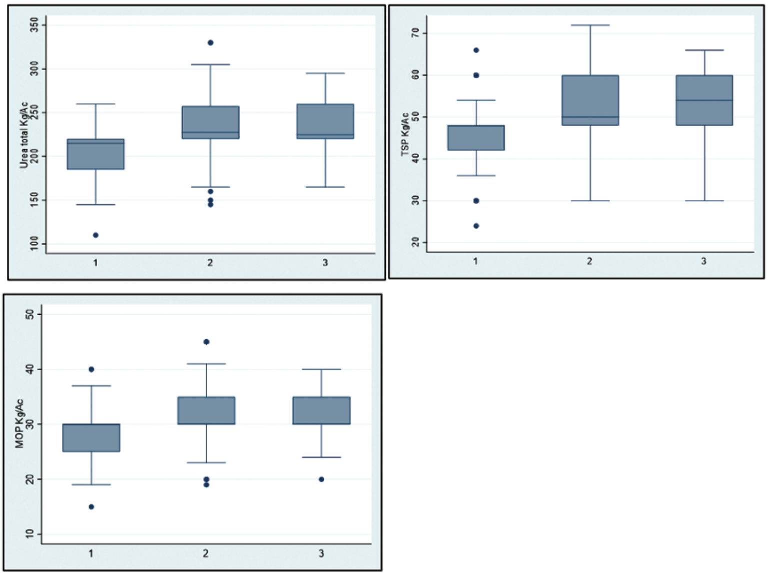

Figure 2. Application of Urea, TSP, and MOP

Notes: Figure reports the quantity of inorganic fertilizer used by farmers for their maize cultivation in 2022/23 Maha season. In horizontal axis 1, 2 and 3 represent respectively FFS trained farmers, and neighbor farmers where FFS conducted in the village and control maize farmers where FFS not conducted in the village.

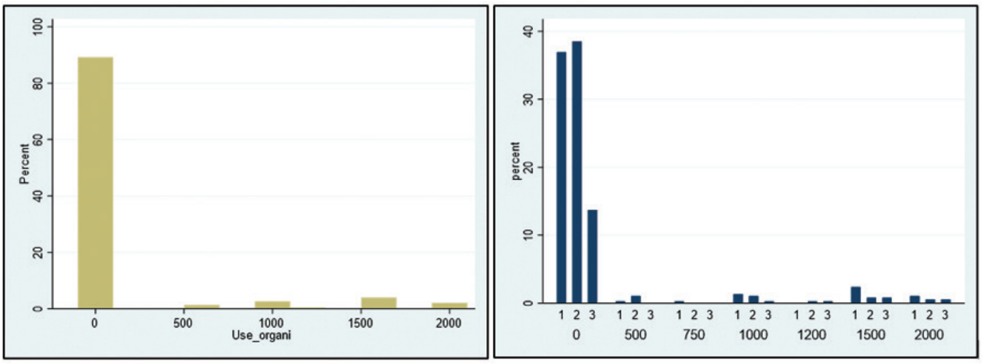

Figure 3. Organic fertilizer application behavior of FFS trainees, neighbors, and other farmers

Notes: Figure reports the quantity (Kg) of organic fertilizer used by farmers for their maize cultivation in 2022/23 Maha season. In horizontal axis 1,2 and 3 represent respectively FFS trained farmers, neighbor farmers where FFS conducted in the village and control maize farmers where FFS not conducted in the village.

Moreover, the results confirm that, after participating in an FFS, the participants are likely to use reduced insecticides than other farmers (approximately 1.1 times), and have acquired greater knowledge on certain principles of insect and pest control. The organic application behavior is depicted in detail highlighting the differences in the Figure 4.

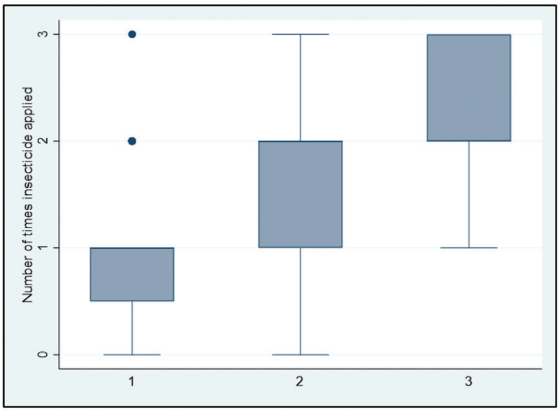

Figure 4. Pesticides application behavior of FFS trainees, neighbors, and other farmers
Notes: Graph reports the number of times insecticides applied by farmers for their maize cultivation in 2022/23 Maha season. In horizontal axis 1,2 and 3 represent respectively FFS trained farmers, and neighbor farmers where FFS conducted in the village and control maize farmers where FFS not conducted in the village.

As per the National Food Production Plan (NFPP), the maize productivity is expected to increase in short period of time. Therefore, increased rates of adoption of high-density planting is highly recommended by the Department of Agriculture. A detailed analysis using equation (1) of the OLS method to explore the factors affecting the adoption of High-density planting and Pesticide application determinants are presented in Table 4.

Table 4. OLS estimation for high density planting & pesticide applied

Variables	(1)-OLS Practice High-density Planting	(2)-OLS Number of times pesticide applied
Participation to FFS trainings (yes =1)	0.13 (0.04) ***	-0.95 (0.09) ***
Maize growing land extent (Acer)	-0.09 (0.03) **	0.06 (0.05)
IPM, IPNS and maize agronomy knowledge (max=10)	0.03 (0.01) **	-0.01 (0.04)
Contact with AI with in last 12 months (yes=1)	-0.005 (0.042)	-0.06 (0.14)
Contact with ARPA with in last 12 months (yes=1)	0.02 (0.039)	0.03 (0.08)
Constant	0.03 (0.301)	1.51 (0.47) ***
Observations	379	379
Number of FFS	18	18
R^2	0.112	0.297
House hold head characteristics	Yes	Yes
Hose holds characteristics	Yes	Yes
Information come from TV, Radio	Yes	Yes
Village FE	Yes	Yes

*Notes: This table reports coefficient of interest estimated based on OLS estimation based on equation (1). All standard errors in the parentheses are clustered at the village level. Statistical significance indicated by the asterisk, ***p<0.01, **p<0.05, *p<0.1 respectively.*

According to the results, the participation in FFS training, IPM, IPNS, and maize agronomy knowledge and education level of the household heads are positively and significantly affecting the decision to adopt high-density planning maize in their fields. However, the land extent is negatively correlated with adoption decision of high-density planting, indicating the DOA attention to introduce seeding machines to reduce the seeding cost and time.

Pesticide application misuse is one of the major threats to the supply of raw materials to maize processing industries threatening ecosystems. The results show that, FFS farmers potentially apply lower rates of pesticides than other farmers in the village. The results further confirm that participation of FFS training farmers is more likely to reduce chemical application in their farming sites.

The R^2 value of the above OLS estimates shows a relatively low value, indicating a moderate fit to the model. Therefore, logistic regression was also conducted using the same variables, and the results are presented in Table 5.

Table 5. Logistic regression estimation for high density planting & pesticide applied

Variables	(1)-Logistic Regression	(2) Logistic Regression
	Practiced High-density Planting	Pesticide Applied
Participation to FFS trainings (yes =1)	3.26 (1.13) ***	-8.74 (6.47) ***
Maize growing land extent (Acer)	-0.52 (0.18) **	0.92 (0.49)
IPM, IPNS and maize agronomy knowledge (max=10)	1.34 (0.19) ***	-0.94 (0.22)
Contact with AI with in last 12 months (yes=1)	-0.81 (0.32)	-0.6 (0.14)
Contact with ARPA with in last 12 months (yes=1)	1.15 (0.41)	0.78 (0.44)
Constant	0.1 (0.183)	0.1 (0.238)
Observations	379	379
LR chi2 (20)	43.84	23.55
Prob> Chi2	0.001	0.17
Pseudo R^2	0.135	0.176
House hold head characteristics	Yes	Yes
Hose holds characteristics	Yes	Yes
Information come from TV, Radio	Yes	Yes
Village FE	Yes	Yes

*Notes: This table reports coefficient of interest estimated based on logistic regression estimation. All standard errors in the parentheses are clustered at the village level. Statistical significance indicated by the asterisk, ***p<0.01, **p<0.05, *p<0.1 respectively.*

These results emphasize the findings in Table 4 and clearly show that participating in FFS trainings is three times more effective for adopting high-density planting compared to other variables. When it comes to reducing pesticide application, it is eight times more effective than other variables.

FFS effects on information and technology diffusion to neighbors

It is proved that farmers often trust their neighbor's agriculture practices and advice rather than extension service information and advice (Valente *et al*., 1999; Feder *et al*. 2004). In many occasions, of the adoption of new inputs and techniques, fellow farmers are the most important source of information. This study provides slight evidence of farmer-to-farmer extension principals discussed in the FFS and it has clearly indicated by a component of IPM and IPNS knowledge gap between the two groups in Table 3.

Table 6 shows the key practices or items of knowledge comparison between neighbor famers of FFS and other farmers who were not exposed to FFS. The results illustrate that there is significant gap between FFS neighbors' farmers and others in the same district. The yield component after FFS training shows a significant difference and, it may be the selection bias of FFS sites as most of FFS selected purposely. The components IPM, IPNS, agronomy knowledge, knowledge about fall-armyworm taxonomy, and knowledge 1.5' X 1' high density planting space show significant deference indicating some information passes to neighbors as well. However, the mean values of these variables indicate very low values indicating the percentage of farmers reaching the information is comparatively very low. Furthermore, the results show that the adoption of technologies like 1.5' X 1' high density planting, Organic fertilizer use, a practice recommended dose of inorganic fertilizer, IPM practices (pheromone tarp use) are insignificant and indicate that, although information and knowledge transfer to the neighbor farmers of FFS, they very rarely practice these technologies.

Conclusions

The evidence from this study indicates that FFS can contribute to a significant increase in IPM, IPNS and agronomic knowledge of the participants. In addition, there is very little evidence of effective transmission of the learning experience to other farmers, and there is inadequate evidence that even FFS participants and neighbors dissolve the knowledge in to the practice gained from FFS participation. Therefore, use of FFS as a tool for technology and information transfer/dissemination is a successful method for participants and there should be a vigorous extension approach to sustain information and knowledge transfer while changing the attitudes for other non-participants in the community. Thus, FFS is an agricultural extension approach that quietly addresses the issues and challenges in the Sri Lankan context, where poverty growing and productivity declining.

Table 6. Knowledge and skill transfer by farmer-to-farmer extension

	Control-1 (FFS villages non-trained farmers)	Control-2 (Farmers in non-FFS villages)	Difference
	Mean	Mean	(1) – (2)
	N=160	N=59	
	1	2	3
Yield after FFS training (Mt/Ac)	1.62	1.55	0.07***
	(0.21)	(0.19)	(0.03)
IPM, IPNS and agronomy knowledge (Max 10)	2.7	2.2	0.5***
	(1.21)	(1.09)	(0.17)
Know fall army worm damage (yes=1)	88.1%	83.1%	5%
	(0.33)	(0.38)	(0.05)
Identification of fall army worm (yes=1)	30 %	13.6%	16.4%***
	(0.46)	(0.34)	(0.06)
2' × 2' and 2' ×1' planting space know (yes=1)	100 %	94.9 %	5.1 %***
	(0)	(0.22)	(0.02)
1.5' × 1' high density planting space know (yes=1)	23.1%	6.8%	16.3%***
	(0.42)	(0.25)	(0.06)
1.5' × 1' high density planting space practice (yes=1)	9.30%	3.40%	5.9%
	(0.29)	(0.18)	(0.05)
Urea used (kg/ha)	190.6	183.3	7.3
	(24.43)	(23.09)	(3.67)
Organic fertilizer used (kg /Acer)	98.1	181.4	-83.2
	(351.54)	(512.75)	(61.08)
Insecticide applied (yes=1)	29.3%	40.6%	-11.3%
	(0.46)	(0.49)	(0.07)
Number of times insecticide applied	1.8	2.1	-0.3*
	(0.84)	(0.71)	(0.12)
Pheromone trap use (yes=1)	6.8%	6.7%	0.1%
	(0.25)	(0.25)	(0.03)
Number of hours monitoring the field in a week	6.5	6.7	-0.2
	(1.07)	(1.06)	(0.17)
Apply insecticides after counting insects or damaged plants (yes=1)	20.6%	20.3%	0.3%
	(0.41)	(0.41)	(0.07)

*Notes: Columns 1 and 2 of the table report the mean of the observed characteristics of households in the control 1 and control 2 groups. The standard deviations are presented in parentheses. Column 3 reports the difference in means between the two groups and its standard error (SE). Statistical-significance is indicated by the asterisk, ***p<0.01, **p<0.05, *p<0.1 respectively.*

These results pose a vital policy implication for agriculture extension in Sri Lanka, where the FFS technique can be used for agriculture extension, especially in programs seeking to spread the new knowledge or skills across small populations or groups. As this paper proves that FFS can increase the knowledge of FFS-trained farmers in particular IPM, IPNS, and crop agronomy, it suggests that it needs to be carefully guided the FFS participants not only gather the knowledge for themselves but also to transfer the knowledge acquired to other non-participants. At the same time, other farmers must be informed about the FFS location and activities, and a method should be in place to ensure this.

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