The Journal of Public Affairs and Development
Volume 2, Number 2, 2015, pp. 107-142
ISSN 2244-3983

Farmer Field School as an Effective Approach in Increasing Farmers' Knowledge, Skills, and Practices, and in Enhancing Diffusion of Innovations: Evidences from Selected Rice Farmers in Masalasa, Victoria, Tarlac, Philippines

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ABSTRACT. The study assessed the effectiveness of the Farmer Field School (FFS) approach in increasing the knowledge, skills, and practices of selected rice farmers in *Barangay* Masalasa, Victoria, Tarlac in the Philippines as well as the diffusion of innovations among them. Empirical evidences were obtained from the 24 farmers who attended the FFS on PalayCheck System and 24 non-participating farmers serving as the control group. The FFS provided farmers with new knowledge and skills on the whole PalayCheck System as demonstrated by the FFS graduates having more knowledge on the PalayCheck component-technologies as compared with non-FFS farmers. All the FFS farmers shared their knowledge to their families, relatives, friends, and other farmers. Farmer-to-farmer diffusion was observed as the FFS farmers shared what they have learned to the non-FFS farmers, who in turn, shared this knowledge with other farmers. Thus, more farmers were reached because of the multiplier effect of farmer-to-farmer diffusion.

While the extent of knowledge diffusion, such as the number of farmers and the management practices shared by the participants, were not determined, this case study suggests that FFS can be a good avenue for building the human and social capital of farmers. However, social

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and technical gains can only be sustained if the appropriate local and national level-institutions, and the necessary supporting mechanisms and policies for continuous capacity development are developed and in place.

Keywords: *Farmer Field School, PalayCheck System, diffusion-adoption process, social impact*

INTRODUCTION

Globally, agricultural extension faces many challenges, one of which is how to develop a sustainable approach that empowers farmers and extends beyond technical knowledge to producers. This challenge is to help small-scale farmers play a leading role in organizing themselves for production, marketing, and advocacy (David, 2007). The Farmer Field School (FFS) approach, which promotes group learning based on the principles of adult education, had been espoused by many authors as one approach to meet this challenge (Erbaugh, Donnermeyer, & Kibwika, 2001; Erin, Sadoulet, de Janvry, Murgai, & Ortiz, 2004; David, 2007; Erbaugh, Donnermeyer, Amujal, & Kidoido, 2010; Godrick & Khisa as cited in Muhammad, Chaudhry, Khatam, & Ashraf, 2013).

The FFS was developed in Asia in the 1980s in teaching integrated pest management (IPM) techniques to groups of farmers. It was introduced in Africa in the mid-1990s, and it is currently being used in over 27 African countries, covering varied topics such as integrated production and pest management (IPPM) of annual and perennial crops, soil management, livestock production, and HIV/AIDS (Davis, 2006; Braun et al., 2006 as cited in David, 2007).

While many studies show the effectiveness of FFS as it leads to reduced pesticide use, increased productivity, and improved farmer's knowledge (Erbaugh et al., 2001; Erin et al., 2004; Feder, Murgai, & Quizon, 2004; van den Berg, 2004; David, 2007), there have also been criticisms to the approach such as high cost of FFS in terms of time, funds, and human resources; and the difficulty of scaling up FFS in a financially sustainable way (Quizon, Feder & Murgai, 2001; Feder et al., 2004). Nearly all of the empirical evidences on the challenges and issues of FFS implementation is taken from Asian and African countries, which implemented several FFS programs.

David (2007) observed gaps in the literature and mixed results, which do not allow conclusions about the effectiveness of the FFS approach. The popularity of the approach among many countries, and the increasing number of donors and governments wanting to establish FFS programs made it necessary to have more empirical evidences on the effectiveness as well as on the strengths and weaknesses of the FFS approach. Particularly, more studies are needed on the effectiveness of the approach in imparting knowledge and in empowering farmers, both of which are strongly influenced by socio-cultural context. This study documented the impact of FFS on farmer's empowerment and provided more detailed analyses of the factors contributing to farmer's learning and diffusion behavior.

Low Rice Production of Farmers and the Need for Discovery-based Learning Training Approach

Low rice productivity has always been a problem of almost all farmers. They continually face many problems such as biotic and abiotic stresses (e.g., pests and agro-climatic conditions). Added to these, they lack the necessary knowledge and skills to deal with pest problems. Often, they resorted to calendar spraying of pesticides, which just aggravated the problems because of pest resurgence. Hence, instead of getting higher yield, they got lower yield.

Previous extension works conducted in *Barangay* Masalasa, Victoria, Tarlac in the Philippines focused on blanket technical messages without much emphasis on understanding the interactions within the rice agro-ecology and the factors contributing to diseases and pests. While demonstrations may have been effective in teaching skills and practices to farmers, these were less appropriate in conveying knowledge about diseases and pests. Similarly, teaching farmers how to spray pesticides based on the calendar discouraged them from observing disease levels and pest infestations as well as depriving them from making their own decisions whether to spray or not, and when. As one FFS farmer said: “We never learned to think for ourselves, and make our own decisions.”

To help increase the productivity of rice farmers, the Philippine Rice Research Institute (PhilRice) in close collaboration with the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) and the local government unit (LGU) of Victoria, Tarlac implemented a project entitled “Science and Technology-Based Farm (STBF) on Increasing Yield through the Utilization of Quality Rice Seeds of Recommended Varieties on Selected Irrigated and Rainfed Areas” in Tarlac.

The project’s general objective was to demonstrate the advantages of using quality rice seeds of the most preferred and newly released inbred and hybrid rice varieties in increasing the productivity and income of rice farmers. It was implemented in four cropping seasons (2010 wet season to 2012 dry season). Part of the project was a weekly training of farmer beneficiaries dubbed as FFS on PalayCheck System, which followed the FFS approach. The FFS is based on adult education principles such as experiential group learning. It is used to disseminate information and technology, educate, and empower farmers. It involves an intensive, season-long training program where facilitators used experiential learning, group dynamics, and simple experimentation to ‘co-learn’ with farmers.

In the typical FFS, a group of about 25 farmers meet regularly with a facilitator during the cropping season. The facilitator helps the farmers learn for themselves by asking questions and encouraging discovery-based learning. Farmers are taught to diagnose and solve problems, set priorities, and perform on-farm experiments (Davis, 2006).

In the study, among the 45 farmers who enrolled during the first cropping season, only 12 of them finished and continued in the second and succeeding seasons. Other farmers enrolled in the second and third seasons, and 32 of them (including the 12 farmers from the first cropping season) graduated from the FFS after the four cropping seasons (Ilar, 2012).

Comparing with typical FFS, the PalayCheck System, on the other hand, is a dynamic rice crop management system. It presents the best key technology and management practices as Key Checks; compares farmer practices with the best practices; and promotes learning through farmers' discussion groups to sustain improvement in productivity, profitability, and environment safety. This system is simply "learning, checking, and sharing for best farming practice."

The PalayCheck System is a Rice Integrated Crop Management (RICM) System, which recognizes that rice growing is a production system consisting of a range of factors that are interdependent and interrelated in their impact on the growth, yield, rice grain quality, and environmental sustainability. It covers the principal crop management areas such as variety and seed selection, land preparation, crop establishment, nutrient management, water management, pest management, and harvest management, where the different yield-enhancing and cost-reducing rice production technologies (termed as component technologies) are recommended. It also encourages farmers to manage their rice crop according to targets by measuring crop performance and analyzing results.

The system provides standards in the form of Key Checks that guide farmers on what to achieve; how to assess the Key Checks; and how to achieve these Key Checks. Hence, through a continuous learning process, the system helps farmers learn from their experiences while improving their crop management practices (PhilRice, 2008).

Prior to the implementation of the FFS on PalayCheck System in the village, varietal trials (VTs) were established to demonstrate the performance of the five newly-released varieties with the aim of developing location-specific variety/ies after four seasons. Aside from demonstrating their performance, these VTs also served as learning fields of the FFS farmers. Likewise, to encourage experimentation, observation, and decision-making of the participants, technology demonstration farms (TDFs) were established by dividing a 1-ha farm of the farmer-cooperator (FC) into two adjacent plots: the PalayCheck System plot, where all the PalayCheck component technologies and practices are implemented; and the farmer practice plot, where the participants carry out their normal farming practices. This is to allow comparisons between their normal practices from that of the new practices and technologies being introduced.

Aside from these, the participants also allotted 0.5 ha of their own farms wherein they may or may not apply the things they have learned in the FFS. Farmers learned from three types of activities. The discovery-based learning exercises allowed farmers to develop an understanding of the concepts and principles related to the topic as well as skills or practices. The field activities focused solely on teaching skills or practices. On the other hand, the conduct of agro-ecosystem analysis (AESA) taught the FFS farmers how to make close observations of farm conditions and to analyze the interactions between the rice plants and other biotic and abiotic factors co-existing in the field.

The group-learning processes, specifically the group dynamic exercises, were designed to increase farmers' communication skills, boost self-confidence, and encourage team building (David, 2007). The process also involved field days where farmers from neighboring *barangays* (villages), LGU officials, and representatives from other government agencies, non-government organizations (NGOs), and people's organizations were invited and taught by the farmers. These field days served as avenues where farmers explain to the participants about their demonstration farms and the things they were doing in the FFS. Farmer participants were sometimes trained as facilitators for future field schools (Davis & Place, 2003; Davis, 2006).

This study examined the knowledge and skills acquired by the FFS farmers, the technology adoption behaviors of both the FFS and non-FFS farmers, the knowledge sharing done by the FFS farmers to the non-FFS farmers, and the socio-economic impacts of this training approach.

Farmers' Benefits from FFS

According to David (2007, p. 36), "the better internalization and retention of knowledge, attributed to the participatory and discovery learning process, coupled with social benefits of FFS training, are key justifications for the relatively high time, human, and cost investments required to implement FFS."

Several studies have shown the effectiveness of the FFS approach in increasing the level of knowledge and skills of the FFS farmers. Erbaugh et al. (2001) found that participation in FFS was effective in increasing both knowledge on IPM and the adoption of cowpea IPM strategies. Farmers' level of IPM knowledge had a very significant effect on technology adoption (Erbaugh et al., 2001; Mutandwa & Mpangwa, 2004; Erbaugh et al., 2010). Furthermore, David (2007) mentioned that FFS provided farmers with new skills and knowledge on cocoa integrated crop and pest management (ICPM), and FFS graduates generally demonstrated superior knowledge on cocoa ICPM as compared with non-FFS farmers. Thus, FFS increased the capacity of farmers to apply new technologies in their fields in order to assess the technologies' relevance to their specific circumstances, and to interact with researchers and extension workers for help when needed to solve a specific problem (Godrick & Khisa as cited in Muhammad et al., 2013). In this light, the FFS is an agricultural intervention that could boost agricultural productivity by allowing farmers, assisted by an expert, to experiment and learn from their own plots. In Cameroon, Africa, David (2007) reported that FFS provided farmers with new skills and knowledge in managing, and in increasing the income from their cocoa plantations. Same results were obtained in Peru where FFS farmers increased their average potato seed output/ input ratio by approximately 52 percent of the average value in a normal year (Erin et al., 2004). Increased knowledge from technological interventions provided opportunities for farmers to be creative in enabling them to solve farm-related issues, such as pest problems (Ooi, 1998). Improved knowledge translated to tangible benefits, such as reduced pesticide use and increased productivity (Erbaugh et al., 2001; Praneetvatakul & Waibel, 2006; van den Berg, 2004; David, 2007). Nevertheless, some studies showed mixed results regarding increased yield and productivity depending on the crop and period under investigation (IDB, 2010).

On the other hand, better communication skills (e.g., confidence in public speaking, negotiation skills) and increased social capital as means to collective action were some of the social benefits derived from the FFS. There are empirical studies showing mixed results regarding the social impacts of FFS. Greater group cohesion and leadership skills were documented in Africa (Mwagi, Onyango, Mureithi, & Mungai, 2003 as cited in David, 2007; Khisa & Heinemann, 2005 also cited in David, 2007) whereas other studies found no evidence of increased social capital (Tripp, Wijeratne & Piyadasa, 2005, as cited in David 2007). In addition, Muhammad et al. (2013) suggested that the results obtained from FFS included self-confidence and pride. Farmers were empowered in gaining greater control over their lives and realizing positive changes in their roles versus the role of professionals.

Likewise, the FFS literature has devoted attention on the challenges of scaling up. According to David (2007), the FAO team that developed the FFS approach recognized farmer-led expansion and farmer-to-farmer diffusion as instrumental in the scaling-up process and critical for making the approach more cost-effective and sustainable.

However, while the effectiveness of the diffusion process was a key factor in the success of the FFS approach, evidences have not been conclusive, partly due to data and methodological limitations of earlier studies (Feder et al., 2004). Likewise, studies on FFS diffusion showed disappointing results in terms of the effectiveness of farmer-to-farmer diffusion and the type of knowledge that FFS farmers shared (David, 2007).

Several researches conducted in West Africa (Simpson & Owens, 2002), the Philippines (Rola, Jamias, & Quizon, 2002), and Sri Lanka (Tripp, Wijeeratne, & Piyadasa, 2004) suggested that FFS farmers were more likely to share practices and skills and less likely to discuss abstract concepts and principles with other farmers. Hence, the effectiveness of farmer-to-farmer diffusion was called into question by the study conducted by Rola et al. in 2002, which showed that the knowledge of secondary recipients on key technical topics was not significantly better than that of the control group of farmers. Likewise, the study of Feder et al. (2004) showed that there was no significant diffusion of knowledge to other farmers who resided in the same villages as the trained farmers. These results implied the need for revision in the training procedures and curriculum to make the FFS approach more viable and effective.

On the other hand, it was observed in Ghana and Mali that some FFS farmers "established close, almost apprentice-ship type, relations with one or two other farmers." However, the literature provided little discussion on how the farmers shared knowledge (e.g., verbally, through apprentice arrangements, or by demonstration) and how these methods affected the knowledge retention and learning of farmers (Simpson & Owens, 2002; David, 2007).

METHODOLOGY

Survey interview was the primary method used to gather quality data in this case study. Out of the 32 FFS graduates, only 24 were interviewed because some have moved out of the area to work elsewhere, while one had died. Another group of 24 farmers served as a control or comparison group because of the unavailability of baseline data that could serve as bases to assess improvements from the FFS intervention. The control group was composed of farmers who did not attend the FFS but were assumed to have attended similar trainings conducted by PhilRice or other agencies. They were selected using systematic random sampling from a list obtained from the agricultural extension worker (AEW) assigned in the area and validated by the Committee on Agriculture in-charge. The total sample size of 48 consisted of 24 FFS farmers and 24 non-FFS farmers.

To determine their level of knowledge on the PalayCheck System, the farmers rated 32 questions (negative and positive questions) on the PalayCheck System and its different component technologies under the seven crop management areas. A Likert scale was used with the following values: 1=strongly disagree, 2=disagree, 3=undecided, 4=agree, and 5=strongly agree. Likewise, they were asked to rate their perceived level of competencies on the different technologies using a Likert scale with the following values: 1=not competent, 2=less competent, 3=slightly competent, 4=competent, and 5=very competent. Open-ended questions were also asked to gather their perceived social impacts of the FFS.

To support the data gathered from the survey, key informant interviews (KIIs) were conducted using the guide questions. The key informants included FC and the AEWs who assisted in the FFS. Secondary data were also collected from project protocol, terminal reports, and other documents related to the STBF project.

Quantitative and qualitative data gathered from the primary and secondary sources were sorted, grouped, categorized, and analyzed. Data analysis used descriptive statistics such as frequency counts, percentages, mean, range, and standard deviation. Highlights of some farmers' testimonies were included to corroborate the findings.

RESULTS AND DISCUSSION

Socio-demographic Characteristics of the Respondents

Appendix 1 shows the socio-demographic characteristics of FFS farmers and non-FFS farmers. Non-FFS farmers were older than the FFS farmers. Majority (42%) of the FFS farmers were from 40 to 50 years old, while nine (38%) were above 50 years old, with a mean age of 48 years. Their age ranged from 23 to

65 years old. On the other hand, majority (42%) of the non-FFS farmers were above 50 years old, and only eight (33%) were 40 to 50 years old, with a mean age of 49 years. Their age ranged from 32 to 81 years old.

Majority were male and married for both groups of farmers. In terms of education, 50 percent of the FFS-participants were high school graduates as opposed to only two (8%) for the non-FFS farmers. Also, there were more college graduates (17%) among the FFS farmers, while there were more high school undergraduates (38%), college undergraduates (29%), and vocational graduates (17%) among the non-FFS farmers.

For farm size, both farmer-groups had equal number (42%) of farmers with 1.0 to 3.0 ha of land. More non-FFS farmers had farm sizes below 1 ha as compared with the FFS farmers. Further, four of the FFS farmers had above 3.0 ha farm sizes. For tenurial status, half (12) of the FFS farmers owned their farms, while only nine of the non-FFS farmers owned theirs. The rest (15) were tenants.

Farmers' Learning and Application of PalayCheck System Component Technologies

Appendix 2 shows the PalayCheck System component technologies that the FFS farmers have learned. When asked about technologies covered in the FFS, all of them recalled the use of high quality seeds of a recommended variety; planting of sufficient number of healthy seedlings; use of leaf color chart (LCC) and minus-one element technique (MOET); use of controlled irrigation (CI); identification of insect pests (IPs) and natural enemies (NEs), IPM, AESA, and the cutting and threshing of the crop at the right time. These were mostly recalled as majority of them learned new knowledge and skills on these technologies.

The other technologies recalled by more than 90 percent of the participants were plowing the field 3 to 4 weeks before transplanting; planting synchronously after a one-month fallow period; management of golden apple snail (GAS); and management of field rats. Likewise, 79 percent of them recalled the management of weeds, while 75 percent recalled the use of muriate of potash (MOP).

The technology that only 58 percent of the farmers recalled was the use of hybrid rice (HR). This may be attributed to the complexity and applicability of the HR technology given the farmers' problems with irrigation water. The use of HR requires a good source of irrigation water because it needs more water as compared with inbred varieties.

As to their knowledge on new technologies, all of them acquired new knowledge on plowing the field 3 to 4 weeks before transplanting; planting synchronously after a fallow period of one month; planting sufficient number of healthy seedlings; using LCC, MOET, MOP, and CI; proper disease diagnosis, and AESA. More than 90 percent also mentioned that they acquired new knowledge on the use of high-quality seeds of a recommended variety, cutting and threshing of the crop at the right time, identification of IPs and NEs, and IPM. Most of them also learned new knowledge on managing field rats, GAS, and weeds. Only half of them learned new knowledge on the use of HR and in harrowing the field at least twice at a one-week interval. Farmers actually harrowed their fields twice but not at one-week interval owing to the unavailability of irrigation water in the area. They learned the science behind why a one-week interval between harrowing was recommended.

In relation with technology adoption behavior of farmers, the level of knowledge on the different technologies was compared between the FFS farmers and non-FFS farmers. The FFS farmers obtained a higher average score of 4.43 (agree) as compared with the average score of 3.25 (undecided) of the non-FFS farmers. Looking at the different crop management areas, the non-FFS farmers had the lowest scores in nutrient management implying that majority of them did not have the right knowledge on this technology. Likewise, they had relatively lower scores about the PalayCheck System as most of them never heard of it (Table 1). This low level of knowledge influenced their technology adoption behaviors.

Table 1. Average knowledge test score among the FFS farmers and non-FFS farmers

PALAYCHECK CROP MANAGEMENT AREA	FFS FARMERS (n=24)	NON-FFS FARMERS (n=24)
1. Overview of the PalayCheck System	4.42	2.54
2. Variety and seed selection	4.67	3.02
3. Land preparation	4.35	3.50
4. Crop establishment	4.35	3.90
5. Nutrient management	4.40	2.62
6. Water management	4.39	3.18
7. Pest management	4.40	3.45
8. Harvest management	4.49	3.83
Average	4.43	3.25

Legend: 1=strongly disagree, 2=disagree, 3=undecided, 4=agree, and 5=strongly agree

These findings supported the claims of Erbaugh et al. (2001) and David (2007) that participation in FFS was an effective mechanism for increasing both the knowledge on IPM and ICPM and the adoption of integrated cowpea-specific IPM strategies as compared with the non-participants. Likewise, the farmer's level of IPM knowledge had a very significant effect on technology adoption (Erbaugh et al., 2001; Mutandwa & Mpangwa, 2004; David, 2007; Erbaugh et al., 2010).

Other factors that influenced technology adoption behaviors were their level of skills or competencies on these technologies. The FFS farmers had higher levels of skills and competencies on the technologies as compared with the non-FFS farmers, primarily because they had tried using these technologies while still undergoing the FFS (Appendix 3).

After the implementation of the FFS in 2012, most of the participants adopted the PalayCheck System component technologies learned in the FFS, consistent with their level of knowledge, skills, and competencies (Appendix 4). This finding was similar to the experiences in all five Eastern and South African countries wherein there was immediate uptake of the technology by participants because trainees discovered, learned, and then integrated positive ideas into their own production systems (Anandajayasekeram et al., 2001). Similarly, the immediate uptake of poultry production technologies (e.g., vaccine, housing, and feeding) by farmers in the poultry FFS in Kakamega, Kenya was a good example of such farmer behavior (Mweri, 2001).

In the 2013 cropping seasons, all of the farmers used high-quality seeds of recommended varieties, followed the proper way of land preparation, transplanted at 25 cm x 25 cm planting distance to obtain sufficient number of healthy seedlings, used CI, and harvested and threshed their crops at the right time. Ninety-two percent adopted nutrient management technologies (i.e., use of LCC to determine when to apply nitrogen fertilizer) and pest management technologies (i.e., proper identification of insect pests and natural enemies, proper diagnosis of diseases).

Majority of FFS farmers were no longer using pesticides heavily to control pests and diseases. They used an integrated approach in management and applied pesticides judiciously only when necessary. This contrasted with majority of the non-FFS farmers who still heavily used pesticides to control pests (Appendix 4). This was supported by the findings of Rola (1997) in other countries that showed that lack of knowledge about the effects of pests on the cotton crop contributed to the overuse of chemical pesticides.

Further, the technologies, with only 50 percent adoption, were the use of HR and synchronous planting. Only half (50%) of them used HR because the technology entailed higher cost for seeds and inputs as compared with using inbred varieties. Likewise, only half (50%) of them were able to adopt synchronous planting because of the unavailability of irrigation water in some areas. They were not able to establish their farms for planting on time. On the other hand, only a few (25%) of the non-FFS farmers adopted the HR technology. Only 63 percent adopted the use of high quality seeds of a recommended variety primarily because of the relatively higher seed cost as compared with their own saved seeds. Some (63%) of them were already using certified seeds before because of the seed subsidy program of the government. However, they did not know the science behind using quality rice seeds. They did not realize that the yield advantage of using high-quality seeds could only be attained if all the crop management areas, which are integrated and interrelated, were properly implemented. Likewise, 67 percent harrowed their fields twice at one-week interval unlike before when majority of them just prepared their lands just one week before transplanting. Nobody adopted the nutrient management technologies such as the use of LCC, MOET, and MOP because of unavailability of MOET kits and the high cost of MOP (Appendix 4).

The case study found that the FFS farmers acquired new knowledge and skills in managing their rice crops that subsequently increased their yields. Table 2 shows the yield and gross income differences between FFS and non-FFS farmers for two cropping seasons in 2013. The FFS farmers had more than 1 ton/ha increase in yield; hence, translating to more income of about PhP47,710 in one year. The increase in productivity and profitability of the FFS farmers was attributed to their adoption of the different technologies taught in the FFS. These results were supported by the findings of David (2007) showing that FFS farmers in Cameroon in Africa increased their yields and income by adopting the cocoa IPM strategies. Moreover, Erin et al. (2004) found that Peruvian farmers who participated in the FFS were able to raise their average potato seed output/input ratio by approximately 52 percent of the average value in a normal year.

Table 2. Yield and gross income differences between FFS and non-FFS farmers for two cropping seasons (CY 2013)

ITEM	FFS FARMERS (n=24)	NON-FFS FARMERS (n=24)	DIFFERENCE BETWEEN FFS AND NON-FFS FARMERS
Average yield (t/ha) in the dry season (DS) of 2013	6.42	5.32	1.10
Average yield (t/ha) in the wet season (WS) of 2013	5.08	4.05	1.03
Average yield for 1 year (WS and DS 2013) (t/ha)	5.75	4.68	1.07
Average gross income (PhP) DS 2013	115,560.00	90,440.00	25,120.00
Average gross income (PhP) WS 2013	91,440.00	68,850.00	22,590.00
Total gross income (PhP) for 1 year (WS and DS 2013)	207,000.00	159,290.00	47,710.00

Knowledge Diffusion of FFS Farmers

The effectiveness of the diffusion process is one of the key factors for the success of the FFS approach. If information diffuses extensively from farmer to farmer through informal communication, higher impact could be achieved at a reasonable cost. The multiplier effect of knowledge diffusion can extend technology promotion and use, but the effect is quite hard to account for because it is often undocumented. This study was able to determine the knowledge sharing done by FFS farmers to non-FFS farmers but not with the knowledge sharing done with their families, relatives, friends, and other farmers.

All of the FFS farmers claimed that they shared some of the technologies learned in the FFS to other non-FFS farmers. All of them shared the technologies on the use of high quality seeds, planting synchronously, and IPM. Majority of them also shared other pest management and nutrient management technologies primarily because they themselves benefitted in adopting these technologies by reducing their pesticide cost and increasing their income. However, many of them (37%) did not share the use of HR technology owing to its complexity and non-applicability to their situations.

Majority of the FFS farmers shared technologies to non-FFS farmers because they wanted to share the benefits of using these technologies (Appendix 5). Moreover, knowledge sharing was done by both farmer-groups to their own family members, relatives, friends, and to other farmers, though it was not determined what specific technologies they have shared. These results were corroborated by the FC during the KII who said that walk-in farmers from nearby and distant *barangays* were inquiring about certified seeds, LCC, and MOET. Furthermore, the FC shared his knowledge during informal discussions with other farmers and visitors in his farm. Moreover, the FFS farmers shared what they knew to hundreds of farmers and other rice stakeholders during the farmers' field day and forum. Such knowledge sharing created the multiplier effect of knowledge diffusion, mainly through farmer-to-farmer diffusion.

This knowledge diffusion from FFS farmers was also one of the factors why non-FFS farmers adopted some of the technologies. While this study did not analyze in-depth how these technologies were diffused (Feder et al., 2004) or while knowledge sharing may not have been as intensive as in formal trainings, still there was knowledge diffusion from FFS farmers to non-FFS farmers. This finding was supported by the study of David (2007), which showed that FFS farmers in Cameroon, Africa were more likely to provide other farmers with information on how to implement management practices rather than share knowledge about concepts and principles of cocoa ICPM.

Social Impacts of the FFS

While there have been considerable evidences that FFS contributes to improved knowledge (Erbaugh et al., 2001; Rola et al., 2002; Erin et al., 2004; Mutandwa & Mpangwa, 2004; David, 2007; Erbaugh et al., 2010), studies on the social impacts of FFS had been less conclusive. This is probably because, according to David (2007), measuring the social impacts of FFS poses major methodological challenges.

This case study asked FFS farmers on their perception on the social benefits of FFS. Table 3 shows that majority (84%) of them perceived that they improved their critical thinking and decision-making skills through AESA. Doing AESA in the FFS led many farmers to base their farm management decisions on observations rather than on habit or recommendations. The FC even commented: "Before, I heavily used chemicals to control pests. I lost a lot of money in calendar spraying. I was harming myself and the environment. Now, I make critical observations on the rice crops by looking at the dynamics of insect pests and natural enemies before deciding whether to spray or not."

Also, 75 percent of them claimed that they were now able to arrive at a consensus, their cooperative behavior had improved, and their social cohesion and solidarity were enhanced. In fact, the group being formally organized into a cooperative showed high spirit of solidarity and cooperativism as a result of the FFS. Because they have become a cooperative, the FFS farmers continued to meet with each other aside from their regular meetings. Likewise, their networks and linkages have expanded to cover stronger partnerships with the LGU-Victoria, the Provincial Government of Tarlac, the DA-Regional Field Office 3, PhilRice, Central Luzon State University, NGOs, and some micro-financing institutions. The cooperative also maintains good partnerships with input suppliers. These claims were corroborated by the AEWs assigned in the area during the KII.

Because of the different group dynamics implemented in the FFS, their interpersonal relationship skills were also enhanced. Furthermore, because of the weekly AESA they conducted in

Table 3. Social benefits from FFS as perceived by the participants

SOCIAL BENEFITS AND CHANGES	NO.	%
Our critical thinking and decision-making skills improved through the agro-ecological system analysis (AESA).	20	84.2
We were always able to arrive at group consensus.	18	75.0
Our cooperative behaviors improved.	18	75.0
Our social cohesion and solidarity were enhanced.	15	62.5
Our networks and linkages increased.	15	62.5
Our interpersonal relationships skills were enhanced.	14	58.3
Our confidence in public speaking was developed and enhanced.	14	58.3
Our leadership skills were developed and further honed.	12	50.0
We developed a positive attitude towards the whole PalayCheck System, especially on experiential group learning.	12	50.0

Note: Multiple responses

which the participants not just observed but reported and defended their observations in front of their fellow farmers and the facilitators, their confidence in public speaking was developed and enhanced. One farmer said: "Before I joined the FFS, I was so timid. I could not even address people in a group, but now I am confident. I can now present in front of many people and freely talk with anyone with confidence."

According to the AEWs who facilitated the FFS, most of the farmers presented the results of their demonstration farms and variety trials to hundreds of farmers and other stakeholders during the Farmers' Field Day and Forum conducted two weeks before the end of every cropping season.

Half of them claimed that their leadership skills were developed and further honed. The terminal report showed that some of them emerged as leaders in their villages. They initiated the establishment of 'baby variety trials' and recruited farmers in their areas to observe the performance of these varieties. Also, as evidence of their good leadership, the Masalasa-STBF Marketing Cooperative was in good standing and was continuously growing in membership. Lastly, half of them (the 12 original FFS farmers) claimed that they have developed a positive attitude towards the whole PalayCheck System, especially on experiential group learning.

All these social benefits could have accrued because of the longer implementation of the FFS (i.e., four seasons unlike other FFS that was implemented for one cropping season only) that enabled the farmers to stay together longer. These findings supported the study of David and Asamoah (2011) on the impact of FFS on human and social capital of Ghanaian cocoa farmers. Results showed that FFS had developed the capacity of farmers in decision making over resources management by inculcating a spirit of self-help among the farming community. Due to confidence building of the FFS, farmers have become good public speakers, and thus, could raise their voices for their rights at any forum. The FFS developed leadership qualities among the participants besides enabling them to resolve conflicts by themselves.

And lastly, the FFS had helped them improve their families' health through better housing facilities and children education as a result of their elevated social status in society. Five case studies of Anandajayasekeram et al. (2001) in East and South Africa showed that FFS contributed to changes in attitudes and perceptions of participants, and facilitated the development of new relationships among farmers, researchers, extension workers, and community development personnel. Lastly, Van de Fliert (1993 as cited in Anderson & Feder, 2004), showed that through group interactions, FFS farmers sharpened their decision-making abilities and their leadership, communication, and management skills.

CONCLUSIONS AND RECOMMENDATIONS

This case study provided empirical evidences on the effectiveness of FFS as a training approach, the potential contribution of farmer-to-farmer diffusion in the scaling up process, and the positive social and economic impacts of this approach.

The FFS was shown to be effective as a discovery-based learning approach. It provided farmers with the new knowledge and skills on the PalayCheck System, especially in using high quality seeds, in properly preparing the land before transplanting, in properly managing nutrients using LCC and MOET, in properly managing pests employing the concepts and principles of IPM, and in the timely harvesting and threshing of rice crops. Generally, the FFS farmers demonstrated superior knowledge and level of competence as evidenced by their relatively higher scores on the whole PalayCheck System and component technologies as compared with the non-FFS farmers. Most of the FFS farmers applied their knowledge and skills acquired from the training to their own farms, which translated to higher yields and incomes.

The important role of farmers in knowledge diffusion was demonstrated. All the FFS farmers were able to share their knowledge to their families, relatives, friends, and to other farmers. Results indicated that FFS can be a good avenue for increasing farmers' human and social capital by improving their technical knowledge and skills; improving their ability to make good decisions through critical observations; applying new knowledge to solving other problems; improving social cohesion, solidarity, and cooperativeness; communicating better; and building self-confidence and leadership skills to form groups in support to rice production activities as well as other livelihood initiatives.

However, these outcomes can be sustainable only with appropriate support mechanisms (e.g., from local and national level institutions) and policies for continuous capacity development. The key challenge is to link the FFS group with other rural development initiatives of other government or non-government agencies that promote farmer empowerment. It is also useful to develop and/or strengthen other farmer groups to sustain the gains created by FFS, and eventually, replicate similar interventions in other villages. The LGU-Victoria should continue to support such initiatives so that more and more farmers in the other *barangays* will be trained and thereby increase their yields and incomes.

PhilRice should continue its development efforts by implementing more FFSs nationwide in close partnerships with the different LGUs and RFOs; hence, increasing productivity and eventually uplifting the lives of poor farmers in rural communities.

Finally, considering the limitations of this study, the following are recommended:

- Other methods must be employed because formal surveys alone cannot provide the kind of in-depth analyses required to understand diffusion pathways, farmer experimentations, and empowerment. Qualitative studies using diffusion and social network mapping, focus group discussions, and participant observation, among other methods, are needed to complement formal surveys.

- More in-depth studies are needed on farmer-to-farmer diffusion processes of agricultural knowledge and practices to fully understand this phenomenon. Areas of research can include the extent of the farmers' knowledge sharing and diffusion, which includes questions such as how many farmers have they shared with? With whom they have shared their learnings? And, what they have shared to others (e.g., whole concepts and principles, or just shared management practices, etc.)?

- Cross-cultural comparative studies could determine the importance of socio-cultural factors in determining impact, particularly technology diffusion and adoption behaviors of farmers.

- Longitudinal studies would also be very useful in evaluating and documenting long-term changes in the knowledge, attitudes, and skills of FFS farmers.

- There is also a rich area for research in conducting rigorous studies evaluating the ultimate impacts of the FFS on PalayCheck System on the lives of the farmers, and how it can contribute to the sustained increase in rice productivity of the country.

ACKNOWLEDGMENT

The author would like to express his sincerest thanks and appreciation to Ms. Rowena de Guzman, Ms. Orie Macapugay, and Mr. Danesto Anacio for their help in data gathering. He would also like to thank the AEWs assigned in the area, Mr. Wilson Gardoce and Ms. Natalia Sanchez-Sagun for assisting him during the data gathering and for serving as key informants. He is also forever grateful to all the respondents especially the farmer cooperator, Mr. Henry Reganit, for patiently answering the questions, for their cooperation, and for their warm hospitality during the data gathering. Lastly, the author would like to thank PhilRice and DA-BAR for the support and for the scholarship grant.

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APPENDICES

Appendix 1. Socio-demographic characteristics of the respondents

SOCIO-DEMOGRAPHIC CHARACTERISTICS	FFS FARMERS (n=24)		NON-FFS FARMERS (n=24)	
	No.	%	No.	%
Age				
Below 40 years old	5	20.8	6	25.0
40 to 50 years old	10	41.7	8	33.3
Above 50 years old	9	37.5	10	41.7
Mean	47.71 years		49.25 years	
Standard deviation	11.56 years		12.60 years	
Range	23–65 years		32–81 years	
Sex				
Male	23	95.8	22	91.7
Female	1	4.2	2	8.3
Marital status				
Single	3	12.5	3	12.5
Married	21	87.5	18	75.0
Widow/Widower	0	0.0	3	12.5
Educational attainment				
Elementary graduate	3	12.5	1	4.2
High school undergraduate	2	8.3	9	37.5
High school graduate	12	50.0	2	8.3
College undergraduate	1	4.2	7	29.2
College graduate	4	16.7	1	4.2
Vocational graduate	2	8.3	4	16.7

Appendix 1. Socio-demographic characteristics...*(Continued)*

SOCIO-DEMOGRAPHIC CHARACTERISTICS	FFS FARMERS (n=24)		NON-FFS FARMERS (n=24)	
	No.	%	No.	%
Farm size				
Small (below 1.0 ha)	10	41.7	14	58.3
Medium (1.0–3.0 ha)	10	41.7	10	41.7
Large (above 3.0 ha)	4	16.7	0	0.0
Mean	2.07 ha		1.32 ha	
Standard deviation	1.52 ha		0.69 ha	
Range	0.5–6.5 ha		0.5–2.90 ha	
Farm ownership				
Owned	12	50.0	9	38.5
Mortgaged	1	4.2	0	0.0
Tenant/Rented	11	45.8	15	62.5

Appendix 2. PalayCheck System component technologies covered in FFS as recalled by the participants

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY	% WHO MENTIONED THAT THE TECHNOLOGY WAS COVERED IN FFS	% WHO ACQUIRED NEW KNOWLEDGE ON THE COMPONENT TECHNOLOGY
Variety and Seed Selection		
Use of high quality seeds of a recommended variety	100	96
Use of hybrid rice	58	50
Land Preparation		
Plow the field 3–4 weeks before transplanting	96	100
Harrow the field at least two times at one-week interval	83	50
Crop Establishment		
Plant synchronously after a fallow period of 1 month	96	100
Plant sufficient number of healthy seedlings	100	100
Nutrient Management		
Use of leaf color chart (LCC)	100	100
Use of minus-one element technique (MOET)	100	100
Use of muriate of potash (MOP)	75	100
Water Management		
Use of controlled irrigation (CI)	100	100

Appendix 2. PalayCheck System component...(*Continued*)

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY	% WHO MENTIONED THAT THE TECHNOLOGY WAS COVERED IN THE FFS	% WHO ACQUIRED NEW KNOWLEDGE ON THE COMPONENT TECHNOLOGY
Pest Management		
Identification of natural enemies (NEs)	100	92
Identification of insect pests (IPs)	100	92
Proper diagnosis of diseases	88	100
Integrated pest management (IPM)	100	92
Agro-ecological system analysis (AESA)	100	100
Management of golden apple snail (GAS)	96	75
Management of weeds	79	67
Management of field rats	92	83
Harvest Management		
Cut and thresh the crop at the right time	100	96

Appendix 3. Level of skills and competencies of the FFS and non-FFS participants on the PalayCheck component technologies

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY	LEVEL OF COMPETENCIES OF FFS FARMERS	LEVEL OF COMPETENCIES OF NON-FFS FARMERS
Variety and Seed Selection		
Use of high quality seeds of a recommended variety	4.58	3.21
Use of hybrid rice	3.33	2.42
Land Preparation		
Plow the field 3–4 weeks before transplanting	4.50	3.71
Harrow the field at least two times at one-week interval	4.58	3.71
Crop Establishment		
Plant synchronously after a fallow period of 1 month	4.54	2.0
Plant sufficient number of healthy seedlings	4.58	2.0
Nutrient Management		
Use of leaf color chart (LCC)	4.29	1.0
Use of minus-one element technique (MOET)	3.38	1.0
Use of muriate of potash (MOP)	3.33	1.0
Water Management		
Use of controlled irrigation (CI)	4.54	2.75

Appendix 3. Level of skills...(*Continued*)

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY	LEVEL OF COMPETENCIES OF FFS FARMERS	LEVEL OF COMPETENCIES OF NON-FFS FARMERS
Pest Management		
Identification of natural enemies (NEs)	4.29	1.79
Identification of insect pests (IPs)	4.38	1.75
Proper diagnosis of diseases	4.33	1.83
Integrated pest management (IPM)	3.79	1.50
Agro-ecological system analysis (AESA)	4.13	1.25
Management of golden apple snail (GAS)	4.29	1.50
Management of weeds	3.79	1.25
Management of field rats	4.33	1.17
Harvest Management		
Cut and thresh the crop at the right time	4.58	3.21

Legend: 1 = not competent; 2=less competent; 3=slightly competent; 4=competent; 5=very competent

Appendix 4. Adoption of PalayCheck System component technologies by FFS and Non-FFS farmers

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY	% OF FFS FARMERS WHO ADOPTED THE TECHNOLOGY	% OF NON-FFS FARMERS WHO ADOPTED THE TECHNOLOGY
Variety and Seed Selection		
Use of high quality seeds of a recommended variety	100	63
Use of hybrid rice	50	25
Land Preparation		
Plow the field 3–4 weeks before transplanting	100	29
Harrow the field at least two times at one-week interval	100	67
Crop Establishment		
Plant synchronously after a fallow period of 1 month	50	50
Plant sufficient number of healthy seedlings	100	29
Nutrient Management		
Use of leaf color chart (LCC)	92	0
Use of minus-one element technique (MOET)	79	0
Use of muriate of potash (MOP)	83	0
Water Management		
Use of controlled irrigation (CI)	100	58

Appendix 4. Adoption of PalayCheck...(*Continued*)

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY	% OF FFS FARMERS WHO ADOPTED THE TECHNOLOGY	% OF NON-FFS FARMERS WHO ADOPTED THE TECHNOLOGY
Pest Management		
Identification of natural enemies (NEs)	92	21
Identification of insect pests (IPs)	92	21
Proper diagnosis of diseases	92	4
Integrated pest management (IPM)	83	13
Agro-ecological system analysis (AESA)	71	4
Management of golden apple snail (GAS)	67	8
Management of weeds	58	8
Management of field rats	71	21
Harvest Management		
Cut and thresh the crop at the right time	100	29

Appendix 5. Diffusion of knowledge and practices acquired by the FFS farmers to the Non-FFS farmers

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY SHARED BY THE FFS FARMERS	% OF FFS FARMERS WHO SHARED THE COMPONENT TECHNOLOGY TO FARMERS	% OF NON-FFS FARMERS WHO HAVE SHARED THE TECHNOLOGY
Variety and Seed Selection		
Use of high quality seeds of a recommended variety	100	87
Use of hybrid rice	63	50
Land Preparation		
Plow the field 3–4 weeks before transplanting	92	58
Harrow the field at least two times at one-week interval	92	58
Crop Establishment		
Plant synchronously after a fallow period of 1 month	100	83
Plant sufficient number of healthy seedlings	83	79
Nutrient Management		
Use of leaf color chart (LCC)	100	87
Use of minus-one element technique (MOET)	92	87
Use of muriate of potash (MOP)	88	79
Water Management		
Use of controlled irrigation (CI)	92	83

Appendix 5. Diffusion of knowledge...(*Continued*)

PALAYCHECK SYSTEM COMPONENT TECHNOLOGY SHARED BY THE FFS FARMERS	% OF FFS FARMERS WHO SHARED THE COMPONENT TECHNOLOGY TO FARMERS	% OF NON-FFS FARMERS WHO HAVE SHARED THE TECHNOLOGY
Pest Management		
Identification of natural enemies (NEs)	96	87
Identification of insect pests (IPs)	96	87
Proper diagnosis of diseases	92	83
Integrated pest management (IPM)	100	87
Agro-ecological system Analysis (AESA)	88	87
Management of golden apple snail (GAS)	67	58
Management of weeds	79	67
Management of field rats	79	58
Harvest Management		
Cut and thresh the crop at the right time	92	87