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Adoption and Uptake Pathways of Corn-Based Technologies by Farmer-Scientists in Bondoc Peninsula, Quezon, Philippines

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Farmer-scientists are trained to improve farm practice through the conduct of on-farm experimental trials and farmer-to-farmer extension. To analyze the adoption of recommended corn-based technologies, the study was conducted in six sites in Bondoc Peninsula, Quezon, Philippines with 66 randomly selected respondents. The sites were purposively chosen due to their accessibility and sufficient number of respondents. The study used survey interviews, focus group discussions, key informant interviews, and actual observations to gather data. Measures of central tendency and variability, correlation and regression analyses were used for data analysis. Results showed that most of the respondents have adopted four to six out of eight corn-based technologies as early as Phase I. Bio-physical, socio-demographic and economic factors showed a very weak to moderate positive relationship with the adoption of corn-based technologies except road terrain, which was found to have a significant positive relationship with the use of organic fertilizer. With the use of logistic regression analysis, the probability of using organic fertilizer was higher for a farmer living in a hilly road terrain. Farmer participation decreased from Phase 1 to Phase 3 and uptake pathways were limited to inner circles of the farmer. Overall, the study provided evidence that this participatory program increases adoption rates but failed to sustain most farmer's interest to participate in subsequent programs that aim to develop scientific and extension skills.

Key Words: adoption of technologies, agricultural extension, farmer-to-farmer technology transfer, farmer-scientists, farmer-extensionists, uptake pathways

Abbreviations: FSTP – Farmer-Scientists Training Program; FS – farmer-scientist; FST – farmer-scientist-teacher

INTRODUCTION

Participatory extension is a product of the limitations of the previous top-down extension paradigm (Mutimba 1997; Ison and Russel 2000). In this paradigm, farmers are not just recipients of knowledge and technologies, but are seen as active contributors to the generation, development and dissemination of technologies (DAES 2011). Examples of participatory extension models are the Farmer First approach (Chambers et al. 1989); and farmer-to-farmer extension approach (GFRAS 2015). The *Campesino a campesino* (farmer-to-farmer) movement in Central America showed that farmers are capable of pursuing their own sustainable development by sharing not only information and techniques but also wisdom, creativity and knowledge towards sustainable agriculture (Holt-Gimenez 2006). According to Olarinde et al. (2017), participation in research and demonstration activities significantly increased the adoption of technologies. Extension systems which combine research and extension reduce uncertainty (Feder et al. 1985) as they encourage exchange of information and increase visibility of outcomes. Hence, higher adoption rates are seen as a consequence of the learning that occurs as a result of the exchange among farmers, researchers and extension. Training programs using participatory extension approach increased the adoption of new crop varieties in Ethiopia (Takahashi et al. 2015) and promotion of food security in Northern Nigeria (Abdoulaye et al. 2012). Rusike et al. (2006) further added that although using participatory approaches is costly compared with the top-down approach, it improves efficiency in developing technologies and building farmers' capacity for experimentation and collective learning.

The Farmer-Scientists Training Program (FSTP) is one of the many extension programs in the Philippines which is guided by the participatory extension paradigm in helping poor farmers planting corn (*Zea mays* L.) in marginal areas. Farmer-scientists (FS) are graduates of FSTP, which is a tri-phased training program where farmers attend a weekly class and establish experimental trials simultaneously (Phase I), conduct on-farm experimental trials (Phase II), and disseminate knowledge by teaching their fellow farmers (Phase III). After completing the first cycle of the training, FSTP will operate at the village level, which is facilitated by the first set of FS through a farmer-scientists association (FSA) with the help of partner agencies (Davide 2004). Based on the review of project reports, it was observed that the number of FS from phase to phase declines. For this reason, only a few FS become farmer-extensionists, resulting in issues on implementation at the village level. Further, the adoption of corn-based technologies after the training had never been followed-up in the first batch of municipalities in the Bondoc Peninsula since the training ended in 2014. Although there are initial accounts about adoption of corn-based technologies, there had been no systematic study about the adoption and the subsequent benefits that can be derived from it (Project reports, various years). Thus, it is important to examine the adoption process and the factors affecting the farmers' adoption and diffusion of technologies so that proper measures to address the issues surrounding implementation and uptake of technologies will be determined. This can facilitate sustainability of the project and encourage more farmers to be engaged in agricultural trainings.

The general objective of the study is to analyze the adoption of corn-based technologies among FS and its subsequent diffusion pattern. Specifically, the study intended to: (1) describe the bio-physical profile and socioeconomic characteristics of the respondents, (2) assess the time and level of adoption and uptake pathways of corn-based technologies, and (3) analyze the factors influencing the adoption of corn-based technologies among the respondents.

MATERIALS AND METHODS

The research study involved both descriptive and correlational analyses. Descriptive analysis was used to describe the bio-physical and socioeconomic characteristics of the respondents; and assess the level of adoption and uptake pathways of corn-based technologies. Pearson and Point bi-serial correlational analyses were used to answer objective 3 which involved various biophysical, socio-demographic and economic factors. Further, correlational analysis focused on the relationships between variables; and logistic regression analysis was used to make inferences on the probability of adoption of certain technologies and practices as affected by specific factors.

Place and Time of Study

The study was conducted in six FSTP-covered areas in Bondoc Peninsula particularly in the municipalities of Catanauan, Buenavista, Mulanay, San Andres, San Narciso and San Francisco in Quezon Province from January 2016 to May 2017 (Fig. 1). FSTP operated in these areas from 2011 to 2014 and is now continuously being implemented at the village level under the management of the local government units (LGUs). The study sites were chosen because of the sufficient number of respondents, accessibility, established partnership with LGUs, and sustained execution even after project implementation in the municipal level.

Respondents

The study focused on the FS in six municipalities in Quezon province. There were a total of 421 FS in these areas but only 79 FS finished Phase III. A sample size of 66 FS was drawn using simple random sampling (SRS) with proportional allocation per municipality. The sample size was determined using Slovin's formula at 95% confidence level and 0.05% margin of error:

$n = N / (1+N * e^2)$, where N = 79

$n = 79 / (1+79 * 0.05^2)$

$\mathbf{n = 65.97077244 \sim 66}$ **respondents**

Data Collection Methods

The study made use of survey, focus group discussion (FGD), and key informant interviews (KII) to gather data; and secondary data gathering for additional information and literature review. KII was done from January to March 2016 to enhance the survey instrument. The key informants were composed of the Presidents of Farmer-Scientists Association of each study site, the AT-in-charge, the Municipal Agriculturist/ Municipal Agriculture

Officer of the study sites, and the village chairperson where Phase I-village level trainings are being conducted. Each KII lasted for 30 to 45 minutes. KII was also used in verifying secondary data obtained from records and literatures. Aside from KII, FGDs were also done per study site between January to March 2016. Participants of the FGD were composed of 6–8 FS; and each session lasted for 1.5 to 2.0 hours. The questionnaire used was validated by two experts and pretested on 10 FS.

Secondary data on the municipal profiles and benchmark surveys from 2011 to 2012 were also retrieved and reviewed. The data on the benchmark surveys, particularly on corn yield and farm income, was used in comparison with the corn yield and farm income as per last cropping season (2015–2016) which were obtained from respondents' farm records.

Data Analysis

The study applied measures of central tendencies and variability for description of relevant bio-physical and socio-economic factors. On the other hand, correlational analysis was used to examine the relationship of bio-physical and socio-demographic and economic factors with adoption of technologies. Further, Logistic Regression analysis was done to determine the probability of adoption in relation to bio-physical, socio-demographic and economic factors.

RESULTS AND DISCUSSION

Respondents Characterization

The six study sites are municipalities under the 3rd district of Quezon province, also known as Bondoc Peninsula. Figure 1 shows the location of each study site. Catanauan, Mulanay and San Francisco are located at the western part of the peninsula, while Buenavista, San Narciso and San Andres are on the eastern part (Municipal profiles of respective study sites, various years).

Majority of the respondents (59%) live near the experimental site during their Phase I based on the average of 6.42 km. More than two-thirds of the respondents (61%) stated that they travel rough roads in going to the experimental site; while majority of the respondents (76%) added that they walk a hilly path in going to the site. More than half of the respondents (52%) classified the soil in their farms as loamy (Faraon Clay). It was also confirmed based on their Municipal Land Use Maps; while almost half of the respondents (48%) have other soil types in their farms such as Catanauan Clay Loam and Bolinao Clay Loam (interview with Agricultural Technicians).

Most of the respondents are male (62%), married (85%) and have an average of six children. Most of them were able to finish 10 years of schooling and were considered as educated based on the average of nine years spent in school. Most of the respondents are 52 years old and above (53%), and were migrants from Masbate and Cebu. Aside from migration to the family homestead, marriage is also a reason for migration to Quezon, especially for female respondents (Table 1).

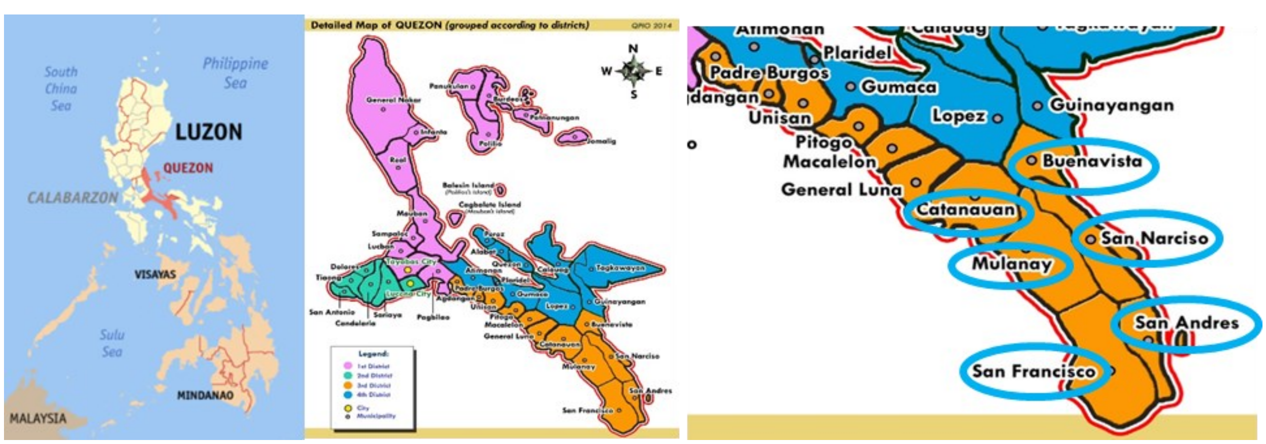

Fig. 1. Location map of study sites.

Majority of the respondents (86%) were members of other organizations aside from the Farmer-Scientist Association in their respective municipalities. More than half of the respondents have attended other trainings, especially Farmer-Field Schools (FFS) implemented by the Department of Agriculture (DA) through the Office of the Provincial Agriculturist (OPAg) and Municipal Agriculture Offices (MAOs).

The respondents' sources of income were classified as farm and non-farm. Farm sources include production of crops (e.g., corn, rice, vegetable, coconut, banana), and animals to be sold as live or in processed form (frozen meat products, roasted pig). Data were gathered from farm records of respondents as of the last cropping season (2015–2016). Non-farm sources were those livelihood activities which are not related to farming such as employment; and data were gathered through interviews. More than two-thirds of the respondents (66%) derived their income from both sources, while some (34%) depended only on farm sources for their income. The respondents' incomes from farm sources were derived from corn production (95%), coconut (88%) and livestock raising (83%). Of these farm sources, the highest income was derived from coconut production as it is the main crop of the province; and harvested every two months to be sold as either whole fruit or dried coconut meat (*kopra*). Income from rice production comes in second as there are four respondents engaged in rice production while most of them plant rice for consumption. This was followed by corn production where majority of the respondents were involved. Corn is normally intercropped with various vegetables; and is usually planted under coconut. Trees were also used in household as firewood, while some converted it to charcoal and sold it per sack. Selling of livestock and poultry also contributed to the total income especially during festivities and special occasions when there is an increased demand for swine and poultry. Table 2 summarizes the respondents' income derived from farm and non-farm sources.

Types of Corn-based Technologies

For this study, cultural management practices for corn production were categorized into eight: (1) pre-planting operations, (2) planting operations, and (3) post-planting operations. Pre-planting operations included: (a) 2-plowing and weeding as land preparation method and (b) use of germination test prior to planting. Planting operations are composed of: (a) use of open-pollinated varieties (OPV) of corn, (b) planting 1–2 corn seeds per hill, and (c) corn-based intercropping. Post-planting operations were: (a) use of organic fertilizers, (b) integrated pest management (IPM), and (c) detasseling for corn-borer control. These were the technologies promoted under the FST program.

In the pre-planting operations, the use of germination test prior to planting and 2-plowing with weeding as method of land preparation were adopted by more than half of the respondents (65% and 64%, respectively) (Table 3). According to the respondents, they have adopted the germination test because of its practicality and convenience especially if the seeds were donated and/or without proper labels. Participants of the FGDs further stated that germination test helped them in decision-making when introduced to new varieties of corn as to whether they will use these or not for massive production. For the 2-plowing and weeding practice, the respondents claimed that a clean, well-maintained farm had positive effects on yield. Based on FGDs, the farmers' traditional corn production practice was to plant corn, visit it occasionally to check for pests, and then go back when ready for harvesting. Now, they visit their farms regularly to weed which lessened rat infestation, resulting in more yield. In addition, Mafongoya et al. (2016) stated that planting corn in ridges would result in higher corn grain yield, encouraged water intake, and lower weed

Table 1. Socio-demographic characteristics of the respondents

Variable	Frequency (n=66)	Percentage
Age		
52 yr old and above	35	53
51 yr old and below	31	47
Sex		
Male	41	62
Female	25	38
Civil Status		
Single	5	8
Married	56	85
Widowed	5	7

infestation compared with zero tillage. However, FGD participants stated that manual weeding is laborious and costly especially for those who have larger farms, thus, they buy herbicide to eliminate the weeds. The use of herbicide in land preparation to lessen the production costs was confirmed by the respondents in the survey.

Among the planting operations, planting 1–2 corn seeds per hill was adopted by 97% of the respondents, followed by corn-based intercropping (89%) and use of OPV (57%) (Table 3). By conducting the population density trial, the respondents proved that using 1–2 seeds per hill, compared with the traditional practice of planting 3–5 seeds per hill, can produce higher yields. This result was consistent with the study of Bee et al. (2014) in Oklahoma, USA which showed that planting 1–2 seeds per hill at 0.16 m apart would increase grain yield and nitrogen uptake. Further, according to Gerpacio et al. (2004), farmers in the Philippines would pay at least P 10.00 per kilogram of seeds; 18–20 kg are needed to plant a hectare. Thus, it could mean savings if farmers use fewer seeds per hill, receive input subsidy from the government, and recycle seeds. However, studies have shown that using recycled seeds would result in minimum harvest; and subsidized seeds usually have lower germination rates. With these circumstances, wise use of resources such as seeds could make a difference in terms of reducing production costs (Gerpacio et al. 2004). On the other hand, respondents testified that intercropping enabled them to have alternative income source especially when natural calamities damaged their corn crops. Based on the seasonal calendar, respondents plant corn and intercrops almost at the same time with some intercrops that are planted a month later than corn. This provided the respondents continuous harvest of various crops as well as income for the months they do not plant corn and wait for the next planting season. The respondents' testimonies are consistent with the study of Chomba (2004) which states that intercropping is used as risk-reduction strategy, to lessen the effects of climate change and safeguard against crop failure. Although intercropping requires more effort and longer time to wait compared with mono-cropping, the respondents adopted it in their own farms. As for the use of OPV, the respondents stated that OPV seeds are usually unavailable and the market for it is low. Since they cater to livestock and poultry feed mill industries, they prefer hybrid varieties as they produce higher yield. Thus, some

Table 2. Recorded average sales from farm and non-farm income sources (2015-2016).

Sources of Income*	Freq. (n = 66)	%	Range	Mean	SD
Farm Sales**					
Corn production	63	95	3,000–166,000	36, 143.97	28, 318.19
Rice production	4	6	7,000–120,000	44, 580.00	51, 252.44
Vegetable production	52	79	150–80,000	20, 868.58	19, 424.16
Coconut production	58	88	5,000–350,000	85, 238.77	63,546.44
Fruits production	5	8	500–45,000	6, 500.00	18,894.94
Charcoal-making	3	5	950–12,000	5, 944.44	5,601.22
Livestock raising	55	83	2,000–86,000	18, 768.55	20,095.61
Non-Farm Income					
Business enterprise	14	21	5,000–146,000	45, 835.71	48, 017.36
Daily labor	15	23	1,000–180,000	40, 106.00	51,075.61
PUV operation	6	9	25,000–78,000	57,833.33	20,044.12
LGU worker	11	17	12,000–142,716	67, 068.00	49,422.55
Remittances	2	3	60,000–120,000	90, 000.00	42,426.41
4Ps beneficiary	2	3	15,800–18,000	16, 800.00	1,697.06

*multiple answers; **from farm records

of the respondents still use hybrid varieties for market and OPV for their food. This observation is consistent with the outcomes of the FGD sessions conducted. It is further consistent with the study of Gerpacio et al. (2004) which showed that farmers' preferences for corn varieties to plant depends on their intended use. Filipino farmers prefer local white varieties for food as they have good eating quality, low material input requirement and low production cost; and hybrid varieties for market for their promising yield, given that they have the capacity to supply the production inputs needed (Gerpacio et al. 2004).

In terms of the post-planting operations, the use of organic fertilizers was adopted by 85% of the respondents, followed by applying IPM (60%), and detasseling for corn borer control (48%) (Table 3). The respondents claimed that they became aware of organic agriculture and its benefits, and learned about its advantages and effects through the fertilizer trial. This phenomenon is similar to the study of Hu et al. (2007) where farmer participatory testing of nitrogen management showed high potential for adoption. However, similar to the study of Hu et al. (2007), farmers made adaptations to the practice as the respondents did not fully shift from inorganic to organic fertilizers, but opted to combine inorganic and organic fertilizers. They further stated that they were afraid that full, immediate shifting will negatively affect their yield and income. Also, based on FGDs and KIIs, most of the farmers underwent training in organic agriculture and were trying to make their own compost formulation to lessen the cost of fertilizer use.

Organic fertilizers are cheaper than inorganic ones but may be costly as there is need to apply large amounts. As for IPM, although it was used by more than half of the respondents, they pointed out that earwigs and Trichogramma were not locally available and needed to be requested from the Office of the Provincial Agriculturist or the Quezon Agricultural Experiment Station in Pagbilao, Quezon. As an alternative, sea weeds were also used in case of the unavailability of earwigs and Trichogramma. The composition of sea weeds was studied and it was found that it can serve as biofertilizer for plants to enhance seed germination, nutrient uptake, resistance to fungal diseases, overall fruit quality and soil condition (Zodape 2001).

Aside from fungal diseases, sea weeds were also found to be effective against plant parasitic nematodes of sunflower and tomato (Sultana et al. 2011). The use of sea weeds for corn borer control, based on FGD sessions, is now being used by FS in Bondoc Peninsula. On the other hand, detasseling, which is removal of corn tassels at 49–56 DAP for corn borer control, was adopted by less than half of the respondents. They stated that although detasseling is effective in controlling pest infestation, it is laborious for them especially for those who have larger farms and when corn plants grow taller because they have to do detasseling manually; and it was considered only as an option when they cannot apply IPM.

In summary, the respondents' decision to adopt or reject corn-based technologies greatly depends on the possible effect of the technology on their overall yield; and the perceived probability of decreasing the cost of production to gain higher net income. The respondents' actual observations, their involvement in experimentation and their active participation in the program contributed to their decision whether to adopt or reject a technology. Participatory extension approaches recognize the value of

Table 3. Number of respondents who adopted the corn-based technologies and practices.

Corn-Based Technologies and Practices	Freq. (n = 66)	Percentage
1-2 seeds per hill	64	97.0
Corn-based intercropping	59	89.4
Use of organic fertilizer	56	84.8
Germination test prior to planting	43	65.2
2-plowing and weeding for land preparation	42	63.6
Applying Integrated Pest Management	40	60.6
Use of open-pollinated varieties (OPV) of corn	38	57.6
Detasseling	32	48.5

farmers' experiences and their traditional experimentation as inputs for improving the productivity of existing farming systems (Monu 1997); and farmers' participation and continuous exposure to technologies would increase chances of technology adoption (Posthumus et al. 2010). Technology adoption, on the other hand, would lead to increasing farm productivity, food availability, and farm incomes (Iheke and Nwaru 2013). Other considerations were availability of the materials needed in the local area, the simplicity or complexity of its use or application, and its compatibility in their respective farms. The least consideration, according to the respondents, is the effect of the technologies on their health and environment. When asked, the respondents justified that they were indeed aware of the implications of using chemicals to the environment and to their health; however, in hoping for a better harvest, they said they cannot immediately shift to safer farming practices as their yield will be unstable, especially for respondents who depend solely on farming for income.

These findings conform with the Diffusion of Innovation Theory of Rogers (1995) which stated that the decision to adopt or reject a technology can be attributed to the technologies' relative advantage, compatibility, complexity, trialability and observability. The findings were also proven in the studies of Nazari et al. (2013) and Dibra (2015) in the acceptability and adoption of online databases and sustainable tourism practices, respectively. Their results revealed that adoption is a complex process where actual observation, exchange of ideas and experimentation all play a role in influencing farmer's decision to adopt specific technologies.

The participatory research and extension program increased the probability of adoption among marginal farmers after Phase I as farmers adopted four to six out of eight technologies. Participatory monitoring and evaluation also give an advantage in terms of measuring technology adoption as influenced by the attributes of the Diffusion of Innovations Theory of Rogers (1995). Njuki et al. (n.d.) emphasized that through participatory monitoring and evaluation, scientists and stakeholders engage in project activities, promote better understanding of project outcomes, reflect and make decisions together, and plan and monitor implementation of activities, thus offering new ways to strengthen learning at the community, project and institutional levels. Participatory monitoring and evaluation also empower stakeholders to take action, and improve public accountability and information provision for strategic planning at different levels (Guijt 1999).

Time and Level of Adoption

According to Sahin (2006), time is a crucial element of the Diffusion of Innovations Theory as it defines the adoption rate of technologies being introduced. A technology may be adopted instantly by its end-users, but would discontinue using it later on; or end-users might reject it at first but would later on decide to use it for a longer time and further recommend it to others (Sahin 2006). In the Diffusion of Innovation Theory, Rogers (1995) broke down the social system into segments based on time of adoption: Innovators (2.5%); Early Adopters (13.5%); Early Majority (34%); Late Majority (34%); and Laggards (16%) (Fig. 2). Early Majority has a good interaction with the social system and their network is important in the innovation-diffusion process (Sahin 2006). Late Majority, on the other hand, are members of the social system who wait for their peers to adopt first before they do (Sahin 2006). Figure 2 further shows the normal distribution of the adoption curve.

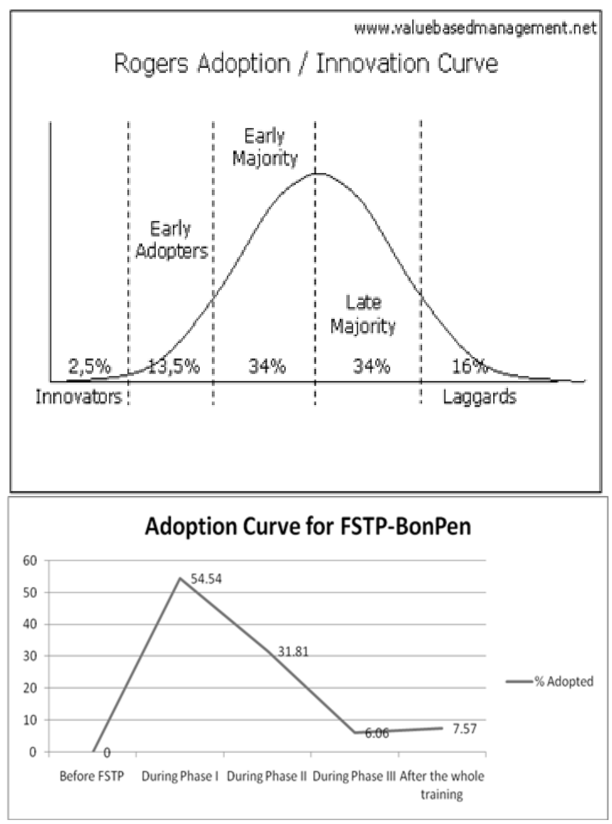

Fig. 2. Adoption curve for FSTP-BonPen in comparison with Rogers' (1995) Diffusion of Innovation Theory.

In this study, the time of adoption was categorized into: before the training; during Phase I; during Phase II; during Phase III; and after the whole training. The respondents who adopted the technologies before the training were considered as Innovators; those who have adopted during or after Phase I were Early Adopters; during or after Phase II were Early Majority; during or after Phase III were Late Majority; and those who have adopted the technologies after the training were considered as Laggards. Data were gathered through survey interviews. In comparison with Rogers' (1995) Adoption/Innovation Curve, it can be observed that the pattern of adoption of corn-based technologies in the study areas is different (Fig. 2). More than half of the respondents (55%) were classified as Early Adopters, who are most likely to have leadership qualities and roles (Sahin 2006). Participatory extension approaches provide an opportunity to farmers to have direct contact with the scientists, implementers and other stakeholders, as well as actual experience and observation in using technologies and innovations (Monu 1997). Thus, continuous participation and observation of relevance of technologies would result in technology adoption (Posthumus et al. 2010). Early Adopters' subjective evaluation and approval of technology by adopting it may reach other members of the social system (Sahin 2006). This phenomenon of participatory on farm trials having a positive effect on adoption rate confirms previous studies such as that of Mariano et al. (2012) who concluded that on farm demonstrations of new technologies encourage adoption. Only 6% of the respondents were recorded as Late Majority; and only a few respondents (8%) were considered as Laggards, who are more traditional and skeptical about innovations and change agents than the Late Majority (Sahin 2006). However, there were no Innovators (applied known technologies even before the training) noted (Fig. 2).

However, the faster rate of adoption implied lesser participation of FS in FSTP phases. FS in FGD sessions pointed out that since they normally practice what they learned from the training and observed what were the advantages and disadvantages of such technologies as early as Phase I, they believed that it was not necessary to finish the whole training; aside from the fact that attending to it meant sacrificing time to do other income-generating activities. Thus, it further resulted in a decline in the number of FS who finished the whole training of three phases. This means that adoption is high right after the participatory trials attended by the farmers.

To assess the level of adoption, it was categorized into low adoption (adopted 1– 3 technologies); partial adoption (adopted 4–6 technologies); and high adoption (adopted 7–8 technologies). Table 4 shows the respondents' level of adoption per municipality. In total, majority of the respondents (64%) were Partial adopters, which means that they have been using 4–6 technologies recommended to them. This is consistent in almost all municipalities except in Mulanay where 100% of the respondents are high adopters since there were only two respondents from this area. High adopters (30%) were also found in all municipalities. Low adopters (6%) were observed in the municipalities of Buenavista and San Andres, which means that these respondents adopted only 1 to 3 technologies recommended to them.

According to FGD sessions and respondents' survey, the attendance of FS in various trainings enabled them to compare and contrast the technologies they were exposed to, therefore, adopting only what they see as beneficial to their farming activities, thus resulting in partial adoption. Further, according to Simtowe et al. (2011) and Singh et al. (2014), active participation and information dissemination positively affects adoption of modern agricultural technologies. Thus, since fast

Table 4. Adoption level of respondents per municipality.

Level of Adoption	Municipality											
	Buenavista		Catanauan		Mulanay		San Andres		San Francisco		San Narciso	
	F	%	F	%	F	%	F	%	F	%	F	%
	(n=12)		(n=12)		(n=12)		(n=12)		(n=12)		(n=12)	
Low	2	17	0	0	0	0	2	20	0	0	0	0
Medium	8	66	11	73	0	0	4	40	8	66	11	73
High	2	17	4	27	2	100	4	40	4	34	4	27

adoption of technologies resulted in less participation in the succeeding phases of the training, the respondents were not able to individually validate further through on-farm trials; and adopted only what they have observed during Phase I.

Factors Influencing Adoption

The adoption of corn-based technologies was correlated with the following factors: distance to experimental site (in kilometers), road type (rough or cemented), road terrain (flat or hilly), soil type (loamy or not), age, number of years in school, number of years in farming, and total and farm income. Based on the analyses, the enumerated factors have a positive relationship with the adoption of corn-based technologies except the relationship of total income with the use of OPV, detasseling for corn borer control and using 1–2 seeds per hill, which showed a negative relationship. This indicates that the higher the total income of the respondents, the higher their capacity to buy hybrid seeds, chemical pest control and more seeds for planting; thus, the lower the probability of these practices to be adopted. Although there was a substantial percentage of respondents who have adopted 1–2 seeds per hill based on previous discussion, according to the study of Mathenge and Tschirley (2007) in rural Kenya, the stability of non-farm income may have affected farmers' decision in undertaking farming activities and adopting farm technologies. Moreover, farmers who have higher non-farm income may become unwilling to invest in farming activities which is risky compared with a more stable source of income (Mathenge and Tschirley 2007). Nevertheless, farm income is positively correlated with the adoption of all technologies, which is consistent with the studies of Damisa and Igonoh (2007), Chirwa (2005) and Chomba (2004), which stated net farm income is positively correlated with the adoption of farm technologies and practices.

However, in spite of having a positive relationship of adoption with almost all the corn-based technologies and practices, these relationships have a correlation coefficient (r) of 0.000 to 0.660, which according to Mukaka (2012), is negligible to moderate. The only strong relationship found was between road terrain and the use of organic fertilizer. This relationship was also significant at 95% confidence. It indicates that the hillier the terrain is, the higher the probability of using organic fertilizer. The reason could be because it is more difficult for them to access inorganic fertilizers compared with those from the lowlands. Organic fertilizers used are animal manure, compost and vermicasts. Vermicasts were manufactured and sold by some farmers at P 15–20 per kilo; while animal manure are readily available in their own farms. On the other hand, since the LGUs are also promoting organic agriculture, they have been conducting trainings on how to make organic fertilizers such as composts, and organic pesticides. Thus, respondents stated that they are now developing their own compost formula to use in their own farms, prefer buying organic fertilizers from co-farmers since they decided to use combination of inorganic and organic fertilizers, and are slowly converting to organic farming.

Further, Logistic Regression analysis was done in order to predict the rate of using organic fertilizer as affected by road terrain. The model for the use of organic fertilizers (Y4) in relation to road terrain is as follows:

$$P(Y_4 = 1) = \frac{e^{-0.5108+1.9315\,roadterrain}}{1+e^{-0.5108+1.9315\,roadterrain}}$$

The use of organic fertilizer is 6.9 times higher for a farmer with hilly road terrain compared with a farmer with flat road terrain. If a farmer has a farm with hilly road terrain, the probability of using organic fertilizer is 0.8054. The overall correct classification is estimated to be 85%, with 100% of the farmers who use organic fertilizer correctly classified and only 0% of the farmers who do not use organic fertilizer correctly classified. This implies that FS residing in hillier areas opted to make their own organic fertilizer formulation than buy from the market to lessen cost of production and obtain higher net income.

Uptake Pathways

According to Torres et al. (2013) and Navarro and Hautea (2014), the term "uptake pathways" was used to define how a certain technology was introduced, adopted, disseminated, and shared by the farmers with others. Torres et al. (2013) stated that a strong motivator for adoption was learning from friends and peers, thus farmers interact and learn from whom they like socially; and peer teaching is their preferred learning process as farmer-to-farmer relationships are more beneficial in terms of first-hand information (Torres et al. 2013). Torres et al. (2013) emphasized in their study that peer and kinship system strongly facilitated farmers' adoption and uptake pathways of technology in using biotech corn. In another study by Navarro and Hautea (2014), it was mentioned that knowledge-sharing is more of an interpersonal and face-to-face encounter due to strong peer system among farmers; and they are obliged to share that information with others especially if it would benefit the whole community. It was also stated that while other farmers are early adopters, some have a wait-and-see attitude that observe first then try it out when positive results were seen (Navarro and Hautea 2014).

In Phase III, FS are required to teach their fellow farmers and be called FSTs; the set of farmers they will be teaching will be called Phase I-village level. However, uptake pathways of certain technologies/practices were noted as early as Phase I but to a few respondents only (27%); and they usually share the ideas with their children who are into farming also but do not attend the weekly training (Fig. 3).

The usual technology they taught to their children was the use of OPV, using 1–2 seeds per hill during planting, and the detasseling method as pest control technique. These technologies were seen as important and new by the respondents and thus they taught their children about it so it can be applied in their children's own farms. In this case, the initiative of sharing the information came from the respondents themselves. According to Musitini (2012), farming in the rural areas, whether for subsistence or commercial purposes, is considered as a family business. The involvement of all family members in planning, decision-making and management aspects of farm business would increase family income; improve living standards, nutrition and food security; and increase productivity and efficiency of family farms (Musitini 2012). Garner and de la O Campos (2014) also added that family farms are transferred from generation to generation, thus, the success or failure of family farms at a given time may not only affect the current operators but the sustainability of family farming as a livelihood of future generations. Therefore, respondents teaching their children emphasized the importance of knowledge sharing among family members to maintain or improve their family farm businesses.

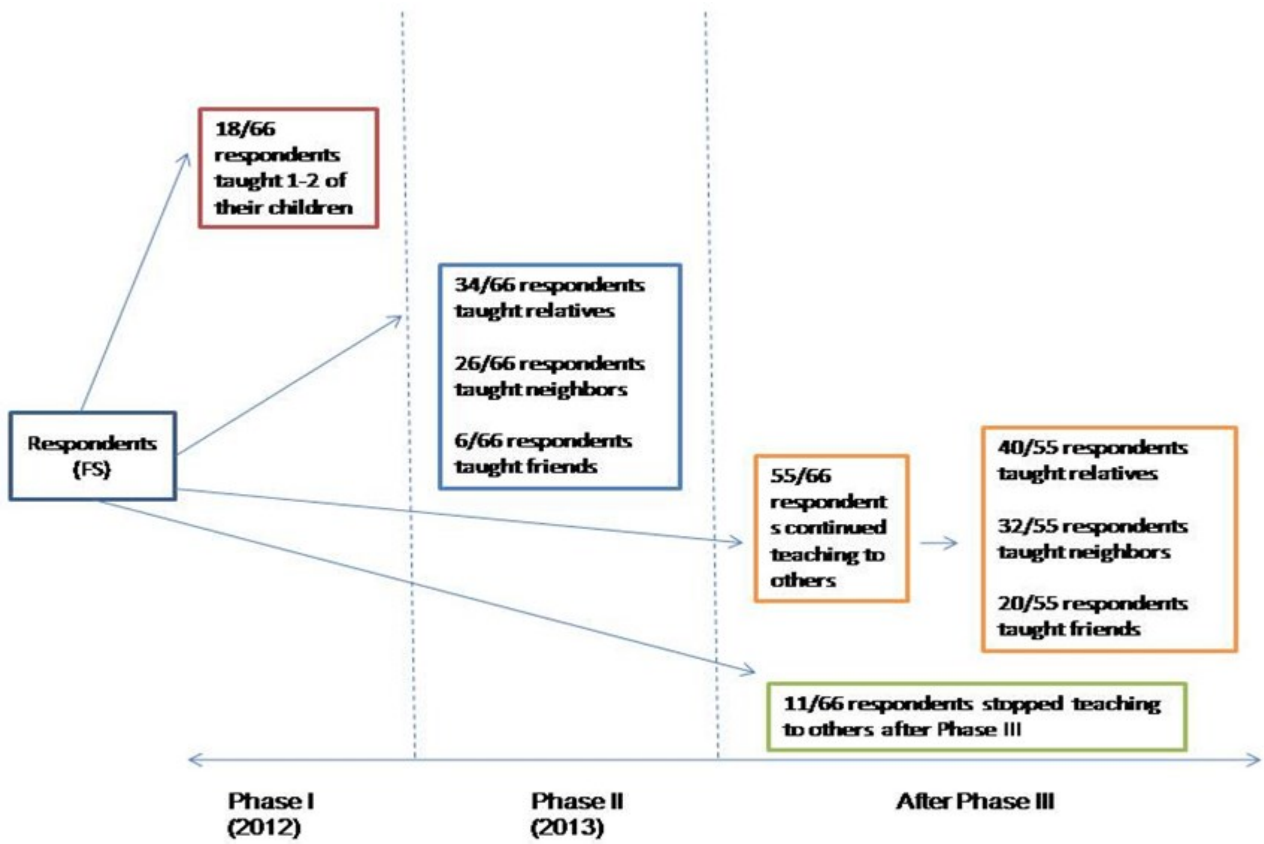

Fig. 3. Uptake pathways of corn-based technologies.

In Phase II, 52% of the respondents stated that they shared the technologies with their relatives, which include children, siblings, parents and other kin; 39% shared it with their neighbors; and 9% shared it with their friends (Fig. 3). However, the respondents pointed out that the initiative of information sharing came from the relatives/neighbors/friends because they asked first about what they are doing in their on-farm experimental trials. The respondents explained to them the details of the technology and encouraged them to join the training program in the next phase as students.

After Phase III, some of the respondents stopped teaching other farmers, while 83% of them still continued to share the technologies/practices even after the training (Fig. 3). It was observed that the number of people they taught went higher compared with during Phases I and II. The reason, according to the respondents, is that they became more confident and well-trained to speak with people, stand in front of a crowd and able to manage small group discussions as a result of attending the training where they were required to present progress reports in the class, be active in the FSAs, and teach their co-farmers. In addition, according to KII, they established relationships with Agricultural Technicians so that when they have questions and subjects to clarify, they can ask them directly and help other farmers too. Aside from that, they became known in their community, especially the officers of the FSAs, and more people came to them to ask things and visit their farms for actual observations (based on KII).

According to the respondents, they shared the things they learned to help their co-farmers, especially their relatives, who also depend on farming for food. Some of them claimed that they felt they have the responsibility to share the things they learn especially if it is for the benefit of the people they value (i.e. relatives, neighbors and friends); and the people went to them asking for [technical] help. As for the respondents who stopped teaching others after the training, they said that they focused on developing their own farms; participated in other trainings; and did not have time and resources anymore as these were not subsidized by the LGU and they ought to spend their own money to participate in trainings. This is consistent with the study of Torres et al. (2013) which claimed that strong interpersonal relationship among peers, relatives and neighbors facilitates uptake pathways of technologies/practices; while lack of resources, inputs and support may hinder it (Torres et al. 2013). In addition, based on the survey and FGD sessions, the children and relatives who were taught during Phases I and II participated in Phase III as Phase I-village level students because they got interested to learn more. This resulted in the increase in the number of participants during Phase I-village level trainings.

CONCLUSION

Farmers adopted four to six out of eight corn-based technologies during Phase I. The most common corn-based technologies adopted were the use of 1–2 seeds per hill during planting; corn-based intercropping; and use of organic fertilizer. The respondents' considerations for adoption of the said technologies/practices were effectiveness in increasing yield and income (relative advantage) based on the experimental trials they have examined (trialability, observability); the difficulty of use (complexity); and compatibility of the technologies/ practices with their own farms. Further, the sooner the respondents recognized the positive features of the recommended technologies and practices, the faster the rate of adoption would be as shown in this study where more than half of the respondents were Early Adopters. This conclusion is a result of the on-farm experimentation where farmers were able to directly observe and discuss findings.

However, while FSTP can lead to higher adoption rates, it cannot guarantee full adoption of technologies since respondents choose to adopt technologies which they observed to be beneficial to them. Further, early adoption may result in a decrease in participation in succeeding phases of the training, thus the decline in the attendance from phase to phase. This result is a major challenge for participatory paradigms as it implies that farmer participation decreases once farmers are able to obtain relevant information. Sustaining participation then becomes a problem as only few more are interested to become adept at technology testing and verification, skills that are important for farmers faced with adverse conditions and changing climate.

This study provides evidence that participatory paradigm is effective in ensuring higher adoption of technologies but the effectivity of the paradigm requires more study in terms of sustaining participation and developing scientific and extensionist skills.

Given the decreasing number of farmers who are willing to participate in subsequent phases to develop scientist and extension skills, it is important to conduct studies on interventions and methods that seek to promote scientific skills that are essential for all farmers. Undoubtedly, we cannot expect everyone to be farmer extensionists but having a set of local farmer teachers and extensionists is helpful for the extension system. Along this line, more studies on the interventions and methods of promoting farmer extension interventions are necessary.

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