Agricultural technology adaptation through farmer-to-farmer learning process (FFLP) model resulting to increase income and productivity

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Abstract: One of the most difficult institutional problems of extension approach in Thailand is the lack of a close working relationship between national agricultural research and extension organizations, and with different categories of farmers and farm organizations. Research and extension organizations compete over the same scarce government resources and leaders of these institutions do not see themselves as part of a broader system: the agricultural technology system (ATS). Instead, they try to increase the flow of resources coming to their respective institutions and to solve day-to-day management problems, rather than ensuring that their respective organizations contribute to the broader goal of getting improved agricultural technology transferring to farmers.

Presently, environmental concerns, decentralization and community participation in agricultural development are being emphasized. The transition to diversified small farming systems will require new skills and capacities among farmers. Traditional forms of extension support to rural farmers from the Green Revolution era, such as the Training and Visit system (T&V), mainly addressed crop and livestock production through technological packages. The nature of knowledge needed today is more complex, diverse and local. Much of this knowledge needs to be developed or adapted "on the spot" through local experimentation.

For this research, farmers were introduced to the concept and methods of on-farm experimentation and learning in an initial workshop. Four farmers from each village participated in an initial workshop and visited farms in the original site. When they went back to their villages, they organized and conducted a workshop for other farmers. A total of 85 farmers attended these secondary workshops. During these workshops, farmers made farm plans and selected technologies that were suitable for their farms. Some farmers, then, began to experiment with the newly introduced technologies. Farmer-to-farmer learning process (FFLP) Had been focused on four agricultural technologies: 1) custard apple pruning and cultivation; 2) liquid organic fertilizer; 3) herbal repellent extraction and 4) cassava–based animal feed. Farmers were exposed to these technologies through the following four methods: 1) group visits to farms carrying out these four technologies; 2) farmer workshops in each village to exchange information; 3) farmer trials with the new technologies and 4) observation of adapted technologies, farm visits and farmers' meetings to share experiences and gain new knowledge from the trials.

The aims of research were to examine characteristics of four agricultural technologies, effectiveness of technologies that transferred by farmers, and effectiveness of a farmer-to-farmer learning process (FFLP) developed and also tested over three years in four amphoes (districts) in Northeast Thailand, and changes in adapted technologies and diversification. Interviewed of 100 farmers had been used. Assessment was made of adaptation of four introduced technologies and of the effects of these technologies on farm income and diversification through annual interview.

The results found that 1) Liquid organic fertilizer was the organic matter that provides the nutrient and improve the physical component of soil and it stimulated the microorganism in soil working actively and efficiently. The cost of liquid organic fertilizer was 5.92 baht/ liter. 2) Bio-extraction is the white liquid made of herbal plants by boiling and streaming technology. Then, the stream flew through a cooling tank and became to be the white liquid. The substance basically protected the crops from insects. The technology cost 75baht/liter. 3) Custard apple pruning and cultivation introduced farmers to prune and cut the tree after two -three years cultivation, the purpose of pruning was to shape a custard apple tree suitable for flowering and fruiting, and then, leading to be good quality of fruit. The cost of technology was 1,601 baht / rai. 4) Cassava-based animal feed had been used for reducing feed cost for cattle production, by using cassava root and leaf products as supplementary feed, such as the cost was 1.3 baht / 1 kilogram of cassava silage.

The research also presented adapting farmers have generated at least one of four technologies on their own farms. Adapting farmers also reduced cost and gained high revenue after applying FFLP technology. The diversification activities were supplementary incomes for adapting farmers. It also indicated that this was high relation level. Farmers gained more farm income from implementing more diversification activities, the Exponential between of diversification activities and number of technology on farm income as $R^2 = 0.958$

The research also presented 64 % of the farmers adapted custard apple management, 58 % adapted liquid organic fertilizer, 38 % adapted herbal repellent extraction, and 18 % adapted cassava–based animal feed. Farmers who adapted more technologies and generated more diversification gained higher incomes. Agricultural technologies introduced and adapted through FFLP contributed 24.6 % of farm income and 20.5 % of total income of the 100 farmers.

Keywords: adaptation, farmers, income, learning, technologies

Introduction

The most important mission of the Agricultural Extension Service is not only to transmit and spread new agricultural technological methods to farmers, but also to promote farmers to participate the extension system as researcher and extension worker. However, the new technologies are usually developed by agricultural research institutes. To get the research results is one of the most important functions of the extension service. Furthermore, farmer learning from each other is more important approach that technologies can be spread widely. As mentioned in previous chapter, the introduced technologies have been adapted in four villages. This chapter will outlines the characteristics of four technologies. The content of each technology will consists of the general information, the purpose, effect of technology, the use of technology cost and constrain. Then, the characteristics of each farmer who adapted and non adapted will be presented.

The nature of agriculture and the role of public extension have changed in Thailand and other countries since the Green Revolution era of the 1960s and 1970s. At that time, monoculture cropping using chemical fertilizers and pesticides was emphasized by public extension to increase production and maximize farmers' incomes, as well as generating foreign exchange for the country. Now, environmental concerns, decentralization and community participation in agricultural development and natural resource management and planning are being emphasized. The transition to diversified small farming systems will require new skills and capacities among farmers and calls for continuing farmer innovations in farming systems to adjust to changing situations. Traditional forms of extension support to rural farmers from the Green Revolution era, such as the Training and Visit system, mainly addressed crop and livestock production through technological packages. The nature of knowledge needed today is more complex, diverse and local. Much of this knowledge needs to be developed or adapted "on the spot" through local experimentation and adaptation (Leeuwis, 2004).

Moreover, the role of government as the major provider of agricultural and rural development services has declined. This is due to reforms in the agricultural extension service in the past 10 years, resulting in reduced staff in the field and at the district and sub-district levels and also due to reduced budgets allocated to such services. As a result, farmers' access to extension services is known to have decreased considerably (Phanthupinij, 2001). Farmer-led extension has thus become more essential now than in the Green Revolution period.

Following end of the technology transfer approach to the Green Revolution in the 1980s, there has been a search for improved methodologies for local experimentation and adaptation based on participatory and group-focused approaches. These methodologies include farmer-to-farmer extension, group extension methods, Participatory Rural Appraisal and Farmer Field Schools (Neuchatel Group, 2006).

In recent years, increased attention has been given to the farmer-to-farmer learning process (FFLP) as a more viable method of technology adaptation, innovation, and dissemination. It is characteristic of the farmer-to-farmer learning process approach that farmers learn from other farmers about new agricultural technologies and practices (Sinja et al., 2004). The dissemination of innovations develops spontaneously when one farmer has successfully tested a new practice or technology, thereby attracting the interest of other farmers. It also can be seen that if the innovator is willing to share the new knowledge, a farmer network may develop.

We propose to go one step further to plan and stimulate a farmer-to-farmer learning process (FFLP). This approach is based on the observation that farmers can often disseminate innovations better than official extension agents because farmers have in-depth knowledge of local crops, practices, culture and individuals. Farmers usually can communicate effectively with other farmers, and are almost permanently available in the community. Innovations provided by agricultural research or developed by farmers themselves are then tested and adapted by other farmers, and if found useful, are subsequently passed on to fellow farmers based on first-hand experience (Sinja et al 2004). The most important criteria that must be met before a farmer network can develop is that the farmer must be willing to become a farmer promoter, extensionist, and trainer who shares his or her knowledge with other farmers. It is important to identify this type of farmer to increase technology innovation and diffusion among farmers.

Leeuwis (2004) indicated that past agricultural extension support had often focused on farm management and innovation at individual farm level, whereas a group approach would allow collective issues to be addressed as farmers learn from each other and problem solving can take place. In addition, costs are greatly reduced and social capital is developed. Working with farmer groups has been found to be more effective than working with individual farmers (IFAD, 1996).

A future agricultural extension would therefore need to contribute more directly to building local institutions such as farmer groups and cooperatives. Extension must be changed from promoting technological solutions to facilitating local knowledge generation, innovation, collective agency and organizational development, through a two-way communication between extension and farmers' groups. In this paper, we report on the effects of testing one model of such a future extension network, combining technical innovation with a farmer-to-farmer learning process (FFLP).

Objectives

The research area is located in the southern part of Khon Kaen Province (Figure 1). Farmers in this area normally cultivate three main crops: rice (R) sugarcane (S) and Cassava (C). Some farmers also grow vegetables (V) and fruit (F) and/or raise livestock (L), primarily for family consumption (Ando, 2004). In this paper, diversification for commercialisation involves the cultivation of fruit (F), especially custard apple and vegetables (V) and the raising of livestock (L), especially beef cattle.

This paper presents the results of a three year long research project of a farmer-to-farmer learning process for scaling out from an original village where farmer-participatory technology development research was initiated, to four new villages, each in one *tambon* (sub-district) of four *amphoes.* This *scaling out* to similar units created a *scaling up* from the *tambon* level to the level of a sub-region of the province (Figure 2). Farmers who had farm ponds in the project area were exposed to four new technologies and adapted them to the conditions on their own farms, through the farmer-to-farmer process introduced in this research.

The aims of this paper are to demonstrate the characteristics of four agricultural technologies, the effectiveness of these technologies that transferred by farmers to farmers learning process and show economic change resulting from FFLP activities with respect to each of the four technologies. Our hypothesis is that the farmer-to-farmer learning and innovation (FFLP) process is an effective method of technology change for increasing income in agricultural production.

Materials and Methods

Sample selection

This research was conducted in four districts of the south-eastern sub-region of Khon Kaen Province Northeast Thailand: Ban Haed, Ban Phai, Peuy Noi and Nong Song Hong. The selection of four sub-districts (*tambons*) for scaling out used a three–stage process: 1) *amphoe* (district) selection; 2) *tambon* (sub-district) selection within districts; 3) village selection within *tambons*. A census was carried out and a typology of farmers based on diversification was developed.

In each *amphoe*, 25 farmers were selected from the census frame using proportional stratified sampling (Johnson and Christensen, 2007) within the typology classes.

Typology classes were based on three types of income-generating agricultural activities that used water from ponds: 1) fruit; 2) livestock; and 3) vegetables. When all three activities were combined (Fruit + Livestock + Vegetable), this was termed integrated. This followed the same method as Ando and Suphanchaimat used in August 2003 to identify farmers for the September 2003 farmer research agenda setting process (Caldwell et al., 2006) for comparison with the original research village.

Design of the farmer-to-farmer learning process (FFLP)

Farmers were introduced to the concept and methods of on-farm experimentation and learning in an initial workshop. Four farmers from each new village participated in an initial workshop and visited farms on 10 February 2006 in the original site, Nong Saeng village. When they went back to their villages, they organized and conducted a workshop for other farmers. A total of 85 farmers attended these secondary workshops. During these workshops, farmers made farm plans and selected technologies that were suitable for their own farms. Some farmers then began to experiment with the newly introduced technologies. Taweekul et al. (2009) explained that the farmer-to-farmer learning process focused on four technologies: 1) custard apple pruning and cultivation; 2) liquid organic fertilizer; 3) herbal repellent extraction; and 4) cassava–based animal feed.

Farmers were exposed to these technologies through the following four methods:

1. Group visits to farms carrying out custard apple pruning and cultivation, herbal repellent extraction, liquid organic fertilizer, and cassava-based animal feed;
2. Farmer workshops in each village to exchange information;
3. Farmer trials with the new technologies; and
4. Observation of adapted technologies, farm visits and farmers' meetings to share experiences and new knowledge from the trials.

Assessment method

A survey instrument was developed and implemented in October 2005. For baseline data, the original survey covered household size and characteristics, land use, income, land location, farm ponds, pond volume, water use periods, animal husbandry, and manure use and destination and membership in groups. Modifications in 2006, 2007 and 2008 added sources of technologies, adapted technologies, adapting and non-adapting farmer incomes, and loans. All data were entered in a standard computer-based spreadsheet. Statistical assessment of differences among farms was done using SPSS (Version 11.5.0, 2002). The Chi-square test was used to analyze the adapting and non-adapting farmers in terms of the effects of farm size and diversification on farm income. Furthermore, the percentage has been analyzed for the change of farm revenue and contribution of FFLP activities. The regression also was used to analyze the correlation between diversification, technology and farm income.

Results and discussion

The characteristics of four technologies

According to introduced technologies in the project, four technologies have been introduced for farmers in four villages, are demonstrated as follows:

Liquid organic fertilizer

General information of the technology

The liquid organic fertilizer is the organic matter that provides the nutrient and improve the physical component of soil. Furthermore, it stimulates the microorganism in soil working actively and then the crop can absorb the nutrient to itself efficiently. The farmers who use the organic fertilizer produce the agriculture friendly with the environment. The liquid organic fertilizer is the concentrated brown liquid. This product made of three main components, there are 1) the yellow, red, orange fruit and vegetables, such as, pumpkin, pineapple, mango, jackfruit, carrot etc, 2) sugarcane molasses and 3) coconut juice. However, if there is not coconut juice , the pure water can be replaced but it needs long period for fermentation.

Another tool is the plastic container with lid, the capacity is about 50 liters (depends on the volume farmers need and the raw material and container available). Actually, the wooden stick is also provided to stir ingredients in the container to increase the oxygen for microorganism. Basically, there are two types of microorganism: 1) need oxygen to react (aerobic microorganism and 2) no need oxygen to react (anaerobic microorganism). Thus, the ingredients need to be stirred to get more oxygen everyday.

The study found that the steps of making the liquid organic fertilizer was following:

1) Cut the fruit or vegetable into the small pieces since this will stimulate microorganism react properly.
2) Weight the ingredients as following ratio: Fruit or vegetable: Sugarcane molasses: Coconut juice = 3 kgs.: 1 kg.: 1 kg., re4spectively
3) Put the pieces of fruit or vegetable in the plastic container first, then add the molasses and the coconut juice.
4) Stir about 5 minutes or until the ingredients mix together firmly.
5) The, to leave it for 20 days is needed for fermentation.
6) Then, the liquid organic fertilizer is ready to be used.
7) Keeping the fertilizer bottle in the shadow is necessary. It can be kept up to 1-2 months.

The purpose of the technology

1) To make organic fertilizer by using raw material in the village and apply it on their farms instead of chemical fertilizer,
2) To reduce the farm cost especially the chemical fertilizer,
3) To improve quality of soil.

The Cost of technology

The cost of organic fertilizer was about 5.92 baht/ liters or approximately 0.006 baht / cc.

The cost of one liter of solution of liquid fertilizer was

1) Clean water		=	1.000	baht / liter
2) Liquid fertilizer	concentrate	=	0.006	baht / cc.
Solution costed		=	1.006	baht / 1 liter of solution

Herbal Bio Repellent Extraction for insect repellent

General information

The bio-extraction is the white liquid made of boiling and streaming by using the herbal plants, that can expel the insects, then the stream pas through the cooling tank and become to be the white liquid. The substance basically does not kill the insects directly, but it can protect the crops. However, some little insect would be eradicate.

Many kinds of herbal plants can be normally used, especially, the local plants which can be fast growing. Actually many parts of plants, for instance : leaf, tuber, fruit, stem and root, can be extract by streaming system. These plants are neems, eucalyptus, wild lemon, lemon grass, Siam weed, lotiens, wild basil, ginger, merry gold etc,. Normally, the insects do not like to destroy these plants. Thus, when farmers extract the liquid and dilute with water, then, spray directly into the plants. The insects will be away from the plots of plants. However, the liquid can protect the crop in short period approximately 3-5 days, thus farmers have to apply very often.

The equipment for making the bio-liquid is called “Bio-extraction tank”, which consists of four main parts. The first part is a boiling tank made of metal resisting high temperature more than 100 Degree Celsius. The capacity of the tank is about 30 liters. This metal tank also came with the metal lid to protect the stream release. Moreover, the filter made of metal is placed inside. The second part is a stream conductor made of cupper. The diameter size of the tube is about 1.5 centimeters, while the length is 40 centimeters. This tube connects the boiling tank and cooling tank with the screw. Furthermore, the third part is called “cooling tank” made of the container protecting the warm water (60 Degree Celsius), for instance, the reuse paint plastic container (cheap) or aluminum container (expensive). Inside the cooling container has the spiral cupper tube that connected from the boiling tank. It is used for reduce temperature causing changing the stream to be the liquid. The end of the spiral tube go outside from the container, about 15 centimeters length, to conduct the bio-liquid to outside. Lastly, the forth part is power source. Normally, farmer in the villages use both wooden and cooking gas.

The steps of making bio-extraction is as follows:

1) Chop the herbal plants including the fruit into small pieces, the total weight is approximately 5 kilograms and the ratio of each plant is equally.
2) Set up the boiling tank on the stove or power source firmly and also set up the cooling tank with the same level

3) Connect the both tanks together by cupper tube with the screw.
4) Put the water into the boiling tank about 8-10 liters, and also fill up the water into the cooling tank.
5) After that, put the metal filter net inside the boiling tank.
6) Then, put the pieces of herbal plants into the metal filter.
7) Next, cover the lid firmly and fire the wooden or turn on the gas.
8) Observe the temperature of both tanks.
9) The stream will pass through the cupper tube, then, will become the white liquid when pass the cooling tank.
10) Using the container with lid to take the bio-extraction liquid. Id required.

The purpose of the technology

1) To repel the insects by using their indigenous knowledge combining with appropriate technology.
2) To promote farmers use the herbal plants from farms for reducing the farm cost.
3) To promote the chemically free agricultural production.

The cost of technology

The cost of bio – extraction liquid 75 baht / liter
= 0.075 baht / cc.
If need 1 liter of solution 1) Water 1.00 baht / liter
2) Bio – extraction 50.00 cc
The solution costs 3.75 baht / 1 liter

Custard apple cultivation and pruning

General information technology

The custard apple is very popular introduced technology for farmers. Farmers expected to prune and cut the tree after two -three years cultivation. This method will make farmers learn and practice from the beginning until harvesting. The suitable location for custard apple growing should be near the water source, such as, on the farm pond bank, on the upland area near farm pond. Importantly, custard apple is not tolerant to soil containing moisture, thus, growing custard apple on lowland must be avoided.

The custard apple is high about 4-5 meters into 3-5 years. Thus, it needs to be pruned and cut for controlling the shape leading to improve fruit quality, such as, big size fruit, tasty, clean peel and free pest and disease. Thus, the custard apple needs pruning after two years to shape the shrub. According variety, there are typically two varieties: Fai and Hnung.

The purpose of pruning is to shape the custard apple tree suitable for flowering and fruiting, moreover, leading to good quality of fruit. The pruning technique is following:

1) Cut the stem high about 1.50 -1.80 centimeters from ground level
2) Cut the dead, broken, disease and spiral branches. And also small branch and green branch growing in wrong position will be pruned.
3) Taking out the minus fruit is strongly required.
4) Shaping the shrub becomes round shape.
5) Pruning 2-3 years after growing will do it easily and can control the shape correctly.
6) After pruning, to plough between row is needed.
7) After cutting and pruning, watering is importantly needed to stimulate flowering.

The purpose of the technology

1) To increase on farm income and provide food for household consumption.
2) To learn on water use efficiently by intercropping system and mulching

The cost f technology

1) Land preparation		250	baht
2) Hole digging 177 holds x 3 baht	531	baht	
3) Manure / Compost		200	baht
4) Seedling 177 x 3.5 baht	620	baht	
Total		1,601	baht / rai

Cassava production technology for animal feed

General information

Both root and leaf of cassava can be used as supplements for animal feeds. Cassava root is the source of energy since carbohydrate is the major component in root. Leaf contains high protein (20-28%), vitamins, beta-carotene and minerals. However, both root and leaf contain hydrocyanic acid and leaf also contains tannin that can cause lethal effect to animal. Sun drying or ensiling can reduce those toxins to the safe level for animal feeding. Low hydrocyanic acid and tannin containing in dried or ensiled cassava can reduce internal parasites in animal. Shelf life of milk is also increased. Sun drying is the save method if sunshine is plentiful. In rainy season or cloudy condition, cassava silage can be conducted. Normally, cassava chip (dried cassava root slices) is used in animal feed industrial as a cheap energy source. However, there is limited used in a local area. Further, cassava leaf is not widely used for animal feed in Thailand, though it has high protein content as mentioned above.

The purpose of the technology

1) To develop methods for animal feed making from cassava root and leaf in local area.
2) To add value to cassava product ad by-product.
3) To reduce feed cost for animal production, especially for cattle, by using cassava root and leaf products as supplementary feed.

Cassava leaf ensilage making

1. A chopper costs 3800 bath each or a Knife cost 150 bath.
2. Making one ton of cassava leaf silage requires 200 plastic bags in the size of 40 x 65 cm. as ensilage containers. The cost of plastic bags is 510 bath
3. Additives; 300 bath for molasses or rice bran, 200 bath for cassava chip, 500 bath for fresh cassava root slices for one ton silage making.
4. Making one ton of cassava leaf silage requires 2 labors, 300 baht

Total 1,890.00 baht / 1,000 kilograms of cassava silage

Average 1.89 baht / 1 kilogram of cassava silage

Cassava root ensilage making

1. A chopper costs 3,800 bath each or a knife casts 150 bath each.
2. Making one ton of cassava root silage requires 100 plastic bags in the size of 40 x 65 cm. as ensilage containers. The cost of plastic bags is 205 bath
3. Additives; 300 bath for molasses or rice bran, 500 bath for cassava fresh leaf, for one ton silage making.
4. Making one ton of cassava root silage requires 1.5 labor

Total 1,310 baht/ 1,0000 kilograms of cassava silage

Average 1.310 baht / 1 kilogram of cassava silage

Mechanism of technology adaptation and effectiveness on costs and income of FFLP technologies

During 2006 -2008, adapting farmer have generated at least one of four technologies on their own farms. Table 2-5 present the mechanism and cost of each technology which adapting farmers operated on farms. Each technology has different mechanism, only liquid organic fertilizer and herbal extraction were similar use by application directly on plant leaves. Table 2-5 also illustrate the cost of old technology use and FFLP technology use. It can be seen that only custard apple management consumed the labour cost since it needed to be pruned and cut, while old technology did not need any management that caused farmers gained low quality of fruit. Liquid organic fertilizer technology had been used for rice production. Farmers applied four times per crop by spraying on the rice leaves. In contrast, before farmer participated FFLP, they applied chemical fertilizer 2 times per crop after transplanting two and eight weeks . Similarly, adapting farmers applied herbal extraction on vegetable leaves to protect the insects instead of using pesticide. Table 4 also shows that adapting farmers reduced cost and gained high revenue after applying FFLP technology. Table 5 demonstrates the cost of animal feed reduced after they adapted cassava - based animal feed. Even though, the price of cattle during 2006-2008 is reduced approximately 25 per cent , adapting farmer gained high net income.

Table 2 Mechanism of technology adaptation and effect on costs and income of custard apple management technology of 64 adapting farmers

Activities : custard apple	Old manage.	FFLP manage.	Cost & revenue change
Cultivating	1 rai	1 rai	-
Pruning	none	1time / year	-
Cost/rai/pruning	-	250 baht/rai	-
Cost	-	250 baht/rai	+ 250 baht/rai
Revenue	575 baht	1,364 baht/rai	+ 789 baht/rai
Net income	575 baht	1,114 baht /rai	+ 539 baht/rai

Table 3 Mechanism of technology adaptation and effect on costs and income of liquid organic fertilizer of 58 adapting farmers

Activities :rice	Chemical ferti.	Liquid organic	Cost & revenue change
Average appli.	5 rai	5 rai	-
Application	2 times /crop	4 times /crop	-
Cost /rai	1,100 baht/crop	55 baht/crop	-1,045 baht/crop
Cost	5,500 baht/crop	1,100 baht/crop	- 4,400 baht/crop
Revenue	24,000 baht/5 rai	27,000 baht/5 rai	+3,000 baht/5rai
Net income	18,500 baht/ 5 rai	25,900 baht/ 5 rai	+7,400 baht/5rai

Table 4 Mechanism of technology adaptation and effect on costs and income of herbal repellent extraction of 38 adapting farmers

Activities: vegetable	Pesticide	Herbal extraction	Cost & revenue change
Average appli.	1 rai	1 rai	-
Application	4 times /crop	6 times /crop	-
Cost /rai	350 baht/time	60 baht/time	-290 baht/time
Cost	1,400 baht/rai	360 baht/rai	- 1,040 baht/rai
Revenue	24,000 baht/ rai	30,000baht/rai	+6,000 baht/rai
Net income	22,600 baht/ rai	25,940 baht/ rai	+7,040 baht/rai

Table 5 Mechanism of technology adaptation and effect on costs and income of cassava - based animal feed of 18 adapting farmers

Activities: cattle	suplement. feed	cassava feed	Cost & revenue change
Average appli.	2 cows	2 cows	-
Application	1 time/day	1 time /day	-
Cost / cow	30 baht/2cow/day	11 baht/2cows/day	- 19 baht
Cost	3.600 baht/2cow/4months	1,320 baht/2cow/4months	- 2,280 baht
Revenue	25,000 baht/2cows	25,000 baht/2cows	-
Net income	21,400 baht/2cows	23,680 baht/2cows	+ 2,299 baht/2cows

Income increase after generating diversification and adapting technologies through FFLP

Table 6–10 present the crop yields increased then resulted to increase revenue after farmer applied FFLP technologies on farms. Custard apple yield increased 37.5 per cent after farmer adapted technologies in 3 years and gained higher income 3 times than revenue in 2005. Farmers also gained high yield of rice after applying organic fertilizer. They also had income from rice higher nearly 2 times compared with non-FFLP technology. Similarly, herbal extraction technology had affected to increase crop yield both in rice and vegetable. However, income from adapting cassava-base animal feed was not different between FFLP and non- FFLP because local merchants did not recognized the kinds of cattle as a result they proposed the same price. However, FFLP farmers gained high income since they reduced cost by using FFLP technology. During four FFLP technologies, organic fertilizer had affected to increase high income than other three technologies.

Table 6 Effect of custard apple technology on production and farm revenue

Planting /Cutting	Yield in 2005 (kg.)	Yield in 2008 (kg.)	+ / - yield (kg.)	Effect from technology (kg.)	Area (rai)	Revenue [1)] (baht)
without	2,000	2,250	350	-	1	2,500
with	2,000	2,750	750	750	1	7,500

[1)] price 10 baht / kg in 2008

Table 7 Effect of organic fertilizer technology on rice yield and farm revenue

Organic fertilizer	Yield in 2005 (kg.)	Yield in 2008 (kg.)	+ / - yield / rai (kg.)	Effect from technology/ rai (kg.)	Area (rai)	Revenue [1)] (baht)
without	350	400	+ 50	-	15	9,000
with	350	445	+ 95	95	15	17,100

[1)] price 12 baht / kg in 2008

Table 8 Effect of herbal extraction technology on rice yield and farm revenue

Herbal extraction	Yield in 2005 (kg.)	Yield in 2008 (kg.)	+ / - yield / rai (kg.)	Effect from technology / rai (kg.)	Area (rai)	Revenue [1)] (baht)
without	350	385	+ 35	-	15	6,300
with	350	430	+ 80	80	15	14,400

[1)] price 12 baht / kg in 2008

Table 9 Effect of organic fertilizer technology on vegetable production and farm revenue

Organic fertilizer	Yield in 2005 (kg.)	Yield in 2008 (kg.)	+ / - yield (kg.)	Effect from technology (kg.)	Area (rai)	Revenue [1)] (baht)
without	2,000	2,400	+ 400	-	0.5	2,400
with	2,000	3,000	+ 1,000	1,000	0.5	6,000

[1)] price 12 baht / kg in 2008

Table 10 Effect of herbal extraction technology on vegetable production and farm revenue

Herbal extraction	Yield in 2005 / rai (kg.)	Yield in 2008 / rai (kg.)	+ / - yield (kg.)	Effect from technology (kg.)	Area (rai)	Revenue [1)] (baht)
without	2,000	2,250	+ 250	-	0.5	1,500
with	2,000	2,750	+750	750	0.5	4,500

[1)] price 12 baht / kg in 2008

Table 11 Effect of cassava feed technology on production and farm revenue

Planting /Cutting	Yield in 2005 (kg.)	Yield in 2008 (kg.)	Period (Month)	Effect from technology (head.)	Number (cow)	Revenue [1)] (baht)
without	120	120	12	9,850	1	9,850
with	120	120	10	11,550	1	11,550

[1)] price 140 baht / kg in 2008
[2)] it also depends on size and healthy

The study, moreover, found that the diversification activities were supplementary incomes for adapting farmers. It also indicates that this is high relation level. Farmers gained more farm income from implementing more diversification activities as shown in Figure 3. This presented the Exponential between of diversification activities on farm income. As diversification level increased, the effect on income was greater than additive, implying that there may be synergy gained from multiple diversification activities.

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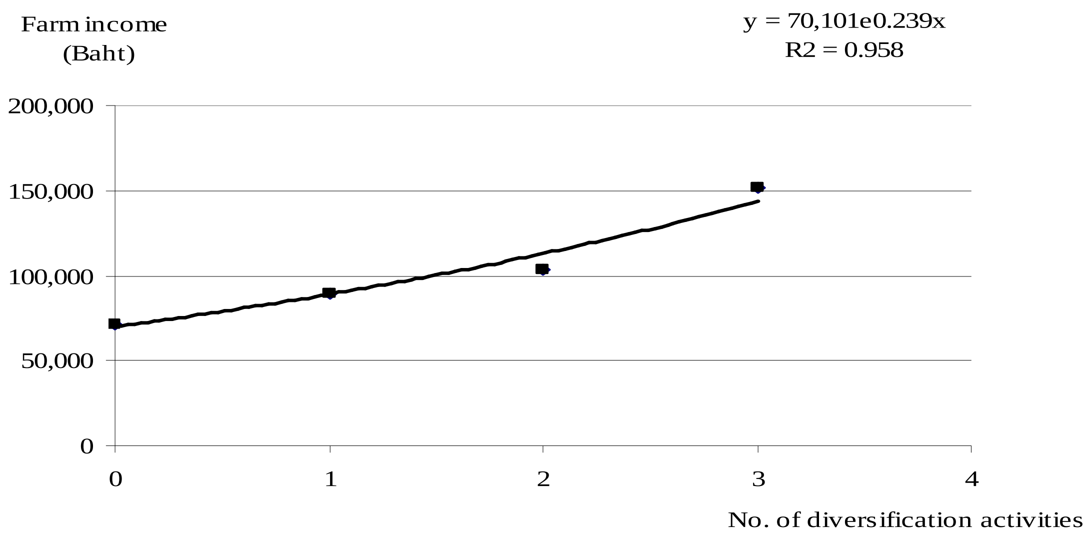

Figure 3 Effect of number of diversification activities on farm income.

Contribution of FFLP activities and diversification based agricultural activities
The activities of FFLP farmers involved increased diversification that brought high income to the farmers. As can be seen from Table 4, FFLP farmers gained lower income from custard apple than from the other three technologies: organic fertilizer, herbal extraction and cassava based animal feed. Table 4 also shows that the cost of herbal extraction was higher than the cost of the other technologies, which involved expenditures to buy equipment and hire labour to operate farm activities. Generally, farmers who adapted FFLP technologies were able to reduce cost largely through the process of modifying local materials used on farms.

Table 5 presents the agricultural revenues deriving from three sources: FFLP, diversification of agricultural activities and basic cropping system. It also shows agricultural income by firm size: small, medium and large. In terms of FFLP, the revenues accruing to CA and OF technologies showed a significant difference between small and medium farms, and not much so between medium and large farms. In contrast, no significant difference was observed with respect to revenues accruing to HE and CF technologies used by small and medium size farms. This is because small farms were operated intensively, so that the income they gained would be similar to larger farms. However, according to CA and OF technologies, farmers who had larger tracts of land gained higher income. Such farmers appear to have used technologies efficiently and also to have worked actively on their farms.

Farmers who adapted organic fertilizer gained higher incomes than farmers in the other three adapted FFLP categories. Farmers applied the organic fertilizer on various crop cultivations such paddy rice field, cassava and vegetable production.

Overall, differences between technology and farm size categories notwithstanding, all FFLP farmers gained more agricultural income than before they participated and adapted the FFLP.

Table 4 Contributions of FFLP activities, other diversification, base agricultural activities, and non-agricultural activities to household income of all 85 FFLP farmers in 2008 (Baht).

Activity	Revenue	Cost	Net income	% contribute[1)]
FFLP activities				
Custard apple	1,114	254	861	
Organic fert.	24,326	333	23,993	
Herbal	26,825	7,199	19,626	
Cassava feed	26,733	590	26,143	
Subtotal, FFLP	**78,998**	**8,376**	**70,622**	**28**
Other diversification				
Fruit	31,900	5,509	26,391	
Vegetables	12,217	1,465	10,752	
Livestock	93,150	10,216	82,934	
Subtotal, diversification	**137,266**	**17,190**	**120,077**	**47**
Basic cropping system				
Rice	18,527	8,781	97,46	
Sugarcane	57,044	27,306	29,738	
Cassava	42,741	18,142	24,599	
Subtotal, basic	118,312	54,229	64,083	**24.6**
Total agricultural	**334,576**	**79,795**	**254,782**	**100**
Non-agricultural	51,699	123,772	-72,072	-
Total income	**386,276**	**219,567**	**182,710**	**-**

[1)] % contribution on total agricultural net income

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Table 5 Agricultural revenue per hectare of FFLP farmers (baht /ha)

Activities	level	small	medium	large
FFLP	CA	6,163a 1)	7,406b 2)	7,325b 2)
	OF	191,794a 1)	201,100b 2)	201,938b2)
	HE	33,044a 1)	34,231a 1)	34,650a 1)
	CF	74,813a 1)	79,281a 1)	85,313b 2)
Diversification	1	53,906a 1)	55,938a 1)	53,519a 1)
	2	62,919a 1)	70,356b 2)	71,163b 2)
	3	96700a 1)	97,5132a 1)	103,313a 1)
Basic agriculture	R	33,975b 2)	34,825b 1)	32,894a 1)
	S	41,563b2)	42,406b 2)	38,175a 1)
	C	26,088a 1)	26,469a 1)	25,638a 1)

1) , 2) Probability of differences between farm size highly significant (**), P<0.01, as determined by Chi-square test.

Remark : CA = Custard apple OF = Organic fertilizer
HE = Herbal extraction CF = Cassava feed
R = Rice S = sugarcane C = Cassava

Conclusion

It has been shown in this paper that FFLP has had a significant effect on farms in terms of increased number of technology adapting cases, and subsequent income increases. FFLP technologies contributed 24 % to farm income and 21 % to total income in 2008. The first harvest of custard apple was 2008, and the average yield was 1,114 baht/family. Liquid organic fertilizer and herbal repellent extract were used for increasing yield and improving quality of crop productions. Cassava–based animal feed was also applied to improve quality of beef and reduce farm cost.

Farmers preferred to cultivate custard apple on land used for sugar cane production in 2007-2008. Farmers increased their savings by using liquid organic fertilizer instead of buying chemical fertilizer, which is more expensive. A smaller number of farmers adapted herbal repellent extraction and cassava feed technologies because they lacked the tools to make extraction and cassava–based animal feed. Moreover, the low price of cattle during 2007-2008 could hardly attract farmers to provide supplementary feed.

The farm participatory extension approach facilitated the farmer-to-farmer learning process (FFLP), providing assistance and support to farmers. As a consequence, farmers themselves became experts and local researchers on the particular practices they have been investigating. Such farmers consequently became promoters or local extensionists, introducing the four technologies to the other farmers in the same village and scaling out in the surrounding areas. FFLP thus helped farmers and communities to achieve their goals and preferences by facilitating the learning process. As a method of action learning (learning by doing, seeing, discovering and experimenting), FFLP encouraged reflection and increased farmers' analytical capacities, and hence the capacity of farmers for effective problem solving and for developing their own technical and social solutions.

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