Chapter 4
Research results

The research results will present into three main parts: there were, activity 1: assessment of the target villages before FFLP and assessment of impacts of FFLP and innovation, activity2: the characteristics and mechanize of FFLP technologies on cost and assessment of effects of FFLP technologies on income of land, and activity 3: dissemination of FFLP to local administration organization and scaling out to other areas and network building.

Activity 1: Assessment of the target villages before FFLP and assessment of impacts of FFLP

1.1 Assessment of the homogeneity of the target village and the relationship of farm ponds with diversification and farm income before FFLP

The chapter begins with the results in which the assessment of the target research areas with homogeneity and the relationship of farm ponds and farm income. The assessment will implement before introducing the FFLP in the villages. The effects of location, household size, land area, farm ponds on diversification and income will also present. Then, in which factors will be assessed after FFLP operated in intervention areas.

1.1.1 Introduction

Diversification of farming systems in northeast Thailand is a priority for farmers who have become economically dependent on sugarcane and cassava as sources of cash income to supplement rice grown primarily for home consumption. Sugarcane and cassava can tolerate the long dry season from November to April that is characteristic of this region. Nevertheless, farm household annual income in the Northeast of US$ 1,152 is lower than other regions with higher, better distributed rainfall, including the Central (US$ 5,455), Northern (US$ 2,273) and Southern (US$ 2,182) regions (Ando, 2004).

Farm ponds have been promoted since the mid-1990s as a potential solution to this problem. However, Ando (2004) found that farm ponds in two villages in Nong Saeng *Tambon* (sub-district) in *Ban Hat Amphoe* (district) were not used effectively for diversification. Only 30 % of the ponds provided farmers with income from livestock over 5,000 Baht (approximately US$ 125), while less than 10% provided this level of income from pond use for vegetables or fruit. The most widespread uses of ponds were for rice, the main staple crop for home consumption, and fish. It has been suggested that farmers do not make full use of ponds due to inadequate water for both rice seedbeds and other crops, but factors affecting the use of farm ponds for diversification have not been fully identified.

Development of technologies to enable farmers to use pond water more effectively for diversification crops is another potential means of increasing diversification. However, technologies developed on research stations under more favorable controlled conditions than farmers have on their own farms are less likely to be widely adopted than technologies which farmers develop in collaboration with researchers on their fields. Farmers' experimental groups have been found to be an effective mechanism to develop technologies with greater impact on farm household income than conventional technology transfer (Ashby et al., 2002). In a pilot project in Nong Saeng *tambon* (sub-district) in Northeast Thailand, farmer experimental groups were found to be an effective means to develop water-saving cultivation, improved livestock feeding, and integrated farming technologies (Oda et al., 2006). However, less intensive methods than a pilot project are needed to extend this approach in other *amphoes.*

In 2005, we began to develop a method of farmer-to-farmer learning and innovation across *amphoes* as an approach to scaling out of the farmer experimental group approach. Scaling out refers to a process of making technology development applicable across similar size units making up a larger unit at a higher scale. In this case, the scaling out was from selected villages in one *tambon* to selected villages in multiple *tambons,* moving the scale up from the *tambon* level to a sub-region of a province, southeastern Khon Kaen Province. For this purpose, we sought to identify factors affecting diversification among *amphoes* before initiating scaling out of farmer-to-farmer learning and innovation.

Our objective is to assess how the factors of location, household size, farm size, number of ponds and pond volume affect diversification, agricultural and total revenue. We focus on five factors hypothesized to affect or be affected by diversification. Our hypotheses for these factors were:

1. **Location:** *Amphoes, tambons*, and villages with similar topography, soils, and cropping systems have similar household sizes, land areas, numbers and volumes of ponds, income levels, and levels of diversification, and can be considered on homogenous set for scaling out.
2. **Land area:** Farms with less land area are less diversified.
3. **Household size:** Farms with more household members are more diversified.
4. **Ponds:** Farms with ponds have a higher level of diversification, and more carry out fruit and vegetable production, than farms without ponds, and farms with a greater number and total volume of farm ponds have a higher level of diversification, and more carry out fruit and vegetable production.
5. **Income:** Farms with a higher level of diversification have greater farm revenue.

To assess these hypotheses in the context of the development of new methods for scaling out of farmer-to-farmer learning and innovation for diversification, we describe a process developed for *amphoe, tambon,* and village selection, and then present results of a rapid census of diversification levels of 2,308 farms and a detailed baseline survey of 200 farms in 18 villages in eight *tambons*.

1.1.2 Results and Discussion

1.1.2.1 Effects of location, household size, land area, ponds on diversification and income

Table 14 shows there were no significant differences between intervention and control t*ambons* in household size (number of members), land area, number of ponds, pond volume, or agricultural revenue. The eight villages can thus be considered to be a largely homogeneous set across the four districts, as hypothesized. However, there were some differences among the four *amphoes* (districts) in household size and number and volume of ponds. Households in Ban Haed had approximately one more household member and a slightly higher average number of ponds compared to the other three districts. Nongsonghong and Peuy Noi had larger pond volumes, even though the number of ponds was similar to the other districts. Overall, farms with four members used approximately 6 ha (1 ha = 6.25 rai) of land to gain about US$ 2,000 of annual agricultural revenue (at the exchange rate of 41.66 baht = US $ 1.00 in 2005). Average pond size was nearly 1,900 cubic meters and each household had approximately 1.6 ponds.

Proportions of farm households with ponds were greater overall in control *tambons* compared with intervention *tambons* as shown in Table 9. However, there was variation among the districts. Ban Phai, Ban Haet and Peuy Noi districts followed the overall trend, but in Nong Song Hong the number of farms with ponds was greater in the intervention *tambon* than in the control *tambon.* Overall, as shown in the last two columns of Table 10, 65% of farms in intervention *tambons* had farm ponds, compared to 49% in control *tambons*. These results were similar to the result of the census of Ando and Suphanchaimat in 2003, in which 49% of 207 households in Nong Saeng had farm ponds (Ando, 2003).

Table 14 Household size, land area per farm, pond number and volume, and farm and total income in intervention and control *tambons* in four districts[1)]

Location[2)]		**Household Members (no.)**	**Land Area (rai)**	**Ponds (no.)**	**Pond Volume (m^3)**	**Agricultural revenue (฿)**
District	*Tambon* Type					
BH		4.66b[5)]	37.2a	1.92b	1,537a	69,837a
	I	4.64	32.8	2.04	1,352	80,750
	C	4.68	41.7	1.80	1,723	58,924
BP		3.82a[6)]	42.5a	1.60a	1,699a	86,003a
	I	3.60	50.0	1.52	1,706	82,750
	C	4.04	35.4	1.68	1,692	89,256
NSH		3.92a	34.0a	1.52a	2,130b	82,302a
	I	3.96	33.8	1.64	1,712	65,797
	C	3.88	34.2	1.40	2,547	98,807

Table 14 (CONTINUED)

Location[2)]		Household Members (no.)	Land Area (rai)	Ponds (no.)	Pond Volume (m^3)	Agricultural revenue (฿)
PN		4.26a	39.2a	1.42a	2,096a	85,543a
	I	4.80	47.5	1.52	2,707	101,543
	C	3.72	31.0	1.32	1,484	69,542
All	I	4.25	41.03	1.68	1,869.50	87,664.25
	C	4.08	35.58	1.55	1,861.75	70,461.75
All		4.17	38.3	1.62	1,866	79,063
District[3)]		0.05*	ns	0.05*	0.05*	Ns
Tambon type[4)]		ns	ns	ns	ns	Ns

[1)] Data from baseline survey, 2005, 25 farmers / *tambon,* 200 farmers total.

[2)] BH = Ban Haet, BP = Ban Phai, PN= Peuy Noi, NSH= Nong Song Hong I = Intervention *tambon*, C= Control *tambon*

[3)] Probability of differences among districts * = significant at 0.01, ns = non-significant, as determined by Student's t-test.

[4)] Probability of differences between intervention (I) and control (C) non-significant (ns),

[5)] Different superscripts a, b indicate different means between districts

Table 15 Numbers of farms with and without ponds in intervention and control *tambons* in four *amphoes* in Khon Kaen province, 2005[1)]

Ponds	BH[2)]		BP		PN		NSH		All	
	I	C	I	C	I	C	I	C	I	C
Yes	134	200	153	216	89	138	263	103	639	657
No	89	152	41	134	123	116	86	271	339	673
χ^2	0.6		16.83		7.05		165.15		58.15	
Sign.[3)]	ns		**		**		**		**	

[1)] Data from census, 2005, 2,308 farmers total.

[2)] BH = Ban Haet, BP = Ban Phai, PN= Peuy Noi, NSH= Nong Song Hong
I = Intervention *tambon*, C= Control *tambon*

[3)] Probability of differences between intervention (I) and control (C), ns = not significant at 0.01, as determined by χ^2 test.

Table 16 Agricultural revenue levels of farmers in intervention and control *tambons*

***Tambon* type[2)]**	**Agricultural revenue level (baht)[1)]**			
	< 50,000	**50,001-100,000**	**100,001-150,000**	**≥ 150,000**
I	23	34	22	21
C	35	37	13	15
Total [1)]	58	71	35	36
χ^2	18.10			
Significance[3)]	**			

[1)] Data from baseline survey, 2005, 100 farmers / *tambon* type, 200 farmers total.

[2)] I = Intervention *tambon*, C= Control *tambon*

[3)] Probability of differences between intervention (I) and control (C),

** = significant at 0.01 as determined by χ^2 test.

Table 16 shows that farm households with less than 50,000 baht (US$1,200) agricultural revenue were more numerous in control *tambons*, while agricultural revenue households with over 100,000 baht ($2,400) agricultural revenue were more numerous in intervention *tambons*. However, both types of *tambons* has similar numbers of farm households at the most common intermediate income level of 50,001-100,000 baht ($1,200-$2,400, at the exchange rate of 41.66 baht =US $ 1.00 in 2005**).** There were no significant differences between intervention *tambon*s and control *tambons* in the proportions of numbers of farms at different diversification levels with and without ponds. Both types of *tambons,* intervention and control, were at a similar level of diversification agricultural activities as it is shown in Table 12 below. This validates the procedure for selection of paired *tambons* and will enable us to assess the effect of FFLP on diversification as a key factor in change in farm economic status based on farm pond use.

Table 17 Diversification levels of farmers in intervention and control *tambons*

***Tambon* type**[2)]	**Diversification level** [1)]			
	0	**1**	**2**	**3**
I	83	564	402	56
C	79	591	460	73
Total [)]	162	1,155	862	129
χ^2	2.72			
Significance[3)]	Ns			

[1)] Data from census , 2005, 2,308 farmers total

[2)] I = Intervention *tambon*, C= Control *tambon*

[3)] Probability of differences between intervention (I) and control (C), ns = non-significant as determined by χ^2 test.

Table 18 shows that there was no relation between household size, land size, number of ponds, or pond volume with diversification level. However, agricultural revenue increased as diversification increased. Farmers who had more agricultural diversification activities generated more farm income than farmers with no diversification activities (vegetables, fruit and /or livestock) in addition to the basic crops of rice, cassava and sugarcane. Farmers at the highest level of diversification level 3 (integrated farm) had the highest agricultural revenue.

Table 18 Household size, land area per farm, pond number, pond volume and agricultural revenue at four levels of diversification with three types of activities[1)]

Diversification[2)]		Household Members (no.)	Land Area (rai)	Ponds (no.)	Pond Volume (m^3)	Agricultural revenue (Baht)
0		3.9a	30.9a	1.6a	1,712 a	69,867b[4)]
1		4.3a	44.1a	1.8a	2,011 a	93,654b
	L	4.4	43.6	1.7	1,900	93,307
	F	4.0	46.9	1.9	2,346	96,004
	V	4.6	35.1	2.0	1,403	85,738
2		4.4a	49.9a	2.1a	2,186 a	92,979b
	LF	4.2	56.4	2.1	2,595	102,022
	LV	4.6	39.1	2.4	1,186	92,800
	FV	4.8	33.7	1.8	1,470	75,180
3	LFV	5.0a	41.6a	2.5a	1,030 a	152,150a[5)]
t-test[3)]		ns	ns	ns	ns	**

[1)] Data from baseline survey, 2005, 100 farmers / *tambon* type, 200 farmers total.

[2)] Single letters indicate one diversification activity on the farm:
L=livestock, F=fruit, V=vegetables (level 1) Multiple letters indicate two or three diversification activities on the same farm (levels 2 and 3)

[3)] Differences in means between diversification levels and types as determined by student t-test.
** = significant level at 0.01 or ns = non significant

[3), 4)] Different superscripts a, b indicate different means between diversification levels

1.1.2.1 Effect of ponds

Farms with ponds had more diversification activities than farms without ponds as shown in Table 14. In control and intervention villages, the greatest proportion of farms had no diversification activities (level 0), although the proportion at level 0 was higher in control *tambons* than in intervention *tambons*. In both control and intervention *tambons*, higher proportions of farms were at levels 1 and 2. These results suggest that farm pond water resources are essential for farmers to carry out agricultural diversification activities. Differences between intervention and control villages were in proportions only, with basic trends the same. Effects of a farm-to-farm learning process can be thus compared between intervention and control *tambons* to assess effects on farm revenue.

Table 19 Levels and types of diversification on farms with and without ponds

Diversification		All		Without ponds		With ponds	
Level	Type[2)]	Without ponds	With ponds	Intervention	Control	Intervention	Control
0	-	529	257	129	400	145	112
1	L	328	349	121	207	158	191
	F	41	144	27	14	83	61
	V	14	11	4	10	2	9
2	LF	77	363	51	26	176	187
	LV	14	24	2	12	11	13
	FV	3	28	2	1	12	16
3	LFV	6	120	3	3	52	68
Total		1,012	1,296	339	673	639	657
χ^2		435.98		82.41		18.13	
Significance[3)]		**		**		*	

1) Data from baseline survey, 2005, 2,308 farmers total.

2) Single letters indicate one diversification activity on the farm:
L=livestock, F=fruit, V=vegetables (level 1) Multiple letters indicate two or three diversification activities on the same farm (levels 2 and 3)

3) * = significant at 0.05, ** = significant at 0.01 as determined by χ^2 test.

Table 20 shows that farms with and without ponds generated diversification activities in significantly different proportions in all districts. Diversification levels of 1 to 3 were more numerous on farms with ponds than farms without ponds. in Ban Haet, Ban Phai and Nong Song Hong districts. Only in Peuy Noy district was the proportion of farmers with ponds generating diversification activities at levels 1 to 3 less than that of farmers without ponds. Some farmers in Peuy Noy indicated that they chose to keep farm pond water for fish during the dry season, rather than carry out diversification activities. Some farmers without farm ponds in Puey Noy used water from natural canals which flowed through their farm land, enabling them to implement diversification activities without relying on ponds. However, overall, diversification levels were higher on farms with ponds.

Table 20 Levels of diversification of farms with and without ponds in intervention and control *tambons* in four *amphoes*

No. of activities	BH1)		BP		PN		NSH		All	
	No	Pond	No	Pond	No	Pond	No	Pond	No	Pond
0	44	13	13	18	48	28	49	29	154	88
1	43	100	19	64	55	38	23	72	140	274
2	2	18	9	59	20	18	13	125	44	220
3	0	3	0	12	0	5	1	37	1	57
χ^2	48.26		13.96		8.23		88.37		155.37	
Significance3)	**		*		*		**		**	

1) Data from census survey, 2005, 978 farmers with ponds.

2) BH = Ban Haet, BP = Ban Phai, PN= Peuy Noi, NSH= Nong Song Hong

3) .* = significant at 0.05, ** = significant at 0.01 as determined by χ^2 test.

Figure 39 shows that farms with a greater number of ponds generated a higher level of agricultural diversification activities. Farmers who had many farm ponds could implement more kinds of activities which use pond water rather than only cultivate the basic crops (rice, sugarcane, and cassava), since these farmers were confident that they would have adequate pond water for rice seedbeds, fish and cattle even after carrying out diversification activities in the dry season. These farmers were active and adapted new knowledge to meet the conditions on their own farms. For these reasons they were able to generate more diversification activities.

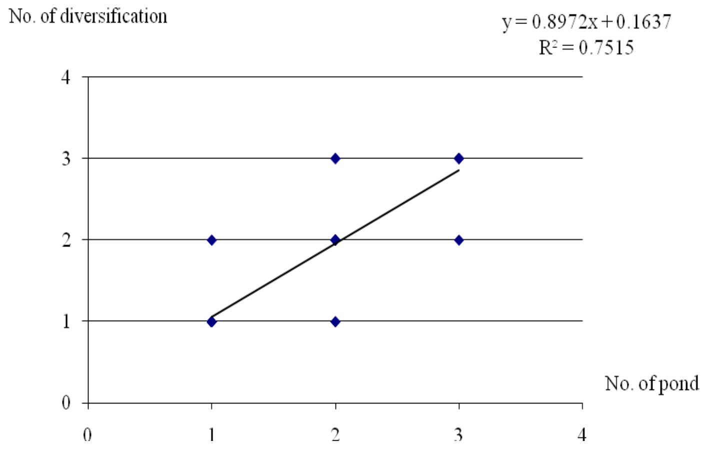

Figure 39 Change in number of diversification level with increasing numbers of ponds

There were no relationship between pond volume and the number (level) or type of diversification activities as shown in Table 21. Livestock was the most common diversification activity regardless of pond volume at level 1, only one diversification activity. Larger pond volume did not increase the proportion of levels 2 and 3. Overall, across the three categories of pond volume, 67 per cent, of the farms had a diversification level of 1, followed by diversification level 2, 18 per cent of the farms. Farms with ponds at a diversification level of 0 were only 10% . This shows that as long as farms have a pond, even if it has small volume, they can have adequate water to implement at least one diversification activity.

Table 21 Relationship between pond volume and diversification level and type

Diversification		Pond volume(m^3)			χ^2	Sign.
Level	**Type**[2)]	**<1,250**	**1,250 ≤ 2,500**	**≥ 2,500**		
1	L	11	50	12	0.82	ns [3)]
1	F	4	15	6		
1	V	6	24	6		
Total		21	89	24		
0		3	12	4	3.85	ns
1		21	89	24		
2		3	25	8		
3		2	4	5		
Total [)]		29	130	41		

1) Data from baseline survey, 2005, 200 farmers total

2) L=livestock, F=fruit, V=vegetables

3) ns = non significant as determined by χ^2 test

Larger farm pond volume was associated with higher agricultural revenue across intervention and control *tambons* as shown in Table 21. Nearly half (48%) of the farms with less than 1,250 cubic meters of pond volume were in the lowest revenue category of less than 50,000 baht (U.S. $1,200). In contrast, only 29% and 30% , respectively, of farms with pond volumes of 1,250-2,500 or greater than 2,500 cubic meters were in the lowest revenue category. Nearly half (46%) of the farms with pond volumes of 1,250 – 2,500 cubic meters gained agricultural revenue in the medium and high categories. Nearly half (48%) of the farms with the largest with pond volumes of more than 2,500 cubic meters had revenues in the highest category, over 150,000 baht (U.S. $3,500) as shown in Table 22.

Table 22 Relationship between pond volume and farm income categories in intervention and control *tambons*

Income categories		Pond volume (m^3)				χ^2	Sign.
Level	**Type**	**≤1,250**	**1,250 - 2,500**	**≥2,500**	**All**		
Low	≤ 50,000	20	58	8	86		
Med.	50,000 - <100,000	7	37	3	47	20.06	** [2)]
High	100,000 - <150,000	12	23	13	48		
Very high	≥150,000	3	13	3	19		
Total		**42**	**131**	**27**	**200**		

[1)]Data from baseline survey, 2005, 100 farmers / *tambon* type, 200 farmers total

[2)]** = significant at 0.01 as determined by χ^2 test.

1.1.1.3 Changes in revenue and pond number with increasing diversification

Figures 40 and 41 show that both total and agricultural revenue increased as diversification level increased. Total revenue increased by 25,000 baht (US$615) for each unit of increase in diversification level from a base total revenue with no diversification of approximately 66,000 baht (US$1,632). Integrated farms with a diversification level of 3 had more than twice the total revenue of farms without diversification. Agricultural revenue increased more rapidly as diversification levels rose to 2 and 3. Addition of only one diversification activity had less effect. Increasing the level of diversification is an importance means for farmers to gain high agricultural revenue. This result can be presented to other farmers who have farm ponds as a reason to adapt and use technologies for new diversification activities.

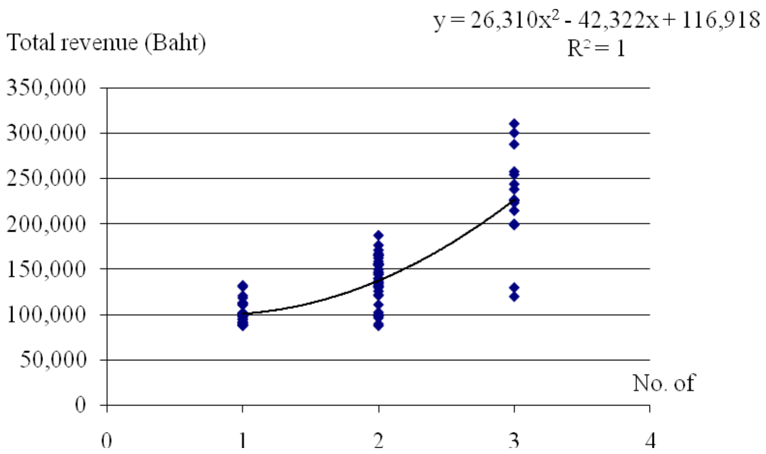

Figure 40 Change in total revenue with increasing levels of diversification

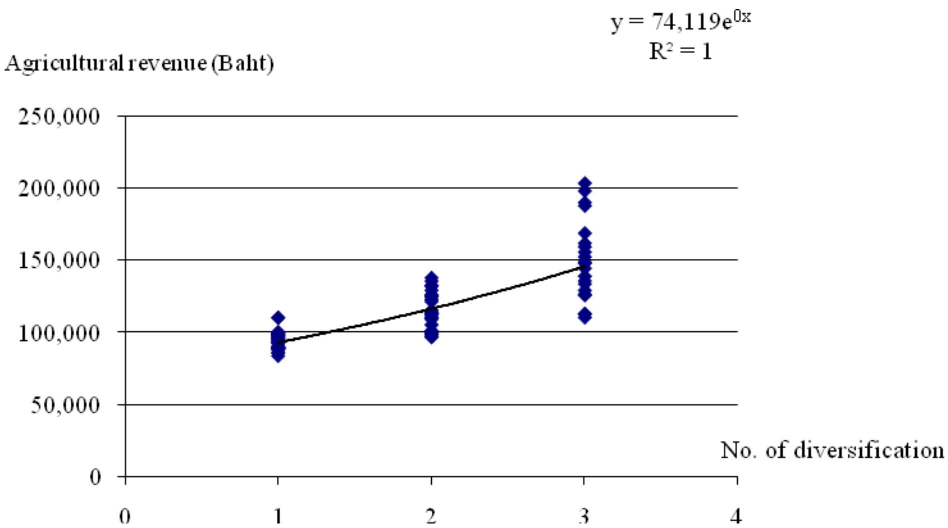

Figure 41 Change in agricultural revenue with increasing levels of diversification

1.1.2 Conclusion

This paper has examined the factors affecting diversification among *amphoes* before promoting scaling out of farmer-to-farm learning and innovation process, based on a rapid census survey of levels and types of diversification on 2,308 farms, followed by a more detailed baseline survey of factors affecting diversification in a sample of 200 farms in eight *tambons* in four *amphoes* of the southern Khon Kaen, Northeast

Thailand. Diversification as used here refers to livestock, fruit, and vegetable production, carried out in addition to base agricultural activities of rice, sugar cane, and cassava production. First, it was found that farm household size, land area, pond number and volume, and diversification level were similar across the four districts and eight *tambons*. This area can be considered as a largely homogeneous geographical unit for scaling out of technology options for diversification based on pond water use. Overall, slightly more farms have ponds than do not, although there are some differences among *tambons* in the relative proportions of farms with and without ponds. Second, farms with ponds had higher levels of diversification than farms without ponds. Third, farms with a greater number of farm ponds had a higher level of diversification, and greater pond volume was associated with higher revenue. These two results considered together suggest that having at least one pond is essential to increase **types** of diversification, but that with larger pond volume, farms tend to expand the **scale** of an initial diversification activity rather than increase the number of diversification activities. Fourth, farm with a greater number of farm ponds had a higher level of diversification, and earned higher agricultural revenue as diversification level increased from 1 to 2 and 3 activities had similar level of diversification. These findings suggest that in *amphoes, tambons* and villages with similar topography, soil and cropping systems, diversification can be an important means for farm to increase agricultural revenue, and thereby reduce dependence on the base crops of sugar cane and cassava as sources of agricultural revenue. These finding will serve as a basis for assessing the effectiveness and impact on farm revenue and income of a new approach to increase for farm with farm ponds which may not now have diversification activities.

The next activity will show the assessment of the impact of a farmer-to-farmer learning and innovation process. The learning process and assessment activities on technology adaptation will also be presented such as reasons for adaptation and diversification after adaptation.

1.2 Assessment of the impact of a farmer-to-farmer learning and innovation scaling out process on technology adaptation, farm income and diversification in Northeast Thailand

The previous result presented assessment of homogeneity of village and the relationship of farm pond and diversification and farm income. This result begins with the results of assessment on adaptation of introduced technology through FFLP, reasons of adapting technology income from adaptation and diversification after adaptation.

1.2.1 Introduction

Since the Green Revolution began in Thailand in 1960, monocropping, chemical fertilizer and pesticide have been promoted to increase production and maximize farmers' incomes (Nakwiboonwong 2003). Extension in this period was based on transfer of standardized technology through communication of information from research stations by extension agents. These approaches were more successful in areas with irrigation systems and good input access. However, they are less effective in rainfed areas and less effective for non-chemical approaches which require that farmers make location- and time period specific decisions. Agriculture in Northeast Thailand could not adopt Green Revolution technology fully because rice is grown under rainfed conditions. A mixed system of rice (R) in lowlands and cassava (C) and sugarcane (S) in highlands has evolved. However, cassava and sugarcane are subject to market price fluctuations. Today, farmers seek to diversify agricultural income sources in response to new market opportunities resulting from urbanization and food pattern changes. Consumers are demanding less chemical input in food products and are willing to pay a price differential for organic or biological agricultural products (2003). Nevertheless, agricultural extension in rainfed areas in Thailand has largely continued to apply the conventional method from the Green Revolution period.

Diversification activities include fruit (F), especially custard apple, vegetables (V) and livestock (L), primarily beef cattle. To develop methods more appropriate to diversified systems, using biological management based on farmer decision-making, more participatory extension approaches need to be developed. Farmer-to-farmer learning in extension is the provision of training by farmers to farmers, often through the creation of a structure of farmer-promoters and farmer-trainers (Scarborough 1997).

Other kinds of farmer-to-farmer learning include Farmers Field School (FFS), local agricultural committees (CIALs) and farmer-to-farmer learning centers (Sinja et al. 2004). These approaches have been typically implemented on a village basis.

1.2.2 Objective and hypothesis

In this study, we chose to develop a farmer-to-farmer learning process (FFLP) to provide a new tool for small-scale farmers in the developing world to allow them to gain insight into the performance of their management of agriculture and to learn by comparing their performance with that of colleague farmers (Sinja et al. 2004). A FFLP should have the following characteristics: (1) FFLP motivates farmers to experiment with new technology on a small scale; (2) FFLP uses technologies that rely on inexpensive and locally available resources; (3) FFLP begins with a limited number of technologies to retain focus and (4) FFLP trains villagers as extensionists and supports them in teaching other farmers. FFLP is a pathway for farmers to communicate and exchange information on their experiences from experiments on-farm. We sought to expand the FFLP method from a village-based approach to a regional-based approach. FFLP is necessary for scaling out introduced technologies from the original research village because research and extension structures do not have the resources to implement intensive on farm participatory research begun in a pilot village to all similar villages in a region.

This article reports on the development of methods for farmer-to-farmer learning and innovation across districts as an approach to scaling out of the farmer experiment group approach. Scaling out here refers to a pathway of technology development applicable across similar size units making up a larger unit at higher scale. In the research area of southeastern Khon Kaen Province in Thailand, the scaling out was from one selected village in one *tambon* to selected villages in four *tambons* in four *amphoes*, moving scaling up from the *tambon* level to a sub-region of a province. Farmers in the project area with farm ponds were exposed to four new technologies and adapted them to conditions on their farms through the farmer-to-farmer process introduced in this research. Some farmers also created technology innovations which were appropriate to their farm activities. We then assessed the impact of these methods of participatory technology development on productivity, income and number of diversification activities.

We compared farms with and without involvement with FFLP over two years of implementation of the farmer-to-farmer learning and innovation process. Our hypothesis is that farmers' adaptation of new technologies through the use of this regionally based FFLP will increase farm income and diversification.

To evaluate this hypothesis, we explain the process of FFLP and how it was implemented, and we present the results of assessment interviews with 100 farmers in four villages in four *amphoes* located in Khon Kaen Province.

1.2.3 Results and discussion

1.2.3.1 Adaptation of four technologies through FFLP

Farmers received information on the four technologies from several different sources. Technology information flow between farmers through FFLP was more important than information flow from outsiders such as extension workers or NGO professionals. This may be because farmers could disseminate technologies and innovations better than extension agents since they had an in-depth knowledge of their local crops, animals, technologies and practices as well as other farmers as individuals, thereby enabling them to communicate effectively with other farmers. They were also almost permanently available in the villages.

Several venues were observed in farmer-to-farmer communication during the course of FFLP implementation. Farmers, who had adapted, implemented and innovated on their own farms and who were willing to spend time to share in-depth knowledge and experiences with other farmers play a key role in FFLP. Kinship was also a factor. Market access and visits by merchants were a third venue for farmer-to-farmer communication about new technologies. Figure 42 shows that FFLP was the most important source of information for all the four technologies. The percentages of farmers obtaining information from FFLP were highest for liquid organic fertilizer and herbal repellent extraction. The number of farmers who adapted technologies increased from 2006 to 2007 after they participated the FFLP.

Figure 43 shows the number of farmers who implemented custard apple management technology increased the most, 156 per cent, from 2006 to 2007. Farmers indicated that their farms were suitable for growing custard apple. They also had experiences with cultivation of other fruits, especially mango, which they applied in custard apple cultivation. Farmers expected that custard apple would provide them high income. In 2007, farmers who adapted liquid organic fertilizer technology increased by 116 per cent and herbal repellent increased by 111 per cent, relative to 2006. Farmers who adapted cassava-based animal feed were fewer in number, but they also increased by 39 per cent compared to 2006. However, Chi-square analysis indicated that the probability of a totaly difference between 2006 and 2007 was 0.328. The apparent difference between two years in farmers adapting the four technologies could not be detected statistically.

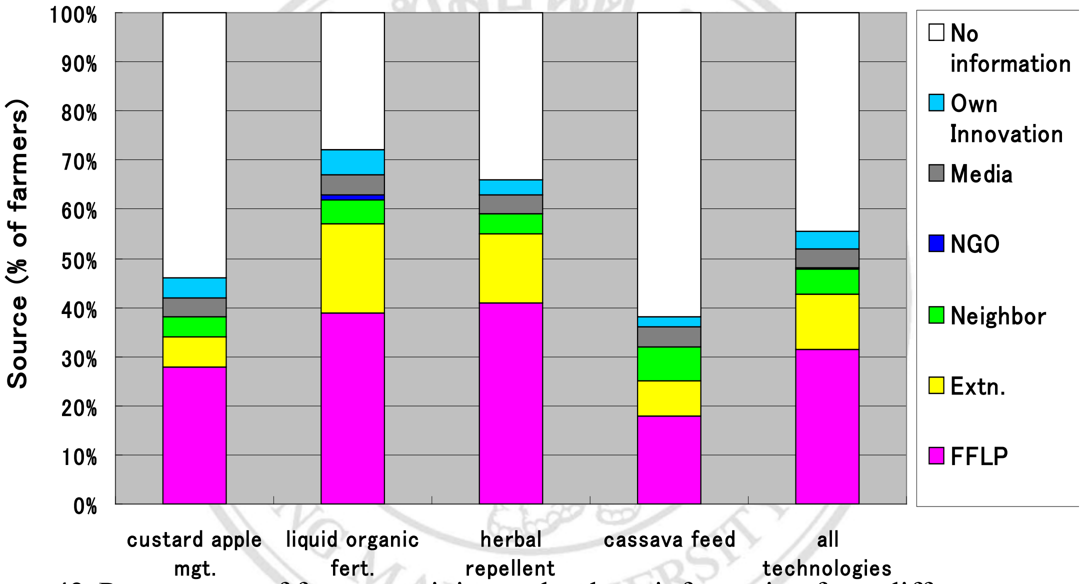

Figure 42 Percentages of farmers gaining technology information from different sources

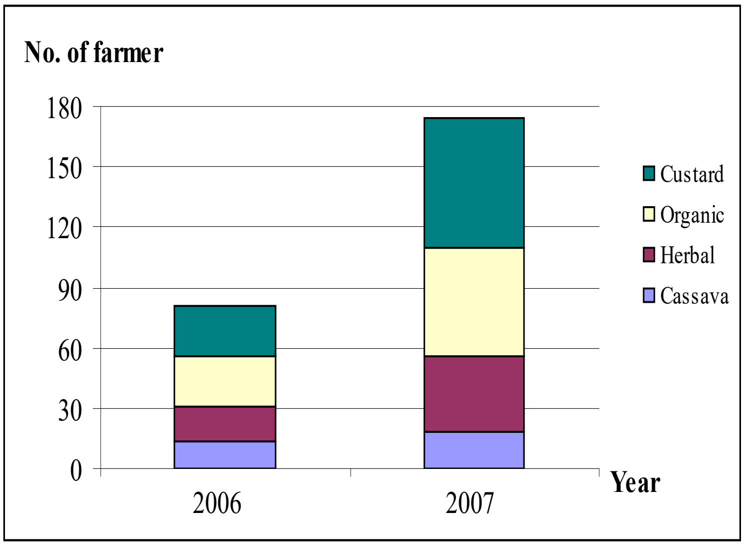

Figure 43 The number of adapted technology farmers in 2006-2007

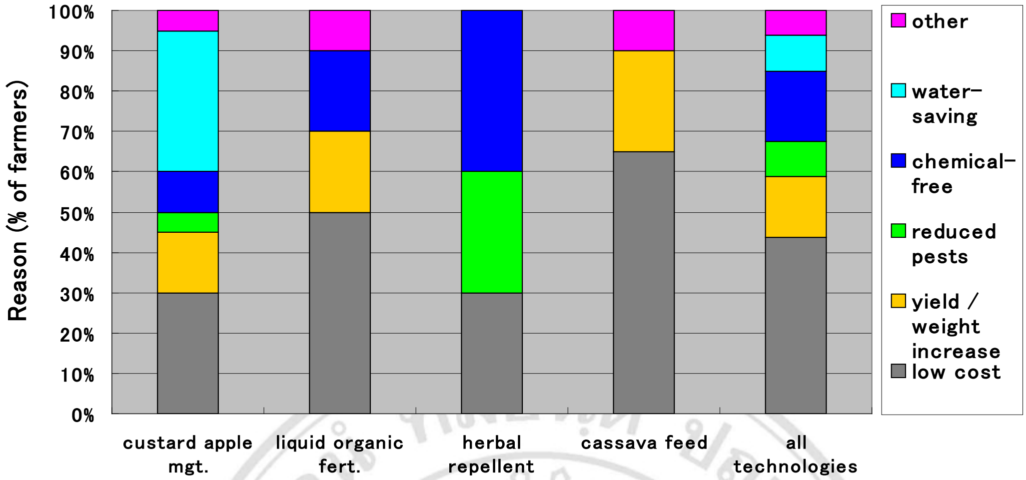

Figure 44 Reasons of farmers for adapting four introduced technologies

Figure 44 shows the reasons for adaptation were different for each technology. Overall, the most important reasons were reduced cost, increased yield and chemical-free products.

For custard apple pruning and cultivation technology, the most important reasons were saving water, reducing costs and increasing yield. Farmers indicated that they cultivated intercrops such as tomato, upland rice and chilli with custard apple. With intercropping, farmers did not need to water custard apple. It absorbed water given to the intercrops in the first year. After one year, custard apple could grow well with rainfall only.

The principal reasons of farmers to adapt the liquid organic fertilizer and cassava-based animal feed were to reduce costs in both cases, as well to increase farm yield with liquid organic fertilizer. Farmers also indicated that they produced liquid organic fertilizer by using local material. Farmers pointed that the price of chemical fertilizer increased by 92 per cent from 2005 to 2007. Liquid fertilizer was applied to rice, vegetables and fruit trees.

Another important reason was to produce chemical-free farm products. This was also the most important reason for farmers who adapted herbal repellent. The differences among the technologies in three categories of reasons for adapting each one were significant as shown in Table 23.

Table 23 Reasons of farmers adapting technologies

Reason category	Custard apple	Liquid organic fertilizer	Herbal repellent	Cassava feed
Economic benefit	10	13	6	20
Organic management techniques	2	3	10	0
Water-serving, other	15	8	0	2
Chi-square		47.62		
Probability		0.00**		

FFLP played a significant role in stimulating farmers to adapt the four technologies in the scaling-out villages. Farmers also translated technologies in ways that other farmers could appreciate and use. Farmers carried out these adaptations in the new villages, enabling other farmers to observe their results easily. Table 24 shows that the number of farmers adapting technologies increased from 16 to 36 farms in 2006 and then to 83 farms or 83 per cent of the sample in 2007.

Table 24 Number of adapting farmers in FFLP

No. of farmers	2006	2007
Participated in workshop in original village	16	–
Participated in workshop in four new villages	85	–
Obtained knowledge from workshop and field visits on four technologies	85	85
Adapted technologies	52	83
Increase in farmer number from FFLP	36[1]	31[2]

[1] No. of farmers who adapted one or more of the four technologies in 2006 and no. of farmers who participated in the workshop in the original village in 2006

[2] No. of farmers who adapted technologies in 2007 and no. of farmers who adapted technologies in 2006

1.2.3 Income from agricultural production of adapting and non-adapting farmers

Farmers have traditionally gained income primarily from sugarcane and cassava. Figure 45 shows that adapting farmers gained higher income than non-adapting farmers. Income of farmers using the four FFLP technologies increased by 33 per cent in 2007, whereas income of non-adapting farmers increased by 10 per cent from 2006 to 2007. Farm incomes of adapting farmers in 2006 and 2007 were higher than non-adapting farmers by 99 and 141 per cent, respectively. Income from sugarcane and cassava is not shown since adapted technologies were not involved.

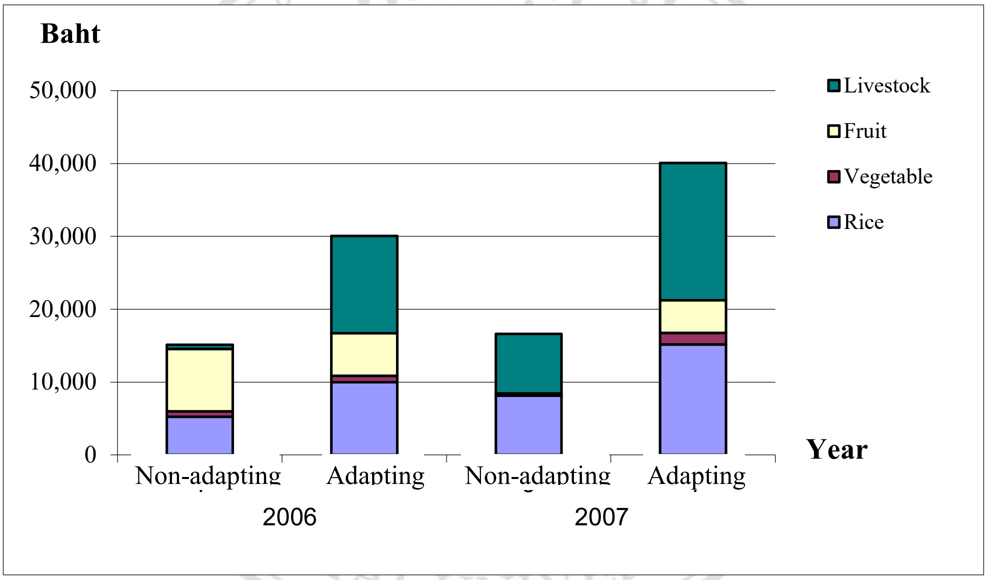

Figure 45 Farm incomes from activities using four technologies of adapting and non - adapting farmers

Figure 46 shows that farmers who adapted one or more of the four technologies gained higher income than non-adapting farmers. Adapting farmers indicated that the technologies introduced through FFLP enabled them to increase yields and reduced costs, especially with cassava-based animal feed and herbal repellent. Many farmers also grew intercrops between custard apple, including upland rice, tomato and chilli. This integrated activity enabled them to use land and water more effectively and thereby gain more yield and income. Farmers who adapted cassava-based animal feed technology generated higher income since they could raise the cattle in less time.

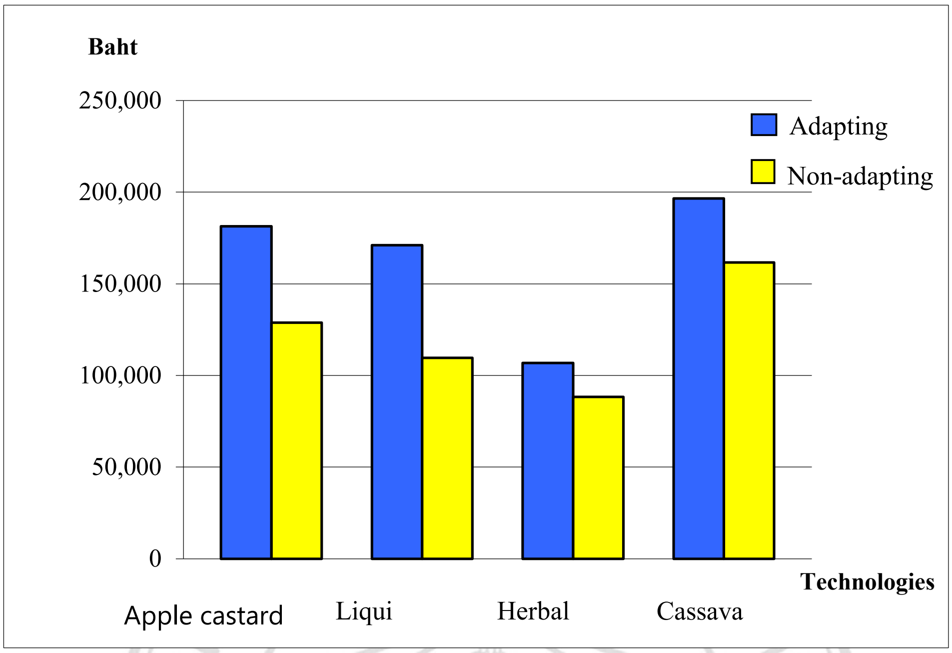

Figure 46 Incomes between adapting and non adapting technologies farmers in 2007

Overall, income increased by 41 and 56 per cent with the use of the improved custard apple management practices and liquid herbal fertilizer, with 80 per cent of the farmers showing increases in both cases. The increase was significant for liquid fertilizer but these increases were not significant for custard apple, cassava and herbal extraction technologies (Table 25 and 26). The reasons for the lack of increase in the other 20 per cent of farmers need to be determined. Income of 70 per cent of the farmers increased with cassava-based animal feed, but the average increase was negative (Table 9). Difference among these farmers also needs to be examined.

Table 25 Income of farmers adapting and not adapting custard apple management and liquid fertilizer technology

No. of Farmers	Custard apple management		Liquid fertilizer	
	Non-adapting	Adapting	Non-adapting	Adapting
1	200,000	302,360	56,400	44,690
2	45,420	93,806	145,080	300,000
3	225,900	170,000	166,450	172,300
4	85,000	115,920	90,300	225,000
5	223,050	253,570	262,820	284,500
6	495,000	566,650	50,000	111,080
7	127,340	112,730	87,810	83,600
8	65,200	109,136	81,500	135,580
9	94,200	75,000	120,800	197,500
10	91,500	165,800	34,080	155,800
Average	161,661a*	196,497a*	109,524a*	171,005a*
Probability of difference	0.068		0.01*	

a* Columns with the same letters are not significantly different according to Student's t-test at the probability of 5 per cent ($p > 0.05$)

Table 26 Income of farmers adapting and not adapting herbal extraction and cassava-based animal feed technology

No. of Farmer	Herbal repellent extraction		Cassava-based animal feed	
	Non-adapting	**Adapting**	**Non-adapting**	**Adapting**
1	75,500	127,900	56,400	44,690
2	143,150	82,040	145,080	300,000
3	127,357	221,800	166,450	172,300
4	21,000	108,600	90,300	225,000
5	107,400	57,936	262,820	284,500
6	55,090	90,070	50,000	111,080
7	65,000	55,600	87,810	83,600
8	114,030	30,000	81,500	135,580
9	47,000	150,900	120,800	197,500
10	126,888	142,500	34,080	155,800
Average	88,241a*	106,734a*	128,831a*	111,431a*
Probability of difference	0.412		0.259	

a* Columns with the same letters are not significantly different according to Student's t-test at the probability of 5 per cent (p > 0.05)

The four technologies were used primarily for fruit, livestock, vegetables and rice. The farm incomes shown are from activities that used or could have used these technologies, and do not include sugarcane and cassava. Figure 47 shows that those farmers who adapted herbal extraction technology earned higher income than farmers who adapted one of the other three technologies. Overall, the largest components of farm income were rice and livestock. Farmers applied herbal extraction for repelling insects in rice paddy fields and animal barns.

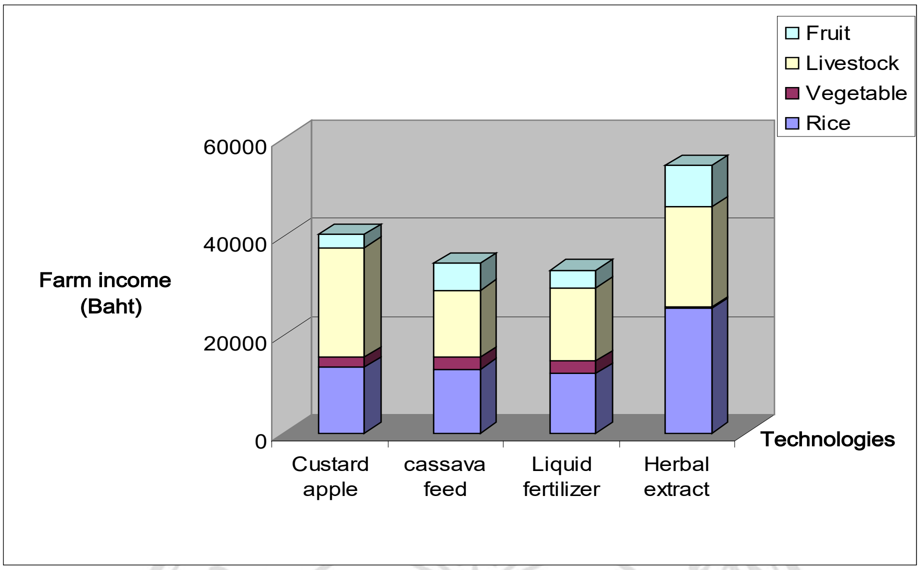

Figure 47 Farm incomes from four agricultural activities of farmers adapting introduced technologies in 2007

1.2.3.3 Diversification after adaptation of the four technologies

After farmers participated in FFLP, their activities on farms were modified with a trend towards more diversification. Figure 48 shows that the number of farmers with two diversification activities increased by 71 per cent from 2005 to 2006, but then decreased in 2007 by 12 per cent. The number of farmers with three diversification activities increased by 350 per cent from 2005 to 2006 and increased by 850 per cent from 2005 to 2007. In contrast, the number of farmers who had one diversification activity (V, L or F) increased by 22 per cent from 2005 to 2006 and decreased by 55 per cent from 2006 to 2007.

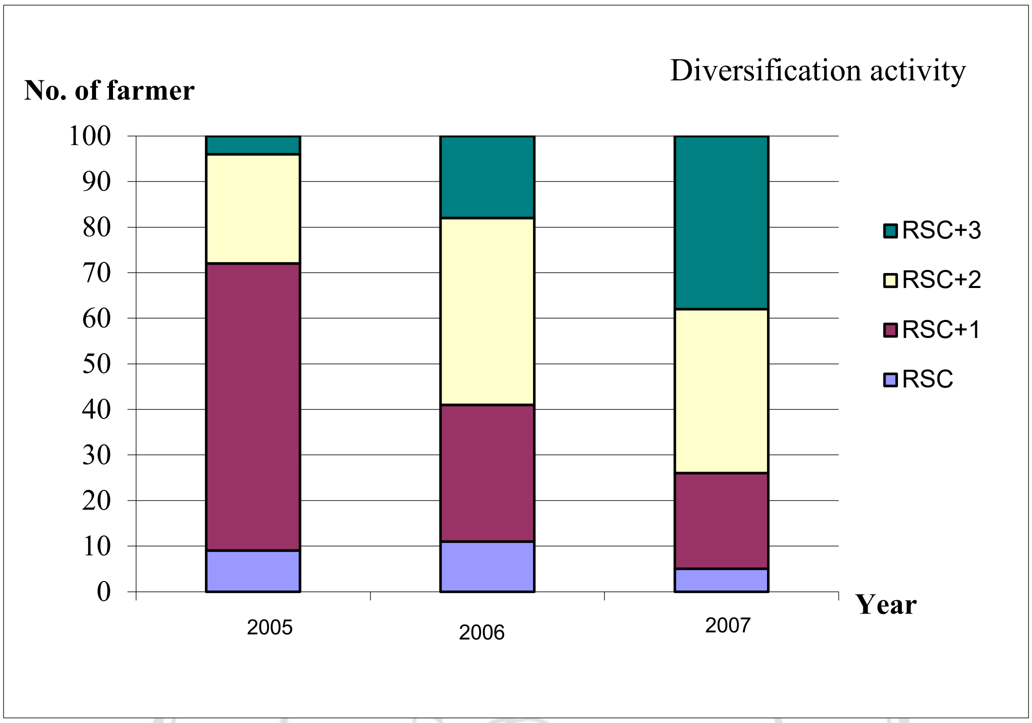

Figure 48 Comparison of the number of farmers at four levels of numbers of diversification activities between 2005-2007

These results suggest that FFLP provided new opportunities for farmers to learn from each other, adapt and innovate the new technologies to increase diversification on their own farms. Overall, the number of farmers with more diversification activities increased, while the number of farmers with fewer diversification activities decreased. Farmers indicated that they were more confident in implementing diversification based on adaptation of new technologies. Farmers in each village followed and learned from other farmers who succeeded in gaining high yield and increased incomes. Farmers had the opportunity to work together in the village in groups which enabled them to learn about successful result of adapting technologies.

Table 27-29 show the patterns of diversification for farmers with base activities or only one activity. Table 27 shows that 67 per cent of farmers who had only base agricultural activities in 2005 implemented diversification activities in four patterns in 2006. Tables 28 and 29 show that the majority of farmers with only one diversification activity, fruit or livestock, retained that activity in 2006. Table 28 shows that nearly one-third of farmers with fruit production in 2005 added another activity (livestock or vegetable) or change to these two activities in 2006.

Table 27 Patterns of diversification changing from base agriculture activity to other levels of number of diversification activities

2005 diversification and no. of farmers	2006 diversification[1]	No. of farmers	Level[2]	Per cent of farmers
R + S + C	R + S + C	3	0	33
(9)	R + S + C + V	1	1	67
	R + S + C + F	2	1	
	R + S + C + L	1	1	
	R + S + C + L + F	2	2	
One type	Five types	9	0.9	100

[1] R, rice; S, sugarcane; C, cassava; V, vegetable; F, fruit; L, livestock

[2] Level 0 means base agricultural activity; level 1 means base agricultural activity plus one diversification activity; level 2 means base agricultural activity plus two diversification activities

Table 28 Patterns of diversification changing from base agriculture activity with fruit to other levels of number of diversification activities

2005 diversification and no. of farmers	2006 diversification[1]	No. of farmers	Level[2]	Per cent of farmers
R + S + C + F	R + S + C	3	0	14
(22)	R + S + C + F	12	1	54
	R + S + C + V + F	2	2	32
	R + S + C + V + L	2	2	
	R + S + C + L + F	3	2	
One type	Five types	22	0.2	100

[1] R, rice; S, sugarcane; C, cassava; V, vegetable; F, fruit; L, livestock

[2] Level 0 means base agricultural activity; level 1 means base agricultural activity plus one diversification activity; level 2 means base agricultural activity plus two diversification activities

Farmers who did not increase their number of diversification activities gave several reasons for this: labour problems (23 per cent), water shortage for natural fish raising (18 per cent) or age making it difficult to manage multiple activities (14 per cent).

Viewed together these tables suggest that it was easier to step up from the base agricultural activity to one diversification activity. Table 27 shows that average change of level was 0.9. In contrast, Tables 28 and 29 suggest that it was more difficult to move up to higher levels of diversification with two or three activities. The average change level in Tables 22 and 23 were 0.2 and 0.1, respectively. Table 29 also shows that the percentage of fruit (F) diversification farmers with two or three diversification activities increased by 32 per cent. In contrast, diversification farmers with livestock (L) who changed to two diversification activities increased less, only 14 per cent.

Table 29 Patterns of diversification changed from base agriculture activity with livestock to other levels of number of diversification activities

2005 diversification and no. of farmers	2006 diversification[1]	No. of farmers	Level[2]	Per cent of farmers
R + S + C + L	R + S + C	4	0	11
(35)	R+S+C+F	1	1	3
	R+S+C+L	23	1	66
	R+S+C+V+F	2	2	20
	R+S+C+V+L	1	2	
	R+S+C+L+F	2	2	
	R+S+C+V+F+L	2	3	
One type	Seven types	35	0.1	100

[1] R, rice; S, sugarcane; C, cassava; V, vegetable; F, fruit; L, livestock

[2] Level 0 means base agricultural activity; level 1 means base agricultural activity plus one diversification activity; level 2 means base agricultural activity plus two diversification activities; level 3 means base agriculture activity plus three diversification activities

The statistical test results in Table 30-32 indicate that the increases in levels of diversification based on two years of comparison were not significant, but if continued, this trend may result in significant increases in two or three years.

Table 30 Differences in levels of number of the diversification change in Table 26

Level of diversification	No. of farmer	
	2005	2006
Low (0–1)	9	7
High (2–3)	0	2
Chi-square	0.52	
Probability	0.47	

Table 31 Differences in levels of number of the diversification change in Table 26

Level of diversification	No. of farmer	
	2005	**2006**
Low (0–1)	22	15
High (2–3)	0	7
Chi-square	0.04	
Probability	0.84	

Table 32 Differences in levels of number of the diversification change in Table 27

Level of diversification	No. of farmer	
	2005	**2006**
Low (0–1)	35	27
High (2–3)	0	7
Chi-square	0.05	
Probability	0.83	

Figure 47 shows that farmers who adapted technologies had higher numbers of diversification activities than non-adapting farmers. Herbal repellent extraction and liquid fertilizer had the highest proportion of farmers, 75 and 55 per cent, respectively, who had implemented three diversification activities. Both technologies were used for various farm activities. Farmers used liquid fertilizer for vegetables, rice and fruit trees. Likewise, they applied herbal repellent extraction for repelling insects of vegetables, rice and fruit trees. Thus, these two technologies could be integrated with many farm activities. For custard apple management, the percentage of non-adapting farmers who implemented basic agricultural activities (R + S + C) was similar to the percentage of adapting farmers with three diversification activities. Farmers have indicated that custard apple has its own purpose, so it was difficult to integrate with other technologies and activities.

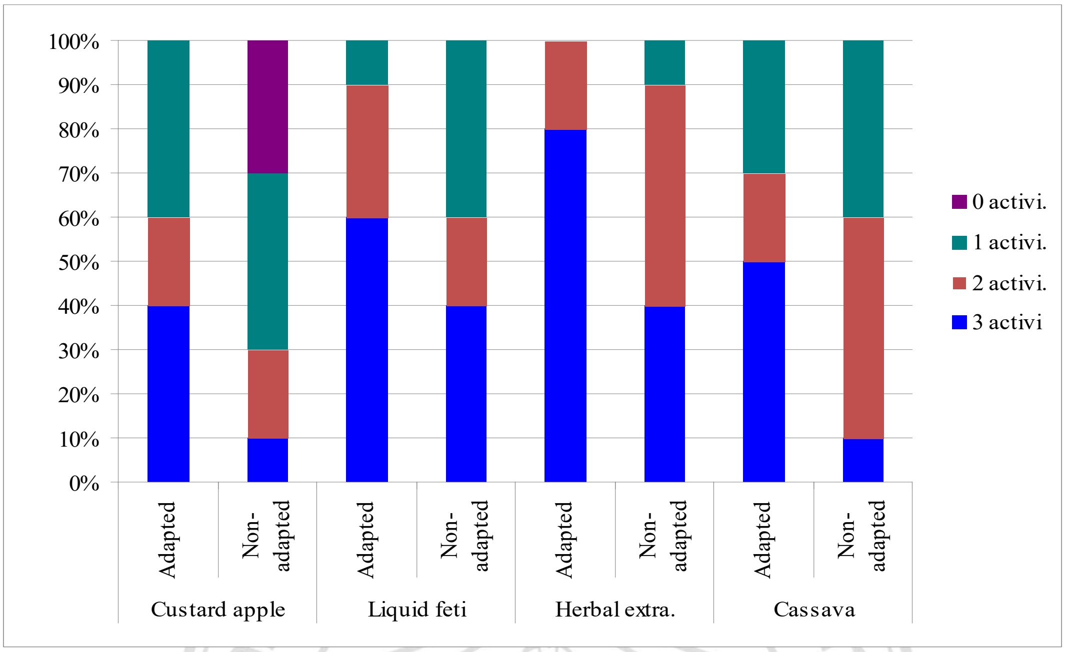

Figure 49 Adapting and non-adapting farmers with diversification in 2007

The results of statistical analyses in Table 33-36 indicate that the apparent differences between adapting and non-adapting farmers in changes of levels of diversification for the four technologies were not statistically significant, but if continued, these trends may result in significant increases in two or three years.

Table 33 Differences in levels of diversification between farmers adapting and not adapting custard apple technology in 2007

Diversify	Non-adapted	Adapted
0–1	7	4
2–3	3	6
Chi-square	1.82	
Probability	0.61	

Table 34 Differences in levels of diversification between farmers adapting and not adapting liquid fertilizer technology in 2007

Diversify	Non-adapted	Adapted
0–1	4	1
2–3	6	9
Chi-square	2.40	
Probability	0.49	

Table 35 Differences in levels of diversification between farmers adapting and not adapting herbal extraction in 2007

Diversify	Non-adapted	Adapted
0–1	1	0
2–3	9	10
Chi-square	1.05	
Probability	0.79	

Table 36 Differences in levels of diversification between farmers adapting and not adapting cassava technology in 2007

Diversify	Non-adapted	Adapted
0–1	4	3
2–3	6	7
Chi-square	0.22	
Probability	0.97	

1.2.4 Conclusion

This research has shown that FFLP had impact on information flows, adaptation of technology, incomes and level of diversification. FFLP was the main information flow in and outside the village. Within two years, 83 per cent of farmers adapted one or more of four introduced technologies through FFLP: custard apple pruning and cultivation, liquid organic fertilizer, herbal repellent extraction and cassava-based animal feed. In 2006, farmers had just began adapting technologies, so some technologies did not provide them with much benefits in the first year, especially custard apple. The technologies had more impact in the second year of adaptation. Custard apple started to produce the fruit in the second year. Farmers also produced custard apple seedlings to sell to other farmers in 2007. This resulted from needs identified in the first and second years. Farmers generated technologies on farms to solve problems with the adapted technologies in their original farms. Farmers fed cattle with both hay and silage from cassava. Hay was easy to make and convenient for feeding cattle. Some farmers dried the cassava leaves on farm field after harvesting two to three days, and then they allowed the cattle to feed. During this research, we also found new issues that should be assessed in a future study, including comparison of adapting and non-adapting farmers for each adapted technology, and the effects on both trees and annual crops with intercropping using adapted technologies.

The next chapter will present the assessment of four technologies in which introduced through FFLP extension system. The chapter will focus on 100 FFLP farmers in intervention *tambons*, 82 FFLP farmers will be assessed the effect on income, economic status and contribution of FFLP including diversification agricultural activities.

Activity 2

2.1 The characteristic and Mechanize of FFLP Technologies on Cost and Income of research

2.1.1 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).

2.1.2 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 research 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. 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 aim of this sup topic is to show economic change resulting from FFLP technologies 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.

2.1.3 Results and discussion

2.1.3.1 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:

1) Liquid organic fertilizer use for plant growth

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

2) Herbal Bio Repellent Extraction use for insect expelling

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 farmer extract the liquid and dilute with water, then, spray directly into the crop. The insect will be away from the plot of plant. 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 make the insect rebelling substance by using their indigenous knowledge combining with appropriate technology.
2) To promote farmers use the local raw materials from farms for reducing the farm cost.
3) To promote the chemical 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

3) 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 177plats x 3.5 baht	620	baht
Total	1,601	baht

4) 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 1310.000 baht / 1,000 kilograms of cassava silage

Average 1.310 baht / 1 kilogram of cassava silage

2.1.3.2 Mechanism of technology adaptation and effect 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 37-40 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 37-40 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 39 also shows that adapting farmers reduced cost and gained high revenue after applying FFLP technology. Table 40 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 37 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 38 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 39 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 40 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

2.1.3.2 Income increase after generating diversification and adapting technologies through FFLP

Table 41-46 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 41 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 42 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 technolog y/ 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 43 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 44 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 45 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 46 Effect of cassava feed technology on production and farm revenue

Organic fertilizer	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 49. 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.

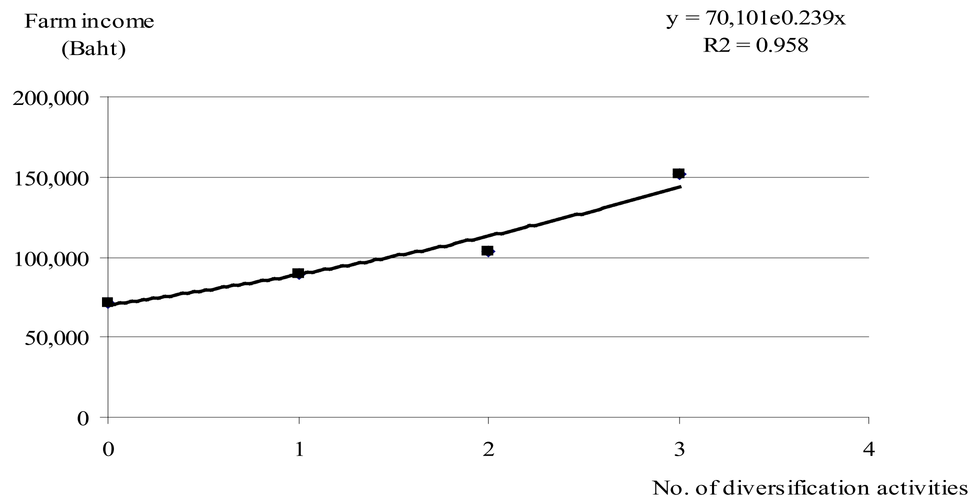

Figure 50 Effect of number of diversification activities on farm income.

2.1.4 Conclusion

This research presents the results there years long research project of a farmer-to-farmer learning process (FFLP) for scaling out from on original village when farmer-participatory technology development research was initiated. The aim of this research is to show FFLP technology characteristic, cost of each technology and effect of four technologies on production and farmer income.

The research reveled the FFLP four technologies characteristics: 1) liguid organic fertilized (OI) and pruning (CA) and 4) cassava-based animal feed (F). The cost of each FFLP technology has been calculated. The solution of CF costed 3.75 bath/liter, while the cost of CA was 1,601 baht/rai. Regarding CP in terms of cassava leaf ensilage costed 1.89 baht/kilogram, while cassava root ensilage costed 1.31 baht/kilogram. Moreover, HE costed 1.006 baht/liter of solution.

The effects and income of FFLP technology were investigated by comparing the mechanism that farmers had operate before joining FFLP. These showed that cost and revenve change such as : +539 bath/rai (CA), + 7,400 baht/5rai (OF), +7,040 baht/rai (HE) and +2.99baht82 cows.

The stud, furthermore, found that the diversification activities were supplementary income for adapting farmer. Farmers gained income from implementing more diversification activities on farm income. As diversification level increased, the effect on income was greater than additive. This implied that there may be synergy gained from multiple diversification activities.

2.2 Assessment of the effect of four technologies introduced by FFLP on the income productivity of land

The previous result pointed out on results of assessment on adaptation of introduced technology through FFLP which focusing on reasons of adapting technology, income from adaptation and diversification after adaptation. This point begins with assessment of effect from four FFLP technologies on farm income and diversification including the contribution of FFLP technology income with total income.

2.2.1 Introduction

Both 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).

2.2.2 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 aim of this paper is to 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.

2.2.3 Results and discussion

2.2.3.1 FFLP flow process of four introduced technologies

Table 47 shows that in 2006, sixteen farmer representatives from four districts participated in the initial workshop and visited farms in the original village- the Nong Saeng village. Then, they went back to their villages and began to implement these technologies on farms. The technologies implemented include custard apple management, liquid organic fertilizer, herbal repellent extraction and cassava for animal feed. The aim of farmers was to see if these technologies would be appropriate for application on their farms. Table 30 also shows there were many farmers who visited the adapting farmers to learn and exchange knowledge on custard apple cultivation and cutting, liquid organic fertilizer, herbal repellent extraction and cassava-based animal feed. The majority of farmers who visited the trial adapted the technologies-except for the cassava-based animal feed-to their own situations. The percentage of adapting farmers who learnt from their neighbors was highest for custard apple and organic fertilizer. Furthermore, the number of adapting farmers is shown to have increased after the first year when they participated in the workshop held in initial village. Table 31, furthermore, indicates the percentages of adaptation cases increasing for custard apple cultivation and cutting, liquid organic fertilizer, herbal repellent and cassava-based animal feed to 540%, 314 %, 245 % and 800 %, respectively. Thus, farmers, who were keen to get more knowledge and technologies related to farms, adapted these introduced technologies with the aim to improve their farm activities. In the event, FFLP proved to be effective as a strategy for the introduction and adaptation of technologies among farmers.

During 2006-2008, adapting farmers effectively applied at least one of the four technologies on their own farms. The study showed that the effects of each technology has different characteristics - only liquid organic fertilizer and herbal extraction had similar use when applied directly on plant leaves and on soil for soil quality improvement. In terms of cost to farmers with and without FFLP technology use, it can be seen that only custard apple management involved labour and tractor cost on account of pruning and cutting activities, including soil improvement. Without the technology, farmers would have low quality of fruit and low yield. The research also showed data relating to farmers who grew custard apple in 2006-2007, that yield was low because the fruit trees were not mature enough. Furthermore, liquid organic fertilizer technology was used for vegetable production. Farmers first applied liquid organic fertilizer directly on soil for soil quality improvement; then, they applied once per week by spraying on vegetable leaves. In contrast, some farmers applied chemical fertilizer up to two times per week which, however, raised the cost. Adapting farmers applied herbal extraction on paddy rice field to protect the insects instead of using pesticide. Both FFLP technologies - organic fertilizer and herbal extraction - not only helped farmers to increase yield and reduce costs, but also enabled farmers to implement environmentally friendly farm activities. The research result also demonstrates that the cost of cow raising reduced after farmers adapted cassava-based animal feed technology. Even though, the price of cattle in 2008 decreased by approximately 25 percent, adapting farmers still gained high income. Moreover, adapting FFLP technology improved the quality of beef.

Table 47 FFLP Flow process for scaling out our introduced technologies and number of adapting farmers

Workshop			**Custard apple**	**Organic fertilizer**	**Herbal extraction**	**Cassava feed**
FFLP (2006)	Participation	yes	16 [1]	16 [1]	16 [1]	16 [1]
		no	0	0	0	0
	Planted/cutting	yes	10 [2]	14 [2]	11 [2]	2 [2]
		no	6	2	5	14
F-to- F (2007)	Neighbor	yes	73 [3]	76 [3]	58 [3]	43 [3]
		no	27	24	42	57
	Adapting	yes	53 [4]	59 [4]	33 [4]	11 [4]
		no	20	17	25	32
FFLP (2008)	Neighbor	yes	16 [5]	10 [5]	12 [5]	14 [5]
		no	4	7	13	18
	Adapting	yes	64 [6]	58 [6]	38 [6]	18 [6]
		no	4	11	8	11
	All adapting	yes	64	58	38	18
	All non- adapting	no	36	42	62	82
	Total	-	100	100	100	100

[1] Number of farmers who attended the workshop at original village (Nong Saeng)

[2] Number of farmers who adapted technologies after visiting original village

[3] Number of farmers who visited and learnt from adapting farmers

[4] Number of adapting technology farmers and implemented on farms in 2007

[5] Number of farmers who visited neighboring farms in 2008

[6] Number of adapting technology farmers and implemented on farms in 2008

Moreover, the research found that the statistical test results of farm income with and without FFLP technologies was significant difference in farm income with FFLP technologies and without technology adaptation. Furthermore, farm income with FFLP technology was higher than without adaptation of the technology. Thus, the evidence obtained from the study lends support to the hypothesis that technology transferred through FFLP improves the income of the adapting farmers.

2.2.3.2 Income increase after generating diversification and adapting technologies through FFLP

The study, moreover, found that the diversification activities generated supplementary incomes for adapting farmers. Figure 50 shows high correlation between number of diversification activities and farm incomes. Farmers gained more income from implementing more diversification activities. As diversification level increased, the effect on income was greater than additive, implying synergy gained from multiple diversification activities.

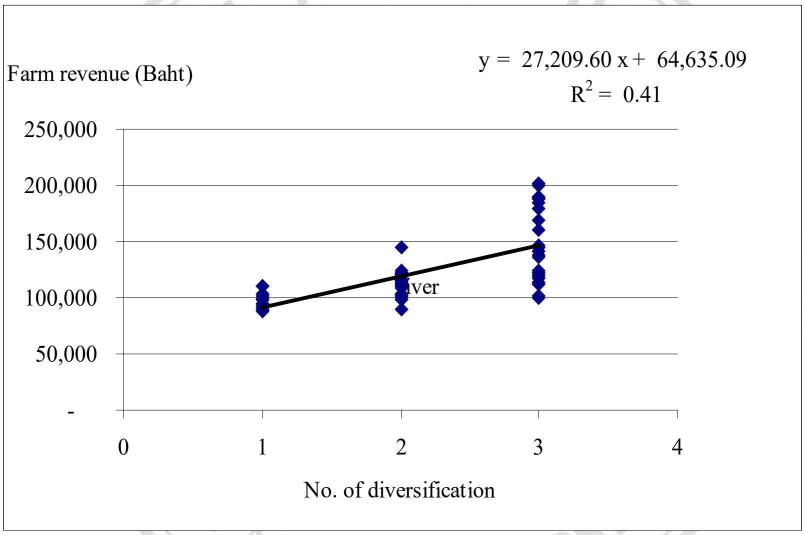

Figure 51 Regression between number of diversification activities and farm income

Furthermore, it is apparent from Table 37 that farm sizes and level of diversification have a direct influence on farm income. Farmers who had larger farm size and operated more diversification agricultural activities gained higher farm incomes than small farms and activities that are not diversified. Table 31 also shows adapting farmers gained higher income than non-adapting farmers at both farm size and diversification activities levels. Agricultural incomes for both adapting and non-adapting farmers were significantly different at every farm size and diversification level.

Farmers implemented the four technologies in different ways, depending on their purposes. Liquid organic fertilizer and herbal repellent extraction were applied to many crops like rice, vegetable and fruit for various purposes. On the other hand, two technologies - custard apple cultivation and cutting and cassava for animal feed - were used for specific purposes only. Our observations confirm high farm incomes to be associated with increased number of diversifications activities. Similarly, farmers who adapted more technologies earned more income as shown in Figure 49. This figure also suggests the farm income gains to have resulted from the synergy obtained from the technologies introduced.

There were however not FFLP farmers who applied integrated technologies on their farms. Farmers gave various reasons: for instance, some technologies were not suitable on farms-i.e. they did not have cutting machine for making cassava–based animal feed; some farmers did not have enough budget to buy new custard apple seedling; other farmers applied herbal extraction technologies on small farm areas and small number of units since they still needed to test the technologies on farms. Regarding herbal extraction, farmers mentioned that they did not have boiling equipment to generate herbal extraction. Some farmers were not confident enough to apply organic fertilizers on paddy fields as they still believed that only chemical fertilizers provided the nutrient for rice. It is apparent from these farmer reactions that FFLP integrated technologies have yet to be seen by farmers to be appropriate before they could be applied on farms.

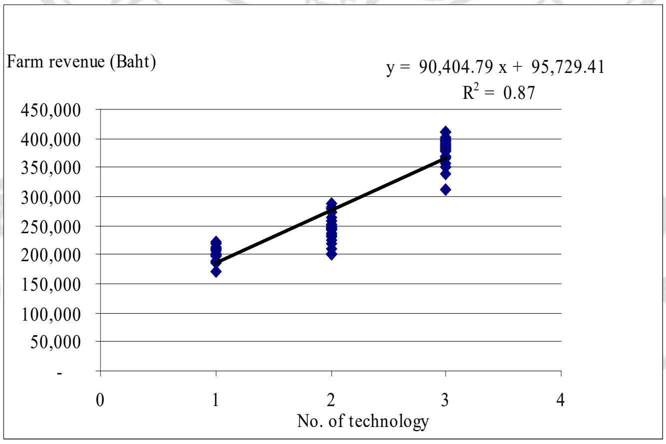

Figure 52 Regression between number of introduced technology and farm income

Table 48 Effect of farm size and diversification level on farm income between adapting and non adapting farmers in 2008

Farm size/ diversification level	Adapting farmers [1]	Non-adapting farmers [2]
Small (< 30 rai)	148,187a	83,104a
0	78,796	83,104
1	153,648	-
2-3	227,711	-
	0.01**	
Medium (31-60 rai)	321,899b	165,161b
0	185,084	165,161
1	302,035	-
2-3	429,873	-
	0.01**	
Large (> 60 rai)	405,020b	356,000
0	206,520	356,000
1	388,197	-
2-3	468,271	-
	Cannot to compare	
All farm size	257,363	116,996
0	117,917a	116,996
1	266,933b	-
2-3	353,744b	-
	0.01**	
Farm size	0.01**[3]	0.05*
Diversification	0.05* [4]	-

1) Data from interview, 2008, 85 farmers total.

2) Data from interview, 2008, 15 farmers total

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

4) Probability of differences between diversification level significant (*), P<0.05, as determined by Chi-square test

2.2.3.3 Economic status of FFLP farmers

As mentioned elsewhere above, the 16 FFLP farmers, who attended the workshop in the original village in Khon Kaen province, transferred the technological knowledge and experience they gained to others farmers in their respective villages. Table 49 shows that FFLP farmers gained higher incomes after they adapted and applied the technologies. The study also found that incomes from fruit, animal and vegetable production increased in 2008, with the highest percentage increase coming from vegetables. Vegetables accounted for the highest percentage increase in income. Table 38 also shows that the diversifications activities FLV (Fruit + Livestock + Vegetable) of FFLP farmers contributed 34.3 per cent to total farm income and basic crops to 65.7 per cent in 2008.

Table 49 Farm revenue between 2005 and 2008 of 16 FFLP farmers who participated Nong Saeng 2006 workshop (Baht)

Activities	2005 (before FFLP)	% contribution	2008 (FFLP)	% contribution	change in revenue	% change [1)]
Basic crop						
Rice	6,998.12	6.89	14,168.75	8.72	7,170.63	+ 102.46
Cassava	25,031.25	24.60	37,645..25	23.14	12,614.00	+50.39
Sugarcane	36,768.75	36.18	55, 031.25	33.84	18,262.50	+49.66
Sub-total	**68,798.12**	**67.67**	**106,845.25**	**65.70**	**38,047.13**	**+55.30**
Diverisi.						
Fruit	8,138.75	8.01	12,576.85	7.74	4,438.10	+54.53
Livestock	22,687.50	22.32	38,762.50	23.84	16,075.00	+ 70.85
Vegetable	2,025.00	2.00	4,437.50	2.72	2,412.50	+119.14
Sub-total	**32,851.25**	**32.33**	**55,776.85**	**34.30**	**22,925.60**	**+69.79**
Total	**101, 649.37**	**100.00**	**162,622.10**	**100.00**	**60,972.73**	**+ 59.98**

1) % change in 2005 to 2008

The study also demonstrated farm income of non-FFLP farmers who did not participate in the FFLP was slightly increased. With respect to income from diversification activities, income accruing to only vegetable production went up sharply. In contrast, income from fruit and livestock fell down slightly in 2008 from the 2005 level. This was because farmers still implemented old technologies which did not involve pruning for custard apple, nor the application of chemical fertilizer to vegetables and rice. Income from diversification activities contributed 25.4 percentages to total farm income, while income from basic crop accounted for 74.6 per cent in 2008. Thus, in 2008, the farm income from diversification activities was higher for the 16 FFLP farmers than it was for non- FFLP farmers.

The 16 FFLP Farmers who participated in the workshop in original village not only gained high farm income in 2008, they also incurred less cost to implement farm activities by using the FFLP technologies such as liquid organic fertilizer and herbal extraction on rice paddy fields and vegetable including custard apple, and cassava-based animal feed for raising cattle. Farmers managed custard apple by pruning. This produced good quality custard apple fruit which earned the FFLP farmers high price in the market. To improve quality and expand farm area under custard apple, farmers spent more on new seedling. The research result also presented the economic status of diversification activities for these 16 FFLP farmers contributed 33.8 per cent to farm income in 2008, while basic crop contributed to 66.2 percent. Figures 50 and 51 present comparison of farm revenue flows between FFLP and non-FFLP farmers during the period 2006 to 2008. FFLP farmers gained higher farm revenue than non-FFLP farmers during the three-year period. What is more, FFLP farmers, unlike non-FFLP farmers, are seen to have gained additional revenue as a result of adapting technologies. Similarly, FFLP farmers gained higher income from both diversification activities and basic crops than non-FFLP farmers.

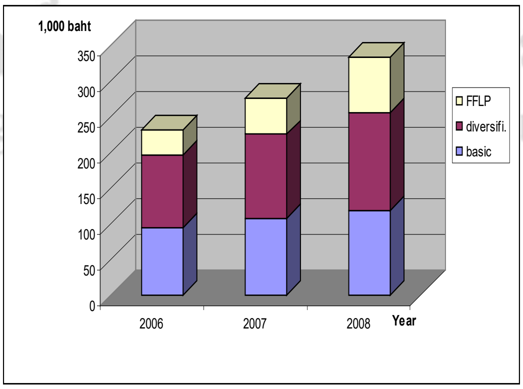

Figure 52 FFLP farm revenue in 2006 to 2008

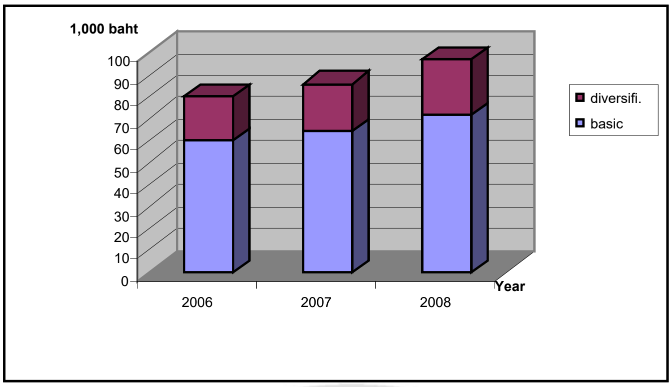

Figure 53 Non-FFLP farm revenue in 2006 to 2008

2.2.3.4 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 50, FFLP farmers gained lower income from custard apple than from the other three technologies: organic fertilizer, herbal extraction and cassava based animal feed. Table 50 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 50 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	% contribute1)
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**

Table 50 (CONTINUED)

Activity		Revenue	Cost	Net income	% contribute[1)]
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	**25**
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

Table 51 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)]	201,938b [2)]
	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	41,563b [2)]	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

Table 51 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.

2.2.4 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.

This research shows the effects of FFLP on various aspects. Next chapter will highlight on the conclusion and recommendations.

Activity 3

3.1 Application of the New Approach to a Wider Area : dissemination to Tambol Administration Organization (TAO)

3.1.1 Introduction

The research session will present how scaling out to new areas. This will start with discussing on an empirical framework for scaling out of FFLP, the target areas such as some districts in Khon Kaen province and four provinces surrounding Khon Kaen province: Nakornratchsima, Mahasarakam, Chaiyaphumi and Kalasin, have been selected. These new areas are similar to the research villages in terms of topography and cropping system. The statistic data, figure and map of new areas will be provided. Furthermore, the chapter will focus on the implementation plan, activities and calendar of FFLP, these are the road map for scaling out which consist five parts. Another part of this chapter is the impact of FFLP that comparison with existing extension, threat to validity and assessment. The scaling out model will be discussed. The chapter will also present the opinions of local governments (TAOs) staff on FFLP process and technologies adaptation. Three years period for scaling out process is recommended.

3.1.2 An empirical framework for scaling out of FFLP

Northeast Thailand comprises of 19 provinces which covers an area of 168,854 square kilometers, one third of the area of the country, and had population of 22.9 million in 2009 (http://www.state.gov/r/pa/ei/bgn/2814.htm). Most of the region occupied by Korat plateau with of average elevation of 160-200 meters above sea level. Average rainfall is less than 1,000 millimeters in the southwest, increasing to about 1,800 millimeters in the northeast. However, the region is drought prone since the effectiveness of rainfall is reduced by the predominant sandy soils.

The problem of drought in Northeast Thailand has intensified over the last 30 years on crop cultivation, especially of cassava, kenaf has led to clearance of forests from rolling uplands. Clearance of forest resulted to reduce water tables and deposited salt dissolved from upland soil layers in surrounding rice lowlands. Many farm ponds also have become shallow and clogged due to sedimentation and growth of aquatic weeds.

Because of its biophysical feature, the northeast region is characterized by mainly low-input, low- yield agriculture that does not offer and adequate living to the large numbers of farmers. The difficulty of marketing relatively small amounts of high-value produce from widely scatters farms and attraction of off-farm income in the dry season that have precluded the optimal use of the irrigation schemes.

Khon Kaen province , located in the middle northeast region, still faced the problems as other provinces, especially water resources for irrigation and soil quality. During 2006-2008 FFLP have been implemented in this areas, focused on 4 *amphoes* and eight villages the southern sub-region of Khon Kaen province. The topography was as undulating land, while soil type was predominantly sandy without large area of saline soil. Furthermore, this farm area consisted of widespread presence of farm ponds. Another important point was the cropping system was rice, cassava and sugarcane, Furthermore, there was not major development project such as Royal project in the research area, Thus, the target area to scaling out of FFLP such others *amphoes* in Khon Kaen including surrounding villages near Khon Kaen for implementing, must concentrate on these criteria.

Khon Kaen province consists of 26 *amphoes* with 205 *tambons* and population in 2009 was 1,781,222 (http://www.thaitambon.com/tambon/tamplist.asp?ID=40). Some *tambons* and *amphoes* have similar criteria as 4 *amphoes* : Ban Haet, Ban Phai, Nong Song Hong and Peuy Noi, in southern sub-region of Khon Kaen. These districts are 1) Muang, Phol, 2) Non Si La, 3) Ubontana, 4) Kao Suan Kwang, 5) Nam Phong, 6) Kra Nuan and 7) Sam Sung. All seven districts have 71 sub-districts. However, lists of similar *tambons* will be found out. Based on selecting criteria, four provinces surrounding Khon Kaen have been selected i.e. Nakorn Ratchasima, 2) Mahasarakam, 3) Chaiyaphumi and 4) Kalasin. These province are the neighboring province with Khon Kaen. This is one reason of similarity of topography (undulating land), soil type and cropping system.

3.1.3 Implementation plan, activities and calendar

To scaling out of FFLP to other areas, the implementation plan to be the road map will be done. The FFLP process from 2006-2008 will be modified for other *tambons* both in Khon Kaen and surrounding provinces in Northeast Thailand. The plan will be divided into five parts.

Part one, this part will start from having the meeting with villagers after informing to officers in district level. Villagers will be informed about the FFLP scaling out activity. The FFLP process will be discussed with villagers, then new farmer group will be stimulated to set up to coordinate with extension workers or researchers. After that farmer representatives will be selected to participate the workshop on introduced appropriate technologies which innovated by farmers and researchers. Then, field visit on farm trial that made by farmers to learn and observe the agricultural activities, will be done.

Part two, this part will focus on farmers meeting in the village after participating the workshop in research site. The main idea is farmer who participated the workshop and farm visit will tell story what they have seen to other farmers. Next, farmers will also make either the farm development plan or what farmers want to do on their farms in next 3-5 year, including what knowledge farmers want to learn more for farm management and improvement. Integrated farm or diversification agricultural activities should be recommended to farmer. Furthermore, the sufficient economy including New Theory Agriculture will be informed to farmers. Each farmer will have own future farm picture. This picture can be used for comparing before and after joining the project.

Part three, farmers select technologies which suitable and necessary to their farms and implement activities as normal with modified technologies. The record is also necessary to keep data and use the data for analyze the farm management. During implementing activities, farmers must have opportunity meet with other farmers especially in the same village to share experiences, problems, solutions and techniques to improve their farms. Researchers will also take this opportunity to meet with farmers for sharing experiences and recommendation some problems. Next visit should be other farms.

Part four, the workshop will be organized in the villages after harvesting season. This process will provide good opportunity for farmers to exchange experiences and share data, report the results, including analyzing data to sump up the activities. Each farmer should have time to present their farm situation and what they will do in next year. Researchers and extensionist should attend for share data and stimulate farmers implement activities continuously. The data of introduced technologies, farm yield, farm income and diversification activities will be recorded. Data analyzing will be done both farmers and extensiosts, then the results will be informed. This part seems to be the evaluation.

Part five, farmer prepared inputs including technologies to implement on farms in coming season based on the results from last cultivated year and new knowledge from others farmers both from visiting and participating the workshop. Farmer must adapt new technologies and methods to improve their farms.

Thus, whole activities are: 1) informing to farmers, 2) farmer participating workshop and farm visit, 3) meeting in the village, 4) farm planning, 5) implementing on farm, 6) obtaining knowledge, 7) presenting trial result and 8) assessment.

The FFLP will be implemented 3 years in the villages. The time period and activities is as shown in the Table 52:

Table 52 Time period and FFLP activities

Time period	FFLP activities
First year	**activities**
January	Farmer meeting and selecting the representatives
February	Obtaining knowledge on introduced technologies by farmers representatives participate the workshop and field visit.
March- April	Workshop in the villages / Identify activities/farmers make plan
May- October	Implementing activities/adapting technologies/obtaining knowledge by field visit to adapting farms Prepare for vegetable cultivation / trial record
November	Workshop for sharing results and next year plan Farm trial on vegetable production
December	Rice harvesting-cooperative labor /
Second year	**activities**
January- February	Assessment-yield, income, cost, diversification, technology etc. Modified the trial result for implementing on farms
March-April	Preparing inputs- making, repairing Obtain more knowledge by farm visit outside villages
May-October	Implementation on farm trial/ trial record
July-October	Obtaining knowledge by farm visit in and cross villages
November	Workshop for sharing results and next year plan Farm trial on vegetable production
December	Rice harvesting-cooperative labor
Third year	**activities**
January-February	Assessment-yield, income, cost, diversification, technology etc. Modified the trial result for implementing on farms
March	Need identification and modified technologies suitable on farms

Table 52 (CONTINUED)

Time period	FFLP activities
Third year	**activities**
April-May	Meeting in the villages to inform the activities
June-July	Obtaining knowledge on new technologies and farm activities
June-December	Trial with technologies/ trial record
August-October	Farm visit and learning on farm trial in and cross villages
November	Workshop for sharing results
December	Assessment / inform to other farmers in villages

The Time period can be adjusted in some villages depending on the culture, labour, farm size and village situation. Furthermore, another factor can be affected such as activity of government office, local government. Thus, to make the plan with farmers will be the good method to implement FFLP in new areas. The participatory planning approach will stimulate farmers to share experience with other farmers and extensionists. Moreover, this method will lead extensionists and researchers know farmer before start to work together. The, FFLP method will build up the good relationship during farmers and between farmers and extensionists. After that the trust each other will be start from this process.

3.1.4 Impact : comparison with existing extension, threat to validity and assessment

3.1.4.1 The existing extension in Thailand

The effectiveness of the conventional training and visit system (T and V) for agricultural extension in developing countries, including Thailand still was doubts. The T and V is part of the top-down transfer of technology paradigm for agricultural research and development in which technical message developed largely by scientists on research station. Then, this was passed on through extension network agents in the villages.

Agricultural extension and advisory services play an important role in agricultural development and can contribute to improving the welfare of the farmers and other people who living in rural areas. A range of approach to extension delivery have been promoted over the years. Early model was focusing on transfer of technology by using top-down linear approach were criticized due to the passive role allocated to farmers. A number of extension models have been implemented since the 1970s, combining approaches to outreach services and adult education, including the World Bank's training and visit (T and V) model, participatory approach, and most recently farmer field schools (FFSs).

Conventional extension services tend to be crop specific, but government departments have been reluctant to establish parallel in other section, such as fisheries, animal husbandry. Recently, Thai government had established the mobile extension units by using staff of difference sectors and extension agent to consult with farmers on their farming problem. Moreover, conventional extension material contains too much information written in a scientific format in too much educated language for farmers to understand. It can be seen clearly that the top-down approach try to solve farmer problem by thinking from the head office in central government. Thus, it was necessary to develop both appropriate extension method and material including channel, extension to farmer based on results of on-farm trial, especially on farmer farm in their villages in which do trial by farmers and researchers.

Waddington et al (2010) reported that since 1980 there has been a decline or stagnation in public expenditure on agriculture in most developing countries. Likewise, world Bank presented that the proportion of official development assistance (ODA) going to agriculture has also declined from about 18 per cent in 1979 to 3,5 per cent in 2004.

3.1.4.2 Impact : comparison with existing extension, threat to validity and assessment

Since the budget and extension worker number were declined, therefore, including the role of agricultural extension has transferred to local government in which new work for this organizations, the research project explored alternative extension strategies, such as farmer participatory extension approach. A farmer-to-farmer learning process (FFLP) was created. The FFLP has been implemented for 5 years and the results already showed. Thus, the scaling out of FFLP should be implemented in other areas where the criteria are similar both in Khon Kaen province and other surrounding provinces of Khon Kaen. Thus, it is very important to set up the assessment of the scaling out of FFLP. The criteria are shown as following:

1) number of adapting farmer,
2) farm yield increased,
3) farm income increased,
4) level of diversification activities,
5) reduced cost

3.1.5 Objectives

1) To disseminate of FFLP through local administration organizations
2) To study TOA known by FFLP technologies and information sources

3.1.6 Results

3.1.6.1 Dissemination of FFLP through local administration organizations

The FFLP for scaling out from original village is disseminated. The research concentrated on the dissemination of farmer-to-farmer learning process and innovation (FFLP) through local administration organizations since *Tambon* Administration Organizations (TAOs) actually are important players to operate agricultural extension in the areas. Presently, the agricultural extension service has been already transferred from Department of Agricultural Extension to the local government management. Thus, it is very necessary to present the FFLP process and four introduced technologies: custard apple pruning and cultivation, liquid organic fertilizer, herbal extraction and cassava-based animal feed, to the local administration organizations.

The experience of Thailand extension, both traditional-based and information technology-based are practically applied, in which effectiveness factor is farmer participation. The technology information set up in *tambon* level known as the Agricultural Technology Transfer and Service Center (ATSC) that able to provide the benefits to farmer and their groups by involving and changing their role from a provider to be an information manager. Especially, agriculture and related warehouse would be advantage to the network system. Hence, The Agricultural Technology Transfer and Service Center (ATSC) is formulated to develop one stop service center for farmers and communities in the areas of agricultural development, agricultural production, agricultural marketing and natural resource development (Narkwiboonwong, 2003).

The ATSC implementation was carried out on the basic of community based development by providing opportunity to farmers, enabling them to participate, and promoting their potential to plan and solve existing problems by themselves. Thus, it can be seen as the establishment of ATSC paved the way to decentralization and empowerment for community development. Such as known that, the ATSC managed by the steering committees which consists of the community representatives and extension officers.

Ministry Of Agriculture and Cooperative (MOAC) had planned to restructure the agricultural extension services by 1999 to be the Agriculture Transfer and Service Center (ATSC) of MOAC offices at *tambon* level. ATSC will work closely to the farmers and community to choose the appropriate technology and activities in order to increase farmers' income, improve their farm productivity and their opportunity to find the alternative activities. Under this restructure, farmers would be the direct beneficiaries of the ATSC. It aimed that the new structure ultimate goal was to improve the income and stimulate economic growth.

Figure 53 illustrates that various organizations getting involved in extension system, namely, Provincial Administration Organization (PAO), *Tambon* Administration Organization (TAO). The farmer groups also operate the center by with supervising and providing the scientific knowledge from researchers and extension workers.

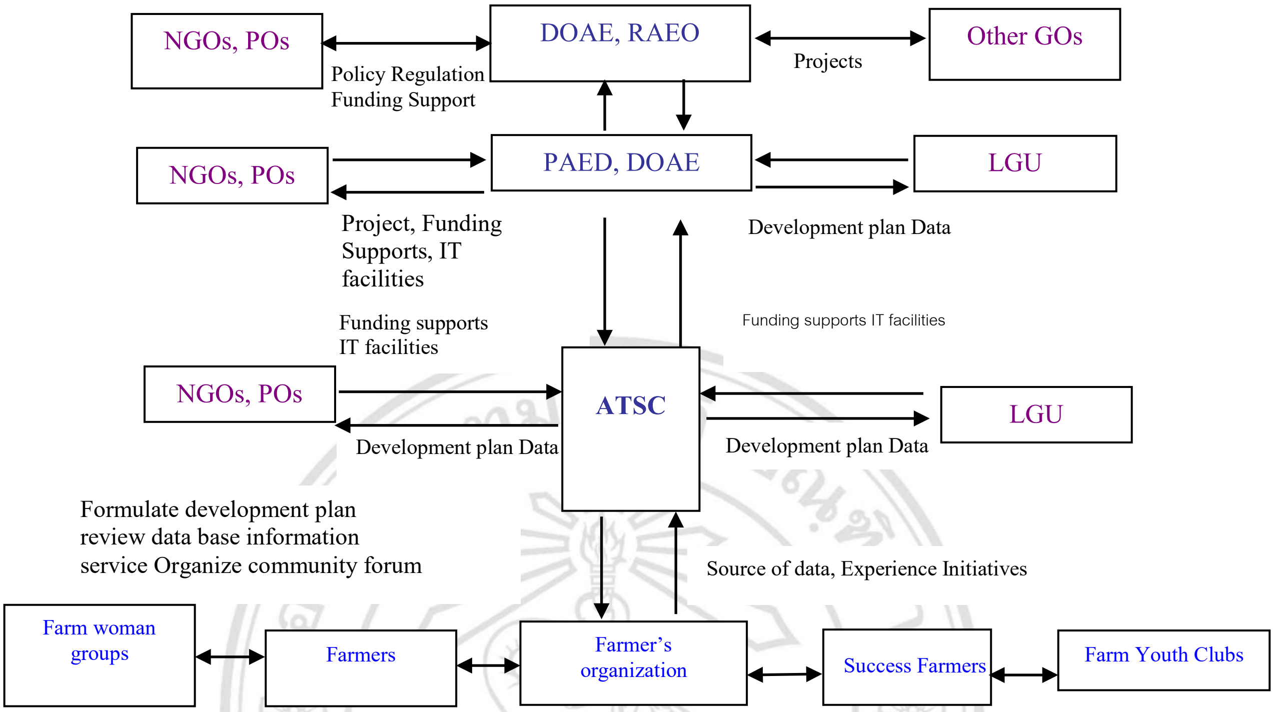

Figure 54 The Linkages of Institution, Role and Information Flow

Many ATSCs set up in the TAO offices, so the extensionists also use the facilities of ATSC to implement the extension services. However, it is very importance for the extension workers to learn about the participatory extension method for improving the extension service at TAO areas. Hence, both TAO itself and extension workers are the target group to disseminate FFLP and innovation process and technologies. After that, they can modify to improve the participatory approach to work with farmers and create the appropriate technology for operating on farms.

Both interview and focus group were used to collect data. TAO officers such as presidents, chairman of TAO council, members of TAO council and agricultural extension and community development staff were introduced about the concept and methods of FFLP (Figure 55-56). Furthermore, the farmer-to-farmer learning process focused on four technologies: 1) custard apple pruning and cultivation (CA), 2) liquid organic fertilizer (OF), 3) herbal repellent extraction (HE), and 4) cassava-based animal feed (CF). These TAO officers were exposed to the technologies through group discussion. Pictures of FFLP and innovation process and four technologies were also shown. Moreover, the results from implementing FFLP in four *tambons*, for example, number of diversification farmers increased, farm income of FFLP farmers increased, farm cost reduction were introduced.

Figure 55-56 Interview TAO's president and TAO's staff

3.1.6.2 Knowing FFLP technologies and information sources

1) Knowing FFLP technologies

The research found that the majority of TAOs officers knew about FFLP technologies: Custard Apple (CA), Organic Fertilizer (OF), Herbal Repellent Extraction (HE) and Cassava For Animal Feed (CF), 80 % of interviewees knew custard apple management, 85 % learnt about organic fertilizer, while only 62 % knew about cassava for animal feed as shown in Figure 57. Almost TAOs officers knew custard apple more than other technologies because they observed the custard apple trees which are available on farms (Figure 58-59) and the fruits were sold in the villages after the research project introduced this technology in the villages. This technology also caused good quality of fruit such as big size, clean peel, less insect damaged. Furthermore, many farmers from outside the villages had visited farms and discussed about the custard apple cultivation and management, moreover, TAO staff eventually participated the meeting in villages. Organic fertilizer also was the most popular to TAOs' staff since they observed farmers applied this technology for various activities such as rice, cassava, vegetable custard apple, including pond water quality improvement.

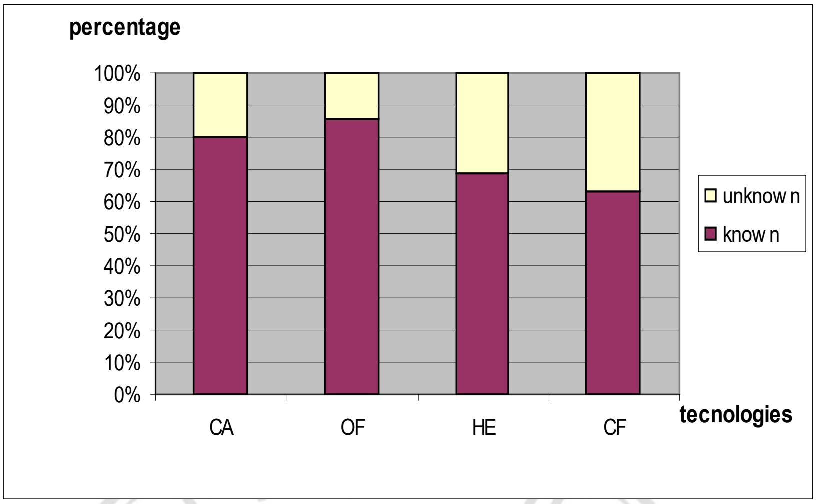

Figure 57 Knowing FFLP technologies of TAOs' officers

Figure 58-59 Custard apple cultivated near farm pond

2) Technology Information sources

TAO officers received information on four technologies from several different sources. Four technology information flowed from FFLP farmers to TAO officers were more important than flow from other sources such as extension workers, other TAO staff, other farmers. This may be because FFLP farmers could disseminate technologies and innovation better than other agencies since they had on in-dept knowledge of their farm such as crops, animal, technologies and practices, therefore, enabling them to communicate effectively with other people, such as TAO officers. The FFLP farmers also almost permanently were available in villages. It was very convenient for anyone who wanted to visit farms and receive knowledge. Figure 60 shows that FFLP was the main important source of technology information of all four technologies. The percentages of TAO staff obtaining technology information from FFLP farmers were highest for custard apple and herbal repellent extraction. The reason was HE was new technology in this area in which FFLP farmers did the trial on their own farms. Farmers mentioned that they wanted to find out the technology in which help them to solve the insect damaging.

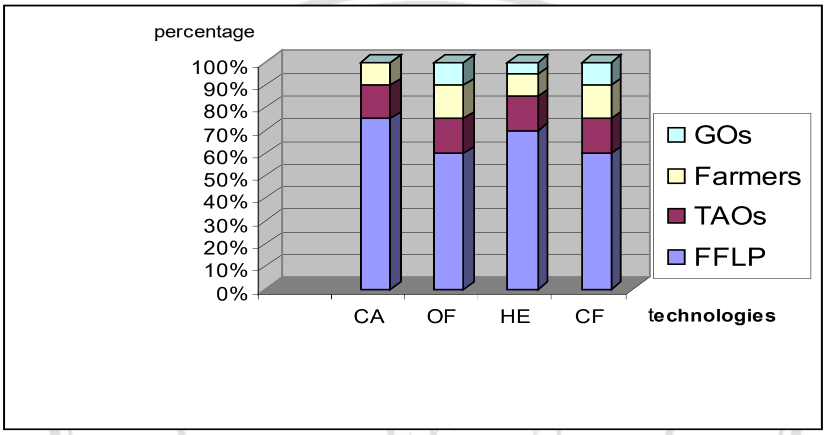

Figure 60 Sources of FFLP technologies information

3.1.6.2 Benefits to adapting farmers

Figure 61 presents benefits to farmers after adapted technologies in point of views of TAO officers. They indicated that farmers adapted FFLP technologies and implemented on farms continuously because the FFLP technologies supported them to solve their farm difficulties, for instance, quality improvement, increased yield, increased income and cost reduction. TAO officers observed that main benefit of FFLP farmers who adapted CA, OF and HE was increased income. For OF, HE, and CF, the most important benefit was cost reduction. In terms of increased yield and increased income, CA, OF and HE were appropriate technologies suitable to use on farms, for example one farmer in Wang Wa applied OF during soil preparation before vegetable cultivation (Figure 62-63) leading her gained 65,700 baht instead of 48,200 baht from growing chili 1 rai. Furthermore, FFLP technologies were applied for farm activities and leading farmers generated high level of diversification agricultural activities, such as vegetable, fruit tree, fish, and cattle.

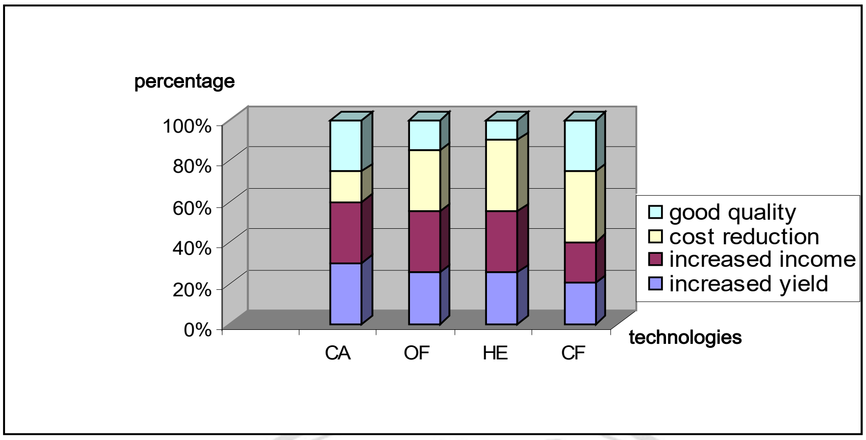

Figure 61 Benefits to adapting farmers

Figure 62 -63 Soil improvement by Organic Fertilizer before growing chili

3.1.6.3 TAOs' plan to implement FFLP technologies to farmers

The research result found that all TAOs officers' opinion showed the FFLP technologies were important for farmers to improve agricultural products, and then finally to increased income. Thus, whole four TAOs: Wangsawan (WSW), Khampom (KP), Wanghin (WH) and Papoo (PP), agreed with adding FFLP technologies into the TAO Development Plan in 2011-2014. Table 53 illustrates WSW-TAO and KP-TAO will put all four technologies on plan during 2011-2014, while WH-TAO only selects HE. However, some TAOs already promoted the FFLP technologies, for example WSW-TAO had adapted and implement CA and HE, another TAO such as KP-TAO already promoted OF and HE. Each TAO, moreover, adapted technologies depending on which technology suitable to farmers and also the budget.

Table 53 Lists of TAOs which plan to adapt FFLP technologies

FFLP technologies	TAOs plan in 2011-2014	Implemented in 2009-2010
Custard apple management	Wangsawan, Khampom Papoo	Wangsawan
Organic fertilizer	Wangsawan, Khampom, Papoo,	Khampom, Papoo
Herbal repellent exaction	Wangsawan, Khampom, Wanghin	Wangsawan, Khampom
Cassava animal feed	Wangsawan, Khampom	-

Regarding FFLP extension approach, TAO presidents of WSW, KP and PP are interested in promoting FFLP to the extension workers and community development staff. They pointed out that the participatory extension system was important to work with farmers and stimulate them solve the problem on their farms. They actually would like to promote the extension workers and community development staff learn the best practices on FFLP and innovation process. However, some TAOs still need time for recruiting new staff to get involved in extension service especially WH-TAO. It can be concluded that TAOs need both FFLP and innovation process for learning-how to work with farmers, and FFLP technologies- how to increased yield and increased farm income.

3.1.7 Conclusion

Almost TAO officers had known about four FFLP technologies through farmers who participated FFLP and innovation process. TAO presidents were interested in promoting FFLP and innovation process for agricultural extension system in the *tambon* areas, and also will allow the extension workers including community development officers learn FFLP and innovation process. FFLP farmers were the main technology information sources followed by TAO staff and government officers. The FFLP farmers gained various benefits from adapting technologies such as increased yield and increased income followed by cost reduction and good quality of farm products. The FFLP technologies also led farmers implemented more diversification agricultural activities. All four TAOs planned to add FFLP technologies in the TAO development plans during 2011-2013. Five steps for application of FFLP process to new areas: 1) initiation, 2) farmer information change and planning, 3) technology adaptation, 4) assessment, and 5) sharing results across *tambons* and provinces. The time period to implement FFLP and innovation process can be adjusted in villages depending on the culture, labor, farm size and village situation. Furthermore, other factors can be affected such as activity of government office and local government. Thus, to make the plan with farmers will be the appropriate method to implement FFLP in new areas. The participatory planning approach will stimulate farmers share experiences with other farmers and extensionists. Moreover, this method will lead extensionists and researchers know farmer and build up the good relationship before starting work together. After that the trust between each other will be start from this process. To implement FFLP process in new areas, three years period is recommended.

3.2 Scaling out FFLP on efficient water use and for chemically free vegetable production and network building

3.2.1 Introduction

Thailand is situated in the heart of the Southeast Asian mainland, covering an area of 513,115 square kilometers and extend about 1,620 kilometers from the north to the south and 775 kilometers from the east to west. Thailand borders the Lao People's Democratic Republic and the Union of Myanmar to The North, the Kingdom of Cambodia and the Gulf of Thailand to the East. And Malaysia to the South. Thailand is a warm and rather humid tropical country with monsoonal climate. Temperatures are high in March and April with average temperature of 28 degree Celsius to 38 degree Celsius and humidity averaging between 82.8 percent to 73 percent. The Northeast Thailand has been consistently the target area of this research. The agricultural land is as large as 9,271,520 hectares in Northeast region, which accounts for 44 per cent of all in Thailand (21,014,620 hectare) and number of the farm household (5,642,890 hectares). The agriculture in this region is characterized by less favor or less developed due to the poor natural conditions such as sandy soil, erratic rainfall. The Northeast region especially around Khon Kaen province, is generally characterized by gently rolling topography with an elevation of approximately 200 meters. The research site, Don Han village located in 30 kilometers west from Khon Kaen city, is also in the same topography as mentioned above in terms of soil characteristic and rainfed area. The dominant of farming system around Khon Kaen province is the rice in paddy, vegetable and sugarcane.

At a present and the future, Thailand has capacity to produce the chemically free and organic food for consumption and export. It can be seen that Thailand shares approximately 10 percent to world market. This results to the trend of world organic food market will increase 20 percent per year. This causes from an awareness on health of customers (Department of Agriculture, 2003). Pumpanwong (2004) mentioned that the chemical can contaminate directly to the food in every process such as the production at farm, post harvesting, transportation and cooking step. The food production is the high chance to get the toxic from using the chemical. The chemically free vegetable is the very important for human being, thus, it is very important for farmers to produce as customer need. The quality control should be done in this step. Thus, at farm level, the farmer group can play significant role to control and manage the production process.

Whole vegetable production of Thailand has been consumed in the country about 95 percent, approximately 3.7 million tons per year, it costs 18,600 million baht (Rojanalert and et al, 2003). Thai people consume vegetable 60 kilograms per year. The average vegetable cost for whole year is 5 baht per kilogram. Furthermore , five percentage of the vegetable is exported. In 2003, the report presented Thailand exported the vegetable 519,849 tons, it cost 7,938 million baht. The country also exported the vegetable seed cost 1,433 million baht. Overall, the vegetable production in Thailand is divided into 3 groups: 1) fresh vegetable, 2) food processing and 3) seed production. The main problems for farmer to produce the vegetable are the vegetable price, marketing channel and using chemical both fertilizer and pesticide. Another difficulty is inappropriate irrigation system that consumed less labor and energy costs. The purposes of the study were: 1) to study and develop the small watering technology for chemically free vegetable production, 2) to study and develop the organic matter for productions of chemically free vegetable and 3) to increase farmer's knowledge based and to develop a farmer-to-farmer learning unit in the community.

The problems of extension approach in Thailand is the lack of a close working relationship between researchers and extensionists. 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. 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), 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 by farmers. Thus, FFLP was developed for new agricultural extension since to solve the old extension method. Taweekul *et al.,* (/2015) found that FFLP provided benefits to adapting farmers in terms of gaining high income and reducing cost. Thus, this research, furthermore, had been used FFLP approach to transfer knowledge during farmers.

3.2.2 Results and discussion

3.2.2.1 Socio-economic aspects of chemically free vegetable group members

The result found that the family size of farmer was 4.5, each family consisted of father, mother and either children or nephews. The average labor force per family was 2.5 The main labors are father, mother including son in law and daughter in law., while other family members have worked in the big cities such as Bangkok and its outskirts, Phuket and the factories located near the village. The average age of the member was 56.28 years old, the youngest member was 35 years old, while the oldest was 68 years old. The average land holding was 20.28 rai (6.25 rai is equally 1 hectare). Each member of chemically free vegetable production group allocated 1.5 rai to generate the vegetable production by using the farm ponds and the natural canal near farms. Moreover farmers also devoted 18 rai to grow the rice for consumption and selling. Importantly, whole land belonged to them. The members started to produce organic rice after they leant on organic matter. Various vegetable were growth such as Chinese kale, chili, egg plant, long bean, gory morning, cabbage, sweet corn, basil etc.

The study revealed the farmer group played important role to implement the chemically free vegetable production. The chemically free vegetable production group found on January 8, 2002. At the beginning, there were 12 members. Each member shared 20 baht. At a present the number of member increased up to 35 farmers, each farmer hold the share at 200 baht. One group member provided the land, 0.55 hectares, for the group activities as demonstration plot by growing vegetable, making the organic matter and meeting. The water sources were four farm ponds which located near the demonstration plot and there was no renting fee for the group.

3.2.2.2 The development of small water irrigation by farmer group

The study found that the old irrigation technology system was very difficult to generate the system in terms of consuming of much labors, much times and high energy cost. The research found that the group members used three horse power water pump using the petrol connecting with plastic pipe diameter was 1 inch and the length was 100 meters which needed 5-6 farmers for watering 3 hours per day as shown in table 53. After the group have used new irrigation technology system (small sprinkler), it took less labor and time, for instance, it needed 1-2 members to watering only 25 minutes per day. This was suitable for the group that consisted of elder members. Furthermore, the group connected the water irrigation system with the organic liquid fertilizer and herbal repulsive extraction tanks. Thus, this appropriate irrigation system resulted directly to save time, save budget and use more often for applying liquid herbal organic matters. Moreover, the efficient water were done by using the irrigation system.

The setting small watering system to irrigate the chemically free vegetable production on farmer farm about 0.55 hectares had been done. This plot of land also has been used for the learning unit of group members (Figure 64 and 65). The farmer recorded data according to irrigation operating time, number of labor, investing cost, energy cost etc.

The data was used for comparing between the old irrigation technology system and the current irrigation technology system. The data was generally analyzed by the figure and the description.

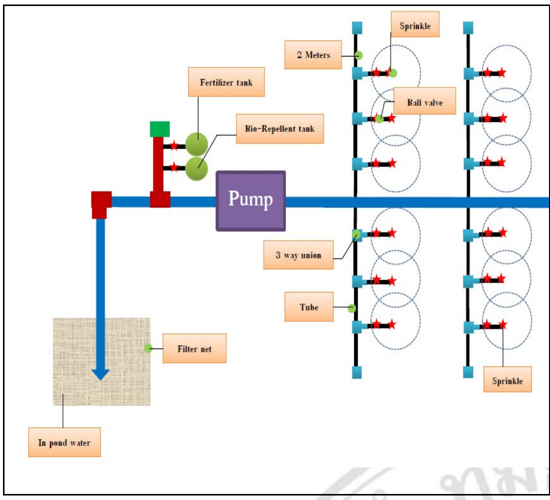

Figure 64 Irrigation system on blue print **Figure 65** Irrigation system at demonstration plot

Table 54 Comparison of the irrigation technology between using water pump and sprinkler irrigation system

Activities	Old irrigation system	New irrigation system
1. Labor for watering	1. Five labors per day	1. One – two labor per day
2. Water applying time	2. Took three hours / day	2. Took 25 minutes /day
3. Insect spraying applied	3. One-two farmers / 1 hour	3. One farmer / 5 minutes (mixed in the irrigation system)
4. Liquid organic fertilizer applied	4. One-two farmers/ 1 hour	4. One farmer / 5 minute (mixed in the irrigation system)
5. Energy cost	5. Petrol costs 1,500 baht /month	5. Electricity costs 150 bath/month
6. First investment	6. Cost 10,600 baht	6. Cost 34,000 baht
7. Water available	7. For 8 months	7. For 12 months

Figure 66 Sprinkle system

Table 54 shows that the number of labor for watering, applying the liquid fertilizer and the bio-pesticide was decreased from using old technology to present technology, from 5 farmers to 1-2 farmers, respectively. The watering time also decrease sharply from 3 hours per day to 25 minutes per day. Interestingly, the farmer group paid for energy cost of water pump cheaper than old system as seen from 1,500 baht per month to 150 baht per month. According the investment, the old irrigation system was cheaper than new water system. The farmer also mentioned that growing vegetable by using the water sprinkler system, as shown in figure 66, connected with the mixed fertilizer and herbal extraction caused vegetable grew vary fast, had less insect and disease, quality of soil also improved. More importance, farmer used water efficiently that they could save water using whole year in stead of 8 months per year.

3.2.2.3 Herbal and organic matter development

The study found that farmers have produced the herbal extraction by fermented the herbs in the tank. The result mentioned that farmers developed the equipment for extraction, named "herbal repulsive extraction". It consists of two parts: 1) boiling tank and 2) cooling tank. Both parts is connected by the copper tube. The operation system was putting the herbal plants into the boiling tank then boiled it. The stream passed through the cooper tube to water cooling tank. Next, the stream change to be the liquid which is used for expelling the insects. Five kilograms of herbal plants by weight can be refined to 5 liters of bio-extraction. It took 2-3 hours. In addition, the operating time and quantity of the bio-extraction depended on the temperature of boiling and cooling tanks. The characteristics of the herbal bio-extraction is presented as Figure 67.

Figure 67 Herbal repulsive extraction equipment

Farmer group investigated the types of herbal plants from 8 plants to be 12 plants to produce the bi-extraction. These plants (figure 68) can be found in the bush around the village. And also three popular formula of bio-extraction has been shown in the Table 54 below.

Figure 68 Herbal plants were used for extraction

Table 55 Formula and types of herbal plants to produce the herbal repulsive extraction

Formula 1 (to expel insect)		Formula 2 (to expel insect)		Formula 3 (to expel mosquito)	
herbal plants	**used part**	**herbal plants**	**used part**	**herbal plants**	**used part**
1. Citronella	Leaf	1. Citronella	Leaf	1. Citronella	Leaf
2. Neem	Leaf/seed	2. Neem	Leaf/seed	2. Eucalyptus	Leaf
3. Eucalyptus	Leaf	3. Eucalyptus	Leaf’	3. Kaffir lime	Leaf/fruit
4. Kaffir lime		4. Kaffir lime			
5. Galangal	Leaf/fruit	5. Galangal	Leaf/fruit		
6. Custard apple	Tuber	6. Custard apple	Tuber		
7. Siam weed	Leaf	7. Siam weed	Leaf’		
8. Cassod tree	Leaf	8. Cassod tree			
	Leaf	9. Tuba root	Leaf		
		10.*Tinospora*	Leaf		
		crispa(L)	Stem/root‘		
		11.Wild	Stem		
		spikenard	Leaf/tip		
		12.*Stemona*			
		callinae	Tuber		

Presently, the farmer group still investigate the local herbal plants for producing bio-extraction. New plant. *Dioscerea hispida* Dennst. is demonstrated on farm to expel insects. This illustrated that farmer can do the research and teach others farmer, including work together to solve their similar problems.

3.2.2.3 Liquid organic fertilizer making

The study revealed that farmer used to attend the training course on organic matter making organized by the Agricultural extension district office, other farmers and Khon Kaen University. Then, the farmer group have developed the organic making method, formula and the raw materials suitable to their agricultural activities focusing on rice farm and vegetable cultivation. The local materials have been considered to be use instead of buying from outside. For instance, jack fruit, star fruit, mango, pumpkin were investigated. Three liquid organic fertilizer formula are found as shown in the Table 56 below.

Table 56 Three formula of liquid organic fertilizer and local raw materials

Formula 1		Formula 2		Formula 3	
materials	**ratio**	**materials**	**ratio**	**materials**	**ratio**
1. Pineapple 2.Sugarcane molasses 3.Coconut juice Total	3 kgs. 1 kg. 1 kg. 5 kgs.	1. Star fruit, jack fruit, pumpkin, mango, carrot, banana 2.Sugarcane molasses 3. Water 4. Effective micro-organism LDD[1] powder number 2 Total	3 kgs. 1 kg. 1 kg. 25 gm. 7.25 gs.	1.Waste vegetable from farm 2.Sugarcane molasses 3. Water 4.Cocobnut juice 5. Effective micro- organism powder LDD number 2 Total	3 kgs. 1 kg. 1 kg. 3 kgs. 25 gm. 8.25 kgs.
Method : chop pineapple into small piece, then add sugarcane molasses and coconut juice. Next, stirring it properly may need, cover lid and stir every 2-3 days. Fermentation needs 30 days.		**Method** : chop the local fruit into small piece, then add sugarcane molasses, water and coconut juice in the container. Also adding LDD no.2 in it is needed. Next, stirring it properly may need, cover lid and stir every 2-3 days. Fermentation needs 30 days.		**Method** : chop vegetable from farm into small piece, then add sugarcane molasses, water and coconut juice in the container. Also adding LDD no.2 in it is needed. Next, stirring it properly may need, cover lid and stir every 2-3 days. Fermentation needs 30 days.	

[1] LDD =Land Development Department

The study found that formula 2 and 3 of liquid organic fertilizer were preferable for farmer. The reasons were: 1) various local raw materials were available, 2) LDD powder number 2 stimulated micro organism was very active and 3) by farm products were properly used efficiently.

2.2.2.4 Increasing farmer knowledge though FFLP

Their knowledge and experience is very important for themselves and other farmers to modify for in their farms. The efficient water use and organic matter for farms are main issues. The study investigated farmer group have developed and improved the chemically free vegetable plot to be the demonstration and learning unit which other farmers come to leant from each other. The learning unit consisted of 1) one learning hut, its area was 32 square meter, 2) liquid organic fertilizer demonstration, 3) herbal repulsive extraction demonstration, 4) cooperative chemically free vegetable demonstration plot, 5) herbal plant plot, 6) latrine for visitors and 7) four water ponds for irrigation. It can be seen that the area of 0.55 hectares has been for various activities especially learning process and on farm trial which farmers have implemented to solve their problems. The learning unit located near the village resulting to many villagers can easily access this farm both for buying the vegetable and exchange the experiences through farmer-to-farmer leaning process (FFLP) as show in figure 69. Thus, this learning unit was almost suitable place to share knowledge based from farmers on various issues of chemically vegetable production.

The study also found that the group members have created and applied the

Figure 69 FFLP on demonstration plot

agricultural activities suitable for the chemically free vegetable production The activities suitable for the chemically free vegetable production. The members also practiced on testing the organic matter making, and vegetable cultivation including new varieties. These farm trials were operated to solve their problems and then modified to both cooperative demonstration plot and their own lands. The knowledge based of farmers happened from their experiences. The research results mentioned that many members were experts in various aspects, for instance, four members were keen on small water irrigation system by using sprinkler connected with fertilizer mixing tank, six members had the skill on liquid organic fertilizer making. Furthermore, three members operated the herbal repulsive extraction excellently, other two members were also keen on making the insect trap. The group learnt more on marketing system until five members had good skills, moreover, two farmer was the soil improvement volunteer supporting the group on soil test and find out the solutions. In addition, three members had good skill and good practices on group management. Thus, their knowledge based have transferred to many people and students who visited the learning unit. It can be seen that 1,049 visitors from 36 groups, in each year both from Thailand and overseas have visited. So, it can be concluded that knowledge based from experience lead them to be confident to transfer to others.

3.2.4 Effects of FFLP to network building and promoting sufficient ecology

Two new districts: Muang Khon Kaen and Prayeun have been promoted FFLP by 60 farmer representative from new districts visited original districts both Ban Haed and Ban Phai. The process wars similar to the step of FFLP. These started with visiting, then came back and run the workshop in the villages that the 60 representative gave the information after that farmer selected the activities and FFLP technologies to modify on their farms.

Basically, farmers in new district cultivated various vegetables such as Chinese kale. Spring onion, cucumber, sticky corn, cabbage, gory morning. Thus, almost of them selected liquid organic fertilizer and bio-extraction for insect repellent technologies. Furthermore, they had learnt sufficient water use and small irrigation management. Farmers in two district received the small irrigation system by using solar cell as source of energy to pump the water which donate by NGOs : Population and Community Development Association (PDA) and Coca Cola Foundation. Actually both NGOs provided the raw materials to build the irrigation system and the technicians including the farmer group fund also provided. Moreover, farmer spent their labor force to build the system. The projects provided opportunity for farmer to participated every step, then these small irrigation system belonged to farmer groups. Especially, the project stimulated them to learn how to repaired all equipment. This was one factor leading the projects sustainability. Another factor to lead the network work together is the markets both in the communities and outside the communities such as department stores, agro processing factories, and various market in the events in which government organized. The connection to build the network as shown in Figure 70 below.

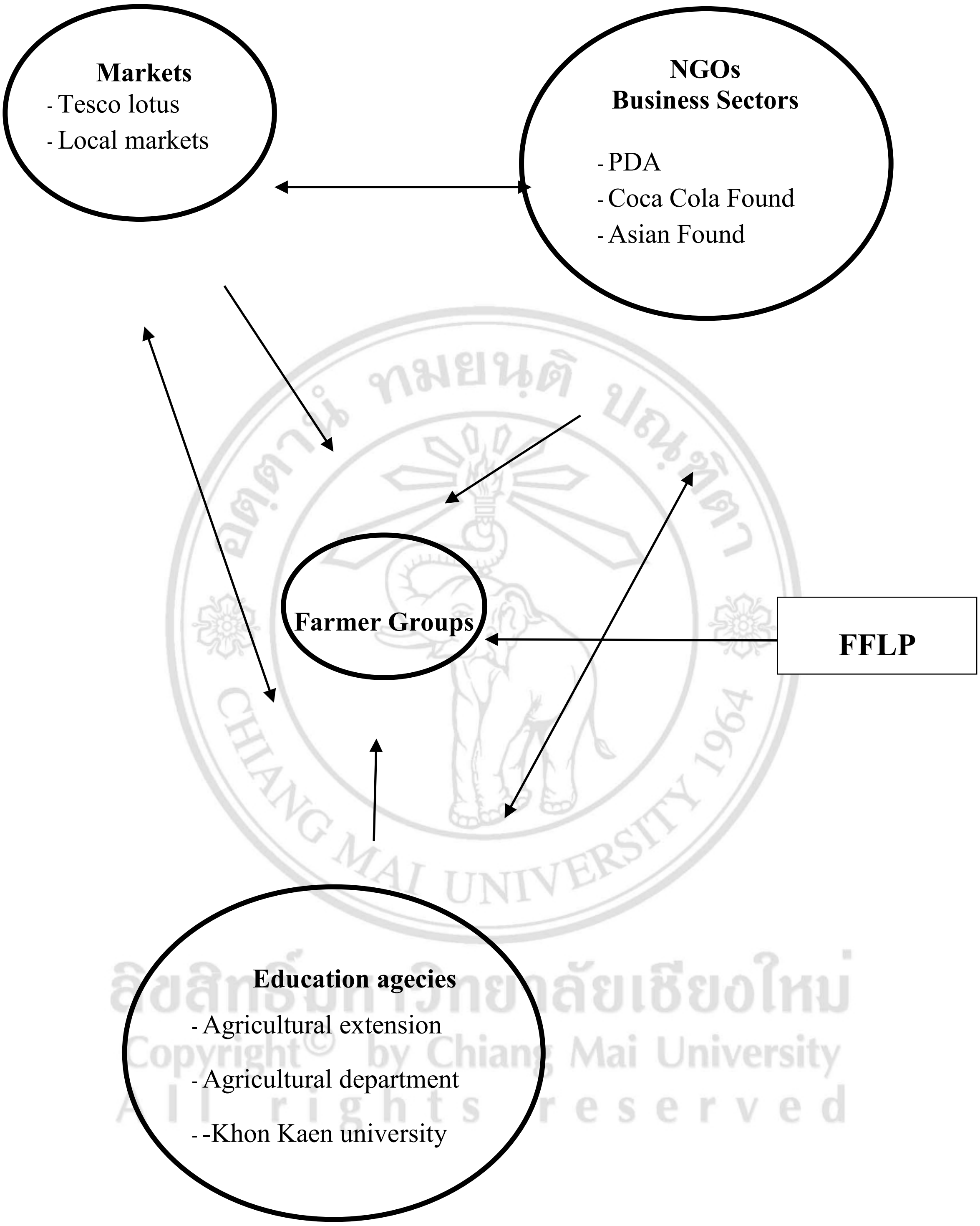

Figure 70 presents the four parties get involved in net building

Table 57 villages, number of farmers and income from vegetable cultivation

Villages	members	Highest income (Baht)	Lowest income (Baht)	Average income (Baht)
Nongpho	24	72,250	2,170	18,014
Nonghee	31	71,245	3,173	12,124
Nongyakaonok	150	42,294	3,382	10,925
Donyanang	30	43,322	2,852	11,736
Total/average	245	57,277.8	2,886.8	13,199.8

As mention earlier that farmers participated the free-chemically vegetable production using solar cell system project in four village. Total 273 farmers have joint the project by cultivating the vegetables. They gained money extra from cultivated basic crops: rice, cassava and sugarcane. Table 57 illustrated all farmers in four village earned average income 13,199.75 baht per year per member. Thus, these showed all farmers of four group gained 3,233,938.75 baht per year. It can be seen that farmers did not gain any baht from vegetable activities, after they joint the project and FFLP activities and technologies, they actually gained higher incomes than the past.

The free- chemically vegetable production using solar cell system project in particular small irrigation system consisted of solar cell panel, convector, submersible pump, water tank, water PVC tube, water meters, small concrete container for each plot of land as showed in figure 71-74. These equipment support by NGO and private company, while knowledge on vegetable cultivation, pest control, group management, marketing and Good agricultural Practice (GAP) have been supported by University and Agricultural agencies and marketing organization.

บ้านหนองโพธิ์ ต.หนองแวง อ.พระยืน จ.ขอนแก่น

บ้านหนองฮี ต.ดอนช้าง อ.เมืองขอนแก่น จ.ขอนแก่น

บ้านหนองหญ้าข้าวนก ต.หนองแวง อ.พระยืน จ.ขอนแก่น

บ้านดอนหญ้านาง ต.ดอนช้าง อ.เมืองขอนแก่น จ.ขอนแก่น

Figure 71-74 show project sites in four villages in two districts

The project sites in four villages (two districts) located near each other, the distance was 1-2 kilometers each, from left to right : Ban Nong Pho, Ban Nong Hee, Ban Nong Ya Kao Nok and Ban Don Ya Nang, respectively.. Thus, farmers in four groups visited and learnt from each other very often. They initially have built the network in four group and also built network with the original FFLP villages. Not only farmer groups have built network themselves, but they also built the network with various organizations who involved the projects, such as NGOs, private companies, university, agricultural government agencies and marketing organizations. The learning framework to study FFLP as shown below. While the network building model is shown in figure 75 in next page.

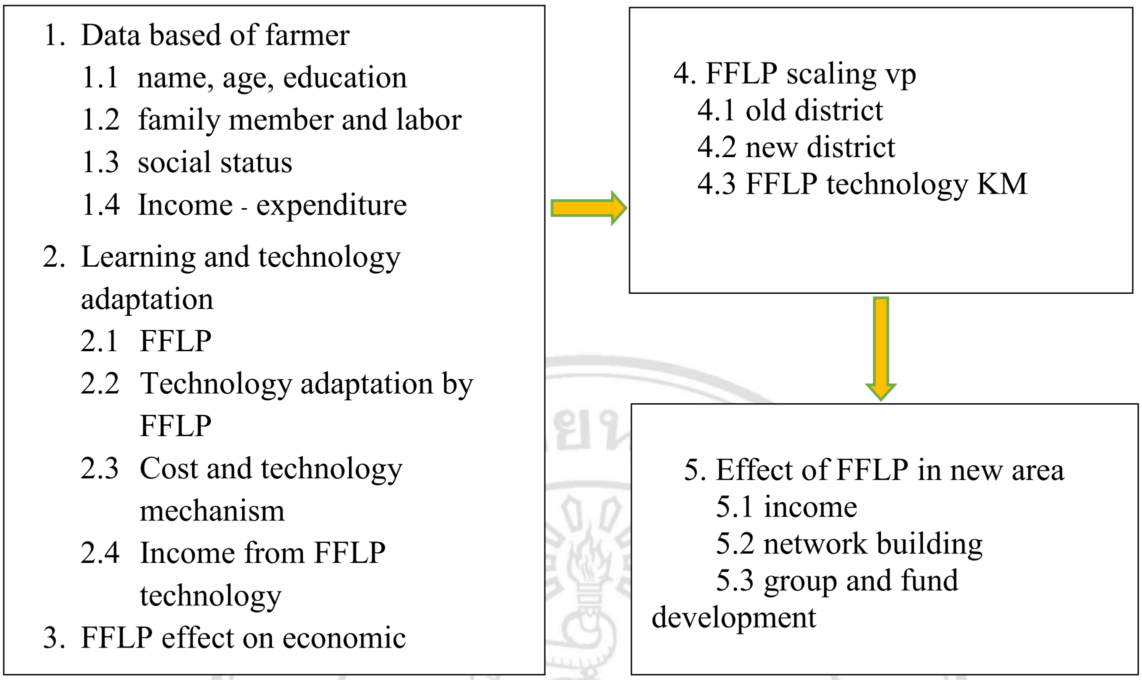

Figure 75 Learning by Framework for scaling out

Interestingly, farmers in four group implement activities follow the Sufficient Economic Philosophy that stresses the middle path as an overriding principle for appropriate conduct. The three components are *reasonableness* (or *wisdom*) , *moderation*, and *prudence*. Two essential underlying conditions are *knowledge* and *morality* have been modified by farmers. They leant how reduce cost, how to increase income, how to work together and support each other.

Farmers were reasonable people by reducing cost for growing free chemically crop production. As mention earlier that farmers have made the liquid organic fertilizer and used on their farms, this helped them to save money without buying expensively chemical fertilizer. They also protected the environment with friendly environmental vegetable production. When they cultivate vegetable for lone time, their knowledge will be wisdom which they can modify it for knowledge management (KM).

Farmer grew many vegetable basically depended on family member consumption. Production in excess of consumption would be given to their friends and then may be sold to earn income for family. This provided information that these farmers were moderation. Other vegetable can be mad for agro processing and can be development to be OTOP.

FFLP stimulated farmers learnt from each other, then modifies to implement on own farms. This provided opportunity to farmers for developing the cultivation and working skills. Farmer built the network and worked together as they have friend to think, to solve the problem and to help each other in various aspects, these led them to have morality and they can work as group properly.

3.2.4 Conclusion

The farmer group has an important role to promote and produce chemically free vegetable by stimulating the 30 members learning from each other at the learning unit before implementing on their own farm. The learning unit compiles chemically free vegetable demonstration plot, efficient water use technology, the learning hut for training and meeting, latrine, organic matter demonstration and four farm ponds.

The farmer group have developed and improved the water irrigation system from using petrol motor pump with 100 meters of plastics pipe to use the sprinkler technology connecting with the liquid organic fertilizer mixed tank. The water pump was electricity submersible pump. This appropriate technology reduced labor for watering 3-5 times, reduced watering time about 4.8 time, reduced time for applies the fertilizer and bio-extraction 12 times and reduced the cost for energy paying 12 times.

The farmer group created and improved the herbal repulsive extraction 2 formula and mosquito expelling 1 formula. In addition, they have developed three formulas of liquid organic fertilizer using local raw materials. The equipment can use multiple energy sources suitable for each area such as natural gas, fire wood and charcoal.

The group members have learnt on many topics from the group. They also gained experiences from implementing the research on farms. The trial has been done to solve their problems. Actually, these knowledge become to local knowledge based which the group can transfer to other farmers including people who interested in these issues. Their knowledge based have led the group moving forward and keep walking properly. Furthermore, it also provided the opportunity for the group members to participate in various seminar and meeting.

Farmers have learnt the technologies and methods how to modify farm practice during the climate change, especially they have succeeded on using the appropriate technologies of efficient water uses and various of organic matters instead of chemical. Farmer also should investigate other energy sources to pump water such as solar cell, wind and other.