CHAPTER VI

ASSESSMENT OF FARMER FIELD SCHOOL APPROACH FOR IPM

The status of IPM program activities and cabbage production practices were studied at Samraong commune, where cabbage is the major crop and has remained a backbone of household income. IPM practices have been introduced by vegetable IPM project in the commune. Chief outputs of this study are furnished with a great deal of thoughts over the changes in farmers' practices on cabbage production of IPM farmers and compared to non-IPM farmer-1 and non-IPM farmer-2. 60 households in two villages were selected randomly and interviewed. Their practices were also directly observed during the fieldwork. This chapter attempts to describe and analyze the effectiveness of IPM practice on cabbage production between IPM farmers and non-IPM farmer-1 and non-IPM farmer-2, IPM farmers' acceptability of IPM practice on technology package, effectiveness of FFS approach in IPM practice, and identify potential of IPM program diffusion among non-IPM cabbage growers.

6.1 Farmers' profile on accessing to IPM program

To broaden the understanding of the objective, the study involved three groups of farmer, IPM farmers and non-IPM farmer-1 and non-IPM farmer-2. The sample farmers were randomly selected from two out of the nine villages of Samraong commune, Sotnikum district, Siem Reap province. The villages selected for the studies are Botdangkor, the Vegetable IPM project site and Samraongcheoung village, outside project area. The detailed information on respondent is presented in Table 8.

The result indicated that 60% of the respondent in IPM group represented female, while there were 78% male respondents in non-IPM groups. Overall it was attempted to ensure balanced gender representation in the survey as strongly stressed by Nuth (2000), where IPM training has been focusing on the participation of women and encouraging them to involve at all level.

Table 8. Farmer access to IPM program at Samraong commune

Village	IPM farmers			Non-IPM farmers			Total
	Female	Male	Total	Female	Male	Total	
Botdangkor	12	8	20	6	14	20	40
Samraongcheoung	-	-	-	3	17	20	20
Total	12	8	20	9	31	40	60
Percentage	60	40		22	78		

Source: Survey data, 2003.

It appeared that higher proportion of female farmers attended the IPM program and also seemed to make most decision with regards to cabbage production. This finding is similar to Shinawatra *et al.* (1990) who state that women had important roles in the farming activities.

6.1.1 Respondent features

Table 9 indicates the educational level and age of respondents. The age of IPM farmers ranged from 22-50 years with an average age of 33 years. The non-IPM farmers' age ranged from 21-56 years with an average age of 40 years. Results indicated that the average year of IPM farmers were a bit lower than non-IPM farmer-1 and non-IPM farmer-2. The difference in ages of two groups can be explained that the IPM trainer would like to select the farmers who are not so young and not too old to participate in field school for IPM program. Those farmers often present the confidence or farming experiences and maturity on farming practices as well as the capability to communicate with other farmers.

Table 9 also shows that the respondents in both categories had different educational level. The average education levels of the IPM farmers were higher than the non-IPM farmer-1 and non-IPM farmer-2. For instance, 75% of the IPM respondents attended primary school, 20% went to secondary school and 5% had completed high school. In contrast only 3% of non-IPM farmer-1 and non-IPM farmer-2 completed high school, 8% secondary school, and 68% of them attended primary school. Nobody in the IPM group were illiterate and had at least completed elementary level as compared to 18% illiterate and 5% in elementary of the non-IPM farmer-1 and non-IPM farmer-2.

Table 9. Educational status and farm experiences of the sampled farmers

Item	IPM farmers (n=20)		Non-IPM farmer-1 & 2 (n=40)	
	Average no.	---(%)---	Average no.	---(%)---
Average Age	33		40	
Educational level				
Illiterate	0	0	7	18
Elementary school	0	0	2	5
Primary school	15	75	27	68
Secondary school	4	20	3	8
High school	1	5	1	3
Farmer experience				
5-10 years	11	55	19	48
>10 years	9	45	21	53

Source: Survey data, 2003.

The result also shows that 55% of the IPM farmers have less than 10 years of growing cabbage. However, 53% of the non-IPM farmer-1 & 2 have been growing cabbage for more than 10 years, accumulating enormous experiences in vegetable cultivation.

Table 10 shows the field size for cabbage was not the same among farmers, which ranged from 700-1,700 m^2 respectively. 40% of IPM farmers and 65% of the non-IPM farmer-1 and non-IPM farmer-2 have field size ranging from 700-900 m^2. Only 30% of IPM farmers and 28% of non-IPM farmer-1 and non-IPM farmer-2 have vegetable land from 1,101-1,300 m^2.

Table 10. Cabbage field size

Field size (m^2)	IPM farmers (n=20)		Non-IPM Farmer-1 & 2 (n=40)	
	Average no.	---(%)---	Average no.	---(%)---
700-900	8	40	26	65
901-1,100	0	0	0	0
1,101-1,300	6	30	11	28
1,301-1,500	4	20	0	0
1,501-1,700	2	10	3	8

Source: Survey data, 2003.

Between the two groups of farmer only 20% of IPM farmers have field size from 1,301-1,500 m^2. Moreover, 10% of IPM farmers and 8% of the non-IPM farmer-1 and non-IPM farmer-2 have field size ranged from 1,501-1,700 m^2 only.

6.1.2 IPM farmers' setting

The vegetable IPM project under the IPM program has officially been operating in Siem Reap province since 2000. It is currently run from the provincial level to district level and then to farmer's community at commune level. Their main principles of IPM program focuses on growing healthy crops by reducing chemical fertilizers application and pesticides spraying, especially for cabbage growers since most farmers in this commune grow cabbage for their main household income.

The program helped farmers to improve their crop production practices in seed selection, land preparation, fertilizer application, pesticide spraying and harvesting. Aside from that IPM trainers and farmer trainers also contributed to share some experiences to identify natural enemies, pests and diseases on cabbage. IPM farmers were selected gradually to participate in IPM farmer field school. Result from filed survey showed 7 farmers in 2000 and 13 farmers in 2001 had attended IPM farmer field school training organized by the IPM program.

The basic idea of having IPM farmers is not only to help them in improving their cabbage production practice and income generation but also establish the local capacity in the village level who are expected to become a farmer trainer to manage and organize others field school to capacitate others farmer in villages.

6.2 The effectiveness of IPM practice on cabbage production

6.2.1 Productivity

Cabbage provides an important source of nutrition and household income for farmers in the study area. The survey result on the average cabbage productivity among three groups of farmers showed that IPM farmers harvest 22 t/ha, while non-

IPM farmers-1 and non-IPM farmers-2 harvested only 18 t/ha and 17 t/ha respectively. These average productivities were statistically different (Table 11). This difference could be contributed to the difference in crop management practices of different groups.

Table 11. Average productivity of cabbage among three groups of farmer

Farmer	Average productivity ----------------(kg/ha)----------------	SD	CV (%)
IPM (n=20)	22,000 [a]	576	3
Non-IPM-1 (n=20)	17,900 [b]	1,493	8
Non-IPM-2 (n=20)	17,350 [c]	1,397	8

Note: [a b c] indicates the result from one way ANNOVA for the mean differences. Average productivity bearing differed letters indicate statistically different at 5% level of significant by DMRT (see Appendix 1).

Source: Survey data, 2003.

The average cabbage productivity of IPM farmers was 23% more than the average productivity of non-IPM farmer-1 and 27% greater than non-IPM farmer-2. In relation to the average cabbage productivity among non-IPM farmer groups, the result indicated that non-IPM famer-1 harvested 3% higher than the non-IPM famer-2. This outcome is similar to Nuth (2000) who found that IPM training in five provinces, Kandal, Takeo, Kampong Speu, Prey Veng and Svay Rieng in 1999 on vegetable crops. That study indicated that cabbage yield in IPM farmers plots accounted for about more than 7% (2.14 t/ha) higher than non-IPM farmer plots.

The variations in productivity of cabbage in different farms in two villages are shown in Figure 6. The result indicated that uniform productivity (CV = 3%) of cabbage among the 20 IPM farms. While, the cabbage yield for the two groups of non-IPM farmer-1 and non-IPM farmer-2 fluctuated equally (CV = 8%) among the different farms (Table 11).

The costs of cabbage production in different groups are illustrated in the Table 12, Table 13, and Table 14. The information is based on estimates from data collected during field survey at study site. Among farmers, on an average they cultivate cabbage in 10,000 m^2.

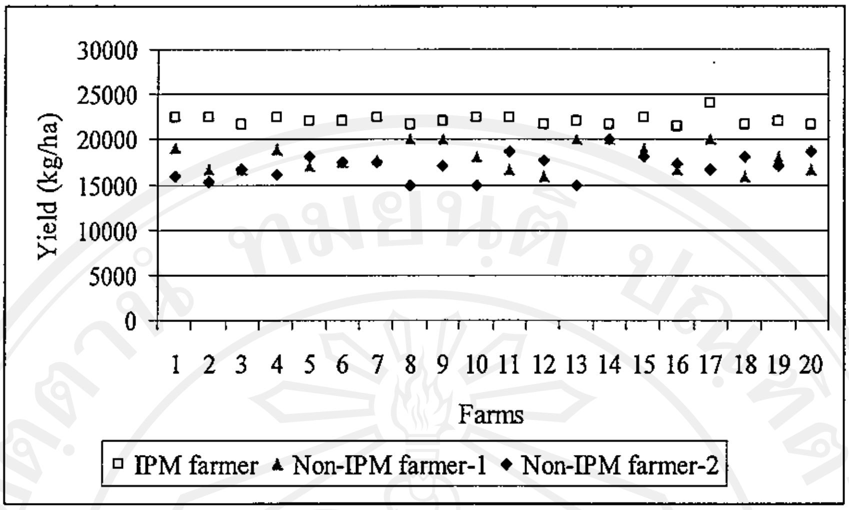

Figure 6. Productivity of cabbage in different farms

The result in Table 12 indicates low variable cost of cabbage production. With the introduction of IPM practices through farmer field school, IPM farmers have reduced the variable cost by minimizing use of chemical fertilizers and pesticides, using moderately and less hazardous pesticides and increasing the crop yield through improved practices. On average farmers spent 2,697,000 Riel per hectare for the use of inputs in one cycle of their cabbage production.

Table 12. Worksheet for deriving average unit productivity values of inputs use on cabbage production per hectare of IPM farmer

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	22,000	kg	700	15,400,000
Variable cost:				
- Seed	400	g		260,000
- Manure	12,700	kg	100	1,270,000
- Urea	300	kg	1,000	300,000
- DAP	154	kg	1,000	154,200
- Pesticide				377,800
- Land preparation				335,000
Total variable cost				2,697,000
Gross margin				12,703,000

Note: DAP=diammonium phosphate, n=number farmer, kg=kilogram
Source: Survey data, 2003.

In contrast non-IPM farmer group generally tended to spend higher on external inputs like chemical fertilizers and pesticides. The results in Table 13 and

Table 14 show that non-IPM farmer-1 and non-IPM farmer-2 spent 16% and 24% higher on external inputs than the IPM farmers respectively.

Table 13. Worksheet for deriving average unit productivity values of inputs use on cabbage production per hectare of non-IPM farmer-1

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	17,900	kg	700	12,530,000
Variable cost:				
- Seed	400	g		260,000
- Manure	8,200	kg	100	820,000
- Urea	417	kg	1,000	417,000
- DAP	296	kg	1,000	296,000
- 16-20-0	240	kg	1,200	288,000
- Pesticide				701,600
- Land preparation				350,000
Total variable cost				3,132,600
Gross margin				9,397,400

Note: DAP=diammonium phosphate, n=number farmer, kg=kilogram
Source: Survey data, 2003.

The details of external inputs use of non-IPM farmer-1 in Table 13 above indicated that they always applied high amount of chemical fertilizers and pesticides in their cabbage plots such as 417 kg of urea, 296 kg of DAP, 240 kg of 16-20-0, and many kinds of extremely hazardous (Ia) pesticides on their cabbage production such as such as Folidol, Foxentol, Metaphos (*methyl parathion*); Phosdrin, Fitor, Lockphos (*mevinphos*); and Marathon (*methamidophos*).

Further, the average cabbage productivity of non-IPM farmer-2 (17 tons) in Table 14 was much lower than IPM farmers' yield and slightly different in term of yield and input used among the two groups of non-IPM farmers at 3,132,600 Riel per hectare (non-IPM farmer-1) and 3,341,900 Riel per hectare (non-IPM farmer-2) respectively.

Table 14. Worksheet for deriving average unit productivity values of inputs use on cabbage production per hectare of non-IPM farmer-2

Item	Quantity	Unit	Price/unit (R)	Value (R)
Average land area	10,000	m^2		
Yield	17,350	kg	700	12,145,000
Variable cost:				
- Seed	400	g		260,000
- Manure	7,100	kg	100	710,000
- Urea	445	kg	1,000	445,000
- 16-20-0	350	kg	1,200	420,000
- 15-15-15	315	kg	1,200	378,000
- Pesticide				763,900
- Land preparation				365,000
Total variable cost				3,341,900
Gross margin				8,803,100

Note: DAP=diammonium phosphate, n=number farmer, kg=kilogram

Source: Survey data, 2003.

6.2.2 Profitability

Profitability is the outcome of what farmers receive back for their effort to cultivate cabbage for their household income. Some farmers get high profit as they are more trained to improve their production practices. On the other hand, farmers who did not participate in IPM program received significantly (Table 15) lesser profit due to poor production technology, low yield and high inputs cost.

The result from field studies carried out for 60 farmers as shown in Table 15 indicates that IPM farmers' inputs use in cabbage production were 20% lower than the average inputs use of both the groups of non-IPM farmers. In addition, the IPM farmers' total revenue of cabbage in one hectare of land was 25% higher than the non-IPM farmers' group.

Moreover, the average profitability was statistically different. The gross margin of IPM farmers from cabbage was 35% more than non-IPM farmer-1; and 44% more than that of non-IPM farmer-2. Importantly, the average gross margin of cabbage of the non-IPM farmer-2 was also 7% lower than the average gross margin of non-IPM farmer-1.

Table 15. Average profitability of cabbage production among the three groups

Farmer	Total input cost	Total revenue	Gross margin	SD	CV
	------------------------(Riel/ha)	------------------------	------------------------		(%)
IPM (n=20)	2,697,000	15,400,000	12,703,000[a]	237	2
Non-IPM-1 (n=20)	3,132,600	12,530,000	9,397,400[b]	801	9
Non-IPM-2 (n=20)	3,341,900	12,145,000	8,803,100[c]	634	7

Note: [a b c] indicates the result from one way ANNOVA for the mean differences. Average profitability bearing differed letters indicate statistically different at 5% level of significant by DMRT (see Appendix 2).

Source: Survey data, 2003.

The variations in profitability of cabbage in different farms in two villages are indicated in Figure 7. The outcome shows uniform profitability (CV = 2%) from cabbage among the 20 IPM farms while, the profitability of cabbage for the non-IPM farmer-1 fluctuated at CV = 9%, and the non-IPM farmer-2 fluctuated at CV = 7% among the different farms.

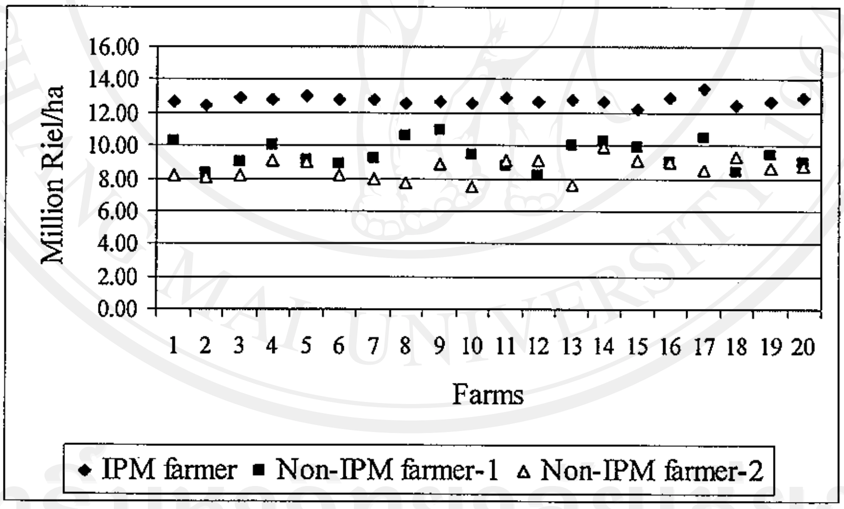

Figure 7. Profitability of cabbage production in different farms

As per the study result the IPM farmers have better advantage on both production and profitability from the cabbage production. The reason for the advantage is the different practice of production technology among the three groups: The IPM farmers follow the production guideline provided by IPM trainer such as proper land preparation, usage of chemical fertilizers at optimum level and increasing the usage of cow dung which leads to higher productivity than non-IPM farmers' group. The non-IPM farmers' groups apply excessive chemical fertilizers, which increase the cost of production and hamper the soil and thus leading not only to the productivity of the crop but also the profitability.

6.3 Implementation of IPM practices

This section explores the implementation of IPM practice with a special focus on IPM farmers by measuring the Acceptability Index (I_a) among the individual recommended practices.

As mentioned earlier, there were 20 IPM farmers in the study area who had participated on farmer field school on vegetable IPM program. These IPM farmers were interviewed on their cabbage production practices. They were asked if they were using the recommended IPM practices on their cabbage production or not. If so on what proportion of their area have they applied the IPM practices for their cabbage plots. The results are shown in Table 16.

Acceptability Index

Acceptability Index (I_a) is one of the indexes to assess extent of adoption of recommended practices and quantifies the adoption (Hildebrand and Poey 1995, cited in Norman *et al.*, 1995). To determine the acceptability Index for a particular technology, information is collected from farmers one or two years after they have participated in large scale testing of technology. The interpretation suggested by Hildebrand and Poey (1995) are as follows:

If acceptability index (I_a) exceed 25 and "C" (percentage of farmers who participated in using technology on at least part of the crop at the time of interview) is equal to or greater than 50, it means that it has a good chance of being adopted. It is important to consider the magnitude of both "C" and "A". Low "C", indicates that only a few farmers are adopting the technology; and low "C" combined with a high "A" (the percentage of area they planted with the technology compared to the total area planted to the particular crop), indicates that those using the technology were using it on a large portion of the land planted to the crop.

The acceptability was operationalized using parameters like different acceptance such as the percentage of the IPM farmers adopting component of cabbage technology packages related to seed selection, land preparation, fertilizer application, pesticide application, and harvest of the area they planted with IPM practice compared to the total area of cabbage production.

The survey result (Table 16) from the study area indicated that most of the IPM practices were applied by IPM farmers, of which acceptability index value for seed selection, land preparation and harvest was high at 100%, 70% and 100% respectively. As a rule of thumb, these IPM practice had more chance of adoption or in other words, more IPM farmers adopted them, except the fertilizer application and pesticide application, where the IPM farmers scored a very low value in acceptability index at 37% and 10% as some of them still believe the use of many types of extremely and highly hazardous pesticide and applying more amount of chemical fertilizer would help them to control pests and make their cabbage healthy and marketable with a high price.

The acceptability index value of seed selection at 100% indicated that seed selection to IPM practice was perfectly accepted by the IPM farmers (100%). IPM farmers mostly grow KK-cross (F_1) that is heat tolerant and early maturing, the recommended variety of cabbage for cultivation in Cambodia by KKVRC (1996).

In cabbage production system the land preparation were done by plowing at least three times among IPM farmers who have adopted the IPM practice. Some of the IPM farmers usually used to plow their field once or twice only. The study has shown that 85% of IPM farmers (at acceptability index value of 70%) have adopted the IPM practice on land preparation system. Further the study has clearly shown that 100% of IPM farmers have adopted the harvesting technology introduced by IPM trainer in all cabbage planted area with an acceptability index value for harvest was 100%. As per the IPM trainer the crop should be harvested after two weeks of pesticide application. This IPM practice needs not only the time but also the IPM farmers' skills and it requires repeating the practices in their cabbage field.

Table 16. Summary of the acceptability index value of IPM practices

IPM practice	Respondent		C	A	I_a
	No. participated	No. adopted	---------(%)---------		
Seed selection	20	20	100	100	100
Land preparation	20	17	85	83	70
Fertilizer application	20	13	65	57	37
Pesticide application	20	6	30	34	10
Harvest	20	20	100	100	100

Source: Survey data, 2003.

In addition, the values of "C" and "A" were used to gain more insight of the magnitude of IPM practice acceptance. The value of "C" was 65% and "A" was 57% for fertilizer application, which demonstrated that more than half of IPM farmers were actually accepted this IPM practice.

The acceptance of fertilizer application was concerned mainly on the knowledge that reducing the amount of chemical fertilizer, the balanced nutrients application than their cultural practices or not applying chemical fertilizer in the wrong ways to reduce the loss from leaching. However, some of the IPM farmers do not follow the guidelines; and about less than half of the IPM farmers in project area (30%) used IPM recommended on pesticide application in case of severe infection of pests and diseases on cabbage crops. The 30% of IPM farmers spray Class II (moderately hazardous pesticides) and Class III (slightly hazardous pesticides) level of chemical to protect their crops as recommended to them by IPM trainer, while most of IPM farmers (70%) still continue using class Ia (extremely hazardous chemical products) and Ib (highly hazardous chemical products), i.e. *methyl parathion*, *mevinphos*, and *methamidophos* (treadmill).

On the average, 85% of cabbage land planted "A" by IPM farmers compared to high "C" ranged from 65-100% of seed selection, harvesting, land preparation and fertilizer application that was recommended by IPM trainer was devoted to IPM practices. In the same way, the farmer field school approach for IPM technology packages was first adopted in Indonesia in 1989, providing farmers with the tools they needed to practice IPM in their own fields (FAO, 2002).

In brief, the acceptability index analysis shown that the acceptance of IPM practices was not uniform among IPM farmers and it indicated that having a good chance of acceptance by IPM farmers. Seed selection and harvest received the highest acceptance of 100% followed by land preparation 70%, chemical fertilizer application 37%, and pesticides application 10%.

6.4 Effectiveness of farmer field school approach

6.4.1 Farmers' knowledge of natural enemies, pests and diseases

With the introduction of chemical insecticides in the 1950s, the control of insect pests became a simple task for farmers (Hoffmann, 1993). However, it soon became obvious that there were other problems associated with the use of insecticides to control all pests and diseases on vegetable. Insect pests became resistant to pesticides, environmental and health hazards were identified, non-target organisms were affected, and pest and disease resurgence occurred. Today, the protection of food and fiber crops from insect pest and disease in conventional agricultural systems still relies primarily on the use and continued availability of chemical pesticides. In vegetable crops there is a need to develop alternatives to conventional pesticides or control measure may be more acute than in other commodities. As vegetables are considered minor crops in many areas, new insecticides are less likely to be registered or existing ones re-registered. Further more, all insect pests of vegetables have natural enemies. This organism may be predators, parasitoids, or disease causing pathogens. Therefore, Integrated Pest Management strategy through farmer field school approach educates farmers to identify natural enemies, pest, and disease that occur in one cycle of cabbage production and have the proper measures to control all these problems in promoting the yield, reduces the use of chemical inputs and generates higher return.

The result in Table 17 indicates the percentage of three different groups of farmer who could identify natural enemies in their cabbage field. All the 60 respondents knew bird and frog as natural enemies of the insects as a whole. Among other natural enemies, 100% of IPM farmers could identify lady beetle, spider, and vespid; while less than 15% of the non-IPM farmer-1 knew lady beetle, spider, and vespid.

Table 17. Percentage of farmer who could identify natural enemies

Natural enemy		IPM Farmer	Non-IPM famer-1	Non-IPM farmer-2
English name	Local name	---------------(n=20)---------------		
Bird	*Chap*	100	100	100
Frog	*Korngkeb*	100	100	100
Lady beetle	*Ordoeukmeas*	100	10	0
Spider	*Pingpieng*	100	15	0
Vespid	*Ormal*	100	10	0
Long-horned grasshopper	*Kandobantenveng*	75	5	0
Carabid beetle	*Sarengmachholbei*	80	5	0
Dance flies	*Ruyrabam*	70	0	0
Ground beetle	*Kmotdei*	85	0	0
Long-horned cricket	*Changretkantol*	70	0	0
Mirid bug	*Kmotdeikouteal*	65	0	0

Source: Survey data, 2003.

In contrast none of the non-IPM farmer-2 could identify any of the natural enemies. Even within the IPM farmers, only 65-85% of them knew the long-horned grasshopper, dance flies, long-horned cricket, ground beetle, carabid beetle, and mirid bug as natural enemies. Generally, both groups of non-IPM farmers seem to have limited knowledge on this group of natural enemies. The difference in knowledge of two groups of farmer regarding natural enemies adequately validates the benefit of farmer field school in IPM program to help farmers to identify beneficial insect. With the acquired knowledge, farmers can make right decision for application of appropriate pesticides judiciously in their cabbage field.

Similar to identification of natural enemies, respondents were asked about their knowledge of insect pests prevalent in cabbage. The interview revealed that 70-100% of IPM farmers could identify most of the insect pests (Table 18). In contrast only 25-35% of non-IPM farmer-1 and non-IPM farmer-2 were aware of the insect pests. Notably, at least 55-75% of IPM farmers could recognize hispa beetle, green stink bug, spiny, red spider mite, cabbage sawfly, green looper, legume pod bug, and cabbage shield bug while only at most 5% each of non-IPM farmer groups knew cabbage shield bug. The ability to identify insect pest will help farmers in better farm management of the insect pests.

Table 18. Percentage of farmers who could identify insect pests

Insect pest		IPM farmer	Non-IPM famer-1	Non-IPM farmer-2
English name	Local name	--------------(n=20)--------------		
Flea beetle	*Tekkou*	100	35	30
Webworm	*Dangkouvsybandol*	100	35	30
Legume aphid	*Chaisandek*	95	30	30
Armyworm	*Dangkovtorb*	95	35	30
Diamondback moth	*Dangkovyurltong*	95	35	25
Cabbageworm	*Dangkovspeykadorb*	90	30	20
Leaf miner	*Dangkovsygne*	90	35	30
Green looper	*Dangkovbaknorng*	70	25	15
Cabbage shield bug	*Sarengspeykadorb*	70	5	5
Green stink bug	*Sarengbaytorng*	75	0	0
Red spider mite	*Pingpangkrorhorm*	70	0	0
Hispa beetles	*Kangongbanlar*	65	0	0
Cabbage sawfly	*Dangkovroyrana*	65	0	0
Legume pod bug	*Sarengchhornchhouk*	55	0	0

Source: Survey data, 2003.

Within the farmer field school approach farmers are taught about insect pests, natural enemies and vegetable diseases. The result on knowledge about cabbage diseases in Table 19 indicated that 100% of IPM farmers could identify white mould, soft rot, and leaf rot, while only 15-30% of non-IPM farmer-1 and 15-20% of non-IPM farmer-2 were familiar with these three diseases.

As much as 50-70% of IPM farmers reported to have knowledge about diseases similar to leaf spot, black leaf mould, black rot, and grey mould. IPM farmers attributed their knowledge about diseases from the farmer field school training organized by IPM program.

Table 19. Percentage of farmers who could identify diseases

Disease		IPM farmer	Non-IPM famer-1	Non-IPM farmer-2
English name	Local name	----------------(n=20)----------------		
White mould	*Kra*	100	20	20
Soft rot	*Roluykoul*	100	30	15
Leaf rot	*Roluysanlek*	100	15	20
Grey mould	*Chome*	70	0	0
Black rot	*Kamoakoul*	65	0	0
Leaf spot	*Ochsanlek*	55	0	0
Black leaf mould	*Kamaosanlek*	50	0	0

Source: Survey data, 2003.

Therefore, Integrated Pest Management strategy through farmer field school approach educates farmers to identify natural enemies, pest, and disease that occur in one cycle of cabbage production and have the proper measure to control all these problems in promoting the yield, reduces input use and generates high return.

6.4.2 The use of fertilizers

Fertilizers have played an important role in improving soil fertility, increasing crop yield and enhancing food security. However, the over dose of chemical fertilizer applied to cabbage by farmers due to their cultural practices result not only in low yield but also destroys the soil structure, and accumulates in the soil and crop. Moreover, the acceleration of nutrient induced by the use of synthetic fertilizer dramatically increased the environmental stress on agro-ecosystems (Giampietro, 1997). The application of chemical fertilizer to rice or vegetable has potential unintended consequences that are of increasing concern in many parts of the world (Mishama *et al*., 1999; Xing and Zhu, 1999). Negative effect on the quality of surface and groundwater are the most common environment impacts.

Intensification of production by applying high nutrient rate in irrigated areas has been reported of nitrogen accumulation in surface and groundwater. Similarly, in the rainfed lowlands, intensification of production by growing dry season vegetables using supplementary irrigation is causing high leaching losses of NO_3-N into groundwater (Shrestha and Ladha, 1999).

The good theoretical guidance from different perspective of scientists advice not only to look at the productivity alone but also to consider about the environmental friendly production systems. Generally, the IPM farmers use cow dung, urea, diammonium phosphate (DAP) for improving their cabbage production, while non-IPM farmer-1 applies three types of fertilizer (urea, DAP, and 16-20-0) and non-IPM farmer-2 also uses urea with 16-20-0 and 15-15-15 for their cabbage crop (Table 20).

Table 20. The stage of fertilizer application of IPM farmer

Type of fertilizer use	Quantity (kg/ha)	Basal	Topdressing/stage (DAT) 10	20	30	40	50
Cow dung	12,700	100%					
DAP	154	100%					
Urea	300		10%	20%	30%	20%	20%

Not: DAT= Day after transplant
Source: Survey data, 2003.

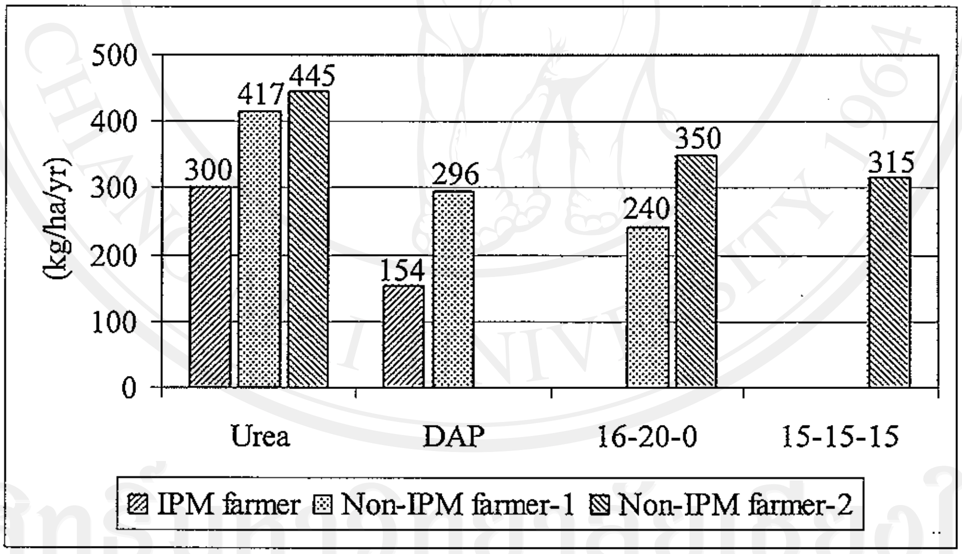

Figure 8. Average in different chemical fertilizers used by farmer groups in cabbage production (kg/ha/yr)

In addition, application of higher amount of chemical fertilizers by farmers lead to higher expense on input cost and environmental degradation. According to the survey result, among the three groups of farmer (Figure 8), the majority of non-IPM farmers at the study site applied higher amount of synthetic fertilizer for increasing their productivities without taking any consideration about the impact to environment in comparison with IPM farmers. Notably, non-IPM farmer-1 applied 417 kg/ha of urea, 240 kg/ha of 16-16-16 and 296 kg/ha of DAP, and non-IPM farmer-2 used 445 kg/ha of urea, 350 kg/ha of 16-16-16 and 315 kg/ha of 15-15-15 which was higher than IPM farmers who applied only 300 kg/ha of urea and 154 kg/ha of DAP. In general, IPM farmers applied cow dung, DAP for basal and urea used for topdressing stage in their cabbage plot as shown in Table 20. Most IPM trainers/district trainers/IPM farmer trainers commonly used all types of chemical fertilizer used above but they are not completely accurate. It is really flexible based on the types of soil and their experience and National IPM program or Department of Agronomy and Agricultural Land Improvement do not recommend it. It is based on trainers' experiences.

6.4.3 The use of pesticides

Pesticide use has recently been intensified in Cambodian agricultural practices. It is used in greater volumes on vegetables, 72 liters or kilogram per hectare per year than rice, 1 liter or kilogram per hectare per year (CEDAC, 2000).
Earlier evidence by way of experience in farmer field school revealed that in Cambodia the use of pesticides had filtered down to the smallest of villages.

According to individual interviews, it was found that cabbage growers were in particular heavy users of pesticides and had become dependent on highly toxic pesticides to manage pests and diseases. Farmers often mixed and sprayed a cocktail of dangerous insecticides repetitively to one vegetable crop. The availability of pesticides, lack of information and knowledge of hazards as well as illiteracy and lack of health facilities seemed to ensure that pesticides could be a major cause of poisoning and in poor health in rural communities.

The majority (98%) of non-IPM farmer groups interviewed said that they believed the use of pesticides helped them control pests and make their cabbage look "beautiful", healthy and marketable, and therefore could be sold for a good price. Nearly all non-IPM farmers believed that the more products used at one time-in quantity, frequency and types of insecticide-the greater the benefit. *"The cabbage crop would become healthier"*. Thus, pesticides are regarded as very important for successful cabbage production. These farmers said that they could not grow cabbage without pesticides.

Interestingly, 100% of respondents in IPM farmers thought that spraying pesticides did not always result in good produce, but sometimes caused more harm than good. If they used an incorrect pesticide or mixed several chemicals together for a specific crop, it would do more damage to the plant. However, they said they have *"no choice"* and therefore the cost of taking the risk was lower than not to use any pesticide at all.

However, 30% of IPM farmers still use some extremely (Ia) and highly hazardous (Ib) pesticides, although 70% out of them used moderately (II) and slightly hazardous (III) pesticides on their cabbage production like Thiodan 35EC (*endosulphan*), Regent 800WG (*fipronil*), and Pegasus 500DD (*diafenthiuron*).

During the survey, the interviewer identified the names of the pesticides by observing the product farmers either used or had stored in their homes. Generally, farmers did not know the name of the product they used and referred to the chemical by the color of bottle, its strength or specific controlling purpose.

The study found numerous pesticides in use by the respondent farmers in study site, including Folidol, Foxentol, Metaphos 40ND (*methyl parathion*), Phosdrin, Lockphos, Fitor (*mevinphos*), Marathon (*methamidophos*), Thiodan 35EC (*endosulfan*), Regent 800WG (*fipronil*), and Pegasus 500DD (*diafenthiuron*).

Methyl parathion and *mevinphos* were classified in 1998-99 by the World Health Organization's International Program on Chemical Safety as Ia products (extremely hazardous to human health) while *methamidophos* as class Ib, highly hazardous; *endosulfan* and *fipronil* are class II, moderately hazardous, and *diafenthiuron* class III, slightly hazardous pesticides. Most of these products have been banned in the rest of Southeast Asia. It therefore appears that Cambodia is serving as a dumping ground for products that cannot be sold in countries neighboring Cambodia.

Looking at the most common types of pesticides used in the study areas, as shown below in Figure 9, it is alarming to note that 73%, 35%, 30%, 48%, 30%, and 15% of the respondents in non-IPM farmers used Folidol, Phosdrin, Fitor, Metaphos 40ND, and Lockphos respectively, while only 10%, 20%, 10%, 5%, and 15% of IPM farmers also used class Ia product. Interestingly, 35%, and 40% of IPM farmers used class II and III, Regent 800WG and Pegasus 500DD, whereas no one in non-IPM farmers' groups have applied.

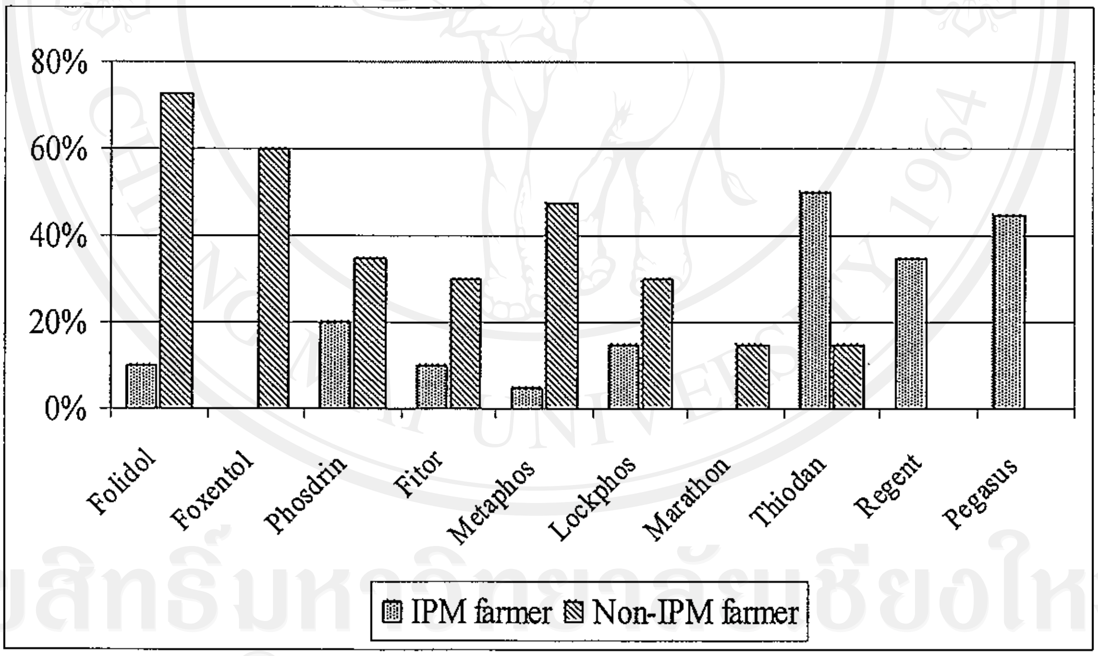

Figure 9. Type of pesticides used by farmer groups

6.4.4 Advantages and disadvantages of farmer field school

A farmer field school approach centers on the farmer and their needs. Its effectiveness heavily depends on the way it involves and motivates farmers. The motivation it generates for cohesive decision and actions in crop and pest management will depend on its effectiveness. The results from the workshop conducted in October 2003 with 20 IPM farmers to discuss about the effectiveness of farmer field school approach are as presented in Table 21.

Table 21. Advantages of farmer field school for IPM program

Factor	IPM farmer (n=20) -----------(%)----------	
	Yes	No
Increase cabbage productivity	93	7
Reduce the cost of production	90	10
Enhance knowledge	100	0
Learning by doing	100	0
Self decision making	95	5
Informal setting for learning (Field based learning)	85	15
Rapid problem solving	80	20
Team building	75	25
Collective learning	70	30

Source: Result workshop, October 2003.

The study found that through the farmer field school approach for IPM practices, the productivity per hectare of cabbage had increased for IPM farmers. It was reported to be 22 t/ha, where as the yield of non-IPM farmer was only 17-18 t/ha (Table 11). This high yield for the IPM farmers was mainly due to adoption of IPM strategy like proper land preparation, good nutrient management which improved soil fertility, judicious use of pesticides, crop rotation, and use of healthy planting material and timely implementation of all their agronomic practices.

Similarly, 90% of IPM farmers reported that their cost of inputs mainly for pesticide and chemical fertilizer had come down. This *reduction in cost* was due to less use of pesticide and chemical following the principle of IPM practices. IPM farmers were more aware of pesticide hazard to human health, resistance developed by pest due to frequent use of pesticide and destruction of beneficial insect's population. Further farmers had reduced the use of chemical fertilizer, as they were aware of decreasing soil health.

As per the study, 60-100% of IPM farmers could identify natural enemies, 55-100% of IPM farmers could identify insect pest, which causes damage to cabbage.

Similarly, 50-100% of IPM farmers were able to identify diseases in cabbage. IPM farmer field school has also created more awareness among IPM farmers about overuse of pesticide, chemical fertilizer and importance of using healthy planting material and adopting proper agronomic management practices. Study also found that IPM farmers were more conscious about pesticide hazard, residual effect of pesticides and overall benefit of producing healthy cabbage.

The result in Table 21 indicated that 100% of IPM farmers reported that the field school offered them the opportunity to learn by doing, by being involved in field experimentation, discussion and decision-making. Farmers learnt by carrying out for themselves the various activities related to cabbage production. The key thing is that farmers conduct their own field studies. The aspect of learning by doing was further explored and discussed with the farmer for better understanding.

According to Ooi (1996), farmer field school provides an opportunity for learning-by-doing, based on principles of non-formal education. Extension workers or trained farmers facilitate the learning process, encouraging farmers to discover key agro-ecological concepts and develop IPM skills through self-discovery activities practiced in the field.

IPM farmers considered learning about production packages, pest and disease management, and safe handling of pesticide as important aspects learnt by doing collectively under the guidance of IPM farmer trainers. The result showed that 95% of the farmers acquire much needed knowledge on beneficial insects, insect pests and disease identification from participating in the farmer field school training. In addition, more than 75% of the farmers considered that they learnt lessons on crop production, safe handling of pesticides and pest and disease management from farmer field school training (Figure 10).

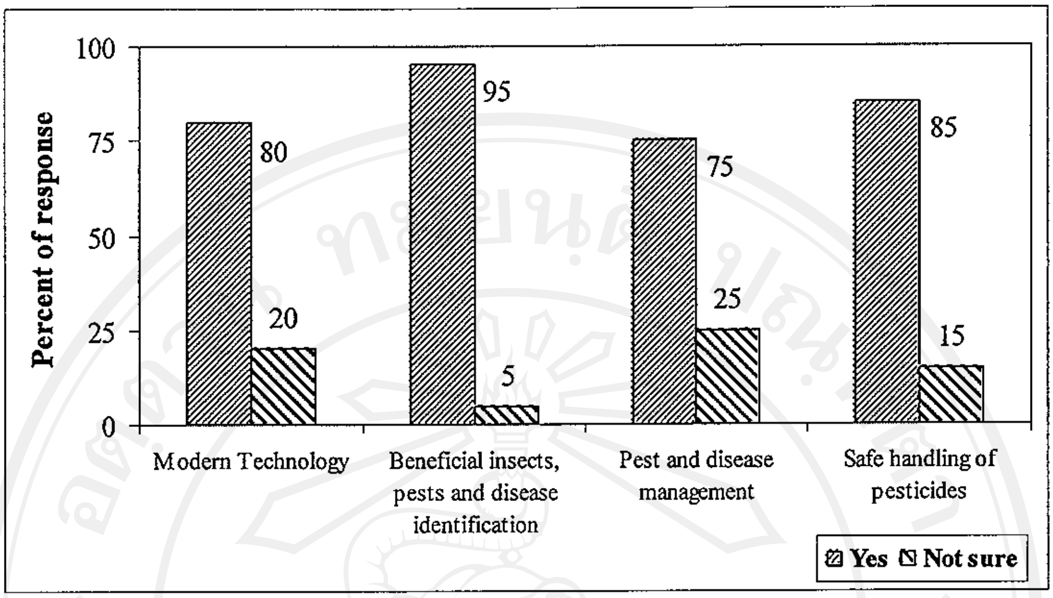

Figure 10. Lesson learned by participation in farmer field school training

95% of IPM farmers informed that the farmer field school provided them with tools, which enabled them to analyze their own production practices and identify possible solutions by self decision-making. Similarly 85% of IPM farmers expressed that all learning in farmer field school is field based. The field is where they learn and work in small sub-group; they collect data in the field, analyze the data, make decisions based on their analysis of the data, and present their decision to the others farmers in the field school for further discussion, questioning, and refinement.

According to 80% of IPM farmers the rapid problem solving capability of farmer field school enhances its effectiveness in the field. Within farmer field school, form of training problems is seen as challenges, and not a constraint. Farmer groups are taught numerous analytical methods, problems are posed to groups in a graduated manner such that trainees can build confidence in their ability to identify and tackle any problem they might encounter in the field, while 20% of them did not consider rapid problem solving as an advantage of farmer field school (Table 21).

Majority of the IPM farmers (75%) reported that team building is advantageous for farmers who participated in farmer field school training that included communication skill building, problem solving, leadership, and discussion methods. On the other hand 25% of the IPM farmers did not find that team building would play a significant role in farmer field school training.

Further, 70% of IPM farmers pointed out that farmer field school approach also helps in collective learning of crop husbandry, horticulture and animal husbandry in association with agro-ecology, economic, society and education to form a holistic approach. Problems confronted in the field are the integrating principle. Interestingly, 30% of IPM farmers did not consider collective learning as an advantage of farmer field school approach (Table 21), which may be because of the intensive learning process and the limited possibility of obtaining such knowledge within a short period of time.

At the same time knowledge intensive nature of farmer field school was reported as the main limiting factor of its approach, which was validated by 70% of IPM farmers who explained that farmer field school training requires lot of learning about the management practices, natural enemies and insect pest behavior and understanding about the agro-ecological principles (Table 22).

Table 22. Disadvantages of farmer field school for IPM program

Factor	IPM farmers (n=20) ----------(%)----------	
	Yes	No
Knowledge intensive	70	30
Require more time to learn IPM principles	60	40

Source: Result workshop, October 2003.

Further, 60% of IPM farmers also complained that farmer field school training is highly time demanding as farmers have to spend lots of time in training and meetings as per the schedule. There are chances that farmers would be constrained by time for other farm and non-farm activities. Yet there were 40% of IPM farmers who did not consider time as a limiting factor to learn IPM principles.

6.4.5 Effectiveness of farmer field school approach for IPM practices

The Multi-Criteria, Multiple Scale Performance Space (MCMSPS) was used to conduct comparative study of different approach. Four criteria related to productivity, profitability, fertilizers use, and farmers' knowledge on individual spines (Figure 11) was used to make the comparison. Each spine is calibrated from zero at the origin to 80% further from origin, so that the further the web is from the origin, the better it is in case of knowledge, productivity, and profitability while the use of fertilizers is worst when the gap is bigger.

The productivity index of IPM farmers was 38%, non-IPM farmer-1 was 31% and for non-IPM farmer-2 was 30%. Similarly, the web figure shows the profitability of different groups. The non-IPM farmer-1 and 2 obtained 30% and 28% respectively and the profitability of IPM farmers, which stood at 41%.

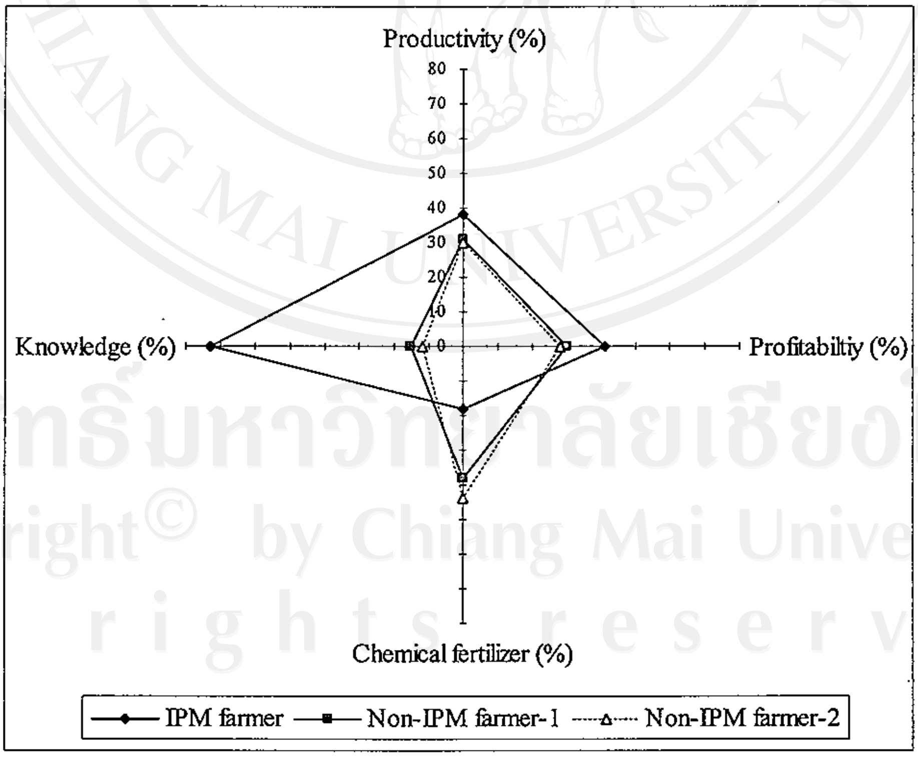

Figure 11. Effectiveness of FFS approach for IPM practice on cabbage production

Figure 11 also shows the effectiveness on farmer's knowledge from field school approach for IPM practices on cabbage production by the three categories. The result indicated that 73% of the IPM farmers who had attended farmer field school for IPM practices were able to identify natural enemies, pests and diseases while the non-IPM farmer-1 and non-IPM farmer-2 could identify only 15% and 12% respectively, which indicated better knowledge in IPM farmers.

Giampietro *et al.* (2001 cited in Gliessman, 2001) advised that the acceleration of nutrient induced by the use of synthetic fertilizers dramatically increased the environmental stress in agro-ecosystems. Similarly the study result indicated that IPM farmers apply small amount of chemical fertilizers in their cabbage at 18% while non-IPM farmer-1 apply 38% and non-IPM farmer-2 apply 44%.

6.5 Potential for diffusion of IPM program

Ever since FAO, through its Inter-country Program for Development set up an international vegetable IPM training project on vegetable to support the National IPM program in 1997 by using the Farmer Field School model as pilot program in Kandal province, the number of farmers adopting IPM has dramatically increased from 35 farmers in 1997 to 1,170 farmers in 2000 (Nuth, 2000). It indicated that IPM program has great potential in Cambodia. The success of past IPM program was also influenced by rapid expansion of vegetable production for urban markets. However, it is important to understand clearly the factors that influence dissemination of IPM program, such that future expansion can adequately address such issues.

Table 23. Discussion result of workshop by IPM staff and IPM farmers

Factor	Description
Funding	Training, input supply, subsidy
Technical knowledge	Trainer/Extension staff/Facilitator
Farmers' need	Cabbage production problem
Farmer participation	Willingness to participate regularly
Administrative support	Input supply, credit, support to organize farmers' group

Source: Result workshop, October 2003.

The result from workshop organized with IPM staff, IPM farmers and non-IPM farmer-2. Broadly there were five factors (Table 23), which they considered for discussion.

The result from the workshop conducted with IPM staff and IPM farmers to identify factors influencing the potential for IPM program dissemination among non-IPM cabbage growers indicated that farmers' need as the most important factor, followed by technical knowledge and farmer participation. IPM staff also considered funding as a factor, while 36% of them did not consider administrative support as an important factor (Table 24).

Majority of the IPM farmers (90%) reported farmer participation as the most important factor for spreading of the program. Similarly, 79% of IPM staff and 85% of IPM farmers considered the need for managing the crop as a vital factor. IPM farmers also suggested that majority of them (60%) were not certain if administrative support would play any role in dissemination of IPM program. Interestingly, 25% of the farmers did not consider funding as a factor because cultivating cabbage is an important source of income for the farmers.

Table 24. Factors for dissemination of IPM program by IPM staff and IPM farmers

Factor	IPM staff (n=14)			IPM farmers (n=20)		
	(%)					
	Yes	No	Not sure	Yes	No	Not sure
Funding	64	14	21	60	25	15
Technical knowledge	71	29	0	80	0	20
Farmers' need	79	21	0	85	0	15
Farmer participation	71	0	29	90	0	10
Administrative support	50	36	14	40	0	60

Source: Result workshop, October 2003.

Based on the informal interviews and discussion with staff and farmers during workshop, it was reported that administrative support to organize farmer groups, meetings, field visits and training will play a vital role for the success of farmer field school in IPM program. Based on the past experiences of the staff and farmers, it was also reported that funding could be a major limiting factor to initiate such program in new areas. Fund is generally required for the purchase of training equipments, supplies and simple agricultural tools.

With the increased demand for vegetable, particularly cabbage, most farmers in the study area cultivate cabbage as cash crop to generate household income. As farmers use local knowledge or traditional practices to grow cabbages they often yield lower and subsequently earn low income. Workshop result (Table 25) shows that all the non-IPM farmer-2 considered the pest and disease problem as the most important determining factor that would influence the dissemination of IPM program.

Table 25. Potential factors for dissemination of IPM program by non-IPM farmer-2

Factor	Non-IPM farmers-2 (n=20) ----------------(%)---------------		
	Yes	No	Not sure
Pest and Disease problem	100	0	0
Want to grow cabbage	90	0	10
Lack of knowledge	70	30	0
Low productivity	85	15	0

Source: Result workshop, October 2003.

As 90% of the farmers have desire to grow cabbage, IPM practice on cabbage has potential for rapid acceptance. Further, 70% of farmers indicated that they also lack knowledge in growing healthy crop of cabbage. Due to poor crop management, 85% of farmers responded that they get a very low production of cabbage.

Study also found that 70% of the IPM farmers were willing to share the IPM knowledge and recommend it to their friends and neighbor. But some of IPM farmers were not will to share the IPM technology to other farmers due to fear of competition.

Considering the increased productivity, profitability and farmer's knowledge of IPM farmers and at the same time, the constraints faced by non-IPM farmer-2 for cabbage production, there is a large potential to diffuse IPM program. However, the factors identified, as output of workshop should be given due consideration for the successful dissemination of IPM program to other areas among vegetable growers.