CHAPTER 4

RESULTS OF FIELD SURVEY

The status of pest management and rice production practices of rice farmers was studied in Roleang Ken commune where double cropping of rice had been made possible due to the provision of irrigation facilities. Chief outputs of this field study furnished with a great deal of thoughts over the changes in knowledge and perception on pest management practices, which was typically concordant with the first set objective of the proposed research attempt, of rice farmers against the rising pest problems.

To broaden the ideal picture of this objective the study involved two groups of rice farmers, namely, the non-IPM and-IPM farmers. The non-IPM farmers are simply defined as those who have not been trained about the integrated pest management (IPM) approach, whereas the IPM farmers are defined as those who graduated from the IPM farmer field schools. They were randomly selected from four villages, including Thmei, Chamkar Tanget, Krang Rolous and Roleang Ken, of Roleang Ken commune, Kandal Steung district, Kandal province. Total numbers of household respondents included in the survey are presented in Table 3.

Table 3: Household respondents included in the survey.

Village	No. of respondents	
	Non-IPM farmer	IPM farmer
Thmei	10	10
Roleang Ken	10	10
Krang Rolous	10	10
Chamkar Tanget	10	10
Total	40	40

4.1. Biophysical settings of the survey site

4.1.1. Climatic condition

The climate in the study area is divided into rainy and dry seasons under the influence of the monsoon regime. Hot and wet condition of the rainy season normally starts from May to November, while a relatively cool weather during the dry season occurs from December to January. Climatic condition in Kandal province is presented in Figure 1.

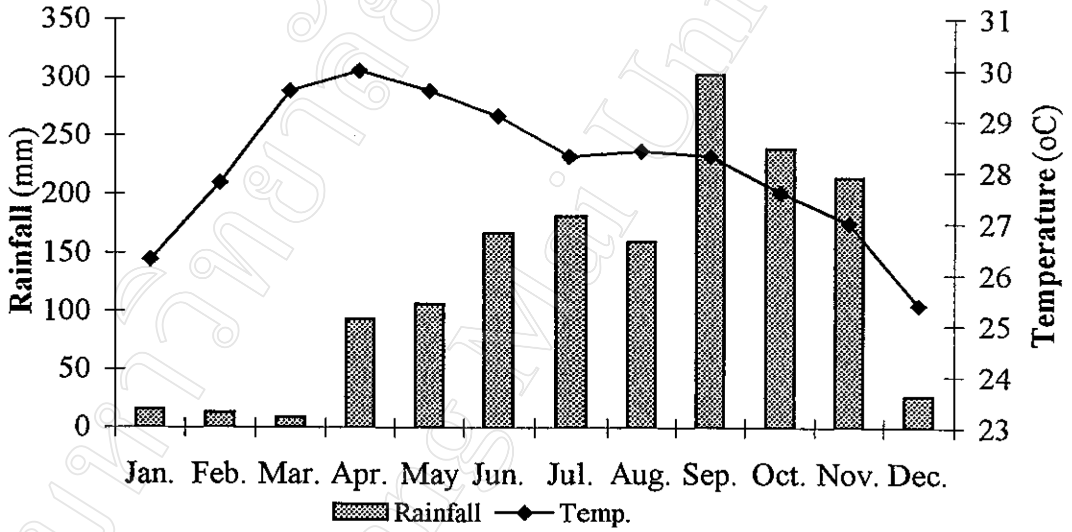

Figure 1. Four-year average of rainfall (mm) and temperature (°C) in Kandal province (1996-1999).

Source: Pochentong Meteorological Station (2001)

A mini dry season, which occurs regularly from late July to mid-August, often causes drought, seriously affecting rice production in the study area. A medium to maximum temperature trend is felt from February to April, respectively. The annual average temperature fluctuated from 25.4°C (December) to 30°C (April). The annual average rainfall ranged from 1,400 mm to 1,618 mm and 90 percent of the rain concentrates in the rainy season.

4.1.2. Change in rice production practices

Roleang Ken is one of 23 communes of Kandal Steung districts, Kandal province. With a total population of 4775 person, it is situated about 50km west of Phnom Penh capital. The commune covers the total area of 740 ha in which 69% (512 ha) is under agricultural production. It had been converted into a rice-based development community since 1997 through the improvement of irrigation scheme. As a result, an intensive rice farming system, i.e., double cropping of rice, had been made into existence. In present days, this rice cultivation system was observed making its ways back to the period before it was introduced. Most farmers have abandoned the dry season rice due to the shrinking support by the government, that is diesel for the operation of pumping machine, and unwell-organized water use committee. Consequently, a rainfed rice monoculture has once again become the only predominant cropping system in the commune.

In general, the commune is characterized as one of areas with relatively low agricultural productivity given that it is part of the Prateah Lang soil group, known as soil with little potential to achieve high yields of rice due to its very poor soil fertility (Oberthür *et al.*, 1997). Unfertilized rice yields on these soils range from 800 to 1400 kg ha^{-1} (White *et al.*, 1997). Nevertheless, results of the field survey revealed that rice yields in the area were relatively high, with an average yield of 2.3 t ha^{-1} (Chhum, 2001). The increase in rice yields in this commune may have owed primarily to the high application of inorganic fertilizers.

In addition to the many interesting changes in scenarios of rice production of the area, it was observed that pest problems are also becoming more momentously intensified. Discussions with researchers, key informant, and farmers have revealed that pest damages have increased in both their frequency and intensity over the past 2 or 3 years. Farmers had little knowledge about the causes of these repeated occurrences of pest infestations. In response to these mounting pest frustrations, it was reported that the levels of pesticide use by rice farmers in the area have risen noticeably. This is causing a great concern over the aggravation of the rice ecosystems, pollution, and related health hazards in the area. The case provided important impetus for the selection of the above commune as the study site.

4.2. Farmer profile

Female respondents were the dominants in this survey. Of the farmers interviewed under each category (non-IPM and IPM) females were 70% and 60%, respectively. All farmers were owner-operators. Non-IPM farmers ranged in age from 18 to 62 years with an average age of 42.6 years. IPM farmers ranged in age from 18 to 67 years with an average age of 39.2 years. Respondents in both categories had 0 to 8 years of education. Nevertheless, results indicated that average year of education of the IPM farmers were slightly higher than that of the non-IPM farmers. Average year of education of the non-IPM farmers against IPM farmers was 3.2:4.7 years. Most respondents spent most of their lifetime as rice farmers. Experience in rice farming ranged from 3 to 50 years with an average of 24.8 years, for non-IPM farmer, and 3 to 53 years with an average of 23.1 years, for IPM farmers. Farm size of non-IPM farmers ranges from 0.2 to 1.7 ha, with an average size of 0.66 ha, while the farm size of IPM farmer ranges from 0.15 to 1.4 ha, with an average size of 0.58 ha. Farmer profile in each village is presented in Table 4.

Table 4. Farmer profiles in survey villages.

Village	Non-IPM farmer (n = 10)				IPM farmer (n = 10)			
	Ave. Age (year)	Ave. Edu. (year)	Ave. Exp. (year)	Female (%)	Ave. Age (year)	Ave. Edu. (year)	Ave. Exp. (year)	Female (%)
Chamkar Tanget	35.6	4.2	18	60	33.9	5.9	17.6	50
Thmei	41.4	2.8	23	80	47.1	3.4	31.3	50
Roleang Ken	47.5	2.5	29.4	80	42.5	3.2	27.2	70
Krang Rolous	45.8	3.2	28.7	60	33.3	6.3	16.4	70
Overall Average	42.6	3.2	24.8	70	39.2	4.7	23.1	60

Note: - n = number of farmers interviewed in each village.

- Ave. Age = Average Age.
- Ave. Edu. = Average Education.
- Ave. Exp. = Average Experience.

4.3. Agronomic practices

4.3.1. Seed use

All farmers transplanted their wet season (WS) rice. On average, seedlings were 48 days old at transplanting and farmers planted 5 to 6 seedlings per hill. Hills were planted at an average of 25 to 26 cm apart. Both groups of farmers reported growing 14 different rice varieties. Most farmers, however, grew traditional varieties. The most popular traditional variety was Srao Sar, a late duration rice variety grown by 22.5% of the farmers. Approximately, 58.8% of farmers used seeds from their own stocks (seed harvested from the previous season), whereas the rest of farmers, about 38.8%, obtained or exchanged seeds with friends and neighbors (Table 5).

Table 5. Number of farmers receiving seeds from different sources.

Village	Self	Neighbor	Government
Chamkar Tanget	13	7	0
Thmei	9	9	2
Roleang Ken	11	9	0
Krang Rolous	14	6	0
Total	47	31	2
%	58.8	38.8	2.5

On individual farmer basis, amount of seed use by farmers varied from 59-kg ha^{-1} to 127.5-kg ha^{-1}, for non-IPM farmers, and from 45.6-kg ha^{-1} to 133.3-kg ha^{-1}, for IPM farmers. On village basis, however, overall amount of seed used by non-IPM farmers ranged from 88-kg ha^{-1} to 96.2-kg ha^{-1}, with an average of 92-kg ha^{-1}, while an overall seed use by IPM farmers ranged from 70.4-kg ha^{-1} to 99.3-kg ha^{-1}, with an average of 85-kg ha^{-1}. Average amount of seed use by each category of farmers in each village is presented in Table 6.

Table 6. Average amount of seed use (kg ha^{-1}) by farmers in survey villages.

Village	Non-IPM farmer			IPM farmer		
	Mean	SE	n	Mean	SE	n
Chamkar Tanget	93	4.1	10	84	6.8	10
Thmei	90	6.0	10	99	7.1	10
Roleang Ken	96	6.9	10	70	5.7	10
Krang Rolous	88	5.0	10	86	7.1	10
Overall Mean	92	2.7	40	85	3.6	40

Note: n = number of farmers interviewed in each village.

The seeding rates of both groups of farmers are closely consistent with the studies by Javier (1997) and Mak and Lando (1991). Javier, as a whole, found that seeding rates used by rainfed lowland rice farmers vary from 50 to 120-kg ha^{-1}. Whereas Lando and Mak (1991) found that the estimated average seeding rate is of 86-kg ha^{-1}, and, for Kandal, a province where the survey was conducted in, they reported that the average seeding rate is of 60-kg ha^{-1}. According to these researchers seeding rate generally varies depending on the location and fertility of nursery and the field, germination rate of the seed, and the varieties. However, only a few farmers were able to draw an association with the germination of the seed. Instead, they very often considered the high seeding rate as a rule-of-thumb given the unreliable weather conditions. Certain amount of seedlings has to be reserved for replanting after extreme events such as droughts and floods.

4.3.2. Fertilizer use

Applying cow manure is an ordinary practice of both groups of farmers. The first manure application, before seeding, was generally worked into the soil by harrowing. As referred to by Ros *et al.* (1998), Tichit (1981) and Lando and Mak (1990) reported that the Cambodian farmers generally show a preference for applying most of their cow manure to the nurseries, which consume approximately one fifth of the mainfields (Lando and Mak, 1994). According to Lando and Mak (1994), up to 60% of cow manure is applied to the nursery bed scheduled at 5 to 10 days in advance of the first plowing (in Ros *et al.*, 1998). The remaining manure was used as basal fertilizer that was normally broadcast into the transplanted field (at the time of transplanting). The amount of cow manure to be applied varies depending upon the availability of cow manure of individual households. However, the survey made no attempt to go into details of the case. Instead, the study focused only on the use of inorganic fertilizers.

All farmers in both categories reported using inorganic fertilizers. Nevertheless, the ways they applied fertilizers differed in terms of stage of production, type of fertilizer used, and mode of application.

Sixty-five percent (65%) of non-IPM and 72.5% of IPM farmers applied different types of fertilizers at 3 main production stages of rice including land preparation (basal), tillering, and panicle initiation stage (Table 7). DAP (18-46-0) was the common type of inorganic fertilizer used as basal application by 47% and 51% of non-IPM and IPM farmers, respectively (Table 8). Urea (46-0-0) was the common type of fertilizer used by 48.7% and 97% of non-IPM farmers and by 46% and 92% of IPM farmers at tillering and panicle initiation, respectively (Table 9&10).

Overall, average amounts of fertilizer use at each stage of production, i.e., basal, tillering, and panicle initiation stage, by non-IPM farmers in each village were 60-kg ha^{-1}, 80-kg ha^{-1}, and 89-kg ha^{-1} respectively, while those of the IPM farmers were 41-kg ha^{-1}, 68.4-kg ha^{-1}, and 65-kg ha^{-1} respectively (Table 11).

Average fertilizer use per crop by non- IPM farmers ranged from 175-kg ha^{-1}, the lowest found in Chamkar Tanget village, to 288-kg ha^{-1}, the highest average fertilizer use rate found in Krang Rolous village. The average fertilizer use rate per crop by IPM farmers varied from 139-kg ha^{-1}, the lowest rate recorded in Thmei village, to 194-kg ha^{-1} recorded in Krang Rolous village (Table 12).

Table 7. Number of farmers practicing different modes of fertilizer application.

Village	Non-IPM farmer (n = 40)					IPM farmer (n = 40)				
	T	B + T	B + PI	T + PI	B + T + PI	T	B + T	B + PI	T + PI	B + T + PI
CT	0	3	0	0	7	0	1	0	0	9
TH	0	1	0	1	8	1	2	0	0	7
RK	0	1	1	0	7	0	2	0	0	8
KR	1	1	0	4	4	0	0	1	4	5
Total	1	6	1	5	26	1	5	1	4	29
%	2.5	15	2.5	12.5	65	2.5	12.5	2.5	10	72.5

Note: - n = number of farmers reporting applying fertilizers in last season.
- T = Tillering Stage; B = Basal Application; PI = Panicle Initiation Stage.
- CT = Chamkar Tanget; TH = Thmei; RK = Roleang Ken; KR = Krang Rolous.

Table 8. Number of farmers applying different types of fertilizers as basal application.

Village	Non-IPM farmer (n = 34)				IPM farmer (n = 35)					
	DAP	Urea	16-16-8-13s	DAP+ Urea	DAP	Urea	16-16-8-13s	16-20-0	DAP+ Urea	16-16-8-13s + DAP
CT	1	5	3	1	5	1	2	0	1	1
TH	5	0	3	1	6	0	1	0	2	0
RK	6	2	1	0	3	5	1	1	0	0
KR	4	1	0	1	4	0	1	0	1	0
Total	16	8	7	3	18	6	5	1	4	1
%	47	23.5	20.6	8.8	51.4	17	14.3	2.9	11.4	2.9

Note: - n = number of farmers reporting practicing basal fertilizer application.
- CT = Chamkar Tanget; TH = Thmei; RK = Roleang Ken; KR = Krang Rolous.

Table 9. Number of farmers applying different types of fertilizers at tillering stage.

Village	Non-IPM farmer (n = 39)					IPM farmer (n = 37)						
	DAP	Urea	16-16-8-13s	DAP + Urea	16-16-8-13s +Urea	DAP	Urea	16-16-8-13s	16-20-0	DAP + Urea	16-16-8-13s +Urea
CT	1	4	1	2	2	2	5	0	0	2	1
TH	1	6	3	0	0	2	3	2	0	1	0
RK	1	4	2	1	1	4	3	0	2	1	0
KR	3	5	2	0	0	3	6	0	0	0	0
Total	6	19	8	3	3	11	17	2	2	4	1
%	15.4	48.7	20.5	10.3	7.7	29.7	46	5.4	5.4	10.8	2.7

Note: - n = number of farmers reporting practicing fertilizer application at tillering stage.
- CT = Chamkar Tanget; TH = Thmei; RK = Roleang Ken; KR = Krang Rolous.

Table 10. Number of farmers applying different types of fertilizers at panicle initiation (PI) stage.

Village	Non-IPM farmer (n = 34)		IPM farmer (n = 37)	
	Urea	16-16-8-13s + Urea	Urea	DAP + Urea
CT	6	0	9	0
TH	10	0	9	1
RK	8	1	8	1
KR	9	0	8	1
Total	33	1	34	3
%	97	3	92	8

Note: - n = number of farmers reporting practicing fertilizer application at panicle initiation stage.
- CT = Chamkar Tanget; TH = Thmei; RK = Roleang Ken; KR = Krang Rolous.

Table 11. Average amount of fertilizer use (kg ha^{-1}) at each stage by farmers.

Production Stage	Village	Non-IPM farmer Mean	SE	n	IPM farmer Mean	SE	n
Basal	CT	54.3	9.5	10	43.7	5.2	10
	TH	57.9	9.8	10	37.2	14.0	10
	RK	60.0	9.9	10	33.2	9.2	10
	KR	63.0	13.9	10	49.8	17.6	10
	Overall Mean	60.0	5.0	40	41.0	5.7	40
Tillering	CT	49.8	7.3	10	68.2	10.8	10
	TH	90.9	8.5	10	37.2	18.5	10
	RK	72.4	19.7	10	72.1	10.2	10
	KR	105.5	13.0	10	96.2	8.2	10
	Overall Mean	80.0	6.3	40	68.4	6.7	40
Panicle Initiation	CT	70.8	11.5	10	78.4	10.1	10
	TH	79.2	8.6	10	65.1	9.5	10
	RK	85.5	16.5	10	64.0	12.3	10
	KR	120.2	16.3	10	52.4	17.0	10
	Overall Mean	89.0	7.0	40	65.0	6.2	40

Note: - n = number of farmers reporting practicing fertilizer application at each stage of rice production.

- CT: Chamkar Tanget; TH: Thmei; RK: Roleang Ken; and KR: Krang Rolous.

Table 12. Average amount of fertilizer use (kg ha^{-1}) per crop by each group of farmers

Production Stage	Chamkar Tanget Non-IPM	Chamkar Tanget IPM	Thmei Non-IPM	Thmei IPM	Roleang Ken Non-IPM	Roleang Ken IPM	Krang Rolous Non-IPM	Krang Rolous IPM
Basal	54.3	43.7	57.9	37.2	60.0	33.2	63.0	50.0
Tillering	49.8	68.2	91.0	37.2	72.4	72.1	105.6	96.2
PI	70.8	78.4	79.2	65.1	85.5	64.0	120.2	52.5
Grand Mean	175.0	190.0	228.2	139.5	218.0	169.3	288.7	198.0

4.4. Knowledge of pests and natural enemies

The majority of farmers in this commune could recognize rice pests. Farmers named 9 different pests that they very often saw in their fields. In general, brown planthoppers (BPH), green leafhoppers (GLH) and rice bugs (RB) were the insect pests most commonly reported by both groups of farmers. As computed against the total number of reporting respondents under each category, the percentages of farmers reported each key pest were 77.7% (n=28), 66.6% (n=24), and 33.3% (n=12), for non-IPM farmers, and 73% (n=27), 78.3% (n=29), and 54% (n=20), for IPM farmers, respectively (Table 13).

Other reported insect pests are stem borers, caseworms, leaffolders, and thrips. Twenty-five percent (25%) and 32% of non-IPM and IPM farmers reported stem borers as pest. Caseworms were reported as pest by about 8% and 48% of non-IPM and IPM farmers, respectively. Caseworms should be easier to manage in areas where farmers have more control over the water in their fields, especially in the dry season. Draining rice fields provides good control of caseworms since damage by these pests occurs only in parts of the field with stagnating water. However, this kind of practice may not be appropriate for wet season rice growers because water is very often uncontrollable. Farmers normally use pesticides to control these pests when their infestations are widespread (Jahn *et al.*, 1996b). Crabs and rats were also reported as major animal pests in the commune. However, rats were the major pests as 47% of the non-IPM farmers and 48% of the IPM farmers reported them.

Respondents were also asked to rank pests according to their experience of pest destructiveness to rice crop. From the responses, it was apparent that brown planthoppers, stem borers, rice bugs, rats, and green leafhoppers were considered by both groups of farmers to be the five most destructive pests (Table 14).

Farmers realized that brown planthoppers have just infested the area over the past recent years but assumed substantial economic losses. The most serious outbreak

Table 13. Most commonly reported pests in survey villages and percentage farmers controlling them.

Pest	Non-IPM farmer (n = 36)			IPM farmer (n = 37)		
	Farmer Reporting	Perc-entage	Farmer (%) Controlling	Farmer Reporting	Perc-entage	Farmer (%) Controlling
INSECTS						
Brown planthoppers	28	77.7	71.4	27	73	66.7
Green leafhoppers	24	66.6	54.2	29	78.4	55.2
Rice bugs	12	33.3	83.3	20	54.0	70.0
Stem borers	9	25.0	22.2	12	32.4	8.3
Caseworms	3	8.3	66.7	18	48.6	22.2
Leaffolders	1	2.7	0.0	5	13.5	60.0
Thrips	1	2.7	0.0	7	19.0	0.0
OTHERS						
Crabs	3	8.3	66.7	8	21.6	100
Rats	17	47.2	64.7	18	48.6	61.1

Note: n = number of farmers reporting pest damages to their last rice production season.

Table 14. Key pests ranked by farmers in survey villages.

Pest	Non-IPM farmer (n = 36)		IPM farmer (n = 37)	
	Farmer Reporting	Percentage	Farmer Reporting	Percentage
Brown planthoppers	15	41.6	13	35.1
Stem borers	7	19.4	9	24.3
Rice bugs	6	16.6	7	19.0
Rats	5	13.8	4	10.8
Green leafhoppers	3	8.3	4	10.8

Note: n = number of farmers reporting pest damages to their last rice production season.

occurred in 1998 wet season cultivation when 111 hectares of paddy rice were damaged. Most of IPM farmers were able to describe correctly the damage behavior of brown planthoppers. However, non-IPM farmers seemed less knowledgeable about these pests. They reported that detecting the presence of the pests and their damages is very difficult. It may be because the pests usually confine themselves at the base of the hill of rice where many farmers are unable to locate them. Consequently, farmers were normally unknown about the presence and infestation of the pests until the full-blown of symptom appeared and then rescue actions of rice crop, if any, were very often too retard and unsuccessful. The damage symptom caused by brown planthoppers was usually described by farmers as a kind of rice disease called '***Kra Phloeung'***-a local language which means fire disease-that makes the base of rice stem and the leaf become rotted and dried up.

Stem borers were the second major insects respectively ranked by 19% and 24% of non-IPM and IPM farmers. A widespread whitehead of rice was commonly observed from a distant in almost every season. Rice bugs were the third key pests respectively ranked by 16.6% and 19% of non-IPM and IPM farmers. They were considered by both groups of farmers as very destructive pests during the milky stage of rice. Large numbers of the insect will reduce the numbers of filled grains, thereby reducing yield.

Green leafhoppers (GLH) were ranked at the bottom of the list though large number of farmers generally recognized them as pests of rice. Farmers considered green leafhoppers as far less severe as compared with the former reported pests. Only 8% and 10.8% of non-IPM and IPM farmers reported green leafhoppers as major pests. Most of non-IPM farmers were unknowledgeable about the cause of infestation of GLH, how these pests attack rice, and how the consequences to be left behind. However, many of farmers who had attended the IPM farmer field schools (IPM FFS) were able to identify the pests with ease and knew that the insects cause rice diseases. While some farmers only described the yellow-spotted symptoms as damage symptoms caused by the insects, a few farmers mentioned correctly the tungro disease. A few farmers reported that low numbers of GLH have no effect on rice yield but high infestation of the insects would reduce rice yield from 20% to 50% as compared with healthy fields. Further attempts were made to question those farmers if they could provide any estimation on the number of insects, i.e., the threshold levels, that would justify the mentioned estimated yield loss. Unfortunately, non-of them could give an interesting answer.

In order to evaluate farmers' knowledge about natural enemies farmers were asked to name insects that do not damage rice, their activities in the rice fields, effects of pesticides on those insects, and the association of reduced number of beneficial insects as affected by the spray of chemicals with the population of the insect pests. Results indicated that farmers were generally aware of the existence of natural enemies in the rice fields. Respectively, 82% and 97.5% of non-IPM and IPM farmers showed their agreements on the fact that there are many beneficial insects co-existing with the harmful insects by naming some of the insects they know of. Of the 33 non-IPM farmers and 37 IPM farmers who agreed with the above point of view, 84.8% and 86.4% were aware of the predatory beneficial insects. Very few IPM farmers were able to name other types of natural enemies, especially the parasitoids. Nevertheless, it is too much to elicit this kind of knowledge from farmers because most of parasitoids are too tiny to be recognized.

Knowledge of both groups of farmers on the effects of pesticide sprays on the natural enemies was considerably different. While only 57.5% of the non-IPM farmers acknowledged that the sprays of pesticides would kill the natural enemies, a high percentage of 92.5% sharing the same positive agreement was recorded on the IPM farmers. Fifteen percent (15%) of the non-IPM farmers said that applying pesticides yields no harmful effect on the beneficial insects because they would be able to escape while the rest 27.5% was equivocal. These responses obviously reflected a low level of awareness on the interactions between pesticides and the arthropods in rice ecosystem among the non-IPM farmers. Likewise, when 62.5% of IPM farmers believed that the reduced numbers of natural control agents due to the use of pesticides would lead to resurgence and outbreak of the insect pests, agreement was found on only 55% of the non-IPM farmers. The non-landslide majority of agreement on the IPM farmers revealed a limited knowledge and perception of the farmers about the interactions between the harmful and beneficial insects. All of the Of the 33 non-IPM and 37 IPM farmers who earlier agreed that there are co-existence of natural enemies and insect pests reported 12 types of natural enemies (Table 15).

Table 15. Common natural enemies reported by farmers in survey villages.

Natural enemies	Non-IPM farmer (n = 33)		IPM farmer (n = 37)	
	Farmer Reporting	Percentage	Farmer Reporting	Percentage
INSECTS				
Spiders	25	75.7	35	94.6
Damselflies	24	72.7	33	89.2
Ladybird beetles	11	33.3	22	59.5
Wasps	2	6.0	22	59.5
M. grasshopper	9	27.3	14	37.8
Mirid bug	1	3.0	9	24.3
M. D. Atrolineata	5	15.1	8	21.6
Carabid beetle	3	9.1	7	18.9
OTHERS				
Frogs	12	36.4	12	32.4
Fish	1	3.0	7	18.9
Snakes	9	27.3	3	8.1
Bats	0	0.0	2	5.4

Note: n = number of farmers reporting the coexistence of beneficial insects and harmful ones.

Spiders and damselflies were the most commonly recognized natural enemies by more than 70% of both groups of farmers. Across-the-board however, a higher percentage of reported individual natural enemies took side on the IPM farmers. Interestingly, higher percentages of beneficial animals such as frogs and snakes were found on the non-IPM farmers. They were reported by 36.4% and 27.3% of non-IPM farmers against only 33.5% and 8% of IPM farmers.

4.5. Pest management practices

Table 13 reported the common pests and percentage of farmers controlling them. Crab control was practiced by 100% of the IPM farmers who considered crab as pest. Only 66% of the non-IPM farmers reported implementing crab control. A reverse finding was recorded on rice bugs in which the highest percentage, 83.3%, of farmers reporting controlling it was found on non-IPM farmers. Only 70% of IPM farmers practiced control measures against rice bugs. Brown planthoppers were subjected to control measures by more than 71% and 66% of non-IPM and IPM farmers. A relatively equal percentage of farmers, 54.2%, for non-IPM farmers, and 55.2%, for IPM farmers, controlled green leafhoppers. Caseworms were controlled by 66.7% of non-IPM farmers, while only 22% of IPM farmers controlled this pest.

A relatively greater percentage of pest control measure resulted from the study associated primarily with the application of pesticides (see Table 16). However, farmers' pest control strategies were seen as even more complex than a mere application of pesticides. Farmers' pest management practices in the surveyed area, for instance, encompassed a variety of techniques ranging from both spiritually to physically action oriented ones. No chemical measure was taken to control crabs. Instead, farmers usually practiced handpick.

Botanical pesticides (mostly a solution of tobacco with soap) were also reported by both groups of farmers for the control of various insect pests, i.e., brown planthoppers, green leafhoppers, and rice bugs. In addition, similar to findings by Jahn *et al.* (1996b), a few farmers mentioned that they chop up a cactuslike plant, the dragon bones plant (*Euphobia lactea*), and place it in the water to repel crabs. Some farmers reported that they stick *Chromolaena odorata* branches, a wild plant known as *Kanthraing Khait* in Khmer, as fence around the yellow rice plants, which then turns green within a week. A few others reported broadcasting a mixture of chopped *Chromolaena odorata* and manure to control BPH. A mixture of ash and fertilizer (either manure or chemical fertilizer or their combination) was another type of pest control practice of the farmers in the commune. Some farmers broadcast a mixture of ash and fertilizer into the field to control brown planthoppers and green leafhoppers. Some farmers set fire with used tires to smoke the field for driving away rice bugs. More surprisingly, some farmers said although various actions had been taken to handle the pest problems they had to ritualize with a purpose to seek helps from God, our Buddha Lord, to lure insect pests to leave their fields.

4.6. Pesticide use and farmers' attitudes

Table 16 presented the number and percentage of farmers reported applying pesticides in the last season. The percentages of non-IPM and IPM farmers using pesticides were not much different. Overall, 42.5% and 37.5% of non-IPM and IPM farmers used pesticides.

Among the two groups of farmers, a greater percentage of farmers applied pesticide was recorded in Chamkar Tanget village where 60% and 50% of non-IPM and IPM farmers reported using pesticides. The lower percentage of farmers applied pesticide was in Thmei village where only 30% and 20% of non-IPM and IPM farmers reported applying pesticides in the last season.

Table 16. Number of farmers reporting applying pesticides in the last rice season.

Village	Non-IPM farmer			IPM farmer		
	Farmer Reporting	n	Percentage	Farmer Reporting	n	Percentage
Chamkar Tanget	6	10	60	5	10	50
Roleang Ken	4	10	40	4	10	40
Thmei	3	10	30	2	10	20
Krang Rolous	4	10	40	4	10	40
Total	17	40	42.5	15	40	37.5

Note: n = number of farmers interviewed in each village.

Table 17 showed the estimate average amount of insecticide use by the rice farmers in the survey villages. On individual farmer basis, the amount of pesticide use by farmers ranged from 47 ml ha^{-1} to 1628.95 ml ha^{-1} per season with an average of 562.5 ml ha^{-1}, for non-IPM farmers, and from 312.5 ml ha^{-1} to 3571.4 ml ha^{-1} per season with an average of 933.7 ml ha^{-1}, for IPM farmers. On the village basis however, the average amount of insecticide use by non-IPM farmers varied from 210 ml ha^{-1} to 1005.3 ml ha^{-1} per season while those by IPM farmers ranged from 453 ml ha^{-1} to 1532 ml ha^{-1}. The highest amount of pesticide use by both non-IPM and IPM farmers were found in Chamkar Tanget village, whereas the lowest amount of pesticide use by non-IPM and IPM farmers were respectively found in Roleang Ken and Krang Rolous village.

Table 17. Estimated average amount (ml ha^{-1}) of farmers' insecticide use.

Village	Non-IPM farmer			IPM farmer		
	Mean	SE	n	Mean	SE	n
Chamkar Tanget	1005.3	195.5	6	1532	545.3	5
Roleang Ken	210.0	55.3	4	745.8	46.1	4
Thmei	309	57.6	3	772.9	372.9	2
Krang Rolous	441	171	4	452.8	96.9	4
Overall Mean	562.5	113	17	933.7	210.2	15

Note: n = number of farmers reporting using insecticide in the last rice production season.

Table 18 presented the common pesticides and the percentage of farmers using them. Both groups of farmers commonly reported eighteen types of pesticide, by trade name, which are grouped into 9 different common names (chemical name). Folidol and Foxentol were the 2 common pesticides used by most farmers in the commune. Folidol was used by 41% and 33% of non-IPM and IPM farmers respectively, while Foxentol was the second major pesticide used by 35% and 27% of non-IPM and IPM farmers, respectively. In addition, Trebon and Azodrin were also found being used by 35% and 29% by non-IPM farmers. But, only 6.7% of IPM farmers reported applying Trebon while non-of them applied Azodrin. In a contrast manner, while Phosdrin was used by 26.7% IPM farmers it was not any kind of preference of the non-IPM farmer at all.

Overall, 53% of the reported pesticides belong to methyl parathion chemical name group holding hazard class Ia-a group of pesticide with the most extreme hazardous capability according to the WHO pesticide classification. Jahn *et al.*, (1996b) conducted a nation-wide survey on farmers' pest management and rice production practice in Cambodia in 1996 reported that methyl parathion is the most commonly used insecticide nationally, and confirmed that his finding is consistent with that of Yech (1994). Recent studies by Yang on pesticide market in Kandal province in 1999, and the situation of pesticide use in areas around the Great Lake

Tonle Sap in 2001 also found the same trend. Interestingly, methyl parathion is one of the few pesticides in Cambodian markets found to contain as much active ingredient as indicated on the label (Jahn *et al.*, 1996b).

Table 18. Common pesticides and percentage of farmers reporting them.

Trade name	Common name	Hazard Class	Non-IPM farmer (n = 17)		IPM farmer (n = 15)	
			Farmer Reporting	%	Farmer Reporting	%
Folidol	Methyl Parathion	Ia[1]	7	41.0	5	33.0
Foxentol	Methyl Parathion	Ia	6	35.0	4	27.0
Trebon	Dimethoate	II[3]	6	35.0	1	6.7
Azodrin	Monocrotophos	Ib[2]	5	29.0	0	0.0
Suthon	Methyl Parathion	Ia	2	11.8	2	13.3
Tora	Methyl Parathion	Ia	2	12.0	0	0.0
Methyl Parathion	Methyl Parathion	Ia	1	5.9	2	13.3
Methaphos	Methamidophos	Ib	1	5.9	0	0.0
Cymerin	Cypermethrin	II	1	5.9	1	6.7
Padan	Cartap	II	1	5.9	2	13.3
Thiodan	Endosulfan	II	0	0.0	1	6.7
Tra Moeng Thong	Methyl Parathion	Ia	1	5.9	0	0.0
Phosdrin	Mevinphos	Ia	0	0.0	4	26.7
Basudin	Diazinon	II	0	0.0	1	6.7
Fitor	Mevinphos	Ia	0	0.0	1	6.7
Bostin	Mevinphos	Ia	0	0.0	2	13.3
Zinc-tox	Zine Phosphide	Ib	2	12.0	1	6.7

Note: - [1]extremely hazardous; [2]highly hazardous; and [3] moderately hazardous.

- n = number of farmers reporting using pesticides in the last rice production season.

Among the farmers using pesticides, 94% and 100% of non-IPM and IPM farmers observed pests or damage prior to deciding when pesticide applications are warranted. Only 1 non-IPM farmer reported spraying on a schedule basis. More than 88% of non-IPM farmers and 80% of IPM farmers decided to spray insecticides when they saw large number of insect pests. The remaining 11.8% and 13.3% of non-IPM and IPM farmers applied pesticide when a few insects had been observed. Only 6.7% of IPM farmers said they had to apply pesticide if any type of insect pests had been found in their fields. From these informations, it is apparent that number of insect pests is the most important indicator prompting farmers to take any form of chemical control action. Nevertheless, field scouting for damage symptoms caused by pests is not a popular practice for both groups of farmers. It is an essential finding that is igniting a great curiosity over the unawareness of agroecosystem analysis approach, which serves as the cornerstone of the integrated pest management farmer field schools (IPM FFS). No a single IPM farmer answered that they did field scouting to identify the proportion of insect pests and the beneficial insects. The case elucidated one of the many setbacks in the implementation of the FFSs.

To assess farmers' attitudes toward pesticide use, farmers were asked to evaluate the correctness of the statement: "Applying pesticides to rice increases yields." While the majority of IPM farmers, 57.5% made a rejection, the statement was ruled out by only 37.5% of the non-IPM farmers. A relatively large percentage of farmers in both categories, 30% for non-IPM and 27.5% for IPM farmers, expressed their agreement with the statement. Ignorance was found with 30% and 5% of non-IPM and IPM farmers respectively. The remaining 10% of IPM farmers spoke in favor of their impartiality to the statement by pointing out that the benefits obtaining from the application of pesticides was actually relative to the pest situation confronted.

4.7. Rice yields and economic returns

Rice yields of farmers obtained in the previous harvest season are presented in Table 19. On a category basis, rice yields of non-IPM farmers ranged from 1360-kg ha^{-1} to 3719-kg ha^{-1}, with an average of 2270.8-kg ha^{-1}, while those of IPM farmers varied from 1587-kg ha^{-1} to 3967-kg ha^{-1}, with an average of 2507.8-kg ha^{-1}. On a village basis however, the lowest average of rice yield of 2111-kg ha^{-1} of non-IPM farmers was found in Thmei village while the highest average yield of 2340.5-kg ha^{-1} was recorded in Roleang Ken village. Among the IPM farmers, the lowest average rice yield of 2173-kg ha^{-1} was found in Roleang Ken village while the highest average yield was observed in Thmei village. The overall means of rice yield of the two groups of farmers were however not significantly different (p>0.05).

Table 19. Mean rice yield (kg ha^{-1}) of farmers in survey villages.

Village	Non-IPM farmer			IPM farmer		
	Mean	SE	n	Mean	SE	n
Chamkar Tanget	2518	200.5	10	2764	189.1	10
Thmei	2111	229.2	10	2869	231.7	10
Roleang Ken	2340	181	10	2173	128.3	10
Krang Rolous	2113	88.2	10	2225	163.8	10
Overall Mean^{ns}	2270	91.8	40	2508	100.7	40

Note: - n = number of farmers interviewed.
- ^{ns} indicates non-significant difference at 5% level, determined by Two-tailed Student's t-test, between mean rice yields of the two groups of farmers.

To better understanding about the efficiency of rice production of both groups of farmers, a gross margin (*GM*) analysis was performed (Table 20 & 21). It was computed by simply subtracting the total revenue (*TR*) earned, deriving from the rice yield multiplied by the unit price of rice, with the total variable costs (*VC*), which included cost of seed, fertilizer, pesticide use, land preparation, and transplanting.

Table 20. Gross margin (in 1000Riels) of rice production of farmers in survey villages.

Village	Variable Cost (*VC*)				Total Revenue (*TR*)				Gross Margin (*GM*)			
	Non-IPM farmer		IPM Farmer		Non-IPM farmer		IPM farmer		Non-IPM farmer		IPM farmer	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Chamkar Tanget	453.3	19.2	455.2	22.4	705.1	56.1	773.9	52.9	251.7	67.3	318.7	56.8
Thmei	473.0	22.6	402.6	41.7	591.1	64.1	803.3	64.8	118.0	64.2	400.7	78.8
Roleang Ken	464.3	27.8	425.6	23.4	669.4	52.2	608.4	35.9	205.0	57.5	182.8	48.8
Krang Rolous	519.2	25.2	448.7	24.6	620.0	43.0	623.0	45.8	100.8	43.7	174.3	54.0

Note: Riels = the Cambodian Currency.

Table 21. Overall gross margins (in 1000Riels) of the two groups of farmers in survey villages.

Indicator	Non-IPM farmer			IPM farmer		
	Mean	SE	n	Mean	SE	n
Revenue	646.4	27.0	40	702.2	28.2	40
Variable Cost	477.5	12.2	40	433.0	14.3	40
Gross Margins*	169.0	29.9	40	261.0	32.9	40

Note: - * Indicates significant difference at 0.05 determined by Two-tailed Student's T-test.

- n = number of farmers interviewed.

Gross margins of the non-IPM farmers ranged from 100800Riels, the lowest income earned by farmers in Krang Rolous village, to 251700 Riels, the highest earnings recorded in Chamkar Tanget village. Likewise, the lowest gross margin among the IPM farmers was again found in Krang Rolous village where farmers could earned only 174300 Riels vis-à-vis the highest gross margin of 400700 Riels gained by their counterparts in Thmei village. Gross margins of the two groups of farmers were significantly different ($p<0.05$) (Table 21), although their rice yields were not significantly different. Greater variable costs deriving from higher input use such as fertilizer and seeding rate, etc. among the non-IPM farmers were the major determinants to this significant difference. In addition, varying reported prices of inputs and rice yields that were purchased and sold in different points of time may also constituted this significant difference in gross margins of the two groups of farmers.