CHAPHER 4
RICE PRODUCTION SYSTEM IN CHIANG MAI VALLEY: FIELD SURVEY RESULTS

4.1 Background

Chiang Mai province is center of the northern part of Thailand. It situated between north latitude 17 to 21° and east longitude 98 to 99°. The total area of Chiang Mai is approximately 12,566,911* rai in which mountainous and upland areas account for 82.7% of the total area. The total areas of 1,316,820 rai were used for agriculture. The average farm size per household is 9.83 rai and there are 133,899 farms located in this region (OCS, 2001). The largest and most important river in Chiang Mai is the Ping River. The flat fertile valley area also lies along the bank of this river which cover an area about of 1,500 km^2. Chiang Mai valley is an important rice production center in the upper north. The boundary of Chiang Mai province was presented in Figure 1.

The annual average temperature range between 10.3 ° to 37.8 Celsius. Average rainfall is about 1,133 mm. (OCS, 2001). In rainy season, both glutinous and non-glutinous rice are grown in the Valley. During the 2000/01 crop year, total rice planted area is 152,977 rai and 460,287 rai for non-glutinous and glutinous rice, respectively. The total rice yield of 287,153 tons was produced (OCS, 2000)

---

* 6.25 rai equivalent to 1 ha.

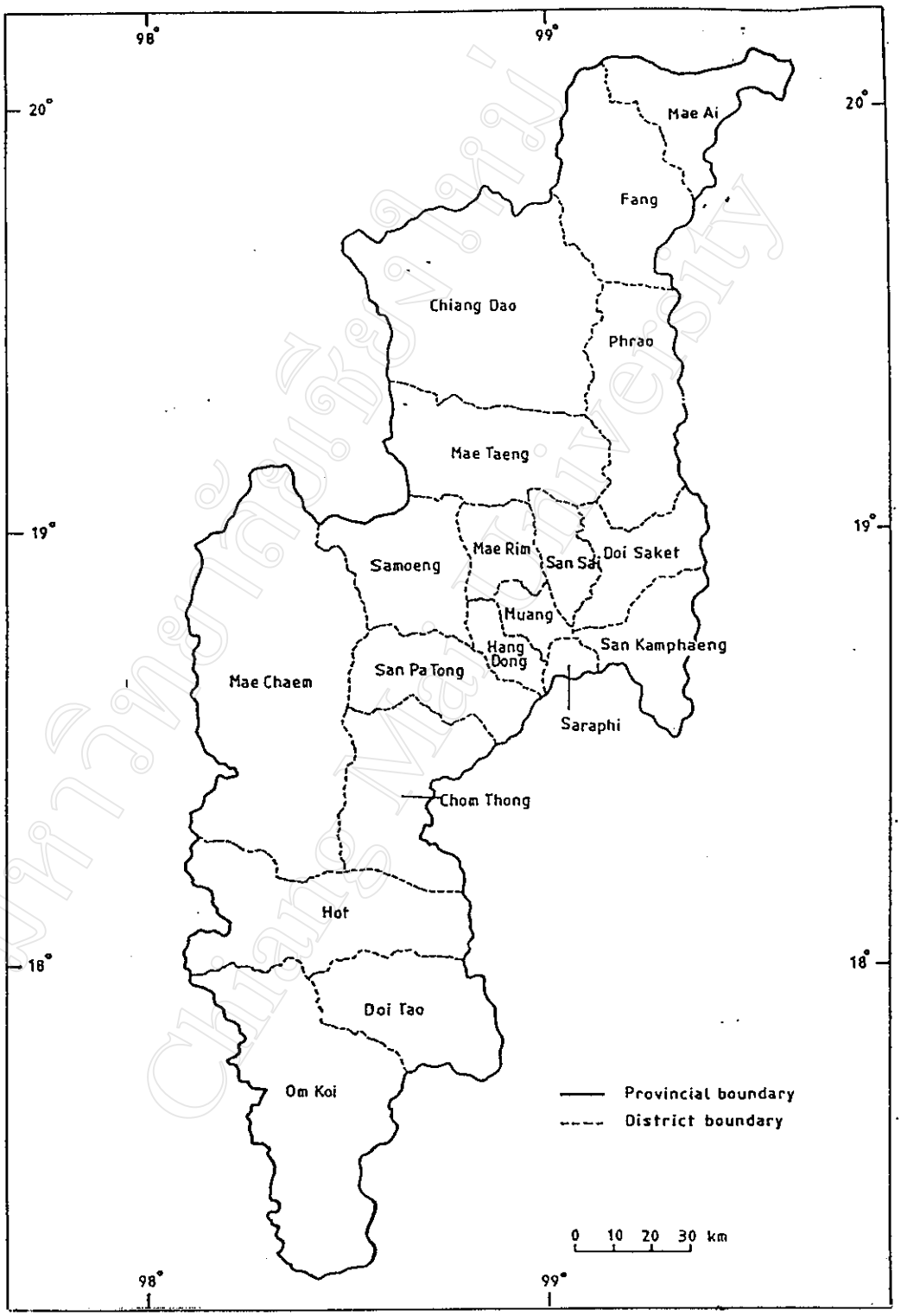

Figure 4.1 Chiang Mai Province Map(OCS, 2000).

4.2 General description of sample household

In this study, the twenty farmers were selected covered four districts namely San Kumpheang, San Pa Tong, San Sai (Chiang Mai province) and Ban Thi district in Lam Phun province.

The selected farmers in this study were interviewed using a pre-designed questionnaire. The results of the study revealed that those farmers have an average age range between 44 to 52 years (Table 4.1).

The majority farmers were educated up to primary level, i.e., grade one to six. Moreover, the farmers with higher than primary level were accounted only one person from all farmers interviewed, which was found from selected farmers in San Pa Tong districts.

The average size of land owned per farm of each household in this study was approximately 7.9 rai. However, interview results showed that the selected farm in San Kumpheang had the highest average size of land owned per farm (10.5 rai /farm) while the lowest was found in the selected farm in San Sai (4.3 rai /farm).

The on-farm trial was studied on the major rice growing season. The water resource using in rice production were received from both rainfall and water irrigation systems in each selected area. The area of water surface irrigation system was presented in Figure 4.2.

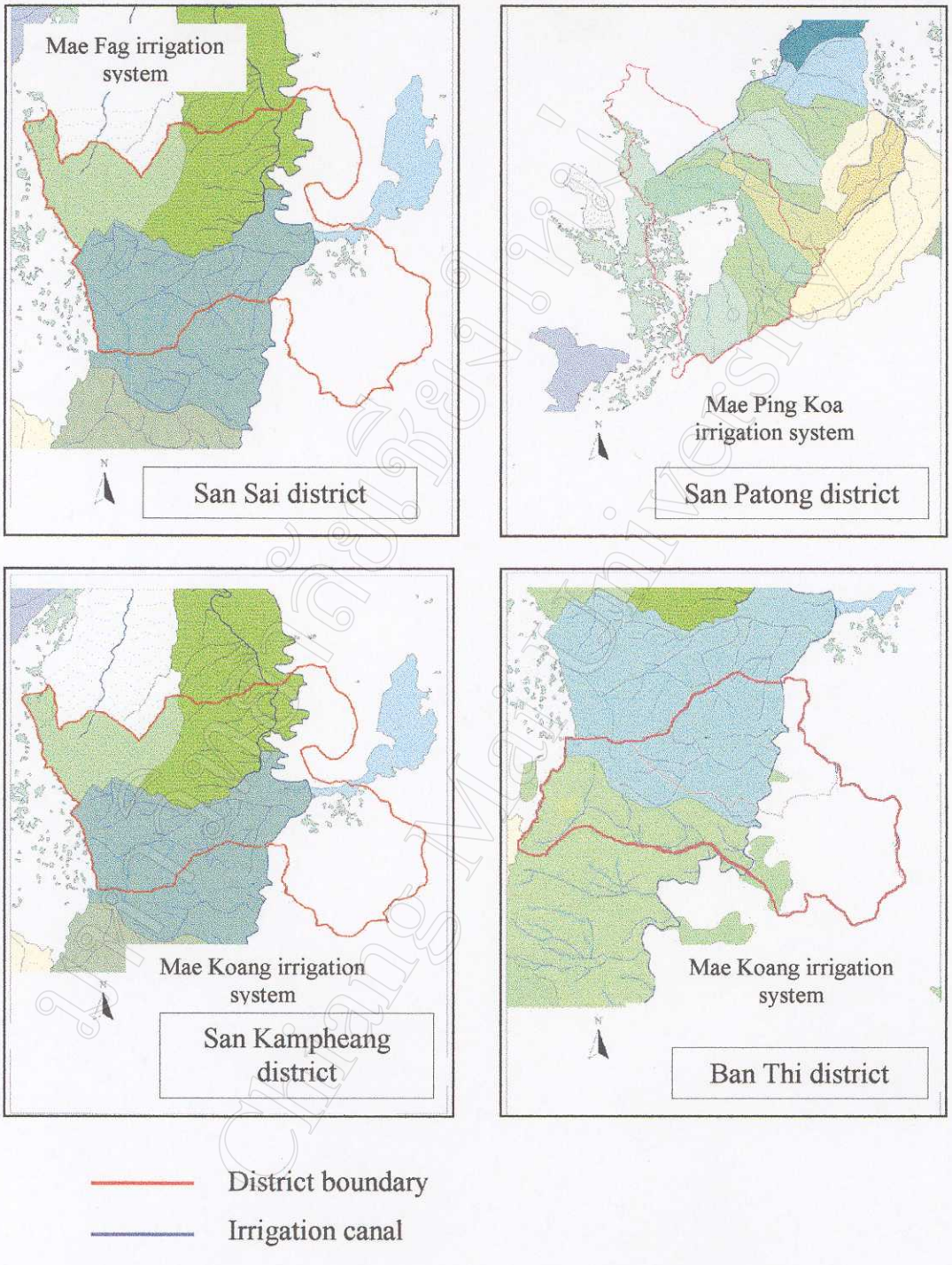

Figure 4.2 Map of the water surface irrigation system of San Sai, San Pa Tong, San Kampheang and Ban Thi district

The common variety grown of non-glutinous rice was KDML 105, while glutinous rice consists of Neaw San Patong and RD.6 (Table 4.2). The main purpose of growing rice in these studied areas could divide in 3 categories namely for 1) household consumption and the excess paddy was for selling, 2) for only household consumption and 3) for only selling, which was account for 55%, 30% and 15%, respectively (Figure 3).

Table 4.1 Generally description of sample households

Attribute	Selected farms				Mean (n=20)	SE
	San Kum Pheang	San Sai	San Patong	Ban Thi		
Number of selected farmers	6	4	5	5		
Age(years)	51	44	45	52	48	1.99
Land ownership (rai/farm)	9.5	4.3	7.1	9.7	7.9	1.10
					Total	
Education (no.of farmers)						
- non-literature	-	-	-	-	-	-
- primary	6	4	4	5	19	-
- higher than primary	-	-	1	-	1	-
Water resource (no.of farmers)						
- irrigated + rainfed	6	4	4	5	20	
Rice varieties (no.of farmers)						-
- Glutinous	3	4	2	5	14	
- Non-glutinous	3	-	3	-	6	-
						-

Source: Survey, (1999)

Table 4.2 Rice varieties being grown in this study area

Selected farms	Farmers (n=20)			Total
	RD.6*	NSP*	KDML105**	
San Sai	4	-	-	4
San Pa tong	1	1	3	5
San Kam Pheang	1	2	3	6
Ban Thi	5	-	-	5
Total	11	3	6	20

* Glutinous rice ** Non- glutinous rice n = number of selected farmers

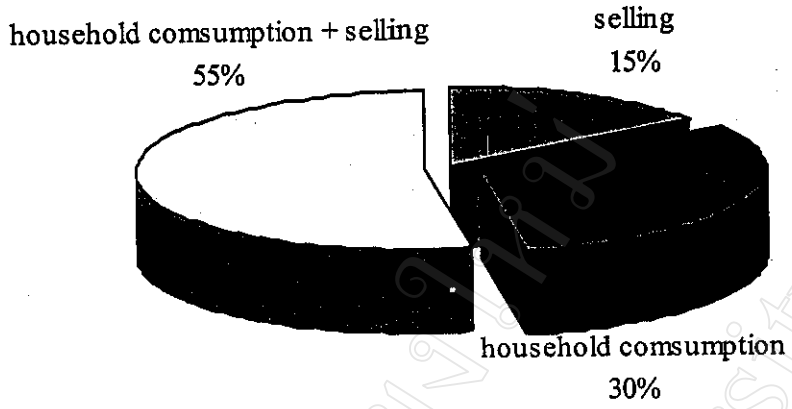

Figure 4.3 Purposes of growing rice in these selected areas (Source: Survey, 1999).

4.3 Agronomic practices

Planting Method

Transplanting is common method used in all selected farms. At first, a separate seedbed was prepared to grow rice seedling which were then transplanted to the main field when rice seedling were 25-30 days old. The amount of seed used per rai of each selected farm varied from 6.0 to 8.28 kg/rai (Table 4.3). The lowest and the highest amount of seed used per rai were found in the selected farm at San Sai and San Pa Tong district, respectively. Generally, all selected farmers started to prepare seedling in July, transplant in August and harvesting usually start from late November to early December.

Table 4.3 Average amount of seed used per rai

Selected farms	n	Seed used/ rai (kg)	SE
San Sai	4	9.2	0.71
San Pa tong	5	8.3	0.61
San Kam Pheang	6	6.0	0.43
Ban Thi	5	7.0	1.84
Total	**20**		

n = number of selected farmers

Fertilizer use

All selected farmers reported using inorganic fertilizer. However, the way they applied fertilizers differed in terms of application timing, type and amount of fertilizer used. Fertilizer was applied at least once or twice in a period of rice production. The first application occurred at tillering stage and the second was applied at the booting stage.

Thirteen farmers applied different types of fertilizer at both production stages of rice (tillering and booting stage) (Table 4.4). About five farmers applied the fertilizer at only the booting stage and one farmer applied at only the tillering stage. The common type of inorganic fertilizer use in both stages was 16-20-0 compound fertilizer (16%N, 20%P_2O_5, %K_2O) (Table 4.5&4.6).

At the tillering stage, the selected farmers at San Sai district applied in the average amount of fertilizer higher than the others, which was 15.42 kgN/rai (Table 4.7). Whereas the average amounts of fertilizer used of the other selected farms were similar significant from each other, which varied from 3.09 to 4.25 kgN/rai. However, the average amount of fertilizer applied at booting stage was not different among all selected farms. It had the average amount of fertilizer used of all selected farms about 5.78 kgN/ rai.

Table 4.4 Timing of fertilizer application

Selected farms	Farmers (n=20)				Total
	N	T	BT	T+BT	
San Sai	1	1	2	1	4
San Pa tong	0	0	3	3	5
San Kam Pheang	0	0	0	4	6
Ban Thi	0	0	0	5	5
Total	1	1	5	13	20

Note: n = number of selected farmer reporting applying fertilizers. T = tillering stage
N = not applied BT = Booting stage

Table 4.5 Number of farmers applying different types of fertilizer at tillering stage

Selected farms	Fertilizer type (from 20 interviewed farmer)		
	16-20-0	46-0-0 **(urea)**	16-20-0 + **urea**
San Sai	0	4	0
San Pa tong	2	0	0
San Kam Pheang	2	0	0
Ban Thi	4	0	1

Table 4.6 Number of farmers applying different types of fertilizer at booting stage

Selected farms	Fertilizer type (from 20 interviewed farmer)		
	16-20-0	46-0-0 **(urea)**	16-20-0 + **urea**
San Sai	4	0	0
San Pa tong	2	1	0
San Kam Pheang	5	0	1
Ban Thi	2	3	0

Table 4.7 Average amount of fertilizer use (kgN/rai)

Selected farm	Production stages			
	Tillering		Booting	
	mean	SE	mean	SE
Ban Thi	3.09	0.52	6.10	1.16
San Kam Pheang	3.98	0.49	6.20	1.63
San Sai	15.42	3.95	5.67	1.37
San Patong	4.25	1.55	5.13	1.88

Harvesting time

Labor shortage at the harvesting time is the serious problem in these regions due to most of the rural labor move into the industrial sector (survey, 1999). For this reason, the farmers were forced to harvest their rice field whenever was available labour.

Thus, the result of early harvesting directly affect to the milling quality of rice grain because harvesting moisture content is the one important factor that influence on the milling quality of rice (Malabuyoc *et al*, 1996 and Oelke *et al*, 1968). In this study, the harvesting moisture content was range among 26.1% to 28.0% (Table 4.8). The suitable moisture content in rice grain should varied from 18-23% in wet season (Nangju and De Datta, 1970).

Table 4.8 Average moisture content at harvesting time of all selected farms

Selected farms	% moisture content	SE
San Sai	28.0	0.46
San Pa tong	26.2	1.56
San Kam Pheang	25.6	1.27
Ban Thi	26.1	2.37

4.4 On-farm result

The results of the on-farm monitoring in various management practices were presented as follow:

4.4.1 Rice yield

The formal survey resulted that the rice management practices of each studied area such as the planting method, seed used, fertilizer used, planting date and harvesting time were similar from each other. The effects of these results were explained in term of rice yield.

Result from this study demonstrated that the average rice yield of all selected farms were not significantly different (Table 4.10). Averages rice yield of the selected farm at San Sai, San Patong, San Kampheang and Ban Thi districts were 564, 556, 549 and 509 kg/rai, respectively. In addition, it was also found that the potassium iodide application did not affect to rice yield of all selected farms. An average yield of rice sample which applied with KI was obviously not different from the average yield of rice control sample (not applied KI).

According to rice yields of all selected farms, it was estimated from three groups of rice varieties namely KDML 105, RD.6 and NSP (Table 4.9). It was found that yield of KDML 105 variety showed the highest of the average rice yield (569 kg/rai), which varied from 533 to 652 kg/rai. Rice yield of RD.6 variety varied from 467 to 550 kg/rai, with an average of 523 kg/rai. An average rice yield of NSP variety was 493 kg/rai which varied from 466 to 541 kg/rai. However, the average rice yields of all varieties were not significantly different.

Table 4.9 Averages yield of rice of each variety

Varieties	Rice yield (kg/rai)	SE
RD.6	523	17.26
KDML105	569	30.66
NSP	493	24.00

Table 4.10 Averages rice yield of each selected farm

Selected farms	Rice yield (kg/rai)					
	KI	SE	Non-KI	SE	**Mean**	**SE**
San Sai	531	36.92	598	25.33	**564**	**30.35**
San Pa tong	587	58.89	525	9.03	**556**	**24.93**
San Kam Pheang	558	29.48	545	32.32	**558**	**26.53**
Ban Thi	510	15.28	509	17.08	**509**	**15.20**

4.4.2 Milling Quality

The investigation of potassium iodide application on rice milling quality and nutritive value in various rice growing systems were shown as followed;

4.4.2.1 Percentage of Head rice

Analysis results (Table 4.11) illustrated that applying potassium iodide (KI) was able to increase percent head rice yield 2.54% as compared with the sample control (not applied with KI).

Table 4.11 presented the average percentage of head rice yield of each variety which was grown in the various location. The result showed that the common variety was grown in this studied area was RD.6, in the proportion 55% of all selected farms (11 farms), the KDML105 and NSP was 30% (6 farms) and 15% (3 farms), respectively.

The results demonstrated that the head rice yield of selected farmer at San sai district produced the highest percent increasing of head rice yield, with an average 7.19%, while the lowest percent increasing of head rice was found in selected farms in San Kampheang district (1.11%).

KDML 105 variety was grown in only selected farm in San patong and San Kampheang district. The percent increasing of head rice yield of those selected farms were obviously different. The average percent increasing about 2.65% was measured in selected farm in San Kampheng district while the little increase of head rice yield was found in San Patong (0.05%).

NSP variety was grown in same location as KDML105 variety. The results showed that rice sample of selected farm in San Kampheang district produced greater in the percent increasing of head rice yield than selected farm in San Patong which was 2.97 and 1.60 %, respectively.

Regardless the location, it was found that RD.6 variety produced the percent increasing of head rice yield (3.12 %) compared to NSP (2.29%) and KDML105 variety (1.36%). However, it can be seen that the trend of percent head rice yield was considerably increased when applied with KI in all varieties.

Table 4.11 Mean percentage of head rice compared with KI and non-KI foliar application

Items	KDML 105						% increasing
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	51.08	1.83	3	51.03	1.82	3	0.05
San Kam Pheang	50.72	3.16	3	48.07	3.15	3	2.65
Mean	50.90	1.63	6	49.55	1.76	6	1.36
			NSP				
San Pa tong	48.87	-	1	47.27	-	1	1.6
San Kam Pheang	50.35	2.88	2	47.38	2.71	2	2.97
Mean	49.86	1.73	3	47.34	1.57	3	2.29
			RD.6				
San Pa tong	51.82	-	1	47.26	-	1	4.56
San Kam Pheang	59.75	-	1	58.64	-	1	1.11
San Sai	53.99	4.52	4	46.80	1.19	4	7.19
Ban Thi	56.19	1.19	5	54.35	1.10	5	1.84
Mean	55.16	1.53	11	52.04	1.55	11	3.12
Overall mean	**52.73**	**1.07**	**20**	**50.19**	**1.04**	**20**	**2.54**

Note: n = number of samples

4.4.2.2 Percentage of broken rice

The comparison of effect of KI and non-KI foliar application on percentage of broken rice was illustrated in Table 4.12 Applying KI produced the lower percentage of broken rice than the rice sample without KI applying. Average percentage of broken rice of KI and non-KI foliar application were 14.83 and 17.38 respectively.

In case of varieties, it was found that the rice sample applied with KI the percent broken rice was decreased when compared with the sample control (not applied with KI) in all varieties. The percent broken rice results were similar to the percent head rice's but it was demonstrated in the opposite way. Regardless of the location, the percent decreasing of broken rice of RD.6 variety produced highest of all samples which was 2.94%. As compared to the other varieties (NSP and KDML105 vareity), the percent decreasing of both varieties were shown 2.61 %and 1.92%, respectively.

Table 4.12 Mean percentage of broken rice compared with KI and non-KI foliar application.

Items	KDML 105						% difference
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	16.54	1.52	3	18.23	1.18	3	1.69
San Kam Pheang	17.52	3.53	3	19.68	2.25	3	2.16
Mean	17.88	1.60	6	18.11	1.73	6	1.92
			NSP				
San Pa tong	12.75	-	1	13.33	-	1	0.58
San Kam Pheang	19.00	2.98	2	22.42	2.54	2	3.42
Mean	19.52	3.48	3	16.91	2.70	3	2.61
			RD.6				
San Pa tong	16.28	-	1	19.53	-	1	3.25
San Kam Pheang	9.30	-	1	8.30	-	1	-1.00
San Sai	14.75	3.94	4	22.39	1.27	4	7.64
Ban Thi	10.78	1.35	5	12.61	1.60	5	1.83
Mean	12.77	1.81	11	15.71	1.60	11	2.94
Overall mean	**17.38**	**1.19**	**20**	**14.83**	**1.19**	**20**	**2.55**

Note: n = number of samples

4.4.2.3 Percentage of milled rice

From the result, it was also found that there was not different in percentage of milled rice of rice samples with KI and non-KI foliar application. In general, applying KI did not affect to the percentage of milled rice of those rice varieties (Table 4.13) which included of KDML105 NSP and RD.6. An average of milled rice of both treatments was measured 67.56 and 67.55% with KI and non-KI foliar application respectively.

Table 4.13 Mean percentage of milled rice compared with KI and non-KI foliar application

Items	KDML 105						% difference
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	69.30	0.36	3	67.57	1.15	3	1.73
San Kam Pheang	68.25	0.43	3	67.74	0.45	3	0.51
Mean	68.78	0.34	6	67.66	0.55	6	1.12
			NSP				
San Pa tong	61.62	-	1	60.60	-	1	1.02
San Kam Pheang	69.35	0.10	2	69.80	0.18	2	-0.45
Mean	66.77	2.58	3	66.73	3.07	3	0.04
			RD6				
San Pa tong	68.10	-	1	66.79		1	1.31
San Kam Pheang	67.94	-	1	68.04		1	-0.1
San Sai	66.82	1.15	4	68.81	0.54	4	-1.99
Ban Thi	66.97	0.41	5	66.96	0.85	5	0.01
Mean	67.11	0.44	11	67.72	0.49	11	-0.61
Overall mean	67.56	0.45	20	67.55	0.50	20	

Note: n = number of samples

4.4.2.4 Percentage of brown rice

Average percentage of brown rice of both treatments was showed in Table 4.14 that there was not difference in percentage of brown rice among KI and Non-KI foliar application treatments. Similar to percentage of milled rice, it was found that applying KI did not change the percentage of brown rice. From Table 14, the average of both treatments (KI and non-KI foliar application) was 73.82 and 73.91 %, respectively.

Table 4.14 Mean percentage of brown rice compared with KI and non-KI foliar application

Items	KDML 105						% difference
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	74.91	0.42	3	74.63	0.91	3	0.28
San Kam Pheang	74.69	0.39	3	74.76	0.19	3	-0.07
Mean	74.80	0.64	6	74.70	0.42	6	0.10
			NSP				
San Pa tong	68.22	-	1	67.49	-	1	0.73
San Kam Pheang	75.31	0.88	2	74.92	0.49	2	0.39
Mean	72.98	2.38	3	72.85	2.68	3	0.13
			RD.6				
San Pa tong	74.38	-	1	74.15	-	1	0.23
San Kam Pheang	73.60	-	1	73.60	-	1	0.00
San Sai	73.63	0.83	4	74.43	0.19	4	-0.80
Ban Thi	73.24	0.37	5	73.22	0.88	5	0.02
Mean	73.52	0.33	11	73.78	0.42	11	-0.26
Overall mean	**73.82**	**0.39**	**20**	**73.91**	**0.44**	**20**	

Note: n = number of samples

4.4.2.5 Percentage of husk

Table 4.15 presented the percentage of husk compared with KI and non-KI foliar application. It was found that the percentages of husk using KI and non-KI foliar application were not different. The percentage of husk was measured 26.18 and 26.08 % with and without application of KI respectively.

Table 4.15 Mean percentage of husk compared with KI and non-KI foliar application

Items	KDML 105						% difference
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	25.09	0.42	3	25.37	0.91	3	-0.28
San Kam Pheang	25.31	0.39	3	25.24	0.19	3	0.07
Mean	25.20	0.26	6	25.30	0.42	6	-0.1
			NSP				
San Pa tong	31.78	-	1	32.51	-	1	-0.73
San Kam Pheang	24.65	0.12	2	24.48	0.13	2	0.17
Mean	25.20	2.36	3	27.15	2.68	3	-1.95
			RD.6				
San Pa tong	25.85	-	1	26.40	-	1	-0.55
San Kam Pheang	26.40	-	1	26.40	-	1	0
San Sai	25.38	1.36	4	25.58	0.19	4	-0.2
Ban Thi	26.76	0.37	5	26.78	0.88	5	-0.02
Mean	26.49	0.33	11	26.22	0.42	11	0.27
Overall mean	**26.18**	**0.39**	**20**	**26.09**	**0.44**	**20**	

Note: n = number of samples

4.4.2.6 Percentage of bran

Table 4.16 presented the comparison of percentage of bran among KI and non-KI foliar application treatments. Average percentage of bran that applied with KI did not show difference when compared with the sample tests.

Table 4.16 Mean percentage of bran compared with KI and non-KI foliar application

Items	KDML 105						% difference
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	5.60	0.12	3	7.06	0.92	3	-1.46
San Kam Pheang	6.45	0.82	3	7.02	0.61	3	-0.57
Mean	6.02	0.42	6	7.04	0.49	6	-1.02
			NSP				
San Pa tong	6.60	-	1	6.89	-	1	-1.46
San Kam Pheang	6.01	0.21	2	5.73	0.05	2	-0.57
Mean	6.21	0.23	3	6.11	0.39	3	-1.02
			RD.6				
San Pa tong	6.28	-	1	7.36		1	-1.08
San Kam Pheang	5.66	-	1	5.61		1	0.05
San Sai	5.81	0.50	4	5.62	0.39	4	0.19
Ban Thi	6.27	0.24	5	6.27	0.14	5	0
Mean	6.41	0.22	11	6.06	0.22	11	0.35
Overall mean	**6.26**	**0.17**	**20**	**6.36**	**0.21**	**20**	

Note: n = number of samples

4.4.2.7 Grain hardness

From the result, it was found that mean grain hardness of rice samples of KI foliar application treatment showed greater than non-KI treatment. Again, the grain hardness of rice samples responded to KI application. Table 4.17 showed that mean grain hardness of rice sample of KI application treatment was approximately 63.61 N/cm^2 compared with non-KI application treatment which was 61.11 N/cm^2.

Regarding KI application treatment, mean grain hardness of three varieties were not much different. The mean grain hardness of KDML105, RD.6 and NSP variety were 64.22, 63.43 and 62.66 N/cm^2, respectively.

In case of grain hardness of each rice management practices, the result showed that the grain hardness of rice samples of all selected farms was increased when applied with KI. Thus, when refer to the percentage of head rice yield (Table 4.11), the both results was concerned to each other. As the grain hardness increased, the head rice yield was also increased.

Table 4.17 Mean grain hardness (N/cm^2) compared with KI and non-KI foliar application

Items	KDML 105						% increasing
	KI			Non-KI			
	Mean	SE	n	Mean	SE	n	
Selected farms							
San Pa tong	63.76	3.50	3	61.71	3.46	3	4.61
San Kam Pheang	65.08	1.13	3	60.47	4.37	3	2.05
Mean	64.22	1.67	6	61.09	2.51	6	3.13
				NSP			
San Pa tong	52.43	-	1	50.82	-	1	1.61
San Kam Pheang	67.78	2.10	2	66.56	0.60	2	1.20
Mean	62.66	5.26	3	61.33	5.26	3	1.33
				RD.6			
San Pa tong	66.56	-	1	61.94	-	1	4.62
San Kam Pheang	60.84	-	1	57.06	-	1	3.78
San Sai	63.06	1.68	4	59.12	3.68	4	3.94
Ban Thi	63.63	2.20	5	63.23	2.54	5	0.39
Mean	63.43	1.16	11	61.06	1.78	11	2.37
Overall mean	63.61	1.03	20	61.11	1.36	20	2.5

Note: n = number of samples

4.4.3 Nutritive values

4.4.3.1 Iodine content in brown rice

The results illustrated that rice sample that applied with KI was greater in iodine content in brown rice than that of control in all varieties. It was found that NSP variety was the highest in iodine content in brown rice, which produced 4.01 mg/100g

Table 4.18 Mean iodine content in brown rice (mg/100g) compared with KI and non-KI foliar application.

Varieties	Iodine content in brown rice(mg/100g)						Percent difference
	KI			Non-KI			
	Mean	n	SE	Mean	n	SE	
KDML105	3.81	11	0.10	3.77	6	0.06	0.04
NSP	4.01	3	0.36	3.70	3	0.17	0.31
RD.6	3.86	11	0.10	3.85	11	0.22	0.01

4.4.3.2 Potassium content in brown rice

It was found that the percent potassium content in brown rice was not different in various rice varieties and locations, when compared with KI and non-KI treatment. The average percentage of potassium content in brown rice was about 219.61%.