

CHAPTER 6

SUSTAINABILITY INDICATORS OF CROP PRODUCTION SYSTEM

In order to understand how farmer households practice in their farm as well as the profits that they achieved from these practices, this chapter presents an overview of the relevant sustainability indicators on the concept of crop production system sustainability. It elaborates on the indicators that are as presented Table 4.1 (Chapter 4).

6.1 General agricultural land use at the household level in three communes

As presented before, land is the most important factor for economic development, especially for agricultural production. Their efficiency in terms of use was affected by many factors, including socio-economic conditions, which are important factors that related to land use types and land sustainability level. The rapid population growth during the past decade in this area has led to the expansion of cultivation, and infrastructure in the study area. Land is more valuable in Nam Dong situation now than in the period when economic base was still developed as self-sufficiency. Based on the existing land characteristics, farmers in three study communes used land as is presented as Table 6.1.

Table 6.1 Area of each agricultural land use type at households of three communes

Land use types	Commune					
	Huong Phu		Huong Loc		Thuong Quang	
	----m ² ----	---%---	----m ² ----	--%--	----m ² ----	--%--
Agricultural land area per household	10,125.45		5,124.72		9,158.67	
1. Land for annual plants	3,818.31	37.7	1,476.74	47.2	6,151.88	67.2
2. Land for miscellaneous gardens	242.00	2.4	155.92	5.0	196.00	2.1
3. Land for perennial plants	6,065.14	59.9	1,492.05	47.8	2,810.80	30.7
Total sample households	40		40		40	

Source: Survey, 2004

To focus on land use in the households, the data listed in Table 6.1 show that an average area of agricultural land per household in three communes ranged from almost 5,124 m² to 10,125 m² depending on available agricultural land and population.

Comparison of land use among the communes shows that for both Huong Phu and Thuong Quang commune, the average area of agricultural land per household is around 10,000 m². In Huong Phu commune, average area reaches 10,125.45 m² nearly double compared with Huong Loc commune (5,124.72 m²). Huong Loc is a commune located in the valley zone and the conditions, both natural and socio-economic conditions, are conducive to agricultural production. However, with limited land available in this zone, the land used for other purposes such as residential purpose, infrastructure, and special-use purpose, is greater than for agricultural purposes. With high population, low average area per household is more common.

In the structure of land use, in Huong Phu commune, agricultural land use for perennial plants makes up high percentage (60%), followed by land for annual crops. Conversely, in Thuong Quang commune, the land for annual crops was dominant than land for perennial plants. In three communes, the land for miscellaneous gardens especially land with water surface constitutes the lowest area (Table 6.1)

6.2 Crop production systems (CPSs)

In Nam Dong area, there are many different CPSs, depending on geophysical and topographical characteristics. However, there are only some popular CPSs in each micro-zone. Through surveys and discussion among farmers and officers in the study area, the CPSs in the three communes presented in Table 6.2.

Table 6.2 Major crop production systems of three study communes

Commune	Crop production systems					
	Rice-A.Crop	Rice-Fish-A.Crop	I.A.Crop	Fruit	Fruit-I.P.Crop	Veg.Str.
Huong Loc	■		■		■	
Huong Phu		■	■		■	
Thuong Quang		■		■		■

Source: Survey, 2004

Notes:

- Rice-A.Crop: Paddy rice-annual crops
- Rice-Fish-A.Crop: Paddy rice-fishpond-annual crops
- I.A.Crop: Industrial annual crops
- Fruit-I.P.Crop: Fruit trees- industrial perennial crops
- Fruit: Fruit trees
- Veg.Str.: Vegetables along stream

Huong Loc commune

Located in the valley zone with alluvial soil and underground water are abundant. There are also more irrigated dams and water reservoirs for agricultural production. From Table 6.2 it can be seen that in Huong Loc commune there are three CPSs; Rice-A.Crop, I.A.Crop, and Fruit-I.P.Crop pattern, these are also feature CPSs for valley zone. The Rice-A.Crop and I.A.Crop pattern located in two sides of stream in Huong Loc where the terrain is rather flat and essentially alluvial soil that are deposited every year. Besides the cultivation of two seasons of paddy rice, an additional crop can be grown with available irrigated water.

The Fruit-I.P.Crop pattern was located on the two sides of valley where there is sloping terrain, rather high, and far from irrigated water source. This is the place where people usually build the houses and developed home garden with fruit trees and some perennial industrial crops. Besides, on the side of hills, farmers also planted protective forests in order to prevent soil erosion as well as water sources. Nowadays, home or hill gardens are stable sources of family income so households want to make more investment in them.

Huong Phu commune

Locating in medium hill zone of Nam Dong district. So their CPSs were a little different from Huong Loc commune. In Huong Phu area, the Rice-Fish-A.Crop, I.A.Crop, and Fruit-I.P.Crop pattern are more popular. The Rice-Fish-A.Crop pattern also is distributed along streams and located in rather high terrain compared with that pattern in Huong Loc commune. It was also in alluvial soil. In the area that has good irrigated condition such as place was nearby KaTu lake, and some places along streams, the farmers cultivated paddy rice and annual crops. In the area that is far from source of water, annual crops in spring-winter season, and upland rice in summer-autumn season were grown. This commune is next to Khe Tre – Nam Dong valley and there is Katu lake, nearby where fishing (carp, catfish) with irrigation to cultivate paddy rice is possible. This created more favourable condition in terms of agricultural production.

The Fruit-I.P.Crop pattern was distributed in the area that has red yellow soil on diorite-gabbros rock and red yellow soil on clay schist rock in Huong Phu and other communes. The terrain in this area is mound with a sloping level of less than 14%, and surface soil layer is greater than 70 cm deep therefore it was suitable for perennial industrial crops and fruit trees (located around house or field in the medium mountain). The fruit trees have high capacity to be grown with high productivity as well as being importance sources of income in this area.

Beside two patterns above, the I.A.Crop pattern was applied on brown yellow soil on ancient alluvial. The terrain is rather flat with sloping level less than 9%. In this area, the mechanical and chemical character of soil was suitable for more crops include temporary industrial crops such as sugar-cane, peanut, etc. as well as the fruit trees such as orange, citrus, banana, etc. The places have rather abundant water sources. There is irrigation, which can satisfy paddy rice cultivation.

Thuong Quang commune

In Thuong Quang commune, the Fruit pattern was distributed in place where has brown yellow ancient alluvial soil and the terrain is rather high. It was distributed between of rice fields along the streams and high hill areas. This is favourable area to develop residence-home garden pattern.

The same situation with Huong Phu commune, the Rice-Fish-A.Crop pattern also was prevalent in this commune. Paddy rice and fish ponds are located along streams on the side of Huu Trach river under red yellow soil on diorite-gabbros rock and brown yellow soil on an ancient alluvial area. This area has medium terrain with sloping level is from 5% to 14%, the soil layer level was greater than 70 cm deep. The soil has poor nutrients and far from irrigated water source but it is suitable for agricultural cultivation for crops that has short root and can salvage natural water source to cultivate annual crops and upland rice. This area can also grow some food crops and temporary industrial crops. Moreover, this commune has high density of river and stream network that are originated from mountains, the Veg.Str. pattern is typical not only in this area but also in Nam Dong district.

6.3 Land use

Field crop production is more dominant of land use area of households in both Huong Loc and Thuong Quang commune, constituting about 46% and 49% of the areas, respectively. The remaining area is utilized as homestead and orchard production. In Thuong Quang commune has one very typical crop production system (CPS) is Veg.Str. pattern that located along stream, however this pattern occupied only 9% in total cultivation area of household (Table 6.3).

Table 6.3 Land use, and crop diversification of three study communes

Category	Average agricultural land per household (ha)	Crop production systems				
		Rice-A.Crop	Rice-Fish-A.Crop	I.A. Crop	Fruit	Fruit-I.P.Crop
Huong Loc	0.5124					
- Proportion		0.466		0.152		0.328
- Index of crop diversification		0.875		0.500		0.750
Huong Phu	1.0126					
- Proportion			0.33	0.115		0.434
- Index of crop diversification			0.833	0.666		0.750
Thuong Quang	0.9158					
- Proportion			0.491		0.339	0.0952
- Index of crop diversification			0.800		0.666	0.500

Source: Survey, 2004

Both Huong Loc and Huong Phu, land use for I.A.Crop pattern constituted smallest area compared with other CPSs, its proportion is just about 0.15. Meanwhile, in Huong Phu commune, the dominant type of land was under homestead and orchard production (43% of total cultivation land), followed by field crop production.

6.4 Crop diversification

The main crops cultivated in all systems of three communes consist of 17 crops type those are paddy rice, maize, sweet potato, bitter melon, bean, peanut, orange, etc. (Figure 6.1, 6.2, and 6.3). Cereal crops, mainly paddy rice, occupy more than 0.185 in proportion of crop area in households both Huong Loc and Thuong Quang commune. Even in Huong Phu commune, although paddy rice constituted low

proportion compared with two communes above but it was still greater than 10% of the cultivation area. Besides paddy rice, orange and citrus, areca, cassava, and banana also occupied more than 10% of cultivation area of households but differentiated between three communes. Orange and citrus was more common in Huong Phu households, and areca was in Huong Loc households. Meanwhile, cassava and banana were rather dominant following paddy rice in cultivation area of households in Thuong Quang commune.

There is similarity in terms of CPSs between three communes such as in Huong Loc and Huong Phu commune, the I.A.Crop and Fruit-I.P.Crop pattern are popular. While Rice-Fish-A.Crop pattern that is popular in Huong Phu and Thuong Quang commune. However, the cropping systems for each CPS in each commune were different as shown in Figure 6.1 and 6.2.

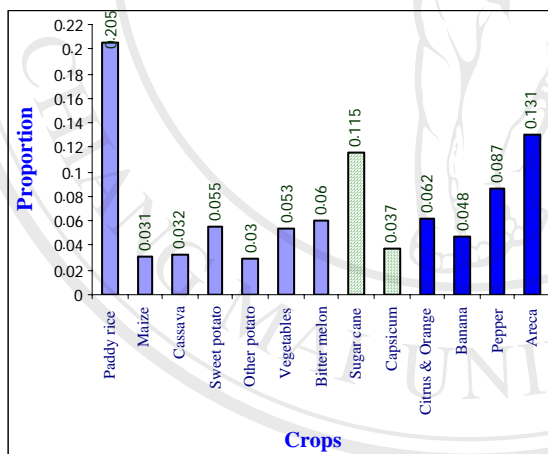


Figure 6.1 Crop proportion in Huong Loc commune

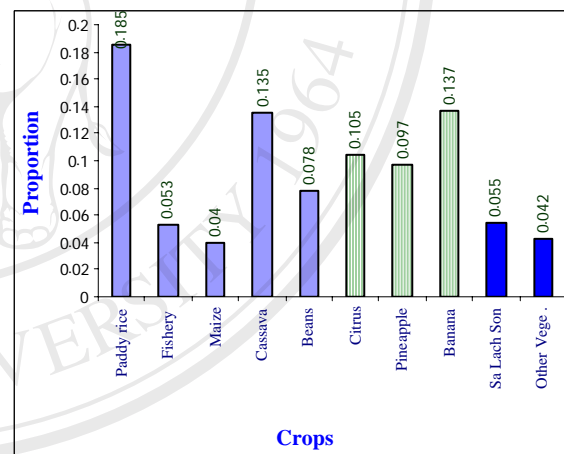


Figure 6.2 Crop proportion in Thuong Quang commune

Figure 6.1 shows that in Huong Loc commune, paddy rice (about 20% of total cultivation area of households) was not only making up the highest proportion in Rice-A.Crop pattern but also making up the highest proportion in land use of households. Following paddy rice was areca (about 13% of total cultivation area of HHs) in Fruit-I.P.Crop pattern and sugar cane in I.A.Crop pattern. The low proportion of land use is potato, maize and cassava. Due to limited cultivation area, and to get high income to guarantee a living, some farmers in Huong Loc commune in recent years changed some crops with low profit into high value crops such as bitter melon, capsicum, and sugarcane. For cassava and sweet potato, although low in profit but

they have an important role in serving livestock, therefore farmers salvaged border areas to cultivate these to satisfy livestock.

Similarly, in Thuong Quang commune, paddy rice has also big area (about 18% of total cultivation area of households), followed by banana and cassava with 13.7% and 13.5%, respectively (Figure 6.2). Unlike in Huong Loc commune, besides cropping systems, fish pond is an important source of income of households. The average area of each pond was about 485 m².

Conversely, in Huong Phu commune, citrus and orange was more dominant in terms of cropping system and constitutes the highest proportion of area (about 30% of total cultivation area of households). Citrus and orange are not only a dominant crop in Huong Phu commune but they make this commune become the center to grow these crops. The difference in crop proportion in Huong Phu commune is illustrated as Figure 6.3.

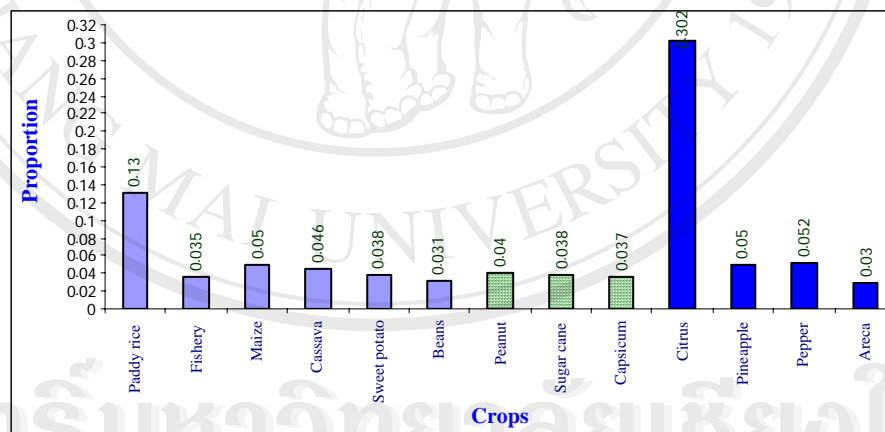


Figure 6.3 Crop proportion in Huong Phu commune

Figure 6.3 also shown that in Huong Phu commune, there are 13 main crops are grown in the farm of farmers. Rice-Fish-A.Crop pattern was production pattern that has more diversification in terms of cropping system. However, the proportion of those crops is not so high except paddy rice (about 13% of total cultivation area of households). Similar to Thuong Quang commune, fish pond is one of component in agricultural production of households in Huong Phu commune. The average area of

each pond was almost 354 m². According to the farmers, the relationship between garden, fish pond, and livestock cannot be separated. They supplement each other and increase production efficiency. If farmers did not feed fish, grass will be thrown away. But when feeding fish, these grasses become food for fishes. Conversely, the mud in pond is a source of fertilizer supplied to crops. Hence, fish culture not only brings about high economic efficiency but also provides a source of water for irrigation while also improving micro-climate in farmer's garden.

A higher degree of crop diversification in this type of pattern is conducive to making efficient use of different types of nutrients available in soil and to increasing biodiversity. Crop diversification reduces the risk of crop failure, thereby making farms less vulnerable to food shortage. Based on index of crop diversification (ICD), in Huong Loc commune, the Rice-A.Crop pattern has the highest ICD (0.875), followed by Fruit-I.P.Crop (0.75) and I.A.Crop pattern (0.5). Similarly, in Huong Phu commune, the lowest index of crop diversification was I.A.Crop pattern give a value of 0.666. The Fruit-I.P.Crop pattern has the same value with that pattern in Huong Loc commune (0.75). The highest index of crop diversification was Rice-Fish-A.Crop pattern (0.833). The priority order of index of crop diversification in Thuong Quang commune was the Rice-Fish-A.Crop, Fruit, and Veg.Str. pattern (Table 6.3).

6.5 Soil fertility management

Declining soil fertility has been the major concern for agricultural sustainability in Nam Dong district. It is believed that declining land productivity can, to a considerable extent, be attributed to the lack of adequate amounts of organic matter in soil (Duy, 1997). Traditionally, farmers used to apply farmyard manure and crop residues to enhance soil fertility. This tradition has been abandoned gradually because of the reduction of livestock herd size and the increasing used demand of dung and crop residues as fuel.

Through pre-survey in three communes in terms of fertilizer used, finding that farmers in those communes rarely used cultivation of legumes for increasing soil fertility. They mainly used chemical fertilizer, organic or compost fertilizer;

especially they used more chemical fertilizer. Thus, we classified the way and volume in fertilizer management applied for each CPS corresponding with each commune. Those are presented as Table 6.4.

Table 6.4 Soil fertility management of households in the three communes

Category	Unit	Crop production systems				
		Rice- A.Crop	Rice-Fish- A.Crop	I.A. Crop	Fruit I.P.Crop	Veg.Str.
1. Huong Loc commune						
* Household used fertilizer						
- Chemical (>75% of all types of fertilizers)	HHs	18 (48%)		7 (18%)		12 (30%)
- Chemical-organic (50%-50% of all types of fertilizers)	HHs	15 (38%)		25 (63%)		22 (55%)
- Compost (>75% of all types of fertilizers)	HHs	4 (10%)		6 (15%)		4 (10%)
* Percentage of total volume chemical fertilizer used in all CPS	(%)	55		10		35
2. Huong Phu commune						
* Household used fertilizer						
- Chemical (>75% of all types of fertilizers)	HHs	9 (23%)		8 (20%)		13 (33%)
- Chemical-organic (50%-50% of all types of fertilizers)	HHs	25 (63%)		23 (58%)		20 (50%)
- Compost (>75% of all types of fertilizers)	HHs	4 (10%)		7 (18%)		4 (10%)
* Percentage of total volume chemical fertilizer used in all CPS	(%)		25	20		55
3. Thuong Quang commune						
* Household used fertilizer						
- Chemical (>75% of all types of fertilizers)	HHs	9 (23%)			8 (20%)	5 (13%)
- Chemical-organic (50%-50% of all types of fertilizers)	HHs	22 (55%)			26 (65%)	6 (16%)
- Compost (>75% of all types of fertilizers)	HHs	5 (13%)			3 (8%)	4 (10%)
* Percentage of total volume chemical fertilizer used in all CPS	(%)		50		40	10

Source: Survey, 2004

Note: Assumed land proportion was equal between CPSs (Huong Loc: 0.466; Huong Phu: 0.434; Thuong Quang: 0.491)

In Huong Loc commune, the results noted that almost farmer households applied at least one of fertilizers on their farm. However, application levels between

CPSs and land use types are different. Making comparison between CPSs, investigation also showed that the Rice-A.Crop is the pattern, which farmers used more chemical fertilizer compared with the rest (Table 6.4). The data in Table 6.4 also showed clearly that farmers used chemical fertilizer with amount greater than 75% in Rice-A.Crop pattern more than compared with other pattern (48% of farmers). This system used 55% of total volume chemical fertilizer used in all CPSs. The lowest chemical fertilizer used is I.A.Crop pattern in both farmer's use and amount; they just make up 18% and 10%, respectively. Nearly 52% of farmer households in Huong Loc commune applied chemical-organic (50%-50%) fertilizers to their land holdings, while only 12% of the farmers in this commune applied compost fertilizers.

Similarly, in Huong Phu commune, the Fruit-I.P.Crop pattern has a great number of farmers using chemical fertilizer (33% of farmers) and total amount of chemical fertilizer (45%). Meanwhile, I.A.Crop and Rice-Fish-A.Crop pattern are not so different in the number of farmers used and total amount of use. They made up 20% and 25% respectively. In this commune, number of farmers who applied compost were also a little (about 13% of farmers). While number of farmers who used chemical-organic (50%-50%) fertilizers were dominant, with an average of 57%.

The fertilizer management of farmer households in Thuong Quang commune has separate features and a little different with farmer households in two communes above. The Veg.Str. pattern is the best system in terms of fertilizer management. This CPS, the farmers used lowest chemical even some cases they did not use any chemical when they cultivated, such as in *Sa Lach Son* (this is one kind of vegetables that are grown along streams) that is located along stream. Making comparison between CPSs, farmers in the Rice-Fish-A.Crop and Fruit pattern still used more chemical fertilizer as compared with Veg.Str. pattern. The average number of households using chemical fertilizer in Veg.Str. pattern is almost 13% of households and they used 10% of total amount of chemical use for the whole farm. Meanwhile, farmers in the Rice-Fish-A.Crop pattern used 50% in total chemical amount use for the whole farm in fertilizer management. Also in I.A.Crop pattern, farmers used more chemical in fertilizer, with the value of 40%.

In summary, most of farmers in the three communes applied organic fertilizers and chemical fertilizers to their farmlands. Discussions with farmers revealed that farmers have had to apply increasingly large amounts of chemical fertilizers over successive years to maintain yields because of gradual deterioration of soil quality caused by monocrop and overuse of chemical fertilizers. Hence, besides deteriorating soil and water quality, the increasing requirement of chemical fertilizers would eventually make farming economically unviable in CPSs by incurring increased costs and eroding farmer's profit margins.

6.6 Pest-disease management

In terms of pest-disease management, the practice of chemical pesticide is main method in three communes. Some farmers also used mechanical method, but farmers rarely used biological method. Thus, we classified the way and volume in controlling pest and disease applied for each CPS corresponding with each commune. Those are presented as Table 6.5.

Table 6.5 Pest-disease management of households in the three communes

Category	Unit	Crop production systems					
		Rice-A.Crop	Rice-Fish-A.Crop	I.A. Crop	Fruit	Fruit-I.P.Crop	Veg.Str.
Huong Loc commune							
- Chemical method	HHs	29 (73%)		24 (60%)		25 (63%)	
- Mechanical or none used	HHs	11 (27%)		16 (40%)		15 (37%)	
- Percentage of total volume chemical pesticide used in all CPSs	%	55		8		37	
Huong Phu commune							
- Chemical method	HHs		26 (65%)	25 (63%)		30 (75%)	
- Mechanical or none used	HHs		14 (35%)	15 (27%)		10 (25%)	
- Percentage of total volume chemical pesticide used in all CPSs	%		45	15		40	
Thuong Quang commune							
- Chemical method	HHs		24 (60%)		27 (68%)		8 (20%)
- Mechanical or none used	HHs		16 (40%)		13 (32%)		32 (80%)
- Percentage of total volume chemical pesticide used in all CPSs	%		55		30		15

Source: Survey, 2004

Note: Assumed land proportion was equal between CPSs (Huong Loc: 0.466; Huong Phu: 0.434; Thuong Quang: 0.491)

In Huong Loc commune, in pest-disease management, the Rice-A.Crop pattern also displayed more use of chemical method and a higher percentage of chemical amount use in total amount used for the whole farm. But for the remains of two CPSs, they were not different so much in average number of farmer households using chemical method (around 60% of households). However, the amount of chemical use was different. In Fruit-I.P.Crop pattern, more amounts of chemical were used compared with I.A.Crop pattern (37% and 8%, respectively) (Table 6.5).

In Huong Phu commune, in terms of pest-disease control practice, in the Fruit-I.P.Crop pattern there were still more households used chemical method as compared with Rice-Fish-A.Crop, and I.A.Crop pattern. The percentage of households used was 75, 65, and 63, respectively. So the difference between Rice-Fish-A.Crop and I.A.Crop was not so much. In the Rice-Fish-A.Crop pattern, although there were a low number of farmers using chemical for pest-disease control but the total amount of chemical used was greater than Fruit-I.P.Crop pattern (45% and 40% respectively). In the I.A.Crop pattern, farmers used the lowest amount of chemical to prevent pest and disease in this commune (about 15% of total amount used for whole farm).

In Thuong Quang commune, from Table 6.5, it can be seen that the Veg.Str. pattern was the best system in terms of pest-disease management. This CPS, the farmers used lowest chemical pesticide. In the cultivation of this pattern, the farmer belonged fully to natural environment. According to farmers, they did not want to use more chemical for that cultivation because sometimes they would be affected by those practices. In addition, if they used any fertilizer or applying chemical method to control pest and disease they will get low productivity, especially the *Sa Lach Son*. Therefore, those are main reasons explaining why farmers did not use more chemical for this CPS. Farmers in this pattern just used almost 15% of chemical in pest-disease control practice. Meanwhile, farmers in the Rice-Fish-A.Crop pattern used 55% in total chemical amount use for the whole farm in pest-disease management. Also in I.A.Crop pattern, farmers used more chemical to prevent pest and disease, with the volume of 30%.

In summary, about 50% of farmers in Thuong Quang commune controlled pests and diseases by weeding and cultivating crops in time, and catching insects using nets. By contrast, almost 65% of the farmers in Huong Loc and Huong Phu commune used chemical pesticides; only 35% of the farmers used both chemical insecticides and other measures to control insects. The use of pesticides would also make farming increasing costs and eroding farmer's profit margins.

6.7 Profitability

Profitability of CPSs was analysed based on financial return. Cost and returns were analysed based on variable costs, including costs of human labor, animal power, seed, fertilizers, pesticides and insecticides, irrigation water, rent on power tillers, and interest on operating capital. Costs of inputs were computed on the basis of market prices whether they were supplied from home or purchased. The cost of family labor was calculated on the basis of the prevailing wage rate. Gross return was determined based on reported crop yield and farm gate price. Thus, based on real data from surveying on CPSs of farmer households, the analysis is applied for each CPS corresponding with each commune and results are shown as Table 6.6.

Huong Loc commune is located in the valley zone and it had three CPSs, those are Rice-A.Crop, I.A.Crop, and Fruit-I.P.Crop pattern. Based on the current proportion of area, the Rice-A.Crop pattern got the highest gross return, followed by Fruit-I.P.Crop pattern, and I.A.Crop is the lowest gross return. If we considered the cost of input, the cost of Rice-A.Crop pattern was also making up high percentage (almost 45%), followed by Fruit-I.P.Crop pattern (almost 40%), finally was I.A.Crop pattern (almost 30%). However, in terms of gross margin Rice-A.Crop pattern still had the highest gross margin compared with others (Table 6.6). However, if gross margin was calculated per ha, I.A.Crop pattern was performing better than the Fruit-I.P.Crop and Rice-A.Crop pattern. The gross profit margin is found to be 23.5% and 60.9% higher in the I.A.Crop pattern than in the Fruit-I.P.Crop and Rice-A.Crop pattern respectively. Labor was the major variable cost in three patterns (Table 6.6).

Table 6.6 Profitability of CPSs in the three communes

Category	Unit	Crop production systems				Veg.Str.
		Rice-A.Crop	Rice-Fish-A.Crop	I.A.Crop	Fruit-I.P.Crop	
Huong Loc commune						
* Proportion of land area	decimal	0.466		0.152		0.328
* Area per household	ha	0.2338		0.0779		0.1681
- Gross revenue per household	mil. VND	6.083		2.508		5.259
- Total cost per household	mil. VND	2.737		0.752		2.190
- Gross margin per household	mil. VND	3.346		1.756		3.069
* Gross margin per ha	mil. VND	14.311		22.542		18.258
Huong Phu commune						
* Proportion of land area	decimal		0.33	0.115		0.434
* Area per household	ha		0.3341	0.1164		0.4394
- Gross revenue per household	mil. VND		6.670	2.984		8.377
- Total cost per household	mil. VND		3.13	1.704		3.937
- Gross margin per household	mil. VND		3.54	1.28		4.507
* Gross margin per ha	mil. VND		10.594	10.993		10.256
Thuong Quang commune						
* Proportion of land area	decimal		0.491		0.339	0.095
* Area per household	ha		0.4497		0.3105	0.0888
- Gross revenue per household	mil. VND		6.305		4.312	2.878
- Total cost per household	mil. VND		3.837		2.509	1.469
- Gross margin per household	mil. VND		2.468		1.803	1.409
* Gross margin per ha	mil. VND		5.488		5.807	15.859

Source: Survey, 2004

Similarly, in Huong Phu commune, the I.A.Crop pattern has the highest gross margin per ha (VND 10.993 mil.), higher than Rice-Fish-A.Crop and Fruit-I.P.Crop pattern was 3.8% and 7.2% respectively, but its total cost of local input was 67.3% is lower than Rice-Fish-A.Crop (85.5%) and Fruit-I.P.Crop pattern (75.5%). The highest local input was Rice-Fish-A.Crop pattern.

Thuong Quang is the commune that had field crops more dominant than another land use types. This is also a commune where has many streams and it has good condition for cultivation of vegetables. So, the Veg.Str. is the typical pattern that just only occurring in this area. This Veg.Str. pattern was also having high gross margin per ha. The Rice-Fish-A.Crop pattern had the lowest gross margin per ha

(VND 5.488 mil.) in this commune. Moreover, the farmers did not concern so much on the Fruit pattern in this commune, as they lacked investment considerably. Although the cropping system was more diversified, but the area proportion of each crop was sparse. However, right now farmers already had changed their mind after they recognized its profits. In general, the gross margin per ha found to be almost three times higher in the Veg.Str. pattern than in the Fruit-I.P.Crop and Rice-Fish-A.Crop pattern. Of which, *Sa Lach Son* was main source of gross margin in the Veg.Str. pattern. However, due to fluctuation of prices, farmers sometimes abandoned this pattern. The gross margin of Fruit pattern was a little higher than Rice-Fish-A.Crop pattern and it was about 5.8% higher.

6.8 Input self-sufficiency

For the input self-sufficiency, dependency on external input was considered. If there is a high dependency on external input such as chemical fertilizers, pesticides, diesel, irrigation water, etc., then farmers increase vulnerability to reduce profit as they have no control over supply and prices of inputs. Thus, sustainable CPS should seek to minimize the dependency on external input. Thus, based on real data from surveying on CPSs of farmer households, the analysis is applied for each CPS corresponding with each commune and results are shown as Table 6.7.

In Huong Loc commune, in the I.A.Crop pattern, there was a tendency to use more local inputs, such as labor, draught power, seed, and organic fertilizers, which account for about 82% of the total input cost, followed by Fruit-I.P.Crop and Rice-A.Crop pattern, 75.2% and 74.5% respectively. Therefore, the I.A.Crop pattern was relatively more self-sufficient in terms of inputs than the Fruit-I.P.Crop and Rice-A.Crop pattern (Table 6.7).

From Table 6.7, it can be seen that in Huong Phu commune, The I.A.Crop was the pattern with the lowest local input cost, with the percentage of 67.3. Although this pattern used less in amount of chemical fertilizers and pesticides as compared to others, other local input of production such as seed, labor, etc. were also not so high.

The highest local input self-sufficiency index was in Rice-Fish-A.Crop pattern, followed by Fruit-I.P.Crop pattern, with the values of 85.5% and 75.5% respectively.

Table 6.7 Input self-sufficiency of CPSs in the three communes

Category	Unit	Crop production systems					
		Rice-A.Crop	Rice-Fish-A.Crop	I.A. Crop	Fruit	Fruit-I.P.Crop	Veg.Str.
Huong Loc commune							
* Proportion of land area	decimal	0.466		0.152		0.328	
- Total cost	mil. VND	2.737		0.752		2.190	
- Local input cost	mil. VND	2.065		0.615		1.645	
- Percentage (local/total)	%	74.5		81.9		75.2	
Huong Phu commune							
* Proportion of land area	decimal		0.33	0.115		0.434	
- Total cost	mil. VND		3.13	1.704		3.937	
- Local input cost	mil. VND		2.678	1.147		2.972	
- Percentage (local/total)	%		85.5	67.3		75.5	
Thuong Quang commune							
* Proportion of land area	decimal		0.491		0.339		0.095
- Total cost	mil. VND		3.737		2.509		1.469
- Local input cost	mil. VND		1.573		1.258		1.255
- Percentage (local/total)	%		75.3		80.2		85.5

Source: Field survey, 2004

Thuong Quang is the commune that had field crops more dominant than another land use types. Especially, this is also a commune where has many streams and it has good condition for cultivation of vegetables. So, the Veg.Str. is the typical pattern that just only occurring in this area. This Veg.Str. pattern was also having high gross margin, especially, the local input cost was the highest as compared with two remains CPSs (85.5%). Because in this pattern, the costs mainly came from labor, so family members can help. The Rice-Fish-A.Crop pattern had the lowest gross margin (VND 2.468 mil.) in this commune. The percentage of local input cost in total input cost was about 5% higher in Fruit pattern than Rice-Fish-A.Croppattern in terms of input self-sufficiency.

6.9 Yield stability

The yield stability is based on the frequency of farmer reported indicating increasing yield, decreasing yield or constant yield. From those frequencies we can determine yield stability through calculated index of trend yield (ITY) as mentioned before (Chapter 4). Thus, based on real data from surveying on CPSs of farmer households, the analysis is applied for each CPS corresponding with each commune and results are shown as Table 6.8.

Table 6.8 Yield stability of CPSs in the three communes

Category	Unit	Crop production systems				
		Rice-A.Crop	Rice-Fish-A.Crop	I.A. Crop	Fruit	Fruit-I.P.Crop
Huong Loc commune						
* Proportion of land area		0.466		0.152		0.328
- HHs reported increase yield (fi)	HHs	22		27		22
- HHs reported decrease yield (fd)	HHs	6		4		7
- HHs reported constant yield (fc)	HHs	13		10		12
* Index of trend of yield (ITY)		0.40		0.59		0.38
Huong Phu commune						
* Proportion of land area			0.33	0.115		0.434
- HHs reported increase yield (fi)	HHs		23	25		20
- HHs reported decrease yield (fd)	HHs		7	6		6
- HHs reported constant yield (fc)	HHs		10	9		14
* Index of trend of yield (ITY)			0.42	0.47		0.35
Thuong Quang commune						
* Proportion of land area			0.491		0.339	0.095
- HHs reported increase yield (fi)	HHs		23		15	20
- HHs reported decrease yield (fd)	HHs		7		7	5
- HHs reported constant yield (fc)	HHs		10		18	16
* Index of trend of yield (ITY)			0.385		0.20	0.375

Source: Survey, 2004

The index of trend of yield (ITY) is constructed following the method described in section 4.4.2.2 in Chapter 4. It is revealed that a positive trend for all CPSs in Huong Loc commune. The overall index value for all crops is found to be 0.4

in Rice-A.Crop pattern, 0.59 in I.A.Crop pattern, and 0.38 in Fruit-I.P.Crop pattern. Those results indicated a considerably higher rate of yield increase in the I.A.Crop pattern, followed by Rice-A.Crop and Fruit-I.P.Crop pattern. This finding is consistent with what farmers reported during our discussions with them.

Meanwhile, in Huong Phu commune, the I.A.Crop was the pattern with the lowest local input cost but in yield stability, it had the highest value with 0.47 (Table 6.8), then Rice-Fish-A.Crop pattern (0.42), and Fruit-I.P.Crop pattern had the lowest value (0.35).

In Thuong Quang commune, the Rice-Fish-A.Crop pattern had the highest value in yield stability index (0.385). Besides Rice-Fish-A.Crop pattern, ITY of Veg.Str. pattern was also high (0.375) as compared with Fruit pattern (0.20), this is pattern had the lowest value of ITY in three patterns. The detail yield stability is shown clearly as Table 6.8.

6.10 Labor use

Labor is one of the key input for agricultural production. Measurement of labor unit can be seen from two different angles i.e. quantitatively and qualitatively. However, here analysis is concentrated only quantity of labor force. The average number of family members in Huong Loc, and Thuong Quang commune is found around 6 members per household, whereas it was about 5 members per households in case of Huong Phu commune (Table 6.9).

About 10% of rural people in Nam Dong district were unemployed or underemployed (Nam Dong Statistical Office, 2004), which is one of the major causes of poverty. Any activities that create employment opportunities will have a higher equity effect, through a process of chain reaction across the rural economy. Thus, it is reasonable to consider labor requirements and ratio of labor cost to total gross revenue as indicators of the equity effect of any CPSs.

Table 6.9 Family size and labor use correspond with each CPS in three communes

Category	Unit	Number family member	Crop production systems				
			Rice-A.Crop	Rice-Fish-A.Crop	I.A. Crop	Fruit	Fruit-I.P.Crop
Huong Loc							
- Average family size	person	5.76					
- Labor requirement	workday		81.8		65.9		66.7
- Ratio of labor cost to total gross revenue			0.336		0.214		0.223
Huong Phu							
- Average family size	person	5.12					
- Labor requirement	workday			133.4	136.6		100
- Ratio of labor cost to total gross revenue				0.380	0.303		0.298
Thuong Quang							
- Average family size	person	5.59					
- Labor requirement	workday			104		94.1	184.7
- Ratio of labor cost to total gross revenue				0.412		0.376	0.317

Source: Survey, 2004

Note: Assumed land proportion was equal between CPSs (Huong Loc: 0.466; Huong Phu: 0.434; Thuong Quang: 0.491)

Labor used in CPSs, which mainly focused on land preparation, sowing, weeding, pesticide spraying, and harvesting. Total labor used for CPSs varies following each specific CPS and locations. In Huong Loc commune, the Rice-A.Crop pattern was more labor intensive (about 82 workdays) than I.A.Crop (about 66 workdays) and Fruit-I.P.Crop pattern (about 67 workdays). Therefore, ratio of labor cost to total gross revenue was also high as compared with others (Table 6.9). The labor requirement in Rice-A.Crop pattern was 24.1% and 22.6% higher than I.A.Crop and Fruit-I.P.Crop pattern, respectively.

In Huong Phu commune, the lowest labor requirement was in Fruit-I.P.Crop pattern it was about 100 workdays. This labor amount was 36.6% less than I.A.Crop pattern, and 33.4% with Rice-Fish-A.Crop pattern. Between I.A.Crop and Rice-Fish-A.Crop pattern, there was only 2.4% difference, in which the Rice-Fish-A.Crop pattern was dominant. This order was also happened at ratio of labor cost to total

gross revenue. Thus, in general, the I.A.Crop was the pattern that was the most labor intensive, followed by Rice-Fish-A.Crop, then Fruit-I.P.Crop pattern.

Similarly, the Veg.Str. was the pattern which was highly labor intensive (184.7 workdays) than two other patterns in Thuong Quang commune. It was nearly double compared with Rice-Fish-A.Crop (104 workdays) and Fruit pattern (94.1 workdays). However, in terms of ratio of labor cost to total gross revenue, the Rice-Fish-A.Crop pattern was the highest with value was 0.412, followed by I.A.Crop and eventually was Veg.Str. pattern. Because input of production of the Veg.Str. pattern was essentially came from labor at the same time this pattern also got high gross revenue. So the Veg.Str. pattern being more labor intensive, creates more employment opportunities either by absorbing farmer's surplus labor or by requiring the hiring of wage laborers, who are partly unemployed. Moreover, as discussed in the previous section, the Veg.Str. pattern used relatively more local resources. The Rice-Fish-A.Crop and Fruit pattern were highly dependent on external inputs, resulting in a constant outflow of money for the benefit of other communities. This suggests that the Veg.Str. pattern may provide more equitable benefits to local people.

6.11 Food security

Food security has remained one of the most important concerns in Nam Dong district because the very limited land for agricultural used and an ever-increasing population. Food security at the farm household level is a matter of individual households being able to meet their daily food needs from their own production, or the means to obtain food from off-farm sources. However, here analysis was considered only for households being able to meet their daily food needs from their own production or potential to purchase food from cash that come from the CPS.

Based on existing area and yield of food crops, the output of food crops was realized for households corresponding with each commune. At the same time based on the size of family member, food per capita was calculated. The number of day enough food of household was also observed through considering on total of food demand of household to total existing output of food grain (Table 6.10).

Table 6.10 Food security of households in three communes

Category	Unit	Commune		
		Huong Loc	Huong Phu	Thuong Quang
Total output of food grain per household	kg	446	685	757
Food per capita	kg	77.4	133.8	135.4
Number of days enough food of household	days/year	116	201	203

Source: Survey, 2004

Overall, farmer's own food grain production in Thuong Quang commune can meet food requirements for 203 days per year as was 201 days in Huong Phu commune, eventually in Huong Loc commune was only 116 days. This mainly because in three communes there were differences in land area used for cultivation of food crops. In Thuong Quang commune, 0.206 ha was used for food grain production in cultivation area of farmer households, whereas only 0.121 ha is used for the same purpose in Huong Loc commune, and was 0.182 ha in Huong Phu commune. However, it should be noted that the shortage of food grain in the CPS was offset by income from other agricultural enterprises, including livestock and orchard, etc. If the overall agricultural income is considered, there is no variation in food security between three communes. The income structure of farmer households in study communes is presented as Table 6.11.

Table 6.11 Structure of household's income in three communes

Category	Huong Loc		Huong Phu		Thuong Quang	
	Value	Rate	Value	Rate	Value	Rate
	-mil. VND-	-----%	--mil. VND--	-----%	--mil. VND--	-----%
Total income/year	16.87	100	15.46	100	11.34	100
Cultivation	5.10	30.25	4.82	31.17	3.88	34.20
Forestry	3.06	18.16	2.85	18.46	2.89	25.45
Livestock	3.68	21.80	2.20	14.23	2.37	20.95
Garden	3.08	18.25	4.51	29.15	1.80	15.90
Other	1.95	11.54	1.08	6.99	0.40	3.50

Source: Survey, 2004

Exchange rate: 1USD = 16,000 VND

The results from Table 6.11 indicated that total income of three communes was different. The farmers in Huong Loc had the highest income (VND 16.87 mil.) as

compared with other communes, meanwhile the farmers in Thuong Quang had the lowest income. However, in terms of the structure of income, in all three communes, cultivation also contributed the highest percentage with greater than 30%. Especially, in Thuong Quang commune, cultivation made up almost 34% in total income. Another sources of income such as forestry, livestock, garden, and others also was not the same between the three communes. Table 6.11 also showed clearly that income from forestry and livestock as well as garden were still important and made up a medium percentage. Income from other sources such as wages from stage, business, or small industry were not contributing so much family income and it just made up around or less than 10% of total income.

However, here analysis was considered only for households being able to meet their daily food needs from their own production

However, if considered only on households being able to meet their daily food needs from their own production, in all three communes, the food grain for households consumption came from Rice-A.Crop pattern or Rice-Fish-A.Crop pattern. The remaining CPSs as though source of income in order to support food security by using cash to buy food grains from market. In addition, in the study, farmers mentioned that most of their paddy production is used to fulfill somewhat household food requirements. As for other source of income, it is mostly utilized to buy non-food items, including clothes and other daily necessities, and also food grain to fulfill household consumption.

In summary, the findings of this study reveal that in each research commune, the farmers practiced different land use, and CPS. The CPSs followed by the farmers in Huong Loc were Rice-A.Crop, I.A.Crop, and Fruit-I.P.Crop. But in Huong Phu commune, the farmers practiced a little different CPS. Farmers in this area followed CPSs of Rice-Fish-A.Crop, I.A.Crop, and Fruit-I.P.Crop. In Thuong Quang commune, Rice-Fish-A.Crop, Fruit, and Veg.Str. were the more popular CPSs. In the three communes farmers practiced different crop diversification, soil fertility management, pest-disease management, etc. In Huong Loc commune, Rice-A.Crop pattern had the highest index of crop diversification. However, this pattern used also

more chemical fertilizer as well as chemical pesticide. In Huong Phu commune, pattern that had the highest index of crop diversification was Rice-Fish-A.Crop (0.875), followed by Fruit-I.P.Crop pattern. Fruit-I.P.Crop pattern used more chemical fertilizer as compared to others (45%). While I.A.Crop pattern used the smallest chemical fertilizer and pesticide in this commune. In Thuong Quang commune, Veg.Str. pattern although had the lowest index of crop diversification, this pattern used the smallest chemical fertilizer and pesticide. Likewise, there were differences between the CPSs in profit, yield stability, requirement labor, and food security. In Huong Loc and Huong Phu commune, I.A.Crop pattern had the highest profit as well as index of trend of yield. While Veg.Str. pattern had the highest profit in Thuong Quang commune. The lowest index of trend of yield in this commune was Fruit pattern, with a value of 0.20. In terms of labor use, the highest requirement labor of the CPS in Huong Loc, Huong Phu, and Thuong Quang commune was Rice-A.Crop, Rice-Fish-A.Crop, Veg.Str. pattern, respectively. In food security, if the overall agricultural income is considered, there was no variation in food security between communes. However, within the commune, food grain for household consumption came from Rice-A.Crop pattern (Huong Loc commune) or Rice-Fish-A.Crop pattern (Huong Phu and Thuong Quang commune). The remaining CPSs as though source of income in order to support food security by using cash to buy food grains from market. It should be also noted that differences happened not just only within commune but also among communes. These because due to differences of natural and socio-economic conditions of each commune. Therefore even in the same CPS, the practices of farmers in different commune presented different typical characteristics. In order to find out the best CPS in relation to all sustainable indicators, methods that can trade-off all these indicators are necessary. Those are clearly presented in Chapter