CHAPTER VI

ECONOMIC COMPARISONS OF THE *hai* SYSTEM AND INTEGRATED RUBBER-BASED FARMING SYSTEM PRACTICE

This chapter deals with economic assessment of both the *hai* system and the integrated rubber-based farming system practice (IRFS). The input cost and benefit of each practice were identified in detail of investment. In addition, the profitability comparisons of the *hai* system, rubber farm only and IRFSs practice were described as well in this chapter.

6.1 Productivity of annual crop in the *hai* system practice

Regarding the *hai* system in the study area, rice, maize and job's tear were the major cereal crops. They constituted the main income sources for farmers' households as well. Based on farmers' experiences in the study areas, they also cultivated some kind of vegetable together in the field, as inter-cropping or mix-cropping, for self-consumption e.g. pumpkin, cucumber, chili, cassava, etc. The costs of farm inputs seem to be low. The upland farmers used simple materials and equipments and also engaged in exchange labour in the farm management. Mostly local varieties were use with the exception of commercial maize where upland farmers used hybrid variety in line with market demand. Farm tools were local-made equipment (e.g. slasing knives, weeding knives, dibbling stick, etc.). Upland farmers only bought necessary materials and/or extra tools that they could not make by themselves e.g. iron, axes, saw, knap-sack sprayers. Nowadays, market-bought tools are available in those villages.

Table 6.1 Productivity of upland rice in a hectare of area

Items	Unit	Quantity	Price per unit ($US)*	Possible year of uses	Total
Input cost					***273.94***
Seed	kg	40	0.19		7.55
Materials					6.29
Knives	piece	3	2.83	3	2.83
Curved hand hoe	piece	3	1.57	3	1.57
Digging head	piece	1	1.05	5	0.21
Sickle	piece	2	1.26	3	0.84
Axe	piece	1	4.20	5	0.84
Depreciation					5.24
Labor	man-day	162	1.57		254.85
Gross revenue					***639.75***
Yields					
Rice	kg	2,000	0.19		377.56
Other crops**	kg	1,000	0.26		262.19
Profit					**365.81**

Source: data collection in the field, May 2008.

Remark: (*) the currency exchange rate, $US 1 = 9,535 Lao Kip *(BANQUE POUR LE COMMERCE EXTERIEUR LAO,15 November 2007)*

(**) other crops were involved chili, pumpkin, cucumber, cassava (Linkham,2006)

As farmers own their land, land is not charged in the economic assessment. Fertilizers are not used in the cultivation of annual crops in the *hai* system practice, but pesticide is used for the maize hybrid variety, by mixing with grain before sowing to protect ants and termites. Family labours were normally used, but some activities in the farms are exchange labour. Generally, upland farmers do not pay for transporting the harvested crop back to the house, but some people pay truck transportation costs. This expenditure was included in the calculation of farm inputs. Table 6.1 – 6.3 display details of the costs in upland rice, maize and job's tear, respectively.

Table 6.2 Productivity of maize in a hectare of area

Items	**Unit**	**Quantity**	**Price per unit ($US)**	**Possible year of use**	**Total**
Input cost					**237.65**
Seed	kg	10	1.89		18.88
Pesticide	bag	1	2.62		2.62
Materials					4.82
Knives	piece	2	2.83	3	1.89
Curved hand hoe	piece	2	1.57	3	1.05
Hoe	piece	1	3.15	3	1.05
Axe	piece	1	4.20	5	0.84
Depreciation					5.24
Labor	man-day	131	1.57		206.08
Gross revenue					**608.29**
Yields					
Maize	kg	3,000	0.12		346.09
Other crops	kg	1,000	0.26		262.19
Profit					**370.63**

Source: data collection in the field, May 2008.

Table 6.3 Productivity of job's tear in a hectare of area

Items	Unit	Quantity	Price per unit ($US)	Possible year of use	Total
Input cost					***228.74***
Seed	kg	20	0.63		12.59
Materials					4.82
Knives	unit	2	2.83	3	1.89
Curved hand hoe	unit	2	1.57	3	1.05
Hoe	unit	1	3.15	3	1.05
Axe	unit	1	4.20	5	0.84
Depreciation					5.24
Labor	man-day	131	1.57		206.08
Gross revenue					***576.82***
Yields					
Job's tear	kg	1,500	0.21		314.63
Other crops	kg	1,000	0.26		262.19
Profit					**348.09**

Source: data collection in the field, May 2008.

The profitability in the *hai* system practices was calculated by gross margin in term of the annual income in a hectare of farm area which is considered for each single crop.

Table 6.4 Profitability of annual crops per hectare of land in the *hai* system

Items	Upland Rice (n=15)	Maize (n=11)	Job's tear (n=10)
Gross revenue ($US)	639.75	608.29	576.82
Variable costs ($US)	13.84	26.32	17.41
Depreciation ($US)	5.24	5.24	5.24
Family labor (man-day)	162	131	131
Total cost ($US)	273.94	237.65	228.74
Profit ($US/ha)	365.81	370.63	348.09
Gross margin ($US/ha)	625.90	581.96	559.41
Return to labor ($US/man-day)	3.83	4.40	4.23

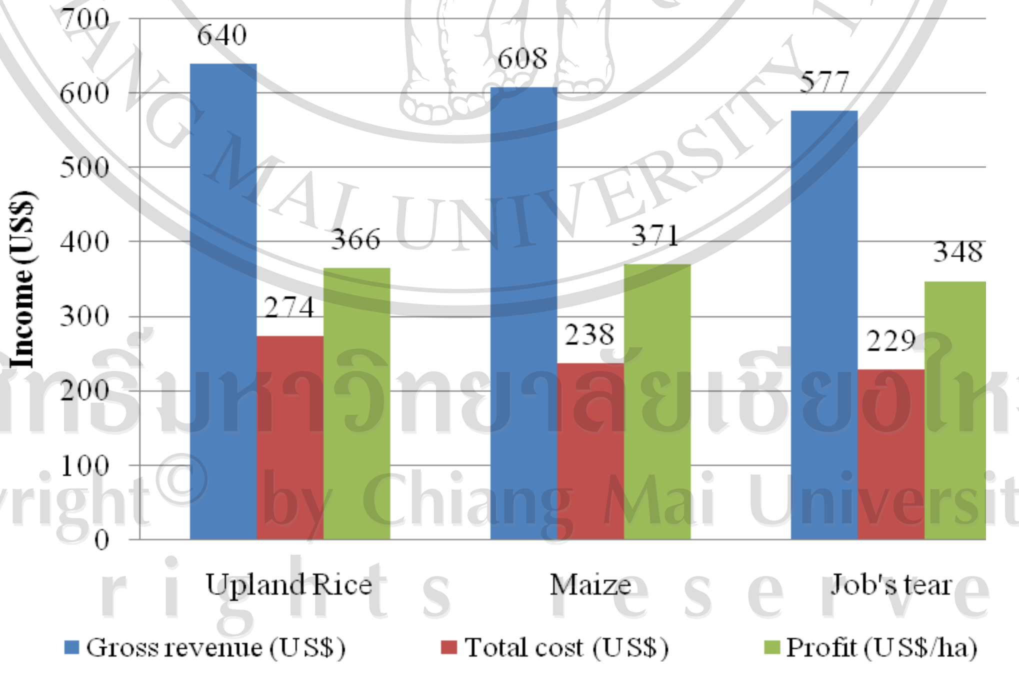

Figure 6.1 Comparison of profitability for three main crops in a hectare of area

Figure 6.1 presented the profitability of three crops that were the priority of farmers' decision choice in their farm. Rice had the highest revenue ($US 640), while maize was $US 608 and job's tear was only $US 577. Even though maize yield was higher than others but its yield price was the cheapest as well. The input cost of rice was also high ($US 359) when compared to others, because it had more activities and expenditures, after harvesting the rice production, e.g. threshing and transporting. In the same way, labour use in rice production was also more than in maize and job's tear production. The gross revenue of three crops was about double the input cost. Farmers in the study areas also had high profitability from annual crops in the *hai* system. When compared to the profit of farm investment by the farm type, maize had higher profit ($US 371), than rice ($US 366) and job's tear ($US 348). In addition, the return to labor in maize production was high ($US 4.40 per man-day), while in job's tear production was $US 4.23 per man-day and in rice production on $US 3.83 per man-day.

Gross margin presented the return of annual crop, exclude the depreciation and labor cost. Figure 6.2 illustrated gross margin for three main crops in the study areas. It is shown that upland rice had the highest income when compared to maize and jobs' tear, because seed and materials cost for rice was less than other crops. Rice was also an important crop for farmers' consumption. Even though, maize had high gross revenue, but it used chemical pesticide and the seed cost was also high. Job's tear was the lowest in the gross margin, because its yield was small (1,500 kg/ha), compared to others though its yield price was high at $US 0.63.

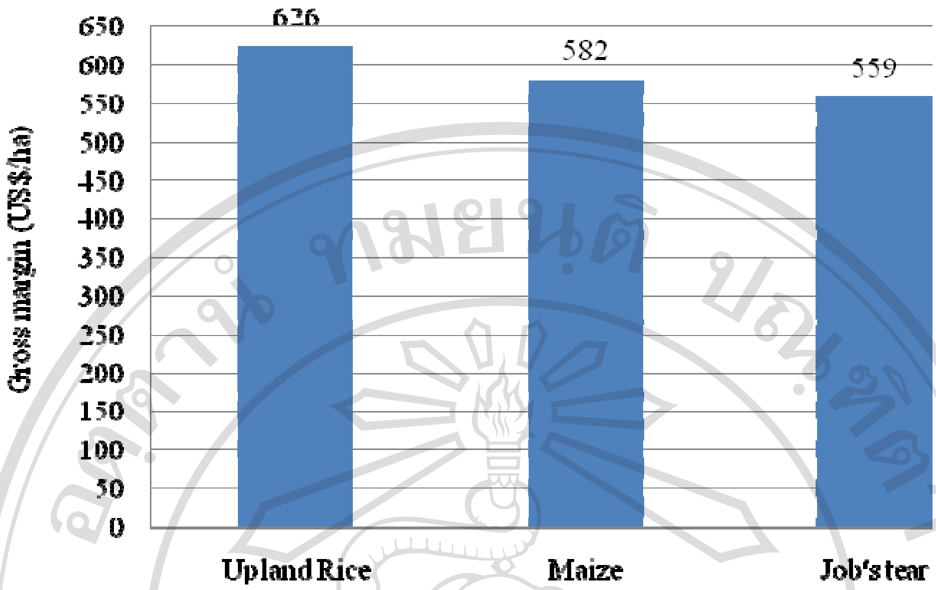

Figure 6.2 the gross margin of the main crops in the *hai* system practice

6.2 Estimated productivities of the rubber plantation only in the study areas.

Due to the high benefit of rubber plantation in the neighbor province (Luang Namtha) and high market demand supported from many companies in China, upland farmers in the study area and in the northern part of Laos wanted to grow rubber and the rubber area were expanding every year. Rubber farm is a perennial crop which provides the long term benefit only after seven years. As the rubber plantations in the study areas have just been grown for four years and it was not ready to be harvested yet. For that reason, the information on yield and prices were obtained from nearby rubber area, Luang Namtha province where rubber product has already harvested. It is expected that rubber plantation is likely to be the new alternative for upland farmers because its yield is higher and also its price is better than annual crops. Farmers paid therefore more attention in the maintenance process by paying some extra labor and special equipments cost for rubber planting.

From farmers' interviews on the rubber plantation, farmers said that rubber was the new alternative which needed more cost at the beginning and it needed to take time before producing their latex. At the first year, to plant rubber in a hectare of land, it was necessary to use about 450 – 500 seedlings, namely 'GT 1', depending on the spacing and slope of land. Based on lessons learnt from successful farmers in the Luang Namtha, farmers used herbicide for killing weeds. The herbicide was imported from China, one bottle contains 10 liters. The rubber farm needed more labor for land preparation at the beginning (lining, terracing and digging), so farmers hired extra labor for preparing their areas. Therefore, the detail of rubber farm investment at the first year was shown in the Table 6.5 below.

Table 6.5 The first year investment of pure stand rubber plantation in a hectare of area

Items	**Unit**	**Quantity**	**Price per unit ($US)**	**Possible year of use**	**Total**
Seed	seedling	500	0.42		209.75
Herbicide	bottle	1	26.22		26.22
Materials:					36.29
Knives	piece	2	2.83	3	1.89
Hoe	piece	2	3.15	3	2.10
Axe	piece	1	4.20	5	0.84
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labors:					231.25
Hired labor	man-day	30	2.10		62.93
Family labor	man-day	107	1.57		168.33
Total cost					**508.76**

Source: data collection in the field, May 2008.

In the second year of rubber plantation, the seedlings have to re-plant once more for 40 – 50 % of numbers the rubber tree in the first year (average 200 seedlings) because of farmers have less skill for maintenance. Therefore, some of them died from many factors e.g. pest damages, accidental cutting while weeding and drought. Hired labor was reduced from the first year because land preparation had been done in the first year.

As previously mentioned, rubber plantation in the study areas have established for four years (begin in 2004). During the 3^{th} – 8^{th} year farmers were only doing maintenance by weeding and killing grass until rubber farm owners could harvest their rubber latex (around the 9^{th} year). Then, the rubber farm income was estimated in economic cultivation by using the net present value (NPV) for 35 years.

Based on the concerning of weather condition and rubber yield that was done harvested in the Luang Namtha. The harvested rubber yield started at the 9^{th} year. The materials used during harvesting period were for tapping, collecting the latex and tree harvesting at the end of plantation life. The tapping and collecting equipment were involved bowls, spouts, iron wire, a plastic brush for congregating latex from the bowl, a tapping knife, a knife sharpening stone, a headlamp, small buckets, large buckets, plastic bags, chemical powder applied at the tapping cut of the rubber trees weekly during tapping period to prevent diseases, chemical liquid applied at the end of tapping season to close the tapping cut of the trees, and a small brush which is used for applying those chemical power and liquid. The replacement of these materials was assumed to occur every ten years for bowls, five years for spouts and wire, and three years for plastic brushes. For the tapping knife, sharpening stone, headlamp, small and large buckets, plastic bags, chemicals, and small brush, an annual replacement was assumed. The materials used for tree harvesting were a set of handy saws

Table 6.6 The estimated input costs of pure stand rubber plantation investment in a hectare of area at the first year of beginning harvested latex yield

Items	**Unit**	**Quantity**	**Price per unit ($US)**	**Possible year of use**	**Total**
Seed	seedling	0	0.00		-
Herbicide	bottle	1	26.22		26.22
Materials:					161.72
Maintaining:					*35.45*
Knives	piece	2	2.83	3	1.89
Hoe	piece	2	3.15	3	2.10
Sprayer	piece	1	94.39	3	31.46
*Harvesting *:*					*173.47*
Tapping Knife	piece	2	2.62	1	5.24
Bowl/cup	piece	500	0.13	10	6.29
Gutter/spout	piece	500	0.03	5	3.15
Iron wire	roll	2	23.07	5	9.23
Plastic brush	piece	2	0.63	3	0.42
Knife sharpening stone	set	2	1.57	1	3.15
Head lamp	piece	2	10.17	1	20.35
Small bucket	piece	2	0.79	1	1.57
Big bucket	piece	2	4.20	1	8.39
Plastic bag	piece	240	0.16	1	37.76
Chemical powder	kg	2.5	6.71	1	16.78
Chemical liquid	kg	1.5	5.24	1	7.87
Small brush	piece	2	0.42	1	0.84
Handy saws	set	1	52.44	1	52.44
Depreciation					5.24
Labors:					180.91
Hired labor	man-day	6	2.10		12.59
Family labor	man-day	107	1.57		168.32
Total cost					**421.29**

Source: data collection in the field, May 2008.
(*) Vongpaphun Manivong (2007)

The rubber's latex yield in this study was using the estimated latex yield in Hadyao village (Luang Namtha Province), where the rubber yield was started to harvest since the year 2002. Therefore, the latex yield was predicted by using the Bioeconomic Rubber Agroforestry Support System (BRASS) model for 35 years (Vongpaphun, 2007). Regarding to the 'rotational calculation method' in the BRASS model offer three criteria, such as the rotation (1) ending in a specified year, (2) ending at a specified tree girth, (3) ending at a specified tree volume. In addition, Hadyao village were new for rubber plantation and rubber tree never harvest yet. Therefore, the end the rotation in a specified year was related issue what the length of the rotation should be. The default value of the model is 40 years, based on the circumstances of Indonesian rubber smallholders. The length of rotation in that study was assumed to be 35 years.

According to Figure 6.3, rubber trees spend eight years to be mature. Then, rubber began to produce its latex yield at the 9th year. The latex yield increased until the maximum production at peak under 1,600 kg/ha at the 22th year and then its yields generally will decrease each year as well, until its production life (35th year).

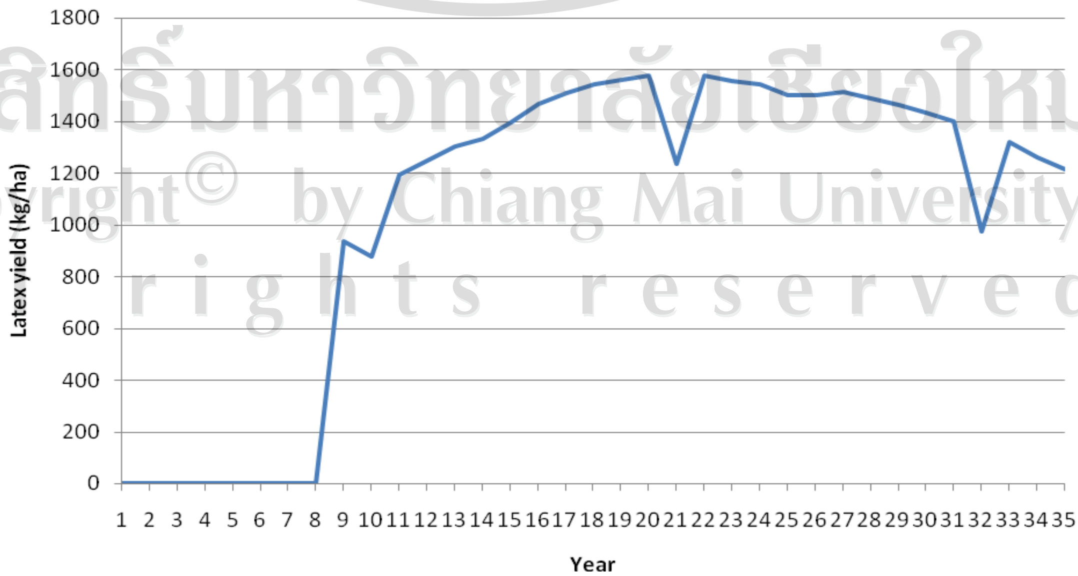

Figure 6.3 The estimated latex yield in the Hadyao village in 2007

Based on the latex yield graph (Figure 6.3), the yield increased in the initial period, then leveled off, and finally entered a long decreasing phase. As notice in the graph, there was a sharp drop in yield in three years – 10, 21, and 32. This drop occurred in the years with unusually low rainfall condition which simulated in the modeling. It should again be noted that this estimated yield profile represents the predicted yield pattern which rubber farmers in Hadyao village would be expected to achieve, given the current state of knowledge, but the actual yields may vary if management practices, weather conditions, or other factors change.

Tub-lump rubber was the main output from rubber production. Farmers in the Hadyao village processed the raw latex into tub-lump rubber by using plastic bags or buckets. The tub-lump rubber was left for a month before selling. There must be some loss in weight from the raw latex compared to the tub-lump rubber due to the loss of moisture content. The extent of the loss was unknown, but it was assumed to be 10% loss in weight.

Figure 6.4 The use of plastic bag and bucket for processing latex into tub-lump rubber and kept at the farm in Hadyao
(Source: Vongpaphun, August, 2005)

Therefore, the tub-lump rubber was calculated from the latex yields from BRASS by taking adjusting downwards by 10% (Vongpaphun, 2007). The tub-lump rubber's yield price used the 2007 price (10,625 Kip/kg or $US 1.11) from the the Luang Namtha rubber management and development unit (NAFRI and NAFES, 2008).

Figure 6.5 The sale of tub-lump rubber on market day in Hadyao Village (Source: Vongpaphun, August, 2005)

At the end of the productive life of the rubber trees, rubber wood was expected to be the final product from the enterprise. As estimated by BRASS, the volumes of rubber wood were 203 m^3 per hectare, including both buttlog and small wood, but only 64 m^3 per hectare of this was buttlog, as found in many countries where plantations are well managed such as Malaysia, Thailand, India, and Sri Lanka

(Vongpaphun, 2007). Buttlog was likely to be commercialized while small wood was likely to be burnt in the field. Consequence, 64 m^3 per hectare of buttlog's volume was used to estimate the benefit from rubber wood. Regards the rubber wood in Laos is no existing market, but the nearest market for rubber wood from Northern Laos is China, the price of rubber wood in Yunnan Province was used. The 2005 price of rubber wood in Yunnan was 360 Yuan/m^3 (Vongpaphun, 2007 and Alton et al., 2005). The farm gate price in Laos was assumed to be about 280 Yuan/m^3 or 364,000 Kip/m^3 (1 Yuan = 1,300 Kip, August 2005). Hence, the estimated farm gate price of rubber wood of 364,000 Kip/m^3 and the volume of buttlog of 64 m^3 were used to quantify the benefit from rubber wood.

Figure 6.6 showed the difference of estimated cost and benefit for 35 years of the rubber plantation alone in the traditional practice. Many farmers in the study areas notified that the rubbers' cost for investment at the first year was very high (about $US 509), when compared to the annual crops' investment, because investment was necessary in land preparation and the seedlings. After that the cost would slightly be reduced to around $US 332 in the second year and the 3rd year continue decreased to $US 248 and constant in this value until the 8th year, before harvesting, those uses for maintaining the rubber plantation e.g. weeding, and using herbicide to kill the *imperata* grass (*Nha Kha*) in every year, when the new seasonal cultivation will start.

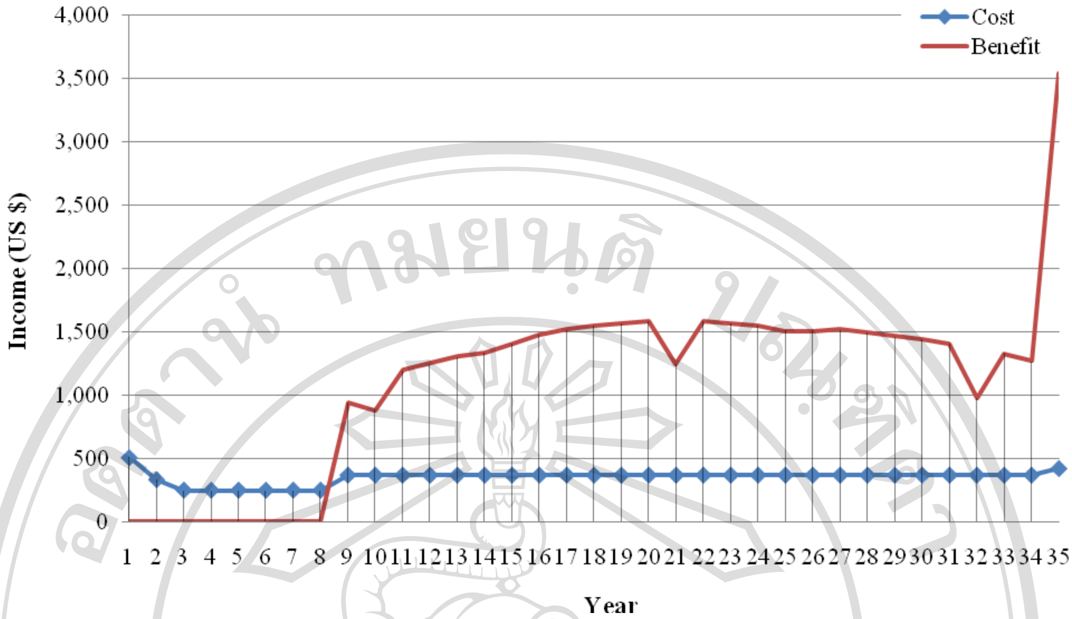

Figure 6.6 The difference of input cost and benefit in the rubber plantation

Then, the cost would increase once more to $US 369, when the rubber would start to be harvested in 9th year and it then was assumed to be consistent value every year. The last year (the 35th year) of rubber plantation's life, the input cost will go up again to $US 421, due to rubber wood would be harvested. On the other hand, the rubber is the long term alternative, so it has no income for the first eight years. Then, the 9th year, the rubber's income would begin to $US 939. After that, its income would be slightly increased every year until the 22th year when rubber could produce the highest yield at the peak of latex production income at $US 1,581. After that, the rubber yields will be decreased every year as its life quality until the 34th year, so its income go down to $US 1,267, and the end of rubber plantation life (the 35th year) when the latex and rubber wood could harvest, the income would sharply increase once more to $US 3,539.

Although the rubber plantation as the high cost without any benefits at the beginning of planting, but for the long term of its life, it could provide higher cumulative income for the owners as well. Regarding farmers opinions, they thought that they were required to change their skills for other alternatives which would be suitable for their land use cultivation and could afford more income for their livelihood. In addition, the rubber plantation also could be solving the environment problems dealing with deforestation and nutrient losses from soil erosion.

6.3 Estimated productivity of the integrated rubber based farming system

In the study areas, the integrated rubber based farming systems (IRFSs) have been employed for income generation from annual crop and fruit tree production in addition to rubber.

6.3.1 The estimated productivity of the IRFS 1

The integrated rubber-based farming system 1, or IRFS 1, was similar practice like the rubber only but it was intercropped with more crops (e.g. rice and/or maize) i.e. rubber and annual crop into the same field. Based on farmers' experiences, they did not use fertilizer but involved in exchange labor for farm operation for annual crops. However, some hired labors were needed for rubber planting and maintaining process.

Table 6.7 The first year of the IRFS 1 investment in a hectare of area

Items	Unit	Quantity	Price per unit ($US)	Possible year of use	Total
Seeds:					217.30
Rubber	seedling	500	0.42		209.75
Rice	kg	40	0.19		7.55
Herbicide	bottle	1	26.22		26.22
Materials:					38.91
Knives	piece	2	2.83	3	1.89
Curved hand hoe	piece	3	1.57	3	1.57
Digging head	piece	1	1.05	5	0.21
Sickle	piece	2	1.26	3	0.84
Hoe	piece	2	3.15	3	2.10
Axe	piece	1	4.20	5	0.84
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labors:					306.76
Hired labor	man-day	30	2.10		62.93
Family labor	man-day	155	1.57		243.84
Total					**594.44**
Outputs					
Rice yield	kg	1000	0.19		190

Source: data collection in the field, May 2008

The annual crop grew a long side with the rubber for three years at the beginning period. They included rice and maize, they were replaced each other year by year. The first year, rice was grown into the rubber plantation. The second year, after harvest rice, farmers cleared the harvested rice area and replace with the maize. Then, rice was instead grown again in the third year. The second year of rubber plantation, farmers re-planted the rubber tree once more for substituting the dead tree from the previous year and pesticide was used for mixing with maize's grain to protect the insect damages (see in the table 6.8). In the third year, the inputs cost of IRFS 1 was reduced because only rice was grown without the rubber re-planting (see the table 6.9).

Table 6.8 The second year of the IRFS 1 investment in a hectare of area

Items	Unit	Quantity	Price per unit ($US)	Possible year of use	Total
Seeds:					102.78
Re-planting rubber	seedling	200	0.42		83.90
Maize	kg	10	1.89		18.88
Pesticide	bag	1	2.62		2.62
Herbicide	bottle	1	26.22		26.22
Materials:					37.34
Knives	piece	2	2.83	3	1.89
curved hand hoe	piece	2	1.57	3	1.05
Hoe	piece	2	3.15	3	2.10
Axe	piece	1	4.20	5	0.84
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labors:					256.42
Hired labor	man-day	6	2.10		12.59
Family labor	man-day	155	1.57		243.84
Total					**430.62**
Outputs					
Maize yield	kg	1500	0.12		180

Table 6.9 The third year of the IRFS 1 investment in a hectare of area

Items	Unit	Quantity	Price per unit ($US)	Possible year of use	Total
Seeds:					7.55
Rubber	seedling	0	0.42		0.00
Rice	kg	40	0.19		7.55
Herbicide	bottle	1	26.22		26.22
Materials:					38.07
Knives	piece	2	2.83	3	1.89
Curved hand hoe	piece	3	1.57	3	1.57
Digging head	piece	1	1.05	5	0.21
Sickle	piece	2	1.26	3	0.84
Hoe	piece	2	3.15	3	2.10
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labors:					256.42
Hired labor	man-day	6	2.10		12.59
Family labor	man-day	155	1.57		243.84
Total					**333. 51**
Output					
Rice yield	kg	950	0.19		180.5

During the harvesting period, the harvested annual crops' yield was collected at the end of seasonal cropping every year in the three year at the beginning and the rubber yield was assumed to start at the 9th year to until its estimated life (in the 35th year), like as the rubber only plantation. The latex tapping and collecting and the rubber wood harvesting materials were used as the same with the rubber plantation.

Figure 6.9 illustrated the cost and benefit of IRFS 1. The cost was higher than rubber only plantation, because it was the inter cropping, so it added the cost of the annual crop seed and the opportunity labor cost was also much more. The costs in the three years at the beginning were $US 594, $US 430, and $US 333, respectively. After that, farmers only keep maintenance in their farm with the cost were around $US 248 per year and it was consistently since the 4th year to the 8th year. Then, the cost was up to $US 367 in the first harvest of latex started (at 9th year) and it also was assumed this value consistently until the year 34th. Finally, the cost also increased to $US 422 when the rubber wood was harvested.

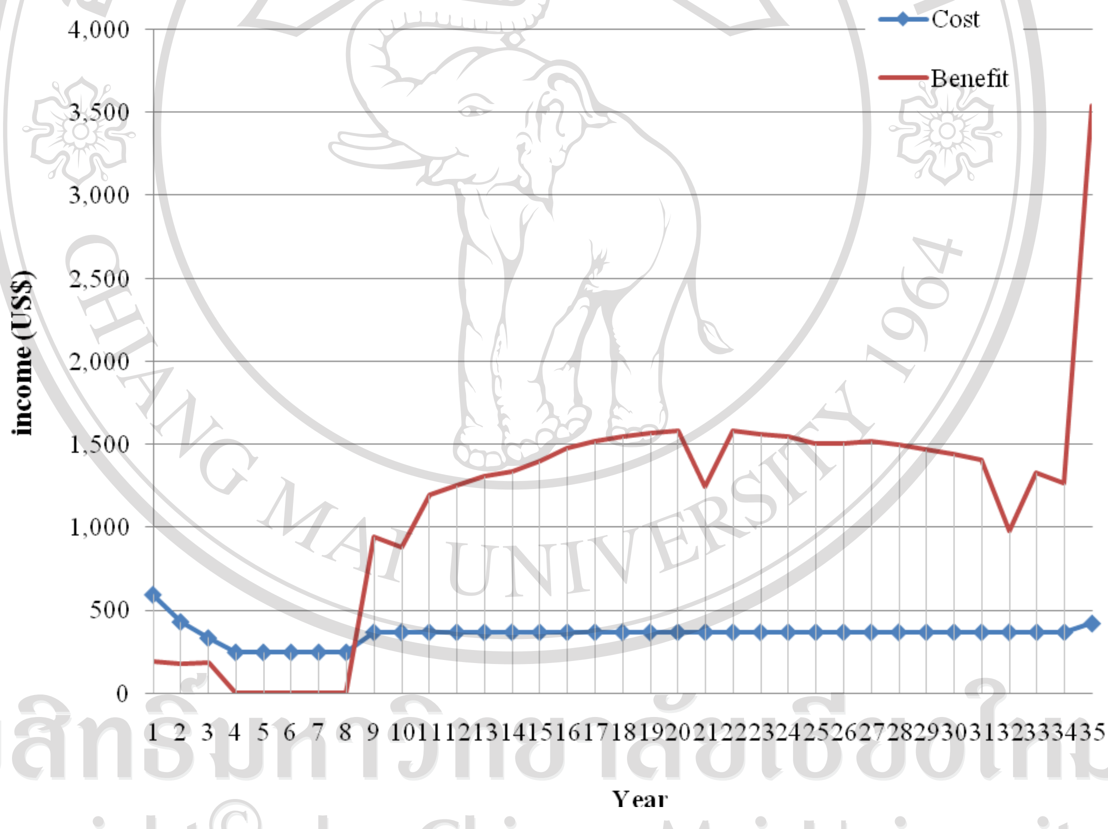

Figure 6.7 The difference of input cost and benefit in the IRFS 1 in the *hai* system

The IRFS 1's benefit was also assumed for 35 years. In the three year at the beginning, farmers had incomes from the annual crops, $US 189, $US 173, $US 179, in ordering of the year. Then, there were no benefits for next five years (the year 4th to the year 8th). Generally, farmers got negative net income value in the beginning. The cost was higher than their benefit of crops' cultivation but farmers did not think that is the big problem because they grew those crops for consuming in their family without trading and another reason, they have other plots of land to grow their main crop for supporting their needs. Regarding to the estimation of the rubber yields in the study areas (see Figure 6.7). The year 9th, the starting harvest year for the latex, its income will be started at $US 939. Then, its income would be going up every year until the 22th year when latex yield could produce the highest yield, and the latex income reached the peak at $US 1,581. After that, the rubber yields will be slightly reduced until the end of its life quality, the 35th year. So, its income goes down every year until the 34th year to $US 1,267, and the 35th year the rubber yield and wood could provide the highest income to $US 3,539.

6.3.2 The estimated productivities of the IRFS 2

The integrated rubber-based farming system 2, or IRFS 2, is similar to the IRFS 1 but now there are fruit trees as a component of system into the rubber plantation (i.e. rubber and annual crop and fruit tree). The IRFS 2 is a complex practice and it needs more attention in maintenance.

Normally, the IRFS 2 practice implementation was done like the general rubber plantation. Based on the L-SUAFRP staff provided rubber and litchi seedling to farmer, the rubber seedlings were less in half of IRFS 1 and rubber plantation (about 225 seedlings) and litchi was 25 seedlings. Regarding farmers' experiences, they did not use fertilizer nor exchange labor for farm maintaining, but some hired labors was needed for land preparation and maintaining process and also some activities of annual crop cultivation. The annual crops (rice and maize) grew at the beginning period (for three years), they also were replaced each other year by year as the same to IRFS practice and rubber plantation. Rice was grown in the first year and third year, the second year was replaced by maize.

Table 6.10 The first year of the IRFS 2 investment in a hectare of area

Items	**Unit**	**Quantity**	**Price per unit ($US)**	**Possible year of use**	**Total**
Seeds:					115.05
Rubber	seedling	225	0.42		94.39
Litchi	seedling	25	0.52		13.11
Rice	kg	40	0.19		7.55
Herbicide	bottle	1	26.22		26.22
Materials:					38.91
Knives	piece	2	2.83	3	1.89
Curved hand hoe	piece	3	1.57	3	1.57
Digging head	piece	1	1.05	5	0.21
Sickle	piece	2	1.26	3	0.84
Hoe	piece	2	3.15	3	2.10
Axe	piece	1	4.20	5	0.84
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labor					314.63
Hired labor	man-day	30	2.10		62.93
Family labor	man-day	160	1.57		251.70
Total					**500.05**
Output					
Rice yield	kg	1000	0.19		190

Source: data collection in the field, May 2008

The second year, there were the modification of some parts in the inputs (Table 6.11). The rubber tree was replanted once more in almost half of seedling amount in the first year (about 100 seedlings) and the maize cultivation was taken place the upland rice. Pesticide was used for maize grains. The materials was excluded the digging stick and sickles. Moreover, the hired labors reduced because the land preparation had done but the rubber plantation owner still need some labor for helping in the field's activities.

Table 6.11 The second year of the IRFS 2 investment in a hectare of area

Items	**Unit**	**Quantity**	**Price per unit ($US)**	**Possible year of use**	**Total**
Seeds:					60.83
Rubber	seedling	100	0.42		41.95
Litchi	seedling	0	0.52		0.00
Maize	kg	10	1.89		18.88
Pesticide	bag	1	2.62		2.62
Herbicide	bottle	1	26.22		26.22
Materials:					37.34
Knives	piece	2	2.83	3	1.89
Curved hand hoe	piece	2	1.57	3	1.05
Hoe	piece	2	3.15	3	2.10
Axe	piece	1	4.20	5	0.84
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labor					264.29
Hired labor	man-day	6	2.10		12.59
Family labor	man-day	160	1.57		251.70
Total					**396.54**
Output					
Maize yield	kg	1500	0.12		180

Source: data collection in the field, May 2008

In addition, the third year of IRFS 2 investment was almost the same as the first year but some inputs were taken off (e.g. rubber and litchi seedling), and hired labors was reduced as the second year (see Table 6.12).

The harvested annual crops' yield was collected at the end of seasonal cropping every year in 3rd year at the beginning. Rubber and litchi recently did not provide any productivity yet. So, their yields and prices were estimated by the information from the neighboring provinces where they could be already harvested in a hectare of land. The rubber's latex yield was estimated by the BRASS model for 35 years that it started to harvest at the 9th year until its life production (in the 35th year).

Table 6.12 The third year of the IRFS 2 investment in a hectare of area

Items	Unit	Quantity	Price per unit ($US)	Possible year of use	Total
Seeds:					7.55
Rubber	kg	0	0.42		0.00
Fruit tree	tree	0	0.52		0.00
Rice	kg	40	0.19		7.55
Herbicide	bottle	1	26.22		26.22
Materials:					38.07
Knives	piece	2	2.83	3	1.89
curved hand hoe	piece	3	1.57	3	1.57
Digging head	piece	1	1.05	5	0.21
Sickle	piece	2	1.26	3	0.84
Hoe	piece	2	3.15	3	2.10
Sprayer	piece	1	94.39	3	31.46
Depreciation					5.24
Labors:					264.29
Hired labor	man-day	6	2.10		12.59
Family labor	man-day	160	1.57		251.70
Total					**341.37**
Output					
Rice yield	kg	950	0.19		180.5

Source: data collection in the field, May 2008

In addition, the litchi yields were estimated from the litchi's yield information from the northern part of Thailand where the famous productions and also yields databases were collected. Based on the orchard establishment technique, the fruit tree's spacing for 8 x 8 meter contained 25 trees per rai (The office of agricultural economics, Thailand, 2007). Table 6.13 presented the Litchi yield in kilogram per rai unit of area, based on the high quality management (i.e. good irrigation system and maintenance). Therefore, the litchi yield in study areas, which applied uncomplicated maintaining processes, were assumed to 50% of yield in the Northern Thailand. Moreover, the litchi price was assumed the farm gate price about 30% of market price in Luang Namtha (Lao PDR). The expected yield and price of litchi were used for estimating in benefit calculation.

The materials used during the harvesting period of rubber involved the latex tapping and collecting material. At the end of rubber plantation life (35th year), the rubber wood would harvested by using the handy saw.

Table 6.13 Litchi yields in Northern Thailand

Harvesting duration	Litchi yield (kg/rai)
1-4 years	0
5-10 years	385
11-20 years	457
21-25 years	424

Sources: The office of agricultural economics, Ministry of Agriculture and Cooperatives, 2007

Figure 6.8 shows the cost and benefit of the IRFS 2. The cost was less than the IRFS1 and pure stand rubber plantation, because the seedlings in the IRFS 2 were less than half of seedlings in the IRFS 1 and rubber plantation. However, the labor using was also much more than pure stand rubber plantation and IRFS1 practices. The costs at the 1st, 2nd and 3rd year in the beginning were diverse, $US 500, $US 396, and $US 341, respectively. After that, the 4th to 8th year, farmers only keep maintenance in their farm with the cost was around $US 247 per year and it was consistently this value. Then, the 9th year cost was up to $US 367 when rubber started to harvest and it also was assumed this value consistently until the 34th year. After that, the input cost was increase more in the 35th year when rubber wood was harvesting in the last year of plantation life

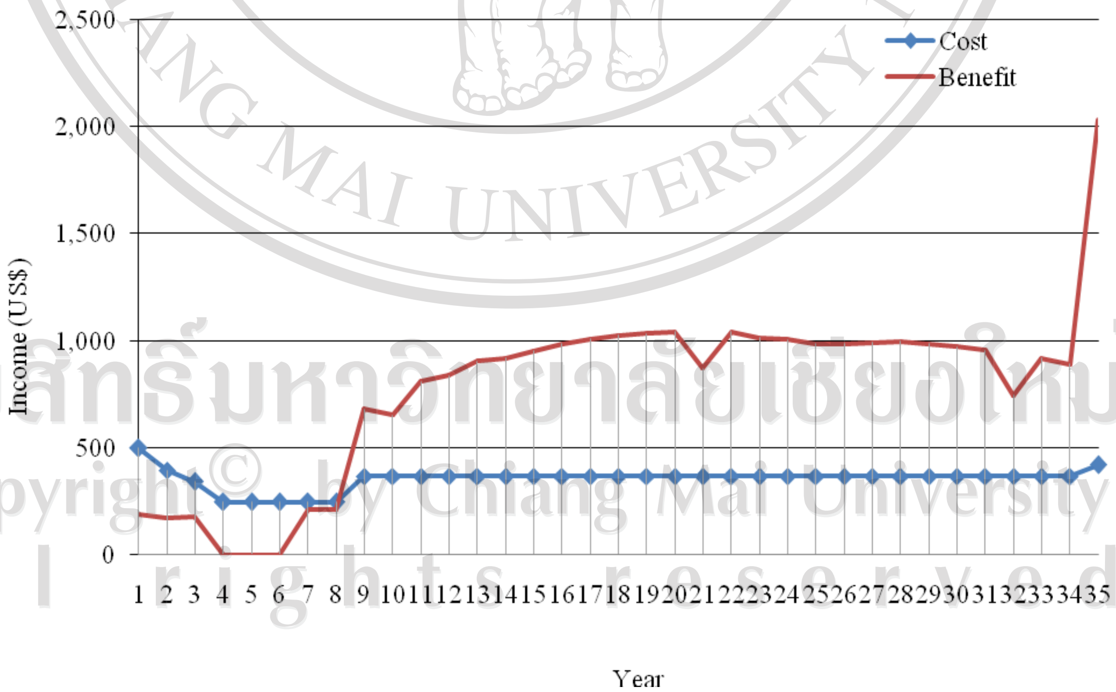

Figure 6.8 The difference of input cost and benefit in the IRFS 2

Regards Figure 6.8, the benefit of IRFS 2 was fluctuated. In the 3rd year at the first period of planting, farmers obtained some incomes from the annual crops being, $US 190, $US 180, $US 180.5, respectively. Then, there were no benefits for three year s later (the 4th and 6th year). Farmers normally got the negative net income value for eight years at the beginning. In the 7th year, the IRFS 2's benefit started at $US 211 from harvesting litchi yield. After that, the benefits were increased rapidly to $US 682 in the 9th year, when the rubber could harvest its latex yield. Next, the IRFS 2's cumulative benefit from rubber and litchi yield will increase every year until reach to the peak at $US 1,042 in the 22th year, which its benefit met the highest income. Later, the IRFS 2 benefit will be slightly decreased annually until reached $US 892 in the 34th years. During this time, rubber and litchi yields reduced because they was produce less yield as their life production capacity. Finally, the 35th year the rubber wood would harvest, so both wood and also latex yield could provide the highest income to around $US 2,030.

6.4 The profitability comparison of the *hai* system, IRFS 1 and IRFS 2

According to Figure 6.9 illustrated the linear graphs of estimated benefit income comparison of the pure stand rubber, IRFS 1, IRFS 2 and the annual crops productivity in the *hai* system for 35 years. Based on the estimated income of four farm types productivities. The *hai* system practice or the annual crop production (rice, maize and job'stear) could provide income at $US 577 to $US 640, in three years continuously, and then land will let's to be the fallow for four year by the cropping rotation. In the same time, farmers will move to cultivate annual crops in another land plot. Farmers will get the income every year in the *hai* system practice but they need to change the cultivated area every two to three years. By the way, the pure stand rubber plantation and IRFSs could be provided higher income than IRFS 2 and the annual crop production in the *hai* system, when the rubber tree started to produce latex yield. The pure stand rubber plantation and IRFS 1 will start to get income at least about $US 939 at the beginning of harvest latex yield (9th year), and they could be reach the highest income at 1,581 (almost triple), then they still provide the high income until the end period of rubber productive life about $US 1,267 and almost $US 3,540 from rubber wood harvesting. While the IRFS 2 benefit income will start to provide income around $US 211 in the 7th year when litchi yield began to harvest and then the IRFS 2 income will be reach the peak at $US 1,042 at the 22th year (almost triple) and at the end of rubber plantation life, it still provide about $US 2,030 for rubber wood harvest. Even though, they were grown in the same place without shifting to another plot of land as the annual crop cultivation. Because of this reason, farmers could make sure that the IRFSs will be better alternatives than their traditional practice in the *hai* system that have little income and not-environmental friendly. Moreover, the pure stand rubber plantation and IRFSs practice could provide more income and afforestation in the future.

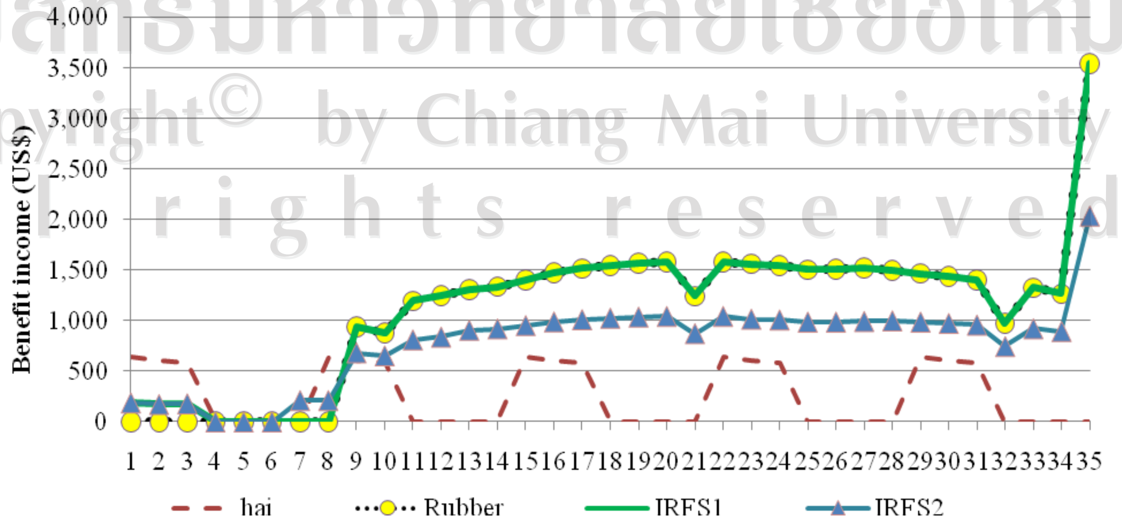

Figure 6.9 The comparison of benefit income in the rubber, IRFSs and the *hai* system

Based on the difference of the *hai* system and IRFS practices in the study areas. The comparison therefore between the *hai* system and IRFSs used the NPV and AEV, as shown in Table 6.15, below, to convert the long term income into annual equivalent value (see chapter 3) by using the discounted rate at 8%.

The NPV of an investment alternative is the total difference between the present value of future benefits and the present value of future costs. A positive value of NPV and AEV for a given project shows that the project's benefits are greater than its costs. On the other hand, a negative value of NPV indicates that the benefits from the project are less than its costs and it is not advisable to undertake it.

Table 6.14 The profit comparison of the *hai* system, pure stand rubber plantation and IRFSs in a hectare of area by using discounted factor at 8%.

	Farm type			
	hai	**Pure Stand Rubber**	**IRFS1**	**IRFS 2**
NPV of gross benefit ($US)	2280.69	2148.11	2612.33	2082.10
NPV of total cost ($US)	929.43	2161.26	2391.59	2273.96
NPV ($US)	2255.13	4376.23	4629.05	2217.38
AEV ($US)	193.50	375.50	397.19	190.26

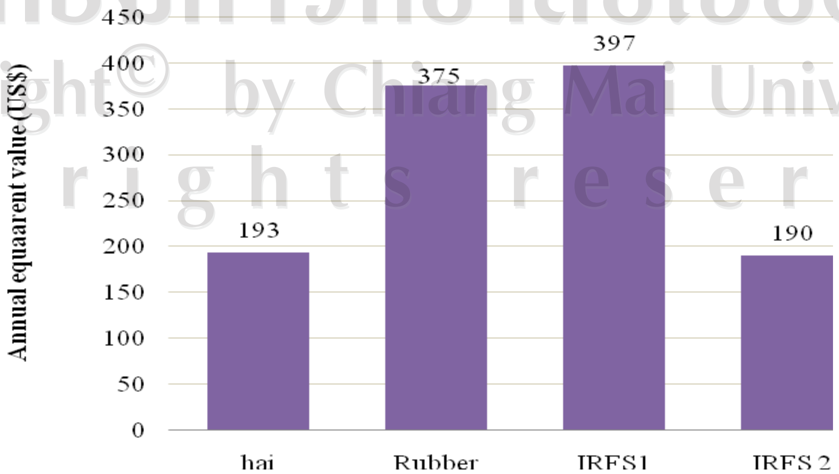

Figure 6.10 The AEV comparison of the *hai* system, pure stand rubber plantation and IRFSs

Figure 6.10 shows the estimated comparison of annual equivalent values (AEV) on cultivated estimation for 35th years of the four choices for upland farmers namely the *hai*, pure stand rubber plantation, IRFS 1 and IRFS 2. It found that IRFS 1 and pure stand rubber plantation had higher, $US 397 and $US 375, respectively. While the *hai* system and IRFS 2 provided $US 193 and $US 190, respectively. Consequently, based on the AEV result, in the discounted factor at interest rate 8% for 35 years productive life, farmers in the study areas should be dealt with the IRFS 1 and pure stand rubber plantation. By the ways, IRFS 2 was a lesser amount of annual income ($US 190) and complicate than others, but regarding the complexity of crops. It could be fulfill income and securing food almost equally the *hai* system.

IRFSs will be more complex in the implementation in the same plot of land and also it will be more complicated to maintain than the traditional practice or the *hai* system. It could support other benefits to the environment in the study areas, for example, afforestation, protection of soil erosion, temperature control and the watershed production. However, the pure stand rubber plantation and IRFSs practices' farmers were still kept the *hai* system practice until rubber will provide the satisfied income to their owner.

6.5 Risk and uncertainty

The previous section presented the economic estimation in a hectare of land of the *hai* system, pure stand rubber plantation and IRFSs practice in the study areas. Nevertheless, when an investment project involved the forecasting future costs and benefits, especially for a long-term investment as rubber plantation, there is no guarantee that the exact estimated of NPV or AVE will be gotten. Consequently, risk and uncertainty are always concerned to the predictions in the future and should be taken into account in the economic situation assessment. The most regularly used technique is sensitivity analysis. The sensitivity analysis engaged, first, identifying key variables which were possible to have the greatest impact on the outcome of an investment project and were most changeable or uncertain and, then, repeat each expected key variables to the economic estimation assessment. Based on the rubber plantation in study areas, the main variables which influenced to outputs of investment projects were yield price and labor cost. Yield price of tub-lump rubber using was $US 1.11 per kilogram (or 10,625 Kip/kg) in the 2007 farm price, and hired labor was $US 2.10 (about 20,000 Kip) was used as a based line of calculation in the farm investment.

Regarding to the tub-lump rubber yields price in 2005 (Hadyao village, Loung Namtha), was the lower price, $US 0.58 or about 5,500 Kip/kg (NAFRI and NAFES, 2007) that appeared during the farmers sell the tub-lump rubber yields. On the other hand, the price in 2007 was $US 1.11, higher about 50% compare to the price in 2005.

Table 6.15 Sensitivity of changing in tub-lump rubber yield price

Yield Price ($US)	**Pure Stand Rubber**		**IRFS 1**		**IRFS 2**	
	NPV	AEV	NPV	AEV	NPV	AEV
0.57	272.73	23.40	525.55	45.09	165.63	14.21
1.11	4376.23	375.50	4629.05	397.19	2217.38	190.26
1.67	8598.91	737.81	8851.73	759.51	4328.72	371.42

Table 6.15 showed the changes of tub-lump rubber price. It found that, when the rubber price was less 50% (or $US 0.57) than price in 2007, the pure stand rubber plantation and IRFSs estimated income in the NPV and AEV were less than the *hai* system. The annual income though was about $US 23.40, $US 45.09 and $US 4.21, respectively. Some farmers would be considered to discontinuing investment. By the way, if the rubber price supposed to be rise up 50% of the yield price in 2007 i.e. $US 1.67 or approximate 15,940 Kip/kg. The NPV and AEV of the pure stand rubber plantation and IRFSs practices expressed higher income than *hai* system that was suitable to invest. Farmers could have the average annual income in around $US 738 in the pure stand rubber plantation, $US 760 in the IRFS 1 and $US 370 in the IRFS 2. Based on the change of yield price, whether the farm gate price of tub-lump rubber was more than $US 1, farmers or rubber plantation owners would have profit from their investment. If the price was lower than $US 1, they might be facing finance problem and discontinues adopting the rubber plantation and IRFSs practice.

Another change to test was the hired labor wage rate, because labor hired was necessary for rubber plantation establishment in the study areas. Based on the labor requirement in the rubber plantation mangement, this study assumed three different levels of labor cost for the hired labor, namely $US 2.10, $US 2.62 and $US 3.15 or about 20,000 Kip, 25,000 Kip and 30,000 Kip, respectively. The present wage rate in the Laos' northern upland areas were fluctuated between $US 2.10 and $US 2.62. But according to the labor requirement in upland areas, labor wage rate sometimes could raise up to $US 3.15.

Table 6.16 showed that even though there were increased in wage rates at the three levels as above. NPV and AEV of pure stand rubber plantation and IRFSs were still got high return of income. It means that though wage rate increased from $US 2 to $US 3, the pure stand rubber plantation and IRFS1 practice could provide better income than the *hai* system practice, while IRFS 2 would be less than, but It could get more benefit in term the environmental friendly sound conservation.

Table 6.16 Sensitivity of changing in labor cost for investing in the pure stand rubber plantation and the IRFSs practice

Labor cost ($US)	**Pure stand rubber plantation**		**IRFS 1**		**IRFS 2**	
	NPV	**AEV**	**NPV**	**AEV**	**NPV**	**AEV**
2.10	4376.23	375.50	4629.05	397.19	2217.38	190.26
2.62	4324.05	371.02	4576.87	392.71	2165.20	185.78
3.15	4271.86	366.54	4524.68	388.23	2113.01	181.30

In conclusion, dealing with farmers' practice in the study areas which consisted the annual cropping (the *hai* system practice) and the integrated rubber based farming system (IRFS), the comparison of the annual crop productivity revealed that maize productivity provided higher profit than upland rice and job's tear. Using gross margin evaluation, it was shown that upland rice could get the highest benefit than others. In term of the estimated input cost and benefit for 35 years, it was shown the pure stand rubber plantation and IRFSs could provide more income than the *hai* system practice. Pure stand rubber plantation and IRFSs could provide about almost triple of the *hai* system income, while IRFS 2 could provide about almost double. At the end of rubber plantation life, the pure stand rubber plantation and IRFS1still provide about US$ 3,540, while IRFS 2 could provide US$ 2, 030 for rubber wood harvest. In addition, the calculation of AEV showed that the

IRFSs practice provided higher AEV when compared to annual crops. The *hai* system provided $US 193 per hectare, while pure stand rubber plantation and IRFS 1 could provide $US 395 - $US 375 of AEV. However, AEV for IRFS 2 was not very high at $US 190 per hectare. Sensitivity analysis was made by changing the rubber yield price and wage rate. It was found that the IRFSs practices were suitable for farmer's adoption when the tub-lump rubber price was more than $US 1, but when the price was about $US 0.5, they might be facing finance problem and discontinues adopting the rubber plantation and IRFSs practice. Using three different wage levels also confirmed that farmers should adopt IRFSs practice, because they could provide positive NPV and AEV for investment projects and also could get more benefit in term the environmental conservation.