CHAPTER VI

ECONOMIC IMPACT ASSESSMENT

6.1 Economic impact assessment

The economic impact assessment focuses on the cost of production, income levels, profitability, producer surplus, market orientation, and factor affecting strawberry prices.

6.1.1 Cost of production

The cost production issue is a consequence part to assess the impact of the study. This study compares between the strawberry and runner production in the NS and VFS. The cost of production was estimated by using budget analysis. The results can assess the impact in short term. The following results about the cost production are classified into 2 parts and they are cost of strawberry production and runner production in the NS and VFS.

6.1.1.1 Cost of strawberry production

As shown in the previous chapter, the main production factors of strawberries are manure, fertilizers, chemicals, mulching material, runners and etc. These inputs are cost of production as variable cost. The comparison in the cost of production is an aspect to be useful for decision making in the strawberry production. Moreover, the different outcomes can explain the short-term impact of the study, as well as, impact on the chemical use is described in this chapter. The production cost is calculated and presented on per rai basis.

Most of each variable cost within the VFS was lower than that of NS excepting cost of mulching materials, plowing, and imputed labor (Table 6.1). Moreover, the insecticide and fungicide costs in the VFS were lower than the NS. So, the result pointed out that the strawberry production in the VFS leads to decreasing in insecticide and fungicide use.

The total variable cost including labor cash cost in the VFS strawberry production was lower than the NS. On the other hand, the result of the total variable cost, including imputed labor cost, was higher than the NS shown in Table 6.1. It was found that the VFS farmers were more labor intensive than the NS. This result can not conclude that the strawberry production in the NS had more efficiency than the VFS. The labor use efficiency in both systems is introduced in the labor use issue (page 106). The cost share of each variable cost is shown in the Table 6.1 as well.

The cost shares were calculated into 2 parts (including imputed labor cost and cash labor cost). The cost shares including imputed labor cost in the VFS, the imputed labor cost was highest percentage as 64.54%. On the other hand, the runner or seedling cost was the highest percentage in the result of the cost shares including cash labor cost as 54.19%.

The lower total variable cost of strawberry production using VFS without imputed labor cost can be given with many reasons. Once, the officers of the RPF controlled and cared for the production of the farmers in order to decrease chemical use by transferring the production technology. Otherwise, the cash labor cost in the VFS was lower than NS because the most VFS planted farmers in smaller scales and thus family labor was almost sufficient.

Table 6.1. Variable cost of strawberry production in VFS and NS (baht/rai)

Production factors	Variable cost of strawberry production					
	VFS			NS		
	Baht/rai	%[1]	%[2]	baht/rai	%[3]	%[4]
Manure and Green	92.73	0.18	0.52	737.0	1.87	2.10
Fertilizers	1,438.74	2.86	8.03	3,748.52	9.53	10.70
Insecticide	1118.42	2.22	6.24	1,785.25	4.54	5.10
Fungicide	554.02	1.10	3.09	1,156.32	2.94	3.30
Other chemicals[1]	95.47	0.19	0.53	1,784.17	4.53	5.09
Lime	113.99	0.23	0.64	277.36	0.70	0.79
Mulching materials	3,420.87	6.79	19.09	3,289.46	8.36	9.39
Runner	10,275.13	20.40	57.34	11,248.41	28.58	32.11
Plowing	44.15	0.09	0.25	429.03	1.09	1.22
Energy	37.74	0.07	0.21	467.50	1.19	1.33
Cash Labor cost	728.66	0.00	4.07	10,105.37	0.00	28.85
Imputed cost Labor	33,183.88	65.87	0.00	14,430.69	36.67	0.00
Total variable cost (I)[5]	17919.92	-	100.00	35,028.39	-	100.00
Total variable cost (II)[6]	50,375.14	100.00	-	39,353.71	100.00	-

Source: Survey 1998

[1] Cost share including imputed labor cost in VFS
[2] Cost share including cash labor cost in VFS
[3] Cost share including imputed labor cost in VFS
[4] Cost share including cash labor cost in VFS
[5] Total variable cost including cash labor cost
[6] Total variable cost including imputed labor cost

[1] Herbicide and hormone

6.1.1.2 Cost of runner productions

As with the cost of strawberry production, there are many production factors in the runner production such as manure, green manure, fertilizers, chemical use, plastic, mulching materials, mother plant or stock and so on.

Most variable costs of runner production using VFS were lower than NS. Particularly, mulching material and labor cost, the RVFS farmers did not pay money for these. They paid money for higher cost of manure application, water supply and stock. All RVFS farmers bought stocks for every year in order to control virus disease. They have paid for water supply because Ang Khang was not sufficient enough with water in dry season. The farmers paid a little money to the RPF for water supply because the RPF invested for irrigation system. The RNS farmers used water supply from natural source.

The total variable costs per plant and per rai of using VFS were 0.152 and 13,536 baht respectively (Table 6.2). The variable cost per plant of using NS (0.514 baht) was higher than VFS. In the VFS, the stock cost was the highest percent in total variable cost (Table 6.2). As the runner production using NS had a stock cost of only 5.25% of the total variable. In the NS, labor cost was the highest percent as about 31% of total variable cost. There was no labor cost in the VFS. This study can not find out the result of the imputed labor cost for the runner production since the data collection was not complete.

Table 6.2. Variable cost of runner production with using VFS and NS (baht/plant)

Production factors	Variable cost of runner production (baht/plant)			
	Using VFS		Using NS	
	(baht/plant)	%	(baht/plant)	%
Manure and green manure	0.010	6.6	0.014	2.72
Fertilizer	0.013	8.6	0.073	14.20
Chemical	0.019	12.5	0.101	19.65
Energy	0.000	0.0	0.004	0.78
Water supply	0.003	2.0	0.000	0.00
Plastic	0.021	13.8	0.046	8.95
Lime	0.001	0.7	0.005	0.97
Mulching material	0.000	0.0	0.080	15.56
Stock	0.085	55.9	0.027	5.25
Cash labor cost	0.000	0.0	0.164	31.91
Total variable cost	0.152	100.0	0.514	100.0

Source: survey 1998

6.1.2 Income levels and profitability

The income and profit assessment can reflect the impact of using VFS, which is the performance of the biotechnology. It is described as income level and profitability of the strawberry and runner production with using VFS and NS. Therefore, the difference of individual results can point out the impact on using VFS.

6.1.2.1 Income levels and profitability of strawberry productions

The results of the study of the income level and the profitability are shown in Table 6.4. On average the income level of the strawberry production using VFS and

NS were 109,888.28 and 50,110.50 baht per rai respectively (calculated from average total income per plant multiplied by 10,000 plants) because of the higher price of the VFS strawberry production leaded to the higher income in the VFS. The average strawberry prices of the VFS and NS were about 78 and 21 baht/kg, respectively. Therefore, the profitability I and II (calculating cash labor cost and calculating imputed labor cost, respectively) of the VFS were also higher than the NS. (Table 6.4). The lower price of strawberry in NS caused lower income and profitability.

Table 6.4. The profitability of strawberry production using VFS and NS (baht/rai)

Entry	Using VFS	Using NS
Total income (TR)	109,888.28	50110.50
Total variable cost I (TVCI)	17,919.92	35,028.39
Total variable cost II (TVCII)	50,375.14	39,353.71
Profitability I (TR-TVCI)	90,928.43	13,010.50
Profitability II (TR-TVCII)	58,473.21	8,685.18

Source: survey 1998

[1] Total variable cost including cash labor cost

[2] Total variable cost including imputed labor cost

More NS farmers than the VFS farmers grew P16. They grew mostly P20, P50 and P70, which yielded lower in productivity than P16. However, the P50 and P70 were new varieties promoted to the VFS farmers so, the ability in adjusting to new environment of these varieties was still questionable. Although, they were lower in productivity, their prices were still quite high. The price of P50 and P70 range between 50-140 baht/kg and 20-60 baht/kg respectively (Table 6.5). On average, the price of P70 and P50 were 110 baht/kg and 40 baht/kg respectively. Hence, the price of strawberry varies during harvesting season. The average income per rai of P70 and

P50 were 125,840 baht/rai and 27,560 baht/rai respectively (Table 6.6). Even the price level of P50 variety was quite good but income per rai was so low due to low productivity.

Table 6.5. Price level of the individual varieties both using VFS and NS

Variety	Using VFS		Using NS	
	Price range (baht/kg)	Average price (baht/kg)	Price range (baht/kg)	Average price (baht/kg)
Phraradchatan 16	12-30	18	10-25	16
Phraradchatan 20	12-40	25	10-30	20
Phraradchatan 50	20-60	45	None	None
Phraradchatan 70	50-140	110	None	None

Source: survey 1998

Moreover, Table 6.6 shows net income of each variety of systems. The result points out that net incomes of P16 and P20 in VFS were lower than that in NS. As mentioned above, the lower productivity of VFS was caused from lower productivity. It is concluded that the strawberry using VFS is not successful. A reason leading to lower productivity such as maybe the adequate understanding of the SVFS farmers and promoters. The result of the study was analyzed by using the first year of introduce of the VFS. Therefore, its performance was not so satisfactory, particularly the production yield of VFS.

However, net income of P50 and P70 in VFS were rather good, although, their production yields were not high. Particularly, P70 variety could give a good income. When VFS is developed in order to increase the production yield there is great potential to raise net income

Table 6.6. Net income of the strawberry in the individual varieties

Variety	Using VFS			Using NS		
	Output (kg/rai)	Gross income (baht/rai)	Net income (baht/rai)	Output (kg/rai)	Gross income (baht/rai)	Net income (baht/rai)
P16	1,882	21,276	3,317	3,156	50,496	17,692
P20	1,105	27,625	8,666	2,316	46,320	13,516
P50	689	31,005	12,047	None	None	None
P70	1,144	125,840	106,881	None	None	None

Note: estimating the net income using total variable including cash cost

6.1.2.2 Income levels and profitability of runner productions

The average prices of runners propagated by using VFS and NS were 1 and 0.9 baht per plant (Table 6.7). Incomes per household per mother stock and per rai of using NS are higher than using VFS. However, net incomes of using VFS were higher than using NS since cost of runner production using NS was higher, particularly in hired labor and chemical cost (Table 6.8).

Table 6.7. Income level of runner production using VFS and NS

Income item	Using VFS	Using NS
Income (baht/plant)	1	0.9
Income (baht/household)	16,594	36,000
Income (baht/mother stock)	20.8	21.2
Income per (baht/rai)	104,178	105,764

Source: survey 1998

Table 6.8 Net income of runner production using VFS and NS

Net income item	Using VFS (baht)	Using NS (baht)
Net income per plant	0.84	0.39
Net income per household	37,876	16,500
Net income per a mother stock	17	8
Net income per rai	90,642	82,433

Source: survey 1998

6.1.3 Farmer surplus analysis

The data sampling of the strawberry NS and VFS farmers in Chiang Mai and Chiang Rai provinces for the study of production efficiency, the numbers of NS and VFS are 61 and 57 farmers, respectively. Due to the Cobb-Dauglas specification, observations of this analysis were suitable data only 48 and 49 observations of the VFS and NS, respective were applicable for the cost function analysis. For a given technology, the cost function in equation 3.5 is now re-specified as equation (6.1) shown as follow;

$$\begin{aligned} .\ln C = {} & \alpha_0 + \alpha_1 \ln y + \beta_1 \ln w_1 + \beta_2 \ln w_2 + \beta_3 \ln w_3 + \beta_4 \ln w_4 \\ & + \beta_5 \ln w_5 + \beta_6 \ln w_6 + \rho_1 \ln y \ln w_1 + \rho_2 \ln y \ln w_2 \\ & + \rho_3 \ln y \ln w_3 + \rho_4 \ln y \ln w_4 + \rho_5 \ln y \ln w_5 + e \end{aligned} \qquad (6.1)$$

where;

	C	=	total variable cost of production (baht/rai)
	y	=	production yield (kilogram/rai)
	w_1	=	price of fertilizer (baht/gram)
	w_2	=	price of insecticide (baht/gram)
	w_3	=	price of fungicide (baht/gram)

w_4 = price of seedling (baht/gram)

w_5 = price of mulching material (baht/gram)

.ln = neutral logarithm

e = error term

The corresponding cost share equation and the revenue share equation in equations 6.2.1, 6.2.1, 6.2.3, 6.2.4, and 6.2.5 now become:

$$\theta_1 = \beta_1 + \rho_1 \ln y \quad \text{--------} \quad (6.2.1)$$

$$\theta_2 = \beta_2 + \rho_2 \ln y \quad \text{--------} \quad (6.2.2)$$

$$\theta_3 = \beta_3 + \rho_3 \ln y \quad \text{--------} \quad (6.2.3)$$

$$\theta_4 = \beta_4 + \rho_4 \ln y \quad \text{--------} \quad (6.2.4)$$

$$\begin{aligned} R = {} & \alpha_1 + \rho_1 (\ln w_1 - \ln w_5) + \rho_2 (\ln w_2 - \ln w_5) \\ & + \rho_3 (\ln w_3 - \ln w_5) + \rho_4 (\ln w_4 - \ln w_5) \\ & + \rho_5 (\ln w_5 - \ln w_5) \end{aligned} \quad (6.2.5)$$

where as;

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 = 1 \quad (6.3)$$

$$\rho_1 + \rho_2 + \rho_3 + \rho_4 + \rho_5 = 0 \quad (6.4)$$

Using Seemingly Unrelated Regression technique, a set of equation (6.2) will be estimated for VFS. Then, the cost functions and marginal cost functions expressed in terms of output will be calculated. The last step of the analysis is to calculate and to compare the producers' surpluses earned by VFS and NS strawberry growers.

6.1.3.1 The cost function of the strawberry production in VFS

The analysis of the VFS model consists of the cost share equation and the revenue share equation by using Seemingly Unrelated Regression Estimation (SURE) which is estimated as the result in the Table 6.9.

Table 6.9 the result of estimating the coefficient for the VFS cost function

Coefficient	Coefficient Value	SE	t-statistics	Sig.
α_1	1.9375	0.1606	12.061	0.0000***
β_1	0.2010	0.0172	-10.371	0.0000***
β_2	0.7419	0.0270	2.745	0.0061***
β_3	0.7122	0.0094	7.603	0.0000***
β_4	0.1748	0.0399	4.378	0.0000***
ρ_1	-0.2513	0.0024	-10.371	0.0000***
ρ_2	-0.7614	0.0038	-1.973	0.0485**
ρ_3	-0.8866	0.0013	-6.654	0.0000***
ρ_4	-0.1096	0.0057	-1.921	0.0548**

Source: Cost function estimation

Remake: *** Significant at 1 percent level

: ** Significant at 5 percent level

: * Significant at 10 percent level

Note : $\beta_6 = 1 - \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5$: $\rho_6 = -(\rho_1 + \rho_2 + \rho_3 + \rho_4 + \rho_5)$

When we considered the significant level in each coefficient of the VFS cost function model. The study was found that the results of t-statistics could explain that the coefficient of production yield such as; the coefficient of production yield (α_1), the coefficient of fertilizer price (β_1), the coefficient of insecticide (β_2), the coefficient of fungicide price (β_3), the coefficient of seedling price (β_4), the coefficient of

interactive term between fertilizer and production yield (ρ_1), and the coefficient of interactive between seedling price and production yield (ρ_3) are statistic significant at the 1% level. The coefficient of interactive term between insecticide price and production yield (ρ_2) and the coefficient of interactive term between seedling price (ρ_4) are statistic significant at the 5% level. (Table 6.9).

From the Table 6.9, the cost function of VFS can be re-written as follows;

$$\begin{aligned}\ln C = -2.6323 &+ 1.9375 \ln y + 0.2010 \ln w_1 + 0.7479 \ln w_2 + 0.0712 \ln w_3 \\ &+ 0.1748 \ln w_4 + 0.4788 \ln w_5 - 0.0251 \ln y \ln w_1 \\ &- 0.0076 \ln y \ln w_2 - 0.0089 \ln y \ln w_3 - 0.0110 \ln y \ln w_4 \\ &+ 0.0523 \ln y \ln w_5\end{aligned}$$

According to calculation of the cost function in above, it can bring to estimate Marginal Cost: MC. The cost equation can be re-written as follows;

$$C = 0.1011 \quad y^{1.8889}$$

Where as; C = cost of production (unit:baht)

y = production yield (unit:kilogram)

The cost function can be calculated the marginal cost as follows;

$$\frac{dC}{dy} = 0.1910 \quad y^{0.8889}$$

The average price of the VFS strawberry is 78.14 baht per kg. The price are replaced into the Marginal Cost equation in order to estimate the production yield

equaling to 864.81 kg at the equilibrium point. So, it can be calculated the farmer surplus of the VFS as such;

$$FS = (78.14x867.87) - \int_0^{867.87} 0.1910y^{0.8889}$$

$$= 67{,}817.06 - 35{,}902.58$$

$$= 31{,}912.44$$

The result of the farmer surplus of the VFS strawberry production is 31,912.44 baht per rai.

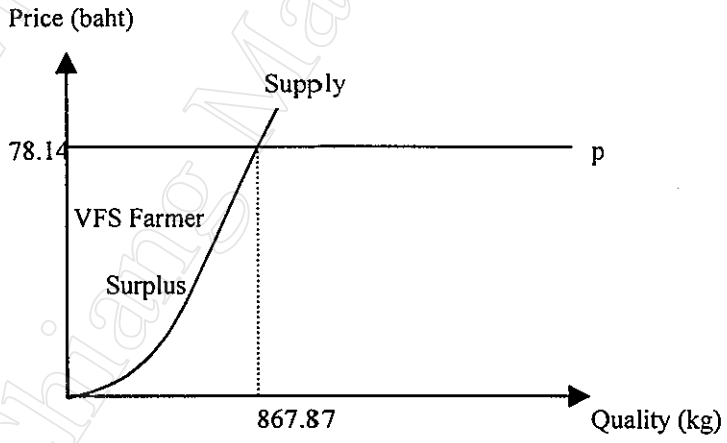

Figure 6.1 Farmer surplus of the VFS strawberry production

6.1.3.3 The cost function of the strawberry production in NS

Equation 6.1 is modified to include an additional input price (w_7) as shown in equation 6.5.

$$.ln\ C = \alpha_0 + \alpha_1 ln\ y + \beta_1 ln\ w_1 + \beta_2 ln\ w_2 + \beta_3 ln\ w_3 + \beta_4 ln\ w_4 + \beta_5 ln\ w_5 + \beta_6 ln\ w_6 + \rho_1 ln\ y\ ln\ w_1 + \rho_2 ln\ y\ ln\ w_2 + \rho_3 ln\ y\ ln\ w_3 + \rho_4 ln\ y\ ln\ w_4 + \rho_5 ln\ y\ ln\ w_5 + \rho_6 ln\ y\ ln\ w_6 + \rho_7 ln\ y\ ln\ w_7 + v \quad (6.5)$$

where;

C	=	total cost of production (baht/rai)
y	=	production yield (kilogram/rai)
w_1	=	hiring cost (baht/day)
w_2	=	price of fertilizer (baht/gram)
w_3	=	price of insecticide (baht/gram)
w_4	=	price of fungicide (baht/gram)
w_5	=	price of seedling (baht/gram)
w_6	=	price of mulching material (baht/gram)
w_7	=	price of other chemical (baht/gram)
v	=	error term
.ln	=	neutral logarithm

The cost function analyzed to express the Cost Share Equation and the Revenue Share Equation are shown as follow;

$$\theta_1 = \beta_1 + \rho_1\ \mathbf{ln\ y} \text{ -------- (6.6.1)}$$

$$\theta_2 = \beta_2 + \rho_2\ \mathbf{ln\ y} \text{ --------- (6.6.2)}$$

$$\theta_3 = \beta_3 + \rho_3\ \mathbf{ln\ y} \text{ --------- (6.6.3)}$$

$$\theta_4 = \beta_4 + \rho_4\ \mathbf{ln\ y} \text{-------- (6.6.4)}$$

$$\theta_5 = \beta_5 + \rho_5\ \mathbf{ln\ y} \text{ -------- (6.6.5)}$$

$$\theta_6 = \beta_6 + \rho_6\ \mathbf{ln\ y} \text{ -------- (6.6.6)}$$

$$R = \alpha_1 + \rho_1 (\ln w_1 - \ln w_7) + \rho_2 (\ln w_2 - \ln w_7) + \rho_3 (\ln w_3 - \ln w_7) + \rho_4 (\ln w_4 - \ln w_7) + \rho_5 (\ln w_5 - \ln w_7) + \rho_6 (\ln w_6 - \ln w_7) \quad (6.6.7)$$

where as;

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 = 1 \quad (6.7)$$

$$\rho_1 + \rho_2 + \rho_3 + \rho_4 + \rho_5 + \rho_6 + \rho_7 = 0 \quad (6.8)$$

When significance levels at 1% and 5% are considered, only 6 variables and cross products are found to have significant relationship to production cost of NS. They are the coefficient of production yield (α_1), the coefficient of seedling price (β_5), and the coefficient of interactive between mulching material price and production yield (ρ_6) are statistics significant at the 1% level. The coefficient of interactive term between insecticide and production yield (ρ_3) is significant at 5% level. The other coefficients are not statistic significant (Table 6.10).

Table 6.10 the result of estimating the coefficient for the NS cost function

Coefficient	Coefficient Value	SE	t-statistics	Sig.
α_1	1.2713	0.2653	4.793	0.0000***
β_1	0.6361	0.4292	1.482	0.1384
β_2	-0.2160	0.2200	-0.982	0.3261
β_3	-0.1852	0.1020	-1.816	0.0694*
β_4	0.0023	0.0611	0.038	0.9698
β_5	0.6115	0.2162	2.828	0.0047***
β_6	-0.1522	0.0957	-1.590	0.1118
ρ_1	-0.0413	0.0546	-0.757	0.4492
ρ_2	0.0401	0.0280	1.435	0.1513
ρ_3	0.0288	0.0130	2.220	0.0264**

Coefficient	Coefficient Value	SE	t-statistics	Sig.
ρ_4	0.0034	0.0078	0.440	0.6598
ρ_5	-0.0424	0.0275	-1.544	0.1225
ρ_6	0.0293	0.0122	2.07	0.0161***

Source: Cost function estimation

Remake: *** Significant at 1 percent level

: ** Significant at 5 percent level

: * Significant at 10 percent level

Note : $\beta_7 = 1 - \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6$

: $\rho_7 = -(\rho_1 + \rho_2 + \rho_3 + \rho_4 + \rho_5 + \rho_6)$

The Table 6.10 can be written the cost function of the NS strawberry production as following;

$$\begin{aligned}\ln C = \; & -0.9421 + 1.2713 \ln y + 0.6361 \ln w_1 - 0.2160 \ln w_2 \\ & -0.1852 \ln w_3 + 0.0023 \ln w_4 + 0.6115 \ln w_5 - 0.1522 \ln w_6 \\ & + 0.3036 \ln w_7 - 0.0413 \ln y \ln w_1 + 0.0401 \ln y \ln w_2 \\ & + 0.0288 \ln y \ln w_3 + 0.0034 \ln y \ln w_4 - 0.0424 \ln y \ln w_5 \\ & + 0.0293 \ln y \ln w_6 - 0.0179 \ln y \ln w_7\end{aligned}$$

The NS cost function in above can be calculated in order to estimate the Marginal Cost: MC. The cost function was evaluated at mean levels of all variables and expressed in terms of the output as follows;

$$C = 2.9046 \; y^{1.2129}$$

where; C = cost of production (baht/rai)

y = production yield (kilogram/rai)

$$\frac{dC}{dy} = 6.5260y^{0.2119}$$

The price of strawberry in the NS was 21.02 by the average. The price was replaced in the marginal cost function to determine output level. Then, the farmer surplus in NS can be estimated.

$$FS = (21.02x4{,}408.12) - \int_0^{4{,}408.12} 3.5230\, y^{0.2119}$$

$$= 92{,}674.77 - 76{,}412.43$$

$$= 16{,}267.34$$

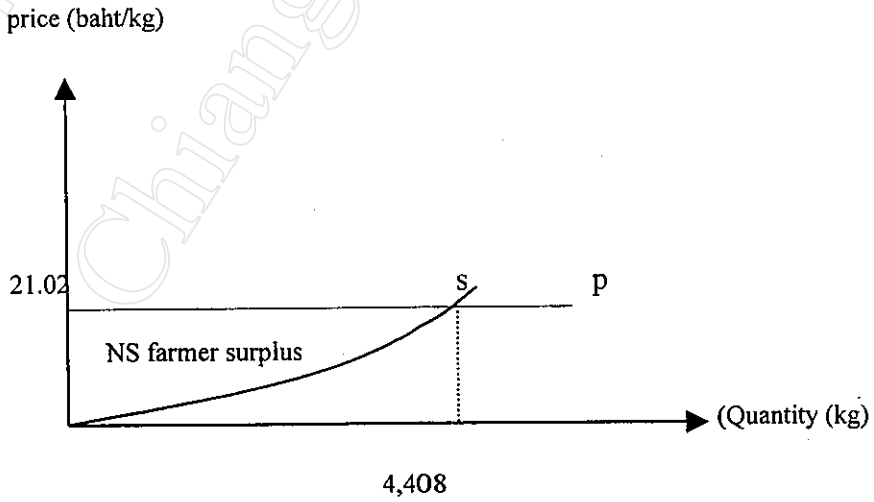

Figure 6.2 Farmer surplus of the NS strawberry production

This estimation shows that the farmer surplus of the NS strawberry production as 16,267.34 baht/rai. The result of the farmer surplus study points out that the NS farmer surplus was lower than the VFS farmer surplus by 14,645.14 baht/rai. It was due to very low price of strawberry received by NS grower. Figure 6.3 compares supply curves and surpluses accrued to growers of VFS and NS.

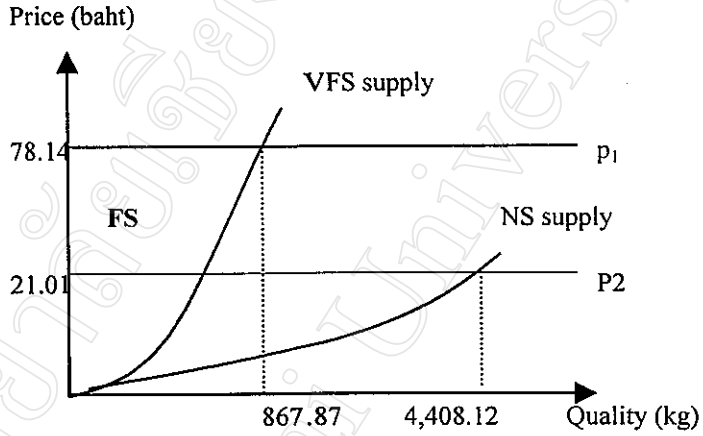

Figure 6.3 Farmer surplus of the NS and VFS strawberry production

Since two new varieties P50 and P70 were newly introduced by the Royal Project, there supplies were limited and their prices were arbitrary set by the Royal Project. It is sensible to predict lower price for both variables when they were widely grown by farmers and price are determined by the market. In the worst scenario, assuming that the price of VFS falls to the same level o NS (21.02 baht /kg), the farmers surplus of VFS would drop drastically below that of NS. That is

$$31{,}912.44 = (21.01 x Yield) - \int_0^i 0.1910 y^{0.8889}$$

Yield = 198.01 kg/rai

So, the production yield at the equilibrium point is 198.01 kg/rai. When this amount of yield is expressed into VFS farmer surplus equation, the result is found that the farmer surplus is 1,957.18 baht per rai.

Evidently, (figure 6.3) the supply curve of VFS line on the left of NS supply curve indicating that VFS production possesses a high cost structure. This implies lower productivity and efficiency of VFS production as compared to that of NS.

6.1.4 Market orientation

The market orientation is the impact study in the medium term. It is found that the strawberry is the commercial fruit crop of Chiang Mai and Chiang Rai provinces, since the areas are suitable to grow the strawberry. During December to January, it is the traveling season of both provinces. In addition, this season is the harvesting season of the strawberry. Therefore, it can be a channel of strawberry marketing in order to sell tourists. Markets of strawberry have many different ways such as fresh and processing markets, both domestic and export. More than 50% of total production was processed for export. Japan is the main exported country from Thailand, especially in processing products. Japan imports strawberry from Thailand, then they mix the many varieties for making Japanese strawberry jam.

Strawberry is a highly perishable fruit, therefore, after harvesting process the farmers hurry to bring their production to the markets as fast as possible. The channel markets had many ways such as fresh market, processing market both export and domestic markets. Generally, (see the Figure 6.4) there were 2 channels from farm gate, these were selling to assembles and the farmer strawberry groups. After that these production were brought to factories, local market and market in Bangkok. As mention in above the factories distributed their production to domestic and export

markets. For fresh market in Bangkok, the merchants distributed their production for export and domestic market.

In Thailand, fresh market of strawberry has played dominantly in early season during December to January, its price at the highest during that period. The farmers prefer selling their products in this period to the fresh market. The price of strawberry will decrease in high productivity period, January to February. Apart from season, prices of strawberry also depend on quality, variety, and market place. The farmers under the project who grow the variety of P70, P50, and Nyoho, get the higher price compare to P16 and P20. Purchasing prices of the Royal Project marketing unit depend on grade and variety. Most of products sold under project's brand name were packed in plastic box and assembled to supper market, on the other hand, the farmers are not contracting with the Royal Project. Their products are sold the middlemen in the village and strawberry farmer groups where are in their villages. From interviewing farmers, most farmers wanted to sell their products for fresh markets because they want to get higher price. The result of the study found that P70 and P50 are the new varieties, which are promoted to hill-tribe farmers. These varieties are the varieties for fresh market. They are higher price than P60 and P20 (processing varieties), so, the development of strawberry varieties led to the development of marketing orientation as well.

According to mention in above about the processing market, 65% of the total production in Thailand was brought for the processing market (Figure 6.4). The strawberries are added value in many forms such as plate, juice, dried, frozen and jam. From the interviewing processing companies, they exported strawberry to Japan, Europe, Spain and Australia. About 78.8 % of total processed products were exported and remaining was for the domestic market. The varieties required by factory was Tioga (P16). Hence, this variety has its characteristics, which are suitable requirement of processing market. Actually, the same farmers grew the P20 variety together with P16. So, the strawberry production, which is brought to factories, had the P16 and P20. The factories complained of the strawberry development and that they required the varieties, which can be processed and follow the marketing requirement. Therefore, the strawberry research and development pays some attention for the processing factories. Since, most of strawberry production played in the processing market

6.2 Factors affecting strawberry prices

This part of the study explains the factors affecting strawberry price. The hedonic price model was used to determine the value of each product attribute. Product attributes include biophysical characteristics of the fruit and augmented factor, which is the type of purchasers (Royal Project or merchant). All attributes are in discrete form represented by binary (dummy) variables. For example, weight of a strawberry fruit is classified in to 4 groups and 3 dummy variables represent 3 different groups, which are larger than 8.99 gram per fruit. Using binary form in place of nominal form makes interpretation of coefficients more practically meaningful.

6.2.1 Hedonic Price Model of Strawberry

The hedonic price model in equation (3.9) is respecified as:

$$\begin{aligned} \textit{In } P = \quad & \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4 + \beta_5 D_5 + \beta_6 D_6 + \beta_7 D_7 + \beta_8 D_8 \\ & + \beta_9 D_9 + \beta_{10} D_{10} + \beta_{11} D_{11} + \beta_{12} D_{12} + \beta_{13} D_{13} + \beta_{14} D_{14} + \beta_{15} D_{15} \\ & + \beta_{16} D_{16} + \beta_{17} D_{17} + e \end{aligned}$$

Where lnP = ln of price of strawberry received by growers (baht per kg.)

D_1 = Weight 1; 1, if weight per fruit is more than 15 grams
0, Otherwise

D_2 = Weight 2; 1 if weight per fruit is 11-15 grams
0, Otherwise

D_3 = Weight 3; 1 if weight per fruit 9.00-10.99 grams
0, Otherwise

D_4 = Width 1; 1, if width of fruit is more than 3.75 cm.
0, Otherwise

D_5 = Width 2; 1, if width of fruit is 3.25-3.75 cm.
0, Otherwise

D_6 = Width 3; 1, if width of fruit is 2.81-3.25 cm.
0, Otherwise

D_7 = Width 4; 1, if width of fruit is more than 3.25 cm.
0, Otherwise

D_8 = Light ; 1, if the value of light of color is less than (L) 33.62 (Average value)

0, Otherwise

D_9 = Hue; 1, if Hue is less than 27.10 (Average value)

0, Otherwise

D_{10} = Croma; 1 if Croma is less than 39.55 (Average value)

0, Otherwise

D_{11} = Firmness; 1, if firmness of fruit is less than 0.50 kg/cm^2 (Average value)

0, Otherwise

D_{12} = Sweetness ; 1, if sweetness is less than 7.63 Brix (Average value)

0, Otherwise

D_{13} = P16-RP; 1, if the product P 16 sold to the Royal Project

0, Otherwise

D_{14} = P20-Merch; 1, if the product P 20 sold to other merchants

0, Otherwise

D_{15} = P20-RP; 1, if the product No 20 sold to the Royal Project

0, Otherwise

D_{16} = P50-RP; 1, if the product No 50 sold to the Royal Project

0, Otherwise

D_{17} = P70-RP; 1, if the product No 20 sold to the Royal Project

0, Otherwise

e = error term

Note : When D13 = D14 = D15 = D16 = D17 = 0, it refers to Nyoho sold to the Royal Project

Table 6.11 Estimated hedonic price model by using generalized least squares (GLS)

Variable	Coefficient	t-statistic	Marginal effects
Constant	3.2392	42.464***	25.5133
Weight 1 : D_1	0.5352	6.040***	0.7078
Weight 2 : D_2	0.3903	4.778***	0.4774
Weight 3 : D_3	0.1133	1.557	0.1200
Width 1 : D_4	0.4250	3.111***	0.5296
Width 2 : D_5	0.4280	3.747***	0.5342
Width 3 : D_6	0.3356	3.114***	0.3988
Width 4 : D_7	0.2242	2.676***	0.2513
Light color : D_8	0.0782	1.783*	0.0813
Hue : D_9	-0.0801	-1.666*	-0.0770
Croma : D_{10}	-0.0807	-1.841*	-0.0775
Firmness : D_{11}	-0.1476	-3.202***	-0.1372
Sweetness : D_{12}	0.0427	1.280	0.0436
P16-RP : D_{13}	-0.9110	-13.612***	-0.5979
P20 : Merch : D_{14}	-0.7604	-12.460***	-0.5325
P20-RP : D_{15}	-0.8622	-14.088***	-0.5778
P50-RP : D_{16}	-0.6088	-9.252***	-0.4560
P70-RP : D_{17}	0.2602	1.787*	0.2972
$R^2 = 0.61$	$\bar{R}^2 = 0.60$	F-test = 43.82***	Breusch-Pagan chi-squared = 412.06***

Source: Calculated by Limdep Version 7.0

Remake : *** Significant at 1 percent level

: ** Significant at 5 percent level

: * Significant at 10 percent level

: Corrected Heteroskedasticity

6.2.2 The results

There were 17 characteristics of strawberries in the hedonic price model, 12 variables are significant at 1% level. Almost of positively variables, which were significantly related to the price, were width and weight per fruit. These represent that the size of the strawberry is the most affected variable to the price. Marginal effects of variables are presented in the last column of Table 6.11. The marginal effect of three weight categories (more than 15 gram, 11-15 gram, and 9-10.99 gram) are 0.70, 0.47, 0.12 respectively. The price of the larger size, e.g., weight per fruit more than 15 gram, is .70 times higher than the price of that weighs less than 9 gram per fruit (holding other factors constant). This implies, for example, that if the price for strawberry weighs less than 9 gram is 30 baht/kg, the price of the largest size is 51 baht/kg.

Width of strawberry fruit is another characteristic that is positively related to the price. The width of fruit was divided in to 5 categories, 4 dummy variables in hedonic price model, which consist of the width that more than 3.75 cm., 3.25-3.75 cm., 2.81-3.25 cm, 2.5-2.8 cm, and less than 2.5 cm. The results from the model show that the corresponding marginal effects of width of product are 0.52, 0.53, 0.39, and 0.25 respectively.

Three characteristics of color that are not significant are the light of color, Croma, and Hue. The light of color is given as lightness (black to white), the higher lightness lead to the lighter color. Croma is the degree of departure from gray toward pure chromatic color. Therefore, Croma is the degree of color yellow to red because the value of a* and b* which were measured by color reader are positive, Hue is ranging between red to yellow. The strawberry measured that the high degree of Hue

and Croma, low lightness was sold higher price. Otherwise, it can be explained that color of strawberry is dark red color getting lower than the light red

Firmness of strawberry fruit is negative and significant at 1 % level in the model, firmness is higher than 0.5 kg/cm^2 that the strawberry price will be more expensive than the 0.13. Sweetness is one of the attributes that is not statistically significant in this hedonic price model. However, its sign shows positive relationship to the price.

The last five variables refer to variety of strawberry and farmers' first buyers represented by D13-D17. When all of these variables take value zero, it means the product "Nyoho" sold to the Royal Project, which is used as basis for evaluation of these product attributes. The results of the model show that for the same quality, the lowest price of strawberry is the product of No.16 sold to the Royal Project, its price is lower than the "Nyoho" variety (P16) sold to merchants. The highest price of the same quality of strawberry with respect to variety is the product of P70, sold to the Royal Project. its price is higher than the "Nyoho" variety by 0.29 times. The price of remainder products, i.e., the product of P20 sold to the project, the product of P20 sold to other merchants, the product of P50 sold to the project are lower than the "Nyoho" by 0.76, 0.86, and, 0.60 respectively. Only P70 was found to have the prices higher than that of Nyoho.

It should be noted that, prices of P20, P50, and P70 were paid by he Royal Project and were not part of the competitive market price. Rather, they were set relative to production cost and marketing service charge. Therefore, interpretation of hedonic price analysis in this study differs from conventional practice. Here, the value of each attribute as shown by its marginal effect does not reflect consumer's utility but value implicitly judged by the Royal Project.