CHAPTER V

OPTIMUM LEVEL OF CAPITAL NEED IN DAIRY FARMING

This study deals with production function estimation to assess productivity and the optimum level of capital need for different dairy farming groups with three loan repayment performance (good, average and poor repayment performance) and three different farm sizes among BAAC's dairy farmers.

5.1 Economic Analysis of Milk Production Function

In this section, Cobb-Douglas production function is estimated by using LIMDEP software. The result of the estimation in term of structural relationships and the optimum level of inputs used is analyzed. The implication of production function analysis is discussed in terms of the relationship of milk output and different inputs used. After the production function has been estimated, the coefficients of the function will be evaluated to determine the productivity of different groups of farmers.

5.1.1 Specifications of the Model

As mentioned in Chapter II, the specification of the model and the variables defined have been presented. The variables defined and relationship of input variables on milk output are again shown below. Determinants of milk production function included land, labor, capital, material, fodder feed, concentrate feed, year of raising, farm size, breed, artificial insemination, mastitis and nonheat in the initial specification of the model as follows:

$$Y = aLn^{b1}Lb^{b2}BE^{b3}Mt^{b4}F^{b5}CF^{b6}YR^{b7}FS^{b8}G^{b9}AI^{b10}M^{b11}NH^{b12}e^{b13D1}e^{b14D2}e^{u}$$

where,

Y	=	Total milk output (kg/year)
Ln	=	Land (rai)
Lb	=	Labor (manday)
BE	=	Building and equipment (baht/year)
Mt	=	Material (baht/year)
F	=	Fodder feed (kg /year)
CF	=	Concentrate feed (kg/year)
YR	=	Year of raising (years)
FS	=	Farm size (No. of dairy cows)
G	=	Breed (%HF)
AI	=	Success in artificial insemination (no. of insemination/conceptions)
M	=	Mastitis incidence (times/year)
NH	=	Nonheat (%nonheat per total milk cow per year)
D1	=	Loan repayment performance (group 1) D1=1 if good performance or 0 otherwise.
D2	=	Loan repayment performance (group 2) D2=1 if average performance or 0 otherwise.
a, b_i	=	coefficient
e	=	2.71828
u	=	error term

Input variables defined:

Ln: Land included two types of land: farm land is homestead and pasture land is the area used for pasture. Land is measured in rai. The effect of land on milk production function should be positive.

Lb: Labor is the summation of farm family labor and hired labor used in the production of dairy products only. Labor is measure in manday per year that one manday is 8 hours/day. Labor should have positive impact on milk production function.

BE: building and equipment is the cost of building and equipment in dairy farm. Building and equipment cost measured in baht per year. Capital should have positive impact on milk production.

Mt: Material is the aggregate value of cash expenditure items purchased and used only in the production of dairy products. Material should have positive impact on milk production.

CF: Concentrate feed is the annual total amount of concentrate feed in farm measured in kg per year. It should positively correlate with milk output although at same ranges of feed, negative relationship can occur.

F: Fodder feed included grass and other fodder such as baby corn husk, baby corn stalk and rice straw in farm. The total annual amount of fodder feed in farm , which is converted in term of kg of dry matter per year. The use of concentrate feed and fodder feed should have positive impact on milk production.

YR: Years of raising is the number of years dairy farmers engage in their dairy farms. The greater the years of raising dairy cows, the greater the quantity of milk production.

FS: Farm size is the number of dairy farmers' cows. The greater the farm size, the greater the milk production.

G: Breed is the average percentage of Holstein Friesian (HF) was calculated from the record of dairy cows in the farms. The higher the percentage of HF, the greater the milk production.

M: Mastitis was taken to be the frequency of the mastitis that occurred in the farm in one year. The occurrence of mastitis should have negative impact on milk production.

AI: Frequency of success in artificial insemination was measured as an average number of insemination per conceptions. The frequency of success in artificial insemination on milk production should have negative impact on milk production.

NH: Nonheat is calculated in percentage of nonheat cows per total milk cow per year. The frequency of nonheat should have negative impact on milk production.

5.2 Descriptive Statistics of the Variables

Descriptive statistics of the variables are shown in Table 5.1 including mean, standard deviation, minimum, maximum and coefficients of each variable.

Dairy farmers in the study sample have an average milk yield of 18,780.7 kg/year/hh, ranging from a maximum of 82,820.2 kg/year/hh to a minimum of 2,147 kg/year/hh (Table 5.1). Farm and pasture land holdings average 7.75 rai/hh and average herd size 10.79 cows/hh. Total family labor and hired labor used for the dairy enterprise on their farms average 387.5 manday/year/hh. The dairy farmers in the study area adopted dairy farming in different years an the average was about 8.48 years. The dominant breed in this area is Holstein Friesians cross. Almost all dairy farmers feed dairy cows with concentrate feed and fodder feed, averaging 4,201.1 kg/year/hh and 82,123 kg/year/hh, respectively. Cost of building and equipments in the study area averages at 97,966 baht/year/hh. Cost of dairy production materials averages at 17,605.8 baht/year/hh.

Table 5.1 Descriptive statistic of variables

Variable	Unit	Mean	Std. Dev	Min.	Max.	N
Yield	kg/year/hh	18,780.7	11,957.4	2,147.9	82,820.2	100
Ln	rai/hh	7.75	5.61	0.25	30.0	100
Lb	manday/year/hh	387.5	143.8	136.9	821.3	100
BE	baht/year/hh	97,996.0	96,187.0	14,357.0	451,350.0	100
Mt	baht/year/hh	17,605.8	9,890.4	5,166.8	54,176.4	100
F	kg/year/hh	82,123.0	39,952.0	29,875	215,960.0	100
CF	kg/year/hh	4,201.2	1,430.0	1,100.0	8,030.0	100
YR	year/hh	8.48	5.38	1.0	24.0	100
FS	cows/hh	10.79	4.37	1.0	27.0	100
G	average %HF/farm	79.56	5.44	50.0	93.0	100
AI	no.of insemination/ conceptions	2.06	1.08	1.0	7.4	100
M	times/year/hh	1.87	2.25	0.0	15.0	100
NH	% nonheat cow /total milch cow	5.76	19.67	0	90.3	100

5.3 Estimation of Milk Production Function

Initially, all variables in the specification of the model is estimated by using LIMDEP program. To improve the estimation result with regard to R-squared and structural coefficients, some variables were dropped and some variables were combined in one variables to find the best model. It was found that after concentrate feed and material were combined in one variable by including expenditure of concentrate feed in material variables namely OP (operational costs), the statistical fit was improved. The final improved model was selected with all variables having correct sign and reasonable good R-square and adjusted R-square. Average operational costs (OP) was found to be 96,554

baht/year/hh with the range of the minimum 15,447 to the maximum of 153,998 baht/year/hh.

As for other variables, mastitis and nonheat variables were also finally excluded from the model. From formal survey, it was found that there were only 9 households having nonheat problem averaging 1-2 cows per farms. With regard to mastitis variable, it was found that mastitis was not so different in each farm, averaging 1.87 times per farm. These two variables may suffer from measurement errors and were finally dropped from the model.

The final model included Ln, Lb, BE, OP, F, YR, FS, G, AI and dummy variables (D1 and D2) were estimated production function by using LIMDEP. Furthermore, multicollinearity and heteroskedasticity were also tested in the final model.

5.3.1 Testing for Multicollinearity and Heteroskedasticity in the Final Model

Multicollinearity is the violation of the assumption that no independent variable is a perfect linear function of one or more other independent variables. Instead, multicollinearity can be defined as a linear functional relationship between two or more independent variables that is so strong that it can significantly affect the estimation of the coefficients of the variables (Studenmund, 1991). Multicollinearity was tested in the model and it revealed that there is no severe multicollinearity among explanatory variables included in the model (Appendix Table 8).

With respect to heteroskedasticity, it tests that the observations of the error term are drawn from a distribution that has a constant variance. Heteroskedasticity often occurs in data-sets in which there is a wide disparity between the largest and smallest observed values. The larger the disparity between the size of observations in a sample, the larger the likelihood that the error term observations associated with them will have different variances and therefore be heteroskedastic. That is, we expected that the error

term distribution for very large observations might have a large variance, while the error term distribution for small observations might have a small variance (Studenmund, 1991).

Breusch and Pagan's method is used to detect heteroskedasticity by measuring the overall significance of a secondary regression that specifies the original residuals, squared to be a function of more than one Z (the possible proportionality factor). Test the overall significance of Equation (1) by testing the null hypothesis:

Ho: $\alpha_1 = \alpha_2 = \ldots\ldots\ldots\ldots \alpha_p = 0$
H_A: otherwise

The appropriate test statistic to use is: $L = \dfrac{ESS}{2\left[\Sigma\left(e_i^2/n\right)\right]}\ 2$ ----------(1)

where,

α_i = the slope coefficients from the i^{th} observation
ESS = the explained sum of squares
e_i = the residual from the i^{th} observation of the original equation
n = the sample size

If L is larger than the critical Chi-square value then we reject the null hypothesis that the slope coefficients jointly equal zero and conclude that L is significant. Such a conclusion is evidence that the variance of the residuals of the original equation is not a constant, and it is likely that the model has heteroskedasticity (Studenmund, 1991).

At the initial stage, the specific model was tested by Ordinary Least Squares (OLS) method. Testing heteroskedasticity was directly estimated by using LIMDEP software to calculate Breusch and Pagan's Chi-Squared test (L). From the result of Breush-Pagan Chi-Squared test (L) showed that L (D.F) = 26.7896 (11) (Appendix Table 9) in the model was larger than the tabulated critical chi-squared (Appendix Table 7) that the model

has heteroskedasticity problem. Therefore, general least squares (GLS) method of correcting heteroskedasticity was employed to get the production parameter. The estimation procedure was done by using the LIMDEP program. Result of GLS estimates of production function are shown in Table 5.2.

Table 5.2 GLS estimates of the production function of milk in the model

Variable	Coefficient	Std. Error	T-ratio	Significance Level
Constant	5.451	2.848	19.14	0.056
Ln	0.032	0.049	0.755	0.450
Lb	0.252	0.115	2.186	0.029
BE	0.113	0.048	2.333	0.020
OP	0.430	0.125	3.451	0.001
F	0.073	0.069	1.053	0.293
YR	0.126	0.055	2.308	0.021
FS	0.260	0.122	2.138	0.033
G	-1.140	0.570	-2.00	0.046
AI	-0.243	0.121	-2.015	0.044
D1	0.273	0.119	2.288	0.022
D2	0.258	0.142	1.810	0.070
R-Squared		0.615		
Adjusted R-Squared		0.567		
F-statistics (11,88)		12.801		

5.3.2 Result of the Production Function Estimation in the Final Model.

As mentioned in the Table 5.2, the result from the production function estimation revealed that R-square value is 0.615 and adjusted R-squared value is 0.567. It is implied that model can explained about 62% of the variation in milk production.

Looking into each key input variables, it was found that in case of land is not significant (p = 0.450) in this model because land used of the dairy farmers in this study area are not so different in size, averaging 7.75 rai/hh.

Labor is significant (p = 0.029) and it has positive impact on milk production. It implied that milk production increases with the increased level of labor.

Building and equipment has positive sign of the coefficient with highly significant (p = 0.020), it indicates that milk yield increase with the increased level of capital.

Operational costs are highly significant (p = 0.001) and it have positive affect on milk production that operational costs included concentrate feed expenditure. It also means that expenditure on concentrate feed has positive affect on milk production. In addition, Ekasingh *et al.* (1997) studied on the efficiency of milk production in Northern Thailand by using multiple classification analysis, discriminant analysis and logistic regression. They found that expenditure on concentrate feed have positive effect on milk production function. In the group of dairy farmers who paid more than 5,000 baht/cow/year for concentrate feed, they enjoyed the highest milk yield with more than 10 kg/cow/year.

Fodder feed is not significant (p = 0.293) due to the fact that most of the dairy farmers did not have enough grass fodder feed either in the dry season and rainy season in the study area. In addition, some dairy farmers bought other fodder such as baby corn stalk, baby corn husk, etc. to feed their dairy cows. In addition, dairy farmers feed fodder depending on its availability. However, amount of fodder feed is not enough for produce milk but fodder feed can help in terms of maintaining the body of dairy cows.

Years of raising or experience on dairy farming is significant (p= 0.021) and it has positive affect on milk production function. It means that the dairy farmers who have more experience have milk production higher than the dairy farmers who have less experience.

Farm size is significant (p = 0.033) in positive effect on milk production. It means that larger farm size have higher milk production than small farm size. On the other hand, Ekasingh *et al.* (1997) found that farm size is significant in having negative effect on milk and it shown that small farm size (1-10 cows) have the highest milk production (8.8 kg/cow/day). Medium farm size (11-20 cows) and large farm size (>20 cows) have slightly less milk production, respectively. Because the larger farm size will have supplemental dairy cow higher than the smaller farm size. At the same time, dairy farmers have limited labor and other factors that it might be have negative affect on milk production.

Genetic factor or breed is significant (p = 0.046) and it has negative affect on milk production. It is implied that higher percentage of HF beyond a certain level (around 75%) crossbred have a negative effect on milk production due to the higher crossbred always has problem on conception rate and adaptation to hot weather which might be the reason for low milk production. Furthermore, Ekasingh *et al.* (1997) also found that the higher percentage HF crossbred > 93.75% and lower percentage HF crossbred <75% have negative affect on milk production.

Success of artificial insemination is significant (p= 0.044) and it has negative impact on milk production. If dairy cows of dairy farmers spent more times to achieve successful in artificial insemination, this will have negative effect on milk production.

The dummy variables are concerning loan repayment. D1 and D2 are significant (p= 0.022 and 0.070, respectively) and they have positive effect on milk production. It mean that the dairy farmers who have better repayment performance have higher milk production than the poor performance. The estimated milk production at mean level of input used in different loan repayment performance group are estimated as shown in Table 5.3.

Table 5.3 Milk production of different loan repayment performance.

Group of loan repayment performance	Milk (kg/year/hh)
Good	18,981.1
Average	18,636.5
Poor	14,398.9

The estimated milk production at mean level of input used in different loan repayment performance group by different farm sizes are estimated as shown in Table 5.4. It is shown that dairy farmers have different milk production according to group of loan repayment performance and their farm size. Dairy farmers with large farm size have higher milk production than those small farm size. Dairy farmers with good and average repayment performance have higher milk production than the poor repayment performance group.

Table 5.4 Milk production of different loan repayment performance by different farm size.

Group of loan repayment performance	Farm size (No. of cow)	Milk (kg/year/hh)
Good	5	42,463.8
	10	50,849.5
	20	60,891.2
Average	5	41,831.6
	10	50,092.5
	20	59,984.7
Poor	5	32,319.8
	10	38,702.3
	20	46,345.1

5.4 Optimum Level of Capital Need in Dairy Farming

After the production function was estimated, the coefficients of the function will be analyzed to obtain input use efficiency, optimum level of input used and optimum level of capital need for the different groups of dairy farmers receiving BAAC's loans. However, to find optimum level of inputs used, some variables such as land and fodder feed are not significant in the model. Thus they were excluded from as these variables did not have effect on milk output. GLS estimation of the model without land and fodder is shown in Appendix Table 11.

The efficiency of inputs used is investigated by comparing the marginal value of product (MVP) of each input corresponding to its prevailing price. Price of input and output variables are as follows:

(a) Milk: average price of milk from three milk markets in the study area is 8.8 baht per kg.

(b) Building and equipment: building and equipment such as dairy barn, transportation such as car and motorcycle, equipment such as mowers, milk containers, milk pumps etc. and etc. Price of capital is evaluated based on rate of capital recovery factors as follows:

$$i(1+i)^n/ (1+i)^n -1$$

Capital recovery factor is used to calculate the amount of each level payment (A) to be made at the end of each of n periods to recover the present amount (P) at the end of the n^{th} period at the interest rate of i. The formula is $A = P(i(1+i)^n/ (1+i)^n -1)$ (Gittinger, 1982).

BAAC sets three different types of interest rate based on the amount of loan sanctioned (Table 5.5).

Table 5.5 Amount of loan and interest rate of BAAC.

Amount of money (baht)	Interest rate (percent per year)
< 60,000	9
60,000 - 1,000,000	12.25
>1,000,000	14.5

Actually, dairy farmers borrowed money for building and equipment such as dairy barns and motorcycles in medium and long terms that they have to pay back not less than 5 years. Thus, price of building and equipment (P_{BE}) (as an annual percentage) for a 5 years pay back period can calculated as follows for a 9% interest rate:

$$P_{BE} = 0.09(1+0.09)^5/ (1+0.09)^5 -1$$

$$= 0.257$$

The price of building and equipment for each of the three interest rates are as shown in Table 5.5

Table 5.6 Price of building and equipment by different interest rates.

Interest rate	Price of building and equipment
----------(percent per year)----------	
0.0900	0.257
0.1225	0.279
0.1450	0.295

(c) Operational costs: price of operational costs are evaluated based on interest rate of capital recovery factors in similar was as building and equipment. Actually, dairy farmers borrowed money for operational costs such as purchasing mineral and purchasing

of animal used in the production of dairy in short term that they have to pay back in one year on the schedule. Thus, the interest rate at 9%, 12.25% and 14.5% for one year is evaluated price of operational costs as follow: Thus, the interest rate at 9%, 12.25% and 14.5% for one year is evaluated price of operational costs as shown in Table 5.7.

Table 5.7 Price of operational costs by different interest rates.

Interest rate	Price of operational costs
----------(percent per year)----------	
0.0900	1.090
0.1225	1.123
0.1450	1.145

(d) Land: the average price of land is evaluated from the value of rent for land reported by farmers during field survey. Average land rent is 2,000 baht/rai/year

(e) Labor: price of labor is calculated from hired labor in the study area. Hired labor's wage was 120 baht per manday in the study area.

(f) Fodder feed: average price of fodder feed is 0.34 baht/kg. Average price of fodder feed in each farm is calculated by weighting on the percentage of usage of fodder feed multiplied by price of each fodder feed. Fodder feed included many items as follows:

- On-farm fodder, produced within dairy farmer's grass land. The price of on-farm fodder was calculated based on cost of production of cultivated grass fodder (baht/rai) per unit of grass fodder produced (kg/rai) (Appendix Table 3 and Table 4).
- Off-farm fodder is collected from outside dairy farmer's land. The price of off-farm fodder is based on the cost of hired labor harvest grass off-farm, per unit harvested (Appendix Table 3).

- Other feeds, include baby corn stalks, baby corn husks, rice straw and molasses. These are generally purchased, so market price in the study area was used (Appendix Table 3).

(g) Farm size (number of cows): average price of dairy cow is calculated from depreciation per year, averaging 2,000 baht /cow/year.

5.4.1 Input Use Efficiency

The input use efficiency is determined as the degree of profit-maximizing from input use. Profit is maximized when marginal revenue equals marginal factor cost. This is expressed mathematically as

$$Py(\Delta Y / \Delta X) = P_x \qquad (2)$$

where; $Py(\Delta Y / \Delta X)$ = value of the marginal product (MVP)

P_x = price of input

P_y = price of output

$\Delta Y / \Delta X$ = marginal product

The marginal product is the amount of output produced by the addition of one unit of input. The estimated coefficient of each inputs derived from the production function can be used to calculate the MVP of the input variables in the linear form as follows:

$$MP_i = \beta_i$$
$$MVP_i = Py * \beta_i$$

where; β i = estimated coefficient of the variables

Py = price of output

However, β_i in Cobb-Douglas are not equal MP_i in the linear form. Thus, β_i in Table 5.5 have to inverse in term of $MP_i = \frac{\partial f_n}{\partial Q_i} = \beta_i \frac{\partial f_n}{\partial Q_i}$ as follows:

$$Y = aLb^{b1} BE^{b2} OP^{b3} YR^{b4} FS^{b5} G^{b6} AI^{b7} e^{b8D1} e^{b9D2} e^{u} \text{.....(EQ. 1)}$$

or $$\ln Y = \ln a + b_1 \ln Lb + b_2 \ln BE + b_3 \ln OP + b_4 \ln YR + b_5 \ln FS + b_6 \ln G + b_7 \ln AI + b_8 D1 + b_9 D2 + u \text{ ----------(EQ. 1)}$$

$$Py * MP_{Lb} = Py * \frac{\partial Y}{\partial Lb} = Py * ab_1 Lb^{b1-1} BE^{b2} OP^{b3} YR^{b4} FS^{b5} G^{b6} AI^{b7}$$

$$Py * MP_{BE} = Py * \frac{\partial Y}{\partial C} = Py * ab_2 Lb^{b1} BE^{b2-1} OP^{b3} YR^{b4} FS^{b5} G^{b6} AI^{b7}$$

$$Py * MP_{OP} = Py * \frac{\partial Y}{\partial OP} = Py * ab_3 Lb^{b1} BE^{b2} OP^{b3-1} YR^{b4} FS^{b5} G^{b6} AI^{b7}$$

$$Py * MP_{FS} = Py * \frac{\partial Y}{\partial FS} = Py * ab_5 Lb^{b1} BE^{b2} OP^{b3} YR^{b4} FS^{b5-1} G^{b6} AI^{b7}$$

The ratio of MVP to the unit price of building and equipment, operational costs and farm size were calculated to find the efficiency of input used for the three different loan repayment groups (good, average and poor repayment performance) in Table 5.8.

Table 5.8 The ratio of MVP to unit price of input variables in different loan repayment performance at mean level.

Items	$MVP_i/Px_{(1)}$	$MVP_i/Px_{(2)}$	$MVP_i/Px_{(3)}$	Px
Lb	1.05	1.04	0.83	120
BE	0.83	0.82	0.66	0.257
	0.76	0.76	0.61	0.279
OP	1.14	1.14	0.91	1.090
	1.11	1.11	0.88	1.123
FS	2.00	1.99	1.59	2000

Note: $MVP_i/Px_{(1,2\ and\ 3)}$ = The ratio of MVP to unit price of good, average and poor repayment performance groups.

From Table 5.8, the ratio of MVP to the unit price of all inputs in three different group of loan repayment performance of dairy farmers are not equal to one. It is implied that the inputs are not used optimally. If the ratio is less than one, the inputs are over-utilized and if it is greater than one the inputs are under-utilized. The comparison of ratio between marginal value product of the inputs in three group of dairy farmers with their respective price shows that level of use of labor and operational costs of good and average repayment performance groups were slightly under-utilized while those for poor repayment group was over-utilized.

As for other input used, building and equipment use of all groups is over-utilized while herd size for all groups is still too small compared with the optimum size (in which MVPx = Px).

5.4.2 Optimum Level of Input Used and Capital Need

In order to find the optimum level of building and equipment and operational costs used of dairy farmers, their optimum input use is solved from the following equation.

$$\frac{MVP_{BE}}{P_{BE}} = \frac{MVP_{OP}}{P_{OP}} = 1$$

$$\frac{MVP_{BE}}{P_{BE}} = \frac{Py * a\,b_3 Lb^{b1} BE^{b2-1} OP^{b3} YR^{b4} FS^{b5} G^{b6} AI^{b7} e^{b8D1} e^{b9D2}}{P_{BE}}$$

$$\frac{MVP_{OP}}{P_{OP}} = \frac{Py * a\,b_3 Lb^{b1} BE^{b2} OP^{b3-1} YR^{b4} FS^{b5} G^{b6} AI^{b7} e^{b8D1} e^{b9D2}}{P_{MAT}}$$

All other inputs were assumed to be at the current level of use. Regarding the labor use an average of 387.5 mandays/year was taken into consideration since the interviewed farmers have labor constraint. However, it was found that household was the main source of labor for 90% of the sampled households, where only 10% used hired labor in their farms. In dairy farming with regard to the labor contribution by male and female it was found that the highest male labor use as 312 mandays/year compared to 150 mandays/year by female counterparts (Ekasingh *et al.*, 1997). In spite of women's participation in all the farm activities their labor contribution in dairy farming is seen low compared to the men, mainly due to the need to take care of other household activities beside farming such as taking care of children, preparation of meals for the family, washing clothes and other household related works. Ideally, labor and farm size can be solved for optimum level but since we are interested in building and equipment and material costs, only the latter two variables were closely examined in this study. Nevertheless, the optimum level of building and equipment costs and operational costs were also found for 3 different farm sizes, consisting of 5, 10 and 20 cows.

The coefficients of input used in Appendix 11 were used to calculate to find the optimum level of building and equipment and operational costs used with three different loan repayment performance. The optimum level of building and equipment and operational costs used at mean level of other input calculated are shown in Table 5.9.

Table 5.9 The optimum level of capital need of three different repayment performance groups by different farm size.

Items	Good repayment performance			Average repayment performance			Poor repayment performance		
	FS (5)	FS (10)	FS (20)	FS (5)	FS 10)	FS (20)	FS (5)	FS (10)	FS (20)
	----------(interest rate 9%) ----------								
Building and equipment	56,643	85,485*	129,074*	56,004	84,522*	127,619*	33,597	50,756	76,608*
Operational costs	45,430	68,573*	103,521*	44,917	67,800*	102,354*	26,960	40,708	61,447*
Total	**102,073***	**154,050***	**232,595***	**100,921***	**152,322***	**229,973***	**60,557**	**91,464***	**138,055***
	----------(interest rate 12.25%) ----------								
Building and equipment	49,490	74,699	112,679	48,932	73,857	111,413	29,366	44,347	66,939
Operational costs	41,824	63,132	95,268	41,352	62,421	94,196	24,823	37,477	56,572
Total	**91,314**	**137,831**	**207,947**	**90,284**	**136,278**	**205,609**	**54,189**	**81,824**	**123,511**

Note: FS = farm size (number of cows) , building and equipment not included value of cows.

: operational costs included aggregate value of cash expenditure used in dairy farm such as purchasing concentrate feed, mineral etc.

: * is not applicable at existing BAAC interest rate.

With respect to capital needs, dairy farmers have different capital needs according to which of the three different loan repayment performance groups and their farm size. Farmers with large herd size have more capital need than those with small herd. Thus, this information will be useful for BAAC in planing credit disbursement to dairy farmers. This analysis is suggested that BAAC can disburse more credit to dairy farmers in the good, and average repayment performance groups than the poor repayment performance group. Because poor repayment performance group have problem on pay back money on the schedule. If BAAC disburse more credit, BAAC will have high risk about bad debt. Furthermore, it was found that capital need with all three different groups of dairy farmers decreased when interest rate increased because dairy farmers who borrowed money with higher interest rate have to pay more money back and they might have problem on pay back loan on the schedule. Thus, a high interest rate implies a lower optimum level of capital need.

The comparison of the actual level of capital need of all three different groups of dairy farmers from Table 5.9 can be revealed as follows:

a) Good repayment performance group:

The optimum level of capital need (at 9% interest rate) reveals that the total capital requirement for the dairy farmers who own 5 cows is about 102,073 baht of which 56,643 is required as building and equipment costs to initiate the farm and 45,430 baht as operational cost. Dairy farmers who own 10 herd size require 154,050 baht as the total capital need, 85,485 baht as building and equipment costs and 68,573 for operational costs. The dairy farmers who own 20 cows need the highest capital investment about 232,595 of which 129,074 baht is for building and equipment costs and 103,521 baht is for operational cost.

The optimum level of capital need (at 12.25% interest rate) revealed that the total capital need of dairy farmers who own 5 cows is 91,314 baht, 49,490 baht is required as

building and equipment costs and 41,824 baht as operational cost. Dairy farmers who own 10 cows have total capital requirement about 137,831 baht of which 63,132 baht is required as building and equipment costs and 74,699 baht as operational costs. The total requirement of the dairy farmers who own 20 cows is about 207,947 baht, 112,679 baht as building and equipment costs and 95,268 baht as operational costs to run in their farms. Compared to the optimum level of capital need at 9% interest rate, there was a reduction of around 9,000 baht of optimal capital due to this increase in interest rate.

b) Average repayment performance group:

The optimum level of capital need (at 9% interest rate) showed that the total capital requirement for the dairy farmers who own 5 cows is about 100,921 baht of which 56,004 baht is required as building and equipment costs and 44,917 baht as operational costs to run the enterprise. Dairy farmers who own 10 herd size require 152,322 baht as the total capital need, 84,522 baht as building and equipment costs and 67,800 baht for variable cost. The dairy farmers who own 20 cows need the highest capital investment about 229,973 baht to initiate farm and 127,619 baht for building and equipment costs and 102,354 baht for operational cost. These levels are very similar to those for good repayment performance group.

The optimum level of capital need (at 12.25% interest rate) revealed that the total capital need of dairy farmers who own 5 cows is 90,284 baht, 48,932 baht is required as building and equipment costs and 41,352 baht as operational costs. The dairy farmers who own 10 cows have total capital requirement about 136,278 baht of which 73,857 baht is required as building and equipment costs and 62,421 baht as operational costs. The total requirement of the dairy farmers who own 20 cows is about 205,609 baht, 111,413 baht as building and equipment costs and 94,196 baht as variable costs to run in their farms. It is noticed that the difference of optimal level of average and good performance group is minimal and both groups can be lumped together as one group.

c) Poor repayment performance group:

The optimum level of capital need (at 9% interest rate) revealed that the total capital requirement for the dairy farmers who own 5 cows is about 60,557 baht of which 33,597 is required as building and equipment costs and 26,960 baht as operational costs. The dairy farmers who own 10 herd size require 91,464 baht as the total capital need, 50,756 baht as building and equipment costs and 40,708 baht for variable costs. The total capital requirement for dairy farmers who own 20 cows is about 138,055 to initiate farm and 76,608 baht for building and equipment costs and 61,447 baht for operational costs.

The optimum level of capital need (at 12.25% interest rate) showed that the total capital need of dairy farmers who own 5 cows is 90,284 baht, 48,932 baht is required as building and equipment costs and 41,352 baht as operational costs. The dairy farmers who own 10 cows have total capital requirement about 136,278 baht of which 73,857 baht is required as building and equipment costs and 62,421 baht as operational costs. The total requirement of the dairy farmers who own 20 cows is about 205,609 baht, 111,413 baht as building and equipment costs and 94,196 baht as operational costs to run in the dairy enterprise.

As for this group, the optimal capital level is substantially lower than the other two groups. This is reasonable because due to their problems caution must be taken to disburse credit to these groups. Too much credit will worsen their debt positions and this result is indicative of the level of credit that BAAC should give to farmers.

BAAC can even disburse less credit than the optimum level of capital need in terms of operational costs as they are short term cash expenditure used only in the day to day production of dairy products such as purchasing concentrate feed etc. Dairy farmers can obtain income from milk sale to pay for part of these expenditure. Thus, the total requirement of the operational costs, the dairy farmers can borrow only 50% (as shown in

Table 5.10.) or less as a loan from BAAC and the remaining amount can come from the sale of their farm products.

For example, dairy farmers in good repayment performance who have 5 herd size require 22,715 baht as operational costs decreasing from 45,430 baht at the optimum level of variable costs. The dairy farmers who own 10 cows require 34,377 baht as variable costs decreasing from 68,573 baht. The dairy farmers who own 20 cows require 51,761 baht as variable costs decreasing from 103,521 baht to operate in the enterprise. Similarly, the capital requirement of the different groups of dairy farmers at the different interest rate can be explained as previously in Table 5.9.

To highlight some interesting figures in Table 5.10, it is shown that for poor performance group, optimal credit stands at 47,077, 71,110 and 107,332 baht (at interest rate 9%) for farmers with 5, 10 and 20 cows, respectively. The total capital requirement (at 12.5%) for dairy farmers who own 5,10 and 20 cows is 41,778, 63,086 and 95,225 baht, respectively. About a third of this amount can be a one-year loan in which farmers have to pay back within a year while 2/3 of it can be 5 year loan. Given these results, BAAC must substantially revise its loan size to dairy farmers so that they can operate efficiently and be available farmers in the long run.

Table 5.10 The optimum level of capital need of three different repayment performance groups by different farm size when use 50% of operational costs.

Items	Good repayment performance			Average repayment performance			Poor repayment performance		
	FS (5)	FS (10)	FS (20)	FS (5)	FS 10)	FS (20)	FS (5)	FS (10)	FS (20)
	----------(interest rate 9%) ----------								
Building and equipment	56,643	85,485*	129,074*	56,004	84,522*	127,619*	33,597	50,756	76,608*
Operational costs	22,715	34,377	51,761	22,459	33,900	51,177	13,480	20,354	30,724
Total	**80,358***	**119,862***	**180,835***	**78,463***	**118,422***	**178,796***	**47,077**	**71,110***	**107,332***
	----------(interest rate 12.25%) ----------								
Building and equipment	49,490	74,699*	112,679*	48,932	73,857*	111,413	29,366	44,347	66,939*
Operational costs	20,912	31,566	47,634	20,676	31,211	47,098	12,412	18,739	28,286
Total	**70,402**	**106,265***	**160,313***	**69,608***	**105,068***	**158,511***	**41,778**	**63,086***	**95,225***

Note: FS = farm size (number of cows) , building and equipment not included value of cows.

: operational costs included aggregate value of cash expenditure used in dairy farm such as purchasing concentrate feed, mineral etc.

: * is not applicable at existing BAAC interest rate.

With regard to new dairy farmers who have limited capital to invest during establishment phase in dairy enterprises, value of cows should be added in the optimum level of capital need as shown in Table 5.11. Thus, total capital requirement (at 9% interest rate) by including value of cows for new dairy farmers who start their farm with 5 and 10 cows is 172,077 and 321,110 baht of which 158,597 and 300,756 baht was required as fixed costs (including value of cows) to initiate farm and which 13,480, 20,354 baht as operational costs to run their enterprise, respectively. Total capital requirement (at 12.25%) by including value of cows for new dairy farmers who start their farm with 5 and 10 cows is 166,778 and 313,086 baht of which 154,366 and 294,347 baht was required as fixed costs (including value of cows) to initiate farm and which 12,412, 18,739 baht as operational costs to run their enterprise, respectively.

Table 5.11 Total capital requirement by including value of cows for new dairy farmers by different farm size

Items	Farm size (5 cows)	Farm size (10 cows)
	----------(interest rate 9%)----------	
Building and equipment	33,597	50,756
Operational costs	13,480	20,354
Value of cows	125,000*	250,000*
Total	**172,077***	**321,110***
	----------(interest rate 12.25%)----------	
Building and equipment	29,366	44,347
Operational costs	12,412	18,739
Value of cows	125,000	250,000
Total	**166,778**	**313,086**

Note : farm size is number of cows and average price of cow is 25,000 baht per head.
: operational costs included aggregate value of cash expenditure used in dairy farm such as purchasing concentrate feed, mineral etc.
: * is not applicable at existing BAAC interest rate.

However, the optimal level of capital need changes as the prices of output and input change, in all three different repayment groups. Assuming, increase in price of output by 10%, total capital requirement (at 12.25% interest rate) for dairy farmers in good and average repayment performance who own 5, 10 and 20 herd size, increases from 91,314, 137,831 and 207,947 baht (Table 5.9) to 112,589, 169,921 and 256,563 baht, respectively (Table 5.12). Likewise, in the case of the dairy farmers in poor repayment performance who own 5,10 and 20 cows, the requirement of the total capital (at 12.25% interest rate) increases from 54,189, 81,824 and 123,511 baht (Table 5.9) to 67,543, 102,040 and 154,011 baht, respectively (Table 5.12). It can be observed that, on an average as price of milk increases by 10%, the total capital need will increases by 23%. This is a result of the fact that milk price increase improved profitability of dairy farms, thereby dairy farmers will be better off expanding their farms and consequently expand capital need for their operations. Given this sensitivity in output price, BAAC should take in account the change in the price of milk to disburse the loans at optimum capital requirement level. The model presented in this study can be used to find optimal capital at different input and output prices.

Table 5.12 The optimum level of capital need of three different repayment performance groups by different farm size when milk price increased 10%.

Items	Good repayment performance			Average repayment performance			Poor repayment performance		
	FS (5)	FS (10)	FS (20)	FS (5)	FS 10)	FS (20)	FS (5)	FS (10)	FS (20)
	----------(interest rate 9%) ----------								
Building and equipment	69,837*	105,360*	159,148*	69,511*	104,869*	158,407*	41,932	63,295*	95,509*
Operational costs	56,014	84,538*	127,643*	55,753	84,144*	127,047*	33,630	50,766	76,623*
Total	**125,851***	**189,898***	**286,791***	**125,264***	**189,013***	**285,454***	**75,562***	**114,061***	**172,132***
	----------(interest rate 12.25%) ----------								
Building and equipment	61,020	92,085	139,051	60,736	91,656	138,402	36,597	55,303	83,466
Operational costs	51,569	77,836	117,512	51,328	77,473	116,963	30,946	46,737	70,545
Total	**112,589**	**169,921**	**256,563**	**112,064**	**169,129**	**255,365**	**67,543**	**102,040**	**154,011**

Note: FS = farm size (Number of cows) , building and equipment not included value of cows.

: operational costs including aggregate value of cash expenditure used in dairy farm such as purchasing concentrate feed, mineral etc.

: * is not applicable at existing BAAC interest rate.