Chapter 6

LOGISTIC REGRESSION ANALYSIS OF ADOPTION OF CROSSBRED CATTLE

Even though, the crossbred cattle production provided the higher average return to family labor and management per day than local cattle production. However, more than 45 % of household in this area did not raising crossbred cattle. So, this chapter investigates the factors to affect the adoption of crossbred cattle in Nam Dong district, Thua Thien Hue province. A binary logistics regression was run using the thirteen independent variables included in the hypothesis as described in the Chapter 2. The binary logistic regression was used rather than a linear regression due to the dependent variable being dichotomous. The logistics model transforms the dependent variable into one that has linear relationships with a set of independent variables. This model estimates the linear determinants of the logged odds or logic rather than the nonlinear determinants of probabilities. The transformation is required in order to analyze the impact of these independent variables on the decision as to whether or not adopt crossbred cattle in Nam Dong district by the farmers.

6.1 Results

Two binary logistics regressions were run in this study. The first model was run by using the eleven independent variables as described in the chapter 2 excluding two variables, access to veterinary services and access to credit. This is because they did not have any correlation to the model. To improve the model, one additional variable, cassava production area, was included into the model because the survey results showed that the cassava production area of adopters and non-adopters were significantly different as present in chapter 3. The results of both models are presented as follows.

The results of the first binary logistic regression model presented in the Table 6.1 show that the Omnibus Test of Model coefficients which indicate the overall goodness-of-fit measure by significance of the Chi-square statistic is high and the percent of correct prediction is also good at 71.3%. Besides, the Hosmer and Lemeshow's Goodness of Fit test shows that the model's estimate sufficiently fits the data. The Table 6.1 also shows the values for Coefficient estimate (B) (a weighting value used in the equation) and Odds ratio (Exp (B)) used in interpreting the meaning of the regression coefficients. The final column, Statistical significance (Prob.) of Wald is also shown in the Table 6.1.

The results of the first logistic regression equation (Table 6.1) show that there were three significant predictors. Two factors, the dummy variable of access to technical training and the area of own grass land were significant predictor of the crossbred cattle at 1 per cent level. The significance level of the access to technical training variable was 0.003 with coefficient (B) of 2.874. The Odds ratio score (Exp (B)) was 17.715. The area of own grass land variable showed a negative relationship with the adoption of crossbred cattle. It had a coefficient of -3.557 with a significance of 0.000 and odds ratio of 0.029. The last significant predictor variable was the numbers of cattle in the family which was significant at the 0.05 level. The variable showed positive relationship with the adoption of crossbred cattle with the coefficients of 0.611 and the odds ration score of 1.841.

Table 6.1 Logit regression analysis for adoption of crossbred cattle in the study area

Variable	B	S.E	Wald (1)	Exp (B) (2)	Prob.
Access to technical training (1=Yes, 0 = No)	2.874	0.962	8.923	17.715	$.003^{***}$
Area of own grass land (Number of sao)	-3.557	0.966	13.569	0.029	$.000^{***}$
Number of cattle in family (Head)	0.611	0.310	3.867	1.841	$.049^{*}$
Constant	-1.334	0.988	1.824	0.263	$.177^{NS}$

Note: (1) Wald statistic tests the significance of individual logistic regression coefficients for each independent variable.

(2) Exp (B) shows the predicted change in odds for a unit increase in the predictor.

Hosmer-Lemeshow Test: χ^2 = 1.980 df = 7 Sig. = 0.961

Omnibus Tests of Model Coefficients: χ^2 = 28.212 df = 3 Sig. = 0.000

Percentage of Correct Predictions: 71.3%

(^{NS}): Not significant level; (*) Significant at 10% level; (***) Significant at 1% level

1 sao = 0.05 hectare

Cassava production area (ArCa) was added in the model as an independent variable. The second binary logistic regression was run and the results were presented in Table 6.2. The Omnibus Test of Model coefficients which indicate the overall goodness-of-fit measure by significance of the Chi-square statistic was high and the percent of correct prediction was 80% which was better than the first model. Also, the Hosmer and Lemeshow's Goodness of Fit test shows that the model's estimate sufficiently fits the data. The results of the Table 6.2 show that there are five significant predictor variables. Three factors, access to technical training, area of own grass land and cassava production area, were significant at 1 per cent level. The significance level of the access to technical training variable was 0.005 with coefficient (B) of 2.936. The Odds ratio score (Exp (B)) of 18.834 could be interpreted that the decision of adoption of crossbred cattle was 18.834 times as likely to adopt crossbred cattle than farmers without access to technical training. The area of own grass land variable showed a negative relationship with the adoption of crossbred cattle. It had a coefficient of -3.470 with a significance of 0.001 and odds ratio of 0.031. It means that the larger area of own grass land, the less adoption of crossbred cattle. The next significant variable was the cassava production area that had a coefficient of 0.225 and odds ratio of 1.253. This mean that a unit increase in area of cassava leads to 1.253 times increase in the odds that the farmer will adopt crossbred cattle, assuming that the other variable were constant (more explanation see chapter

6.2)

The other two significant predictor variables were the numbers of cattle in the family and the household income (Net income), both significant at the 0.1 level. The number of cattle in family variable showed positive relationship with the adoption of crossbred cattle with the coefficients of 0.617 and the odds ration score of 1.853. This mean that a unit increases in number of cattle leads to 1.853 times increase in the odds that the farmer will adopt crossbred cattle, assuming that the other variables were constant. Although the household income was significant predictor variable, the household income variable did not affect to the model because it had the value of coefficient equal zero and the odds ration score of 1.000.

Table 6.2 Logit regression analysis for adoption of crossbred cattle in the study area

Variable	B	S.E	Wald (1)	Exp (B) (2)	Prob.
Household income (Net income) (VND)	0.000	0.000	3.343	1.000	$.067^{*}$
Access to technical training (1=Yes, 0 = No)	2.936	1.046	7.876	18.834	$.005^{***}$
Area of own grass land (sao/household)	-3.470	1.058	10.756	0.031	$.001^{***}$
Number of cattle in family (Head)	0.617	0.360	2.931	1.853	$.087^{*}$
Cassava production area (sao/household)	0.225	0.086	6.802	1.253	$.009^{***}$
Constant	-1.019	1.222	0.694	0.361	$.405^{NS}$

Note: (1) Wald statistic tests the significance of individual logistic regression coefficients for each independent variable.

(2) Exp (B) shows the predicted change in odds for a unit increase in the predictor.

Hosmer-Lemeshow Test: χ^2 = 1.373 df = 8 Sig. = 0.995

Omnibus Tests of Model Coefficients: χ^2 = 40.446 df = 5 Sig. = 0.000

Percentage of Correct Predictions: 80.0%

NS: Not significant level; (*) Significant at 10% level; (***) Significant at 1% level

1 sao = 0.05 hectare

$$\text{Probability of adoption} = G(x) = \frac{e^{\beta_0 + \beta_1 x}}{1 + e^{\beta_0 + \beta_1 x}}$$

According to the above result the logit transformation of probability of adoption of crossbred cattle, G(x) can be representing as:

$$G(x) = \ln\left[\frac{p(x_i)}{1-p(x_i)}\right] = \beta_0 + \sum_{i=1}^{n} \beta_i x_i$$ = - 1.019 + 2.936 Access to technical training – 3.470 Area of own grass land + 0.617 Number of cattle in family + 0.225 Cassava production area

Where,

Access to technical training = Dummy variable (1 = Yes, access to technical training, 0 = No, not access to technical advice)

Area of own grass land = Area of own grass land per household in sao (sao = 0.05 hectare)

Number of cattle in family = Number of cattle kept in a family (head of cattle)

Cassava production area = Cassava production area per household in sao

From the equation above, the probability of combination of the important factors could be interpreted as shown in Table 6.3. The probability indicated the most important factor influencing the adoption of crossbred cattle and indicated how it was changed when the value of a factor was changed. The result of Table 6.3 show that if the cattle raisers have area of own grass land 0.338 sao, have access to technical advice, keep about 3 heads of cattle and plant about 4.5 sao of cassava, the probability of adoption of crossbred cattle would be 0.9799. It means that there was 98 % of chance that a farmer will make a decision to adopt the crossbred cattle. However, the probability would decrease to 0.4842 when a cattle raiser do not have access to technical training and do not grow cassava. If a cattle raiser do not have access to technical training, raise only 2 heads of cattle and have only 1 sao of cassava, the probability would decrease to 0.3246.

Table 6.3 Probability of combination of the four important factors influencing the adoption of crossbred cattle

AtTech	AreLaPas	TotalCa06	ArCa	Probability
1	0.338	3.45	4.5	0.9799
0	0.338	3.45	4.5	0.7210
1	0.338	3.45	19	0.9992
1	0.338	3.45	1	0.9568
1	0.338	2	4.5	0.9521
1	0.338	6	4.5	0.9958
0	0	3.45	4.5	0.8930
1	0.5	3.45	4.5	0.9652
0	0.338	3.45	0	0.4842
1	0	3.45	0	0.9828
0	0.338	2	1	0.3246

Note:

AtTech: Access to technical training (1=yes, 0= no)

AreLaPas: Area of own grass land (at the average of 0.338 sao per household)

TotalCa06: Number of cattle in family (at the average of 3.45 head of cattle per household)

ArCa: Number of area cassava (at the average of 4.5 sao per household)

One of the outputs of a logistic regression model is the model of coefficients. The Omnibus tests of model coefficients show whether or not all of the variables entered into the regression equation have a significant effect on predicting the dependent variable. The Chi-square value of 40.446 as shown in Table 6.4 was significant at 0.000 with the five variables in the regression equation. This indicates that of the twelve variables used in this analysis, five were significant in predicting the adoption of crossbred cattle.

Table 6.4 Omnibus tests of model coefficients

		Chi-square	df	Sig.
Step 9[a]	Step	-1.143	1	.285
	Block	40.446	5	.000
	Model	40.446	5	.000

([a]) A negative Chi-square value indicates that the Chi-squares value has decreased the previous step.

In the logistic regression model, a Classification Table compares the predicted values for the dependent variable with the actual observed values in the data. As can be seen in the Classification table shown as Table 6.5, the regression equation of twelve independent variables predicts the adoption or non-adoption of crossbred cattle correctly 80.0 per cent of the time. Specifically, 32 of the 40 adopters and 32 of the 40 non-adopters were predicted correctly.

Table 6.5 Classification table [(a)]

Observed			Predicted		
			Adoption cattle breed		Percentage Correct
			Not Adoption	Adoption	
Step 3	Adoption cattle breed	Not Adoption	32	8	80.0
		Adoption	8	32	80.0
	Overall Percentage				80.0

(a) The cut value is .500

When Hosmer-Lemenshaw test is significant, it means that the observed counts and those predicted by the model are not close, and the model does not describe the data well. When the Hosmer-Lemenshaw test is not significant it means that the observed and the predicted counts are close and the model describes the data well. The results of logistic regression model in Table 6.6 shows the Hosmer and Lemenshow test is not significant (0.995). So, it means that the observed and the predicted counts are close and the model describes the data well.

Table 6.6 Hosmer and Lemenshow Test

Step	Chi-square	df	Sig.
9	1.373	8	.995

6.2 Interpretation of results

Access to technical training was supposed to positively affect the adoption about crossbred cattle. If a farmer has access to technical training, the farmer is more likely to raise crossbred cattle than local breed cattle. The farmers who attend a technical training was understand and be able to apply technique to raise crossbred cattle well. They had known how to take care the cattle to reduce the risk of epidemic disease. They had learned how to mix concentrated feed with by-product and applied to increase the nutrient value of cattle feed. Due to increase nutrient value of feed, cattle will grow well and get high value. So, the access to technical training has significantly affected to farmer's decision making on cattle breed.

The area of owned grass land showed the non-expected sign of relationship with the adoption of crossbred cattle. This is because the farmers who adopt the cross bred cattle used concentrated feed more than the farmers raising local cattle, which can be seen from the cost of feed as explained in Chapter 5. In addition, the survey result show that cultivated grass was not the main feed of cattle but the natural grass on road sides and along the rice and annual crop fields as well as in the forest was the main resources feed. Other feeds such as agricultural by-products may be fed for crossbred cattle more than for local breed cattle. This can be seen from cassava products which were used as feed for crossbred cattle more than for local as explained in Chapter 3. These may be the reason that the crossbred cattle adopters need less area of own grass land.

Cassava production area was supposed to positively affect the adoption of crossbred cattle as cassava is usually used for producing cattle feed in the study area. If a farmer had more land to produce cassava, the farmer is more likely to raise crossbred cattle than local breed cattle. Feed is the second highest cost of input used for cattle production. In the study area, cassava was the most popular concentrates feed used for raising cattle. If the farmers planted the cassava, they could reduce the feed cost of cattle production and get the higher profit. Besides, the cassava was one stored feed in the winter when the natural grass was shortage which was one of the main problems of crossbred cattle raisers.

The number of cattle kept per household was used as an indicator of farmers' decision making. The farmer that kept more cattle which need more money to invest for buying cattle seems to have a higher potential for investing in crossbred cattle raising than the farmer that kept less cattle. On the other hand, the farmers who kept more cattle have a higher probability to have a good cow which could apply the artificial insemination (AI) technology. The artificial insemination (AI) technology needs the cows which have a big body size and higher potential to give more milk. The good cow was easily to reproduce the new calf.

The household income hypothesized that the household with higher household income will be more likely, to adopt crossbred cattle. As the capital is need when a farmer wants to buy crossbred cattle, the household that has less income would be difficult to adopt crossbred cattle. However, the result of this model showed that it did not have any effect to the adoption.

Other factors hypothesized to influence adoption did not have significantly coefficients. They included age of household head, education of household head, having vehicle, labor availability in the family, having social position of household head, number children in family and access input market.

While two independent variables as access to veterinary services and access to credit did not have any correlation to the model. So, it was not allowed to run in the model and excluded.

In summary, factors affecting the adoption of crossbred cattle were analyzed using maximum likelihood estimated of a binary logistic regression model. The final results showed that four of twelve variables influenced the adoption of crossbred cattle. The most important factor was the area of owned grass land which has the negative relationship with the adoption of crossbred cattle. Other factors were access to technical training, cassava production area and numbers of cattle kept per household have the positive relationships with the adoption of crossbred cattle.