Chapter III

Research methods

3.1 Study site

The study was conducted in Rajanganaya major irrigation area in Anuradhapura district in low country dry zone (LCDZ) in Sri Lanka where majority of farmers grow rice (Figure 1.1). The area comes under DL1 Agro Ecological Region and annual rainfall is about 800 mm. The mean annual air temperature is about 30^{o}C. The main great soil groups are Reddish Brown Earth (RBE) and Low Humic Gley (LHG). Drainage classes varied from well drained to poorly drained. Rice is mainly grown in moderately to poorly drained soils. During the *maha* season, all the rice lands are used for rice, but during the *yala* season imperfectly to poorly drained soils only can be used for paddy cultivation under rainfed condition and moderately drain RBE soil needs fair amount of water, as supplementary irrigation, for a good rice crop. Therefore, these moderately drained lands are suited for other field crops during the *yala* season. Under good management conditions, 6-8 t/ha paddy yield can be expected during both *maha* and *yala* seasons. The landform pattern of this region is mainly undulating and the slope varies from 2-8%. Landform pattern of rice growing LHG soils are confined to the valley bottoms of the undulating terrain.

With respect to the agriculture extension the major irrigation area in Anuradhapura districts has divided geographically into three AO (Agriculture Officer) ranges. Each range has different extension staff and is divided into several AI (Agriculture Instructor) blocks. Each range is covered with more or less similar agriculture extension activities with respect to paddy cultivation.

Rajanganaya reservoir, which has the full-scale capacity of 10,066 hactare-metres and full-scale level approximately 68 m above MSL, provides irrigation water

for the area where the survey was conducted. This irrigation networks essentially designed for rice culture and distributory-channels in the system are constructed with control structures. Hence somewhat controlled water management practices have been introduced into this system. Water is issued mostly on pre-scheduled rotations. Decisions regarding water release from the reservoir are taken by a committee including irrigation officers, extension officers and farmer representatives. Dykes are constructed to retain water in the field and they are maintained well to prevent water leakages.

Rajanganaya right bank area consists of seven AI blocks and left bank consists of six AI blocks. Paddy growing extent of two areas are 2,585 ha and 2,203 ha respectively. There is not much variability among the farmers in different ranges with reference to living conditions and farming pattern. All most all the farmers in the area cultivate rice.

3.2 Sampling techniques

Since there is not much variability among the farmers in different AI blocks in this area, three AI blocks, namely Rajanganaya, Angamuwa and Naigala, were selected randomly from the Rajanganaya right bank area. From each AI block, sixty farm households were selected through systematic sampling. Whenever selected farmer was not involved in active farming, adjacent farmer was selected. That means mere landowners are excluded from the sample.

3.3 Data collection

Information on rice cultivation practices adopted by farmers, their socio economic conditions, institutional support, status of land and infrastructure facilities were collected through field observations and group discussions. Secondary data were extracted from various published and unpublished reports, journals, literatures, proceedings, personal communications, key informants and observations.

A structured questionnaire was developed based on a preliminary analysis. The questionnaire was pretested with five farmers (not included in the sample) and necessary changes were made to the questionnaire where the difficulties identified by the researcher. Visual assessments while conducting interview survey were also used to gather relevant information. The interview schedule used in this study is presented as appendix 5.

Questionnaire based structured interviews were conducted for each household in two cropping seasons, namely 2003/2004 *maha* and 2004 *yala*. Detailed information on rice farm practices, social, economical and institutional factors were collected through the survey. Besides this information farmer's and extension worker's perceptions on adoption of farm practices were collected through Participatory Rural Appraisal (PRA).

In addition, Inter Provincial Assistant Director of Agriculture Office, Anuradhapura and Agrarian Service Center, Rajanganaya provided both formal and informal information.

3.4 Socio-economic and Institutional characteristics of sample households

Farmers in the area have different levels of resource endowment and socioeconomic and institutional characteristics. Those may shape their farming practices and potentially affect their agricultural technology adoption behavior. The major socio-economic and institutional characteristics of the study area are displayed in the Table 3.1. Since there is less variability among the three AI blocks, the 60 households from each block pooled together to form a composite sample of 180 households. Some of the questions related to household wealth and income turned out to be sensitive for respondents and since they generated inconsistent information these were not used in the analysis.

3.5 Selection of rice production practices and grouping

Many technology adoption studies distinguish between the rate of adoption (e.g., the proportion of farmers adopting rice farm practices) and the level of adoption

(e.g., based on the level of use of the technology) by each farmer. In the smallholder paddy sector in Sri Lanka, farmers tend to adopt the new farm practices gradually with respect to the extent of land. Level and continuity of adoption varies widely among paddy farmers even in the close vicinity of the area. Hence, in this study, data have been gathered both on the rate of adoption and level of adoption for each rice production practice. Also, various other socio-economic and institutional factors, which might determine the rate and level of adoption, were recorded.

Table 3.1: Socio-economic and institutional characteristics of sample households.

Characteristic		Mean	SD	% Total
Age of household head		48.50	8.18	
Education:	≤Grade 5			26.7
	Grade 6 -8			35.6
	Grade 9 -10			23.9
	>Grade 10			13.9
Family size		4.98	1.70	
Family labor available for agriculture		2.35	0.95	
Number of social organizations involved		1.66	0.82	
Agriculture decision making: By hh head only				50.6
	With family members			49.4
Lowland extent (ha)		1.44	1.40	
Lowland tenure status:	Owner			89.4
	Part owner			7.2
	Not owner			3.3
Highland extent (ha)		0.51	0.82	
Distance to paddy field from home (km)		1.35	1.12	
Distance to extension office from home (km)		3.38	1.20	
Paddy Yield:	*maha* (kg/ha)	5031	764	
	yala (kg/ha)	5401	1238	
Purpose of growing paddy: Consumption				10.6
	Consumption and Selling			89.4

Source: Field Survey, 2004.

To determine the overall degree of adoption of land management practices index can be developed by assigning a score for each practice based on level of adoption. Index of adoption can be used as dependant variable in regression analysis to understand the factors explaining intensity of adoption of land management practices (Paudel *et al*., 2004; Bandara, 1995)

During last few years Department of Agriculture has introduced a set of improved sustainable rice production practices through different extension and training programs to rice growing farmers. This set of farm practices consist of recommended methods from land preparation to harvesting and processing. In this study 11 farm practices were selected and grouped them to form 3 response variables. These response variables with nested farm practices are as follows;

1. Land Preparation and Planting (LPP)
    - Commencement of land preparation within a week of water release
    - Method of land preparation
    - Use of recommended seed rate
    - Quality of seed paddy
2. Soil Improvement Methods (SIM)
    - Straw application
    - Green manure application
    - Farmyard manure application
    - Charcoaled rice husk application
3. Use of Agrochemicals (UAC)
    - Use of inorganic fertilizer
    - Use of weedicides
    - Use of pesticides

3.5.1. Land Preparation and Planting (LPP)

The data regarding the adoption of these practices were collected for two consecutive seasons namely *maha* 2003/2004 and *yala* 2004. The score of "0" was given if a farmer had not adopted the practice. "1" if he had adopted a particular practice in a particular field and "2" was given if a farmer had completely adapted a particular practice in all his fields in one season. The method of assigning scores based on the degree of adoption for each sub practice is explained below.

Commencement of land preparation with in a week.

- 0: if farmer had not started land preparation with in a week.
- 1: if farmer had started land preparation only in a particular field.
- 2: if farmer had started land preparation in all of his fields.

Method of land preparation

- 0: if farmer had not deep ploughed the land.
- 1: if farmer had deep ploughed only a particular field.
- 2: if farmer had deep ploughed all of his fields.

Use of recommended seed rate

- 0: if farmer had not used recommended seed rate.
- 1: if farmer had used recommended seed rate only for a particular field.
- 2: if farmer had used recommended seed rate for all of his fields.

Quality of seed paddy

- 0: if farmer had not used seed paddy from reliable source.
- 1: if farmer had used seed paddy from reliable source only for a particular field.
- 2: if farmer had used seed paddy from reliable source for all of his fields.

Cumulative score	Level of Adoption
0-5	Not adopted (0)
06-10	Partially adopted (1)
11-16	Adopted (2)

In order to compute the adoption score of particular practice for two seasons, score of each season was added. The cumulative score of Land Preparation and Planting (1st dependant variable) is computed by adding the scores of all four nested farm practices. The level of adoption was measured by considering those cumulative scores as above.

3.5.2. Soil improvement methods (SIM)

The score of "0" was given if the farmer had not adopted the practice, "1" if he had partially adopted in a specific field, "2" if he had partially adopted the practice in his all fields, "3" if he had adopted the practice completely in a particular field, and "4" was given if a farmer had completely adapted a particular practice in all his fields in one season. The method of assigning scores based on the degree of adoption for each sub practice is explained below.

e.g.: **Straw application**

- 0: if farmer had not applied straw.
- 1: if he had applied less than the recommended amount of straw in a specific field.
- 2: if he had applied less than the recommended amount of straw in his all fields.
- 3: if he had applied recommended amount of straw in a particular field.
- 4: if a farmer had applied recommended amount of straw to all of his fields with in a season.

Other three farm practices nested in this dependant variable will be treated in the same manner.

In order to compute the adoption score of particular practice for two seasons, score of each season was added. The cumulative score of Soil Improvement Methods (2nd dependant variable) is also computed by adding the scores of all four nested farm practices. The level of adoption was measured by considering those cumulative scores as follows.

Cumulative score	Level of Adoption
0-10	Not adopted (0)
11-20	Partially adopted (1)
21-32	Adopted (2)

3.5.3. Use of agrochemicals (UAC)

The adoption score of this dependant variable will also be computed as 'soil improvement methods'. The method of assigning scores based on the degree of adoption for each sub practice is explained below.

Inorganic fertilizer:

- 0: if farmer had used compound fertilizers.
- 1: if he had used recommended types of single fertilizers at incorrect stages with incorrect amounts.
- 2: if he had used recommended types of single fertilizers at correct stages with incorrect amounts.
- 3: if he had used recommended types of single fertilizers at correct stages with correct amounts in a particular field.
- 4: if he had used recommended types of single fertilizers at correct stages with correct amounts in all of his fields.

Weedicides:

- 0: if farmer had mixed the weedicides.
- 1: if he had used single weedicides with incorrect amount at incorrect stages.
- 2: if he had used single weedicides with corrects amount at incorrect stages.

- 3: if he had used single weedicides with corrects amount at correct stages.
- 4: if he had controlled weeds successfully with non-chemical methods or used single weedicides with correct amounts at correct stages.

Insecticides:

- 0: if farmer had used incorrect insecticides.
- 1: if he had used correct insecticides for identified pests with incorrect amounts at incorrect stages.
- 2: if he had used correct insecticides for identified pests with correct amounts at incorrect stages.
- 3: if he had used correct insecticides for identified pests with correct amounts at correct stages but no IPM is practiced.
- 4: if he had controlled insect pests successfully by IPM.

The cumulative score of 'Use of Agro Chemicals' (3rd dependant variable) is computed by adding the scores of all three nested farm practices. The level of adoption was measured by considering those cumulative scores as follows.

Cumulative score	Level of Adoption
0-8	Not adopted (0)
9-17	Partially adopted (1)
18-24	Adopted (2)

3.6. Variables Explaining Adoption

Explanatory variables were selected based on the literature reviewed by the researcher regarding technology adoption and Participatory Rural Appraisal (PRA) results. Prior studies have related farmer's adoption behavior to various factors such as personal, physical, social, economic, institutional etc. The particulars of variables considered for the study is presented in Table 3.2.

Included in the list are social characteristics such as age of the household head, education level, family labor, agriculture decision making behavior, number of social organizations involved by the household head; the economic characteristics of the household lowland area, lowland ownership; and the institutional characteristics such as distance to the paddy field from home, distance to extension office from home, number of training attended by the household head, number of demonstrations attended, number of office visits by the farmer, number of farm visits by the officer, frequency of using radio, newspaper or television for agriculture information.

3.7 Categorization of Explanatory Variables

The different explanatory variables are categorized as explained below. The details required to make this categories are collected through interview schedule and it is displayed in Appendix 5.

Age: Four age categories were formed by considering the wide range of age difference with in the households of the sample. Those four age categories are: 40 years or below, within 41 to 50 years, within 51 to 60 years and over 60 years.

Education: Based on the highest grade the household head has successfully completed in the school, four categories of education are formed: below or equal to grade 5, grade 6 to grade 8, grade 9 to grade 10 and above grade 10. The boundaries of categories are demarcated based on the cut off points existing in the education set up in Sri Lanka and by considering the frequencies of each category.

Family labor: Data were collected whether the family members involved in full time or part time basis in agricultural activities, whom are permanent residents of the household. If they were involved in full time, score 1 was assigned and 0.5 was assigned if they involved in part time basis. Then three categories were formed based on the number of family members involved in agricultural activities.

Decision-making: In this farming community, generally the eldest male is considered as the household head. All most all the family decisions are taken with his consent.

But other family members, especially housewives have a big say in domestic decisions. In this study, data regarding the number family members involved in agricultural decision making were collected. Based on this two groups are formed; in first group, agricultural decisions are taken only by household head and in second group, in addition to household head other members are also involved in agricultural decision making.

Social Participation: There were several rural social organizations in the study area. They were operating within the farming community and serve for farmers' domestic, religious and agricultural requirements. In this study, only the household heads' involvement in such social organizations was considered as the measure of social participation.

Lowland area: The total lowland area in which paddy is cultivated by households was considered. Total land area may include the lands with different kinds of tenureship, such as owner, leaseholder, tenant, part owner etc.

Lowland tenureship: The low land tenureship of the study area is quite complicated and different kinds of tenureship are observed. There are landowners (who have legal ownership), leaseholders (who has leased in the lands for a season or longer period), tenants (who have different kinds of material agreements with land owners) and shareowners (who owned only a portion of unpartitioned land but cultivate it fully and share the harvest with other share owners, most probably siblings). Also there were considerable number households who have more than one plot of land with mixed type of tenureship. Therefore by considering all types of lowland tenureship three categories are formed; *not owner*, *part owner* and *owner*. Shareowners and households with mixed tenureship are considered as *part owners*.

Distance to paddy field: Approximate distance to the paddy field from farm dwelling was obtained and when households cultivate more than one plot of land, the distance taken to the largest plot from residence.

Table 3.2: Particulars of variables.

Definition	Label	Code
Land Preparation and Planting	LPP	0 = not adopted, 1 = partially adopted, 2 = adopted
Soil Improvement Methods	SIM	0 = not adopted, 1 = partially adopted, 2 = adopted
Use of Agro Chemicals	UAC	0 = not adopted, 1 = partially adopted, 2 = adopted
Farmer age (years)	Age	1 = ≤40, 2 = 41-50, 3 = 51-60, 4 = >60
Formal education (Grade)	Education	1 = ≤5, 2 = 6-8, 3 = 9-10, 4 = >10
Family labor in Agriculture	Family labor	1= ≤1.5, 2 = >1.5-2.5, 3 = >2.5
Number involved in ag. decision making	Decision making	1 = 1, 2 = >1
Number of social organizations involved	Social organization	Number
Lowland area (ha)	Lowland area	1 = ≤1, 2 = >1-2, 3 = >2
Lowland ownership	Lowland ownership	0 = not own, 1 = part own, 2 = own
Distance to paddy field (km)	Distance to field	1 = ≤1, 2 = >1
Distance to extension office (km)	Distance to office	1 = ≤3, 2 = >3-6, 3 = >6
Easiness to irrigate paddy field	Easiness to irrigate	1= very difficult, 2 = difficult, 3 = not easy, 4 = easy
Number of trainings attended by household head	Training	1 = trained, 2 = not trained
Number of field demonstrations attended by household head	Demonstration	Number
Number of extension office visits by household head	Office visit	Number
Number of farm visits by extension officer	Farm visit	Number
Frequency of listening ag. radio programs	Listening	0 = non listener, 1 = irregular listener, 2 = regular listener
Frequency of reading ag. articles	Reading	0 = non reader, 1 = irregular reader, 2 = regular reader
Frequency of viewing ag. television programs	Viewing	0 = non viewer, 1 = irregular viewer, 2 = regular viewer

Distance to extension office: Approximate distance to the agricultural extension office from farm dwelling was obtained.

Easiness to irrigate: Though Rajanganaya area where the study has done is under major irrigation system; there are irrigation problems in some pockets of fields. The fields, which are located at far ends of distributory-channel system, may have water

scarcity especially during *yala* season. Also water retention ability of the soil type of the particular blocks of land can cause water scarcity problem too. Four categories are formed based on the easiness to irrigate the paddy field; *very difficult, difficult, not easy* and *easy.* Based on the easiness to irrigate four categories are formed; east , not easy, difficult and not difficult.

Trainings: The data on number of paddy production trainings attended by farm household heads during last two years were collected and based on those data two groups are formed: *not trained* and *trained.* All the trainings were conducted by DOA officials and some were held in farming locality while some were held in agricultural training centers.

Field demonstrations: Data on number of rice field demonstrations attended by farm household heads during last two years was considered. DOA has organized a series of field demonstrations to up lift the paddy yield during last few years in which new recommended practices were introduced to the farming communities. All the demonstrations were conducted by agricultural instructors and all of them were farmer field demonstrations and some were held in farming locality while some were held in agricultural training centers.

Farm visits: Data were collected from farmers that how many times the extension officers visited them within two consecutive seasons (2003/04 *maha* and 2004 *yala*) and average number of visits per season calculated.

Office visits: Number of office visits by household heads in two seasons (2003/04 *maha* and 2004 *yala*) was considered here and average number of office visits by household heads per season is calculated.

Listening to radio: Based on the information collected about household head's nature of listening to radio programs, three listening frequency categories are formed: *non-listener, irregular listener and regular listener*.

Reading newspaper: Three categories are formed based on the information collected about household head's nature of reading of news paper agricultural articles. Those categories are formed: *non-reader*, *irregular reader* and *regular reader*.

Viewing Television: Based on the information collected about household head's nature of viewing TV agricultural programs, three viewing frequency categories are formed: *non-viewer, irregular viewer and regular viewer.*

3.8 Analysis of Data

The relationship between level of adoption of three rice production practices and categories of each predictor variables are examined using contingency tables. Multinomial logistic regression was performed to develop models to predict the level of adoption for three different rice production practices. SPSS version 13.0 was used for data analysis.

3.8.1 Contingency Tables

Contingency tables are prepared for different level of adoption with the categories of independent factors. Chi squared tests are performed to test the hypothesis of independence of the different levels of the variables with adoption levels in contingency tables.

If two variables (row variable and column variable) have r and c number of levels respectively, we will get r x c contingency table, where r is the number of rows and c is the number of columns. Expected value of each cell can be computed by

$$E_{ij} = \frac{(R_i)(C_j)}{G} \qquad [1]$$

where E_{ij} is the expected value of the $(i,j)^{th}$ cell, R_i is the total of the i^{th} row, C_j is the total of the j^{th} column and the G is the grand total (Gomaz and Gomaz, 1984).

Chi square value can be computed by;

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(n_{ij} - E_{ij})^2}{E_{ij}} \qquad [2]$$

where n_{ij} is the observed value in i^{th} level of the row variable and j^{th} level of column variable or $(i,j)^{th}$ cell.

Then computed X^2 value is compared with tabular X^2 value with *(r-1)(c-1)* degrees of freedom. If the computed X^2 value is greater than the corresponding X^2 value at 0.01 level of significance, reject the hypothesis of independence.

3.8.2 Modeling technology adoption

The decision to adopt rice production practices can be explained as a discrete variable. Inherently the level of adoption has a multivariate nature. Attempting bivariate modeling excludes useful information contained in the interdependent and simultaneous adoption decisions (Dorfman, 1996). Therefore it is more appropriate to treat adoption of rice farm practices as a multivariate decision. Hence, regarding choice of models, the most important aspect of the decision framework is the multinomial response variable. Classical linear methods are inappropriate for discrete choices since they can lead to heteroscedasticity variances. This problem is typically remedied by using Maximum Likelihood Estimation (MLE), although heteroscedasticity in MLE is also a potentially serious problem leading to inconsistent estimators (Green, 2000). According to Wooldridge (2000), when heteroscedasticity is observed such models require more general estimation. However, such models are not often used in practice, since logit models with flexible functional forms in the predictor variables tend to work well.

The logit analysis is well-established approaches in studies focusing on the adoption of technology (Burton *et al*., 1999). In this study, based on the land extent in which rice production practices are applied and continuity of adoption, level of

adoption is computed. According to the level of adoption, three categories of outcome variable (Adopted, Partially adopted and Not adopted) were computed (see section 3.5). Since the dependent variable is discrete, the multinomial logistic analysis was undertaken to assess the factors associated with farmers' level of adoption in three different rice production practices separately.

The ratio of probability that an event occurs to the probability that it does not can be defined as odds.

$$Odds = \frac{probability(event)}{probability(no-event)} \qquad [3]$$

Then the logistic model can be written in terms of the log of odds.

$$\log\left[\frac{probability(event)}{probability(no-event)}\right] = g(x) \qquad [4]$$

where $g(x)$ is assumed to be linearly related to the predictor variables.

For this set of data the categories of the outcome variable, Y, are coded 0, 1 or 2. In three category model we have two logit functions: one for Y =1 versus Y = 0, and other for Y =2 versus Y = 0. Thus the group coded Y = 0 will serve as the reference outcome value. The logit of comparing Y = 2 to Y = 1 may be obtained as the difference between the logit of Y = 2 versus Y = 0 and the logit of Y = 1 versus Y = 0 (Hosmer and Lemeshow, 1989).

Let x_j be the predictors of i[th] variable, two logit functions can be denoted as

$$\ln\left[\frac{P(Y=1)}{P(Y=0)}\right] = g_1(x) = b_{10} + b_{11}x_1 + b_{12} + \ldots\ldots + b_{1j}x_j \qquad [5]$$

and

$$\ln\left[\frac{P(Y=2)}{P(Y=0)}\right] = g_2(x) = b_{20} + b_{21}x_1 + b_{22}x_2 + \ldots\ldots + b_{2j}x_j \qquad [6]$$

where b_{1j} and b_{2j} are the j^{th} coefficients for the logit of $Y = 1$ and $Y = 2$ respectively. ln in the natural logarithm. In this study $g_1(x)$ is the estimated log odds of adopting Rice Production Practices and $g_2(x)$ is the estimated log odds of partially adopting Rice Production Practices. Also $g(x)$ is assumed to be linearly related to the predictors.

According to the multinomial logit model, the probability of an individual rice farmer's level of adopting new production practices, given socio-economic and institutional characteristics can be specified as

$$P(Y=0) = \frac{1}{1 + e^{g_1(x)} + e^{g_2(x)}} \qquad [7]$$

$$P(Y=1) = \frac{e^{g_1(x)}}{1 + e^{g_1(x)} + e^{g_2(x)}} \qquad [8]$$

and

$$P(Y=2) = \frac{e^{g_2(x)}}{1 + e^{g_1(x)} + e^{g_2(x)}} \qquad [9]$$

The parameters associated with last category of each predictor variable are considered as reference category and they are redundant given the intercept term. Since the objective of the study is to assess the factors affecting the level of adoption, value of Not adopted category = 0 is used as the reference outcome category.

Wald Statistics:

The Wald statistic is used to test the coefficients for statistical significance. The ratio of the coefficient (B) to its Standard Error (SE), squared, equals the Wald statistic and it has the Chi square distribution (Norušis, 2003). The Wald statisitic for the regression coefficient is:

$$Wald = \left[\frac{B}{S.E._B}\right]^2 \qquad [10]$$

which has chi-square distribution with one degree of freedom.

The Wald is simply the square of the (asymptotic) t-statistic. If the observed significance level of the Wald statistics is small (less than 0.05), it is concluded that the parameter is different from zero. Parameters with significant positive coefficients increase the likelihood of being in that response category with respect to the reference category. Parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category.

Model Evaluation:

There are several statistics which can be used for evaluating the performance of a model.

1. **Likelihood ratio test**: The change in the likelihood value is used to determine how the fit of the model changes as variables are added to the model. Here we test the model against one in which all the parameter coefficients are 0. The chi square statistic is the difference between the -2 log likelihoods of the null and final model. Use the Model Chi-Square statistic to determine if the overall model is statistically significant. If the significance level of the test is less than 0.05, it is concluded that the final model is outperforming the null model. The likelihood ratio statistic is defined as

$$likelihoodratio = -2LL(null\ \mathrm{mod}\ el) - (-2LL(full\ \mathrm{mod}\ el)) \qquad [11]$$

2. The "**Percent Correct Predictions**" statistic is also another method of evaluating the model. Predictions are made based on the estimated probabilities of three dependent categories for each case. The higher the % Correct Predictions, the better the model

3. In multiple regression, R2 is an intuitive measure of how well the model predicts the values of the dependant variable. It is the proportion of the variance in the dependent variable, which is explained, by the variance in the independent variables. Unfortunately there is no such easily interpretable measure for logistic regression. But there are several other statistics (**Pseudo R^2 statistics**), which can be used for evaluating the performance of a model.

Two measures that attempt to quantify the proportion of explained variation in the logistic regression model are Cox and Snell R^2 and Nagelkerke R^2 (Norušis, 2003). They are similar in intent to R^2 in the general linear regression model of a continuous dependent variable and is given as

$$R^2_{CS} = 1 - \left[\frac{L(0)}{L(B)}\right]^{2/N} \qquad [12]$$

by Cox and Snell where L(0) is the likelihood for the model with only a constant, L(B) is the likelihood for the model under consideration, and N is the sample size. The problem with this measure for logistic regression is that it cannot achieve a maximum value of one.

Nagelkarke proposed a modification of the Cox and Snell R^2 so that the value of 1 could be achieved. The Nagelkerke R^2 is

$$R^2_N = \frac{R^2_{CS}}{R^2_{\max}} \qquad [13]$$

where $R^2_{\max} = 1 - [L(0)]^{2/N}$ [14]

3.9 Limitations of the study

The ability of generalizing the results of this study to other geographic areas is restricted due to the following factors:

1. The study area is in dry zone where farmers are involved in paddy cultivation under major irrigation. So the study does not represent the farmers in wet zone and intermediate zone and also does not represent the farmers involved in paddy cultivation under different other irrigation systems such as minor irrigation and rain fed.
2. Farmers in the study area belong to one ethnic group, Sinhalese: it does not include all the ethnic groups involved in farming.
3. Farmers often responded inconsistently to some of the questions asked in the interview, e.g., number of field demonstrations attended.