CHAPTER 3

Materials and Methods

3.1 Site of Study

Chom Thong District, Phrao District, Saraphi District and San Pa Tong district are the main planting areas of longan in Chiang Mai province. In terms of planted area, Chom Thong District is the largest longan framing region, however, it yielded less output than Phrao and San Pa Tong Districts due to its relatively lower productivity per rai. In terms of output, Phrao has been the largest producer and is also where the longan planted area has expanded rapidly from 5,531 rai in 1999 to 34,151 rai in 2008 (Department of Agricultural Extension, 2009).

Phrao District is one of the districts in the northern part of Chiang Mai Province. It is located in the coordinate 524,000 E 2,135,000 N., approximately 90 kilometers from Chiang Mai City with the area of 2,021 square kilometers. The area is lowland surrounded by upland and highland areas but the highlands are predominate. Generally, there are 3 types of climate with averagely 1,200 millimeters of rain throughout the year, while the average minimum temperature is 13 ˚C and the maximum is 35 ˚C. The location for the present research is shown in Figure 8.

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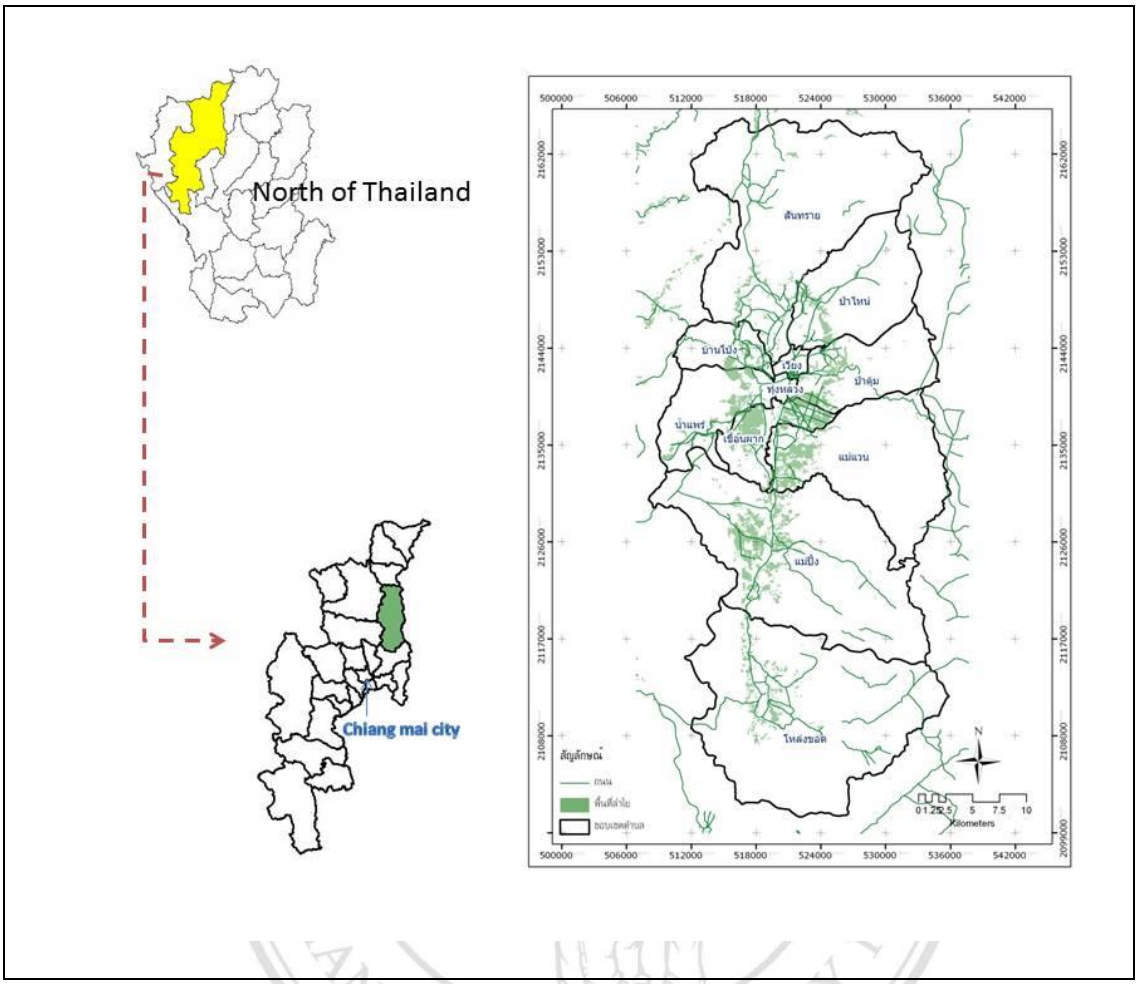

Figure 8 Location of research site, Phrao District, Chiang Mai Province.

3.2 Conceptual Framework for Research

To make the system or the instrument for longan plantation assessment in this research, the researcher used various kinds of integrations; consisting of Geographic Information System (GIS), Remote Sensing Analysis, and the participation between the specialists and experienced longan growers by using the questionnaire and focus-group interview. Moreover, the information got from the field survey was also used to make a survey in the real area in order to make further significant databases. Therefore, this research might be a new possible method to develop tool or system that supports the decision of longan plantation operators with high efficiency as well as for facilitates longan price negotiation or agreement among the growers, buyers and exporters.

The concept of this research can be divided into 3 important parts as follows: classification of longan production system, spatial estimation of longan in the target area through spatial database analysis. The result will be in Land Mapping Unit (LMU)

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and used to define sample group in the process of sample photographing of longan fruit in canopies' data collection, which is part of the photo analyzing process. This process is used to classify what happened in the photo between longan and the parts which are not longan in order to find out the ratio of longan area and to describe the possibility to develop it to be real finally. Moreover, LMU is also used to choose all kinds of sampled group of longan growers in order to develop a questionnaire related to longan production as well as to choose the sampled groups for focus-group interview for sharing opinions. The results from this process and the prior process will be used as input data for modeling a BBN. The estimations of longan production from many situations and the results from BBN will be used further to create the Longan Yield Estimation Map in Phrao District, Chiang Mai Province. The workflow of the process is illustrated in Figure 9.

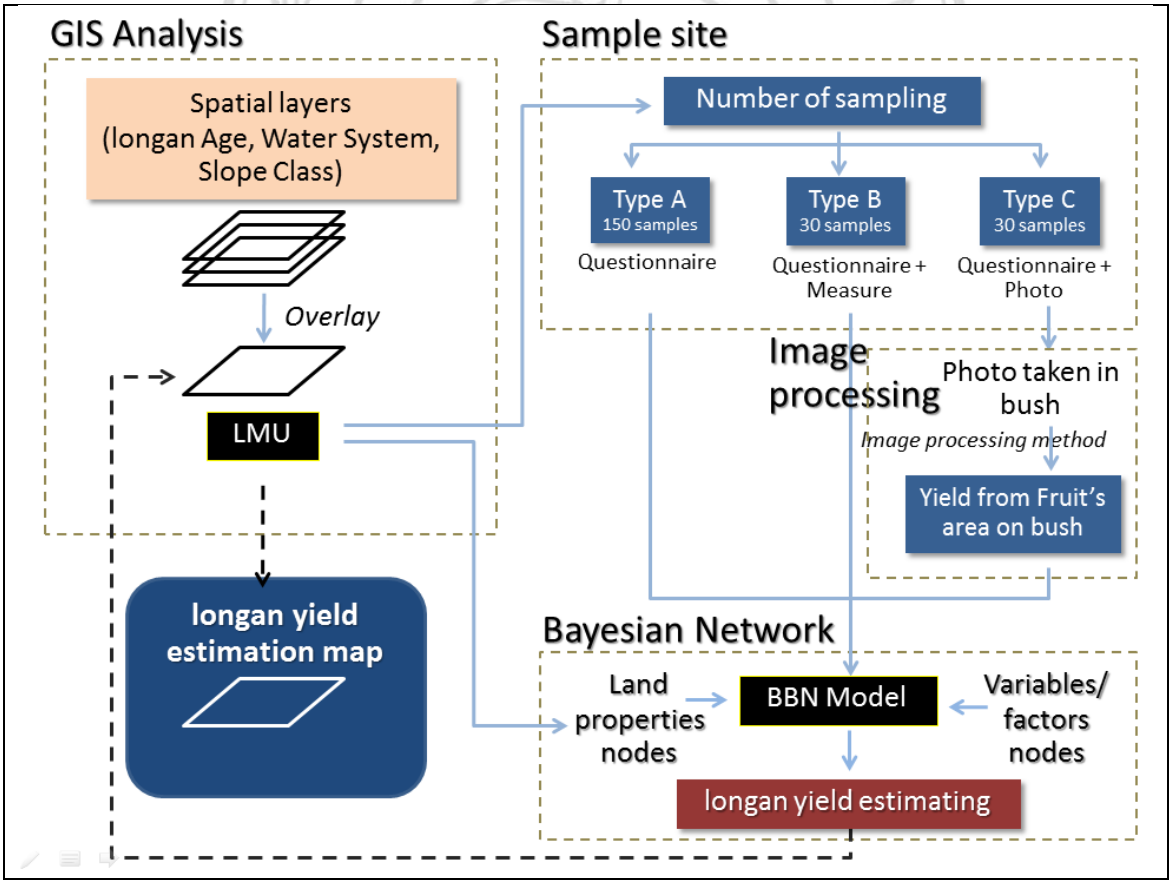

Figure 9 Conceptual framework of the research.

3.3 Classification of Longan Production System

Spatial database is the crucial part of physical description to make a better understanding of the area. The database can be used as both reference data and primary data for analyzing in order to create the new information according to the subjective. Furthermore, it is used as a map describing spatial distribution showing the correlation of resources linking towards longan production. So it is imperative to collect necessary information for the analysis as well as update the information to be currently correct and with details to meet the need for the spatial analysis, especially the classification of longan management systems resulted from the resources' changes in the area. In reality, there are many different limitations in a land that affect the different longan production performance. Therefore, it is necessary to make land Management Unit (LMU) in the area assuming that in each LMU longan trees are grown similarly, and LMU is beneficial for choosing samples of longan orchard randomly in order to accumulate the information to construct a model and test it as well as assessing longan in each management unit. The working processes are as follows:

1. Collecting, inputting and analyzing data to make the basic geodatabase such as road, waterway, condition of landscape, soil, weather and water resource, etc.

2. Classifying longan grown area using color aerial image, 1:4000 map scales, to find the planting site and the age of longan orchard. The information will be analyzed together with the above land and water resource information.

3. Performing overlay analysis in GIS system in order to generate land Management Unit (LMU).

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3.4 Farmers and Orchards Sampling

Totally 150 samples of longan plantation area were randomly identified covering all longan plantation systems. Questionnaire was used to get the information about each longan plantation, and focus-group interview was arranged to draw the opinions from experienced persons. All this information will be utilized to determine the Conditional Probability (CP) in the process of constructing BBN Model.

Questionnaires with guidelines for in-depth interview and focus-group interview with the longan grower were used in this research. The questionnaire is designed to gain

a comprehension of the production system, especially the factors and form of management utilized in each orchard which significantly affect production performance longan. The required information can be separated into 4 parts as follows:

Part 1: General background information of the grower.

Part 2: Cultivated area, output and distribution.

Part 3: Factors of production and management.

Part 4: Income earned from longan production.

For general background data, the analysis and information descriptive statistics including frequency and percentage.

Furthermore, 30 random samples of longan plantation area in each LMU were identified for conducting a field survey in the process of image collection. The images taken were processed for analysis of longan fruit quantity appeared in the canopy with remote sensing technique in order to separate the fruit bunches from other plant parts.

3.5 The Quantity of Longan Fruits in the Canopy

The quantity of longan fruit in the bush before harvesting is an important information for the validity of BBN Model. In this process, an image of each longan canopy is taken under region of interest (ROI), and the visible image will be analyzed by remote sensing technique which is an effective method used in many researches such as classification of orange fruit with RGB image (Bulanon et al., 2009; Okamoto and Lee, 2009), classification of apple fruit estimation (Stajnko et al., 4) and the research on crop density estimation with RGB Image (Pan et al., 2007).

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For the field survey, the samples of longan orchard will be chosen in order to record the quantity of output. The selection will be appropriately randomized considering from the form of the canopy which can be taken a photo. The site selection for the present research was made on the basis of overall area coverage as well as the permission from the owners of the sampled trees. After the sample orchard was identified, two sample trees were chosen randomly for taking photos. For each sample tree 6-12 photos will be taken; the covering 2-4 sides out of 3 parts of the canopy namely the bottom, the middle and the top depending on the size and the distance of each canopy since most of the old longan trees have the canopy close to those of the

others making it quite difficult to take photo of all 4 sides. In addition, a digital camera was chosen for use in this process, taking photos in RGB mode and in JPG format. Consequently, the images were classified by image analysis for further interpretation/inferance. The details of this research process are illustrated in Figure 10.

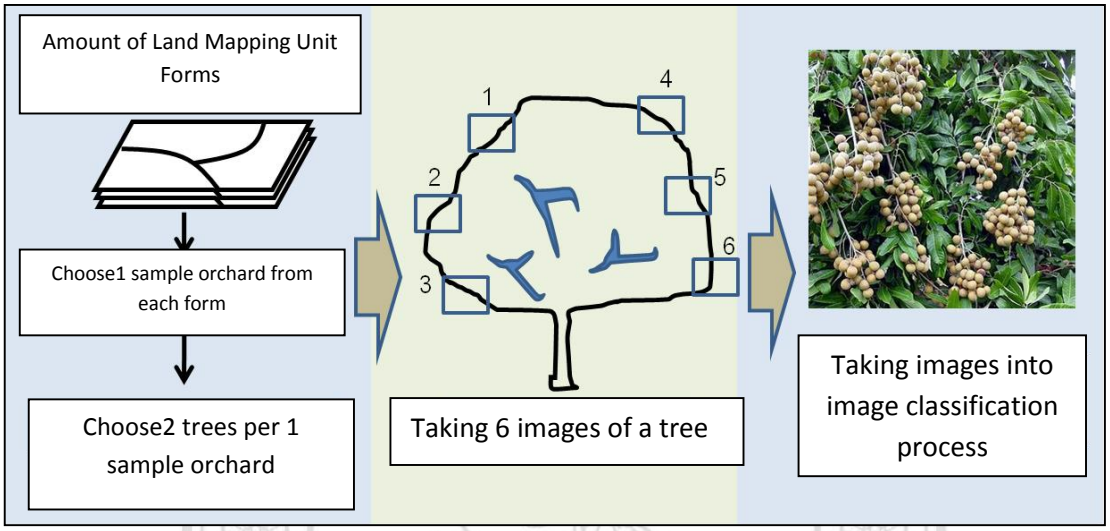

Figure 10 Process of recording image of sample longan tree.

In the image classification process, the images will be prepared to be readily used in the program and then transformed into several formats to define the symbol that can specify the area of longan fruits out of other plant parts. After that, the area of fruits in each image will be classified and subject to coding in terms of number. The workflow of the process is shown in Figure 11.

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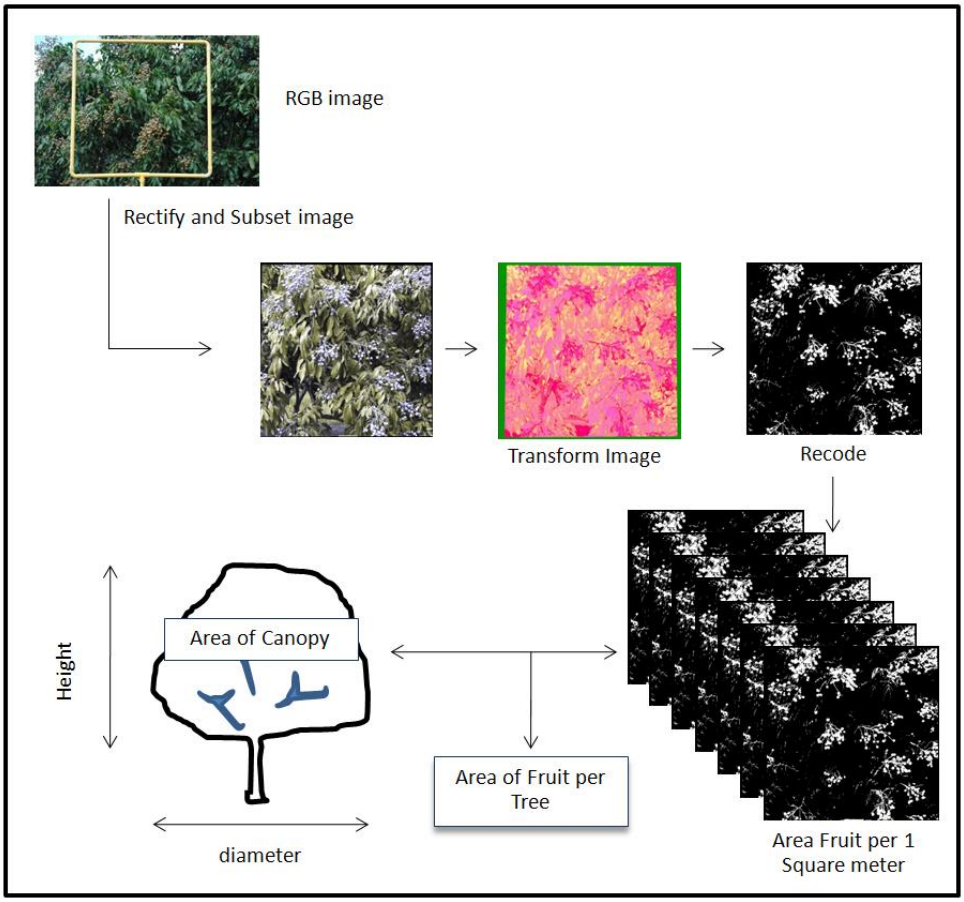

Figure 11 Process of digital image analysis.

The results of image analysis will be processed further to make BBN Network Model.

3.6 Longan Yield Model by BBN

The variables determining longan performance in BBN, were defined after collecting secondary data or inquiring the specialists and experienced longan farmers including collecting data from fieldwork in the selected plantations. The Netica program was used in this research to facilitate the development of a BBN Model. This model was presented to the specialists and the experienced farmers for their opinions/comments in order to improve the model to closely represent the production situation of the longan growers in target area, as there exited no data to find the probability of accurance variables in input and output nodes. Nevertheless, the probability value obtained from making a random to find Conditional Probability (CP) is done with the aim to use it as a guideline for survey and gathering the data to define variables for the assessment of longans. The process of sampling needs to cover the variance of the variables in the

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target area because each variable will affect the variance of longans and each variable has different means for data collection. Figure 12 is an example of the BBN Model, generated from Netica software package.

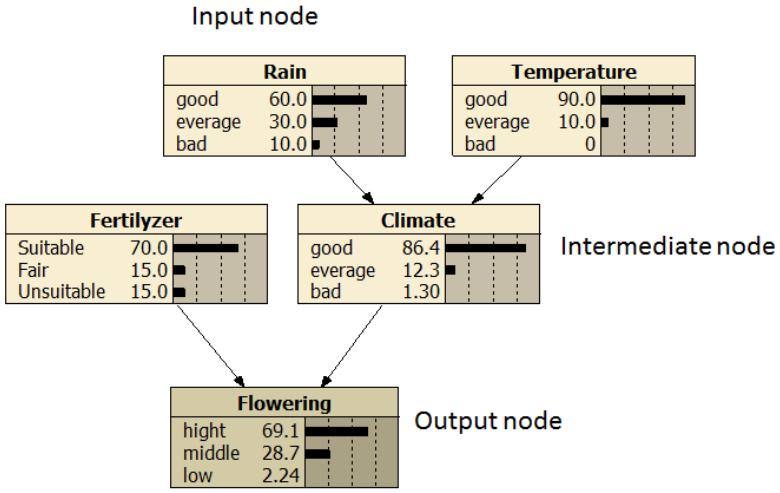

Figure 12 Parts of the BBN model from Netica software.

In BBN Model, Conditional Probability (CP) of output node depends on the probability value of input node. The greater the number of input nodes are, the more complicated computation of Conditional Probability will be and more time used. However, Cain (2001) has suggested several ways to find the value no matter the data having continuous value or interval value. Furthermore, the Netica Program also takes part in calculating the Conditional Probability Table (CPT). The user may change the probability values in an input node, and the program will automatically calculate CP value in the output node. The processes of developing a BBN Model are as follows.

From these discussions with experts, the flowchart and BBN model were improved by checking each factor with conditional probability (CP). Table 1 shows the various ways the data can be collected for each of these factors.

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Table 1 Factor in the creation of the BBN model

Level 4	Level 3	Level 2	Level 1	Method of Collecting the Data
Yield of longan (surveys)	Canopy Size (surveys)		Tree Spacing Species Branch Trimming Age of longan Tree	Surveys, Interviews Interviews Surveys, Interviews Interviews
	Longan Tree Health	Plant Nutrition (estimation)	Soil Fertility Fertilizing	Estimated from the Soil Database Interviews
		Management of the Land (interviews)	Management of Diseases and Pests Herbicides	Interviews Interviews
			Watering Amount	Interviews Opinions of Experts
	The Amount of Flowering and Fruit-Setting	Flowering Stage	Temperature Chemicals Used to Trigger Flowering	Surveys and Estimations Interviews
		Fruit-Setting	The Amount of Fruit Setting	Technique of Classifying from Images

3.7 Model Testing

The objective of model analysis is to specify the probability of the variable related to the products at various levels. The analysis will be done repeatedly until the result is satisfied for supporting the decision on longan assessment in the area of each management unit. The analysis result will show the probability levels of variables which used to be the objective for longan imitating in each scenario.

Error test of a model error was based on RMSE (Root Mean Square Error) (equation 2) criteria by estimating the quantity of longan fruits using the sample data derived from observation to compare the estimated yield with the real yield in each sample area, and then specify the error as a percentage. When RMSE value is close to zero the model will be close to reality. The discrepancy between error of the estimated output and the actual output is found from in equation 3

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$$RMSE = [\, N^{-1} \sum_{i=1}^{n} (p_i - o_i)]^{0.5} \text{.....(2)}$$

Where: p_i : Model Yield

o_i : Observed yield

N : number of obsevation

(Timsina and Humphreys, 2006, Buddhaboon, 2011)

The error of the estimated product and the real product is shown in equation 3.

$$Error\ (\%) = \frac{Yield_p - Yield_a}{Yield_a} * 100 \text{.....(3)}$$

Where: $Yield_p$: Model Yield,

$Yield_a$: Observed yield

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