TECHNICAL EFFICIENCY OF GROUNDNUT PRODUCTION IN CENTRAL REGION OF MYANMAR

SOE SOE WIN

MASTER OF SCIENCE (AGRICULTURE)

IN AGRICULTURAL SYSTEMS

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A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN

PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

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ประสิทธิภาพทางเทคนิคของการผลิตถั่วลิสงในเขตภาคกลางของประเทศเมียนมาร์

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บทคัดย่อ

การศึกษานี้มุ่งเน้นถึงประสิทธิภาพทางเทคนิคของการผลิตถั่วลิสงในเขตพื้นที่การผลิตหลักของประเทศเมียนมาร์ โดยมีวัตถุประสงค์อย่างจำเพาะในการศึกษาดังต่อไปนี้; (1) เพื่อศึกษาถึงลักษณะของระบบการผลิตถั่วลิสงในเขตภาคกลางของประเทศเมียนมาร์, (2) เพื่อประมาณค่าพรมแดนการผลิตของประสิทธิภาพทางเทคนิคของการผลิตถั่วลิสงในเขตภาคกลางของประเทศเมียนมาร์, (3) เพื่อทราบปัจจัยที่มีผลต่อความไม่มีประสิทธิภาพทางเทคนิคในการผลิตถั่วลิสงสำหรับผู้ปลูกในเขตภาคกลางของประเทศเมียนมาร์ โดยทำการศึกษาในพื้นที่มณฑลมันดาเลย์และมณฑลมะเกว ซึ่งเป็นแหล่งการผลิตถั่วลิสงที่ใหญ่ที่สุดของประเทศเมียนมาร์ โดยการศึกษาครั้งนี้

ได้ทำการสำรวจข้อมูลระดับฟาร์มในปีการผลิต 2550-2551 จากตัวอย่างทั้งหมด 269 ตัวอย่าง, 118 ตัวอย่างจากมณฑลมันดาเลย์และ151 ตัวอย่างจากมณฑลมะเกว

การวิเคราะห์ข้อมูลแบ่งออกเป็น 2 ส่วน คือ การวิเคราะห์เชิงพรรณนาเกี่ยวกับสถิติพื้นฐานทั่วไปเพื่อบรรยายถึงระบบการผลิตถั่วลิสงและลักษณะทางเศรษฐกิจและสังคมของครัวเรือน และการวิเคราะห์เชิงปริมาณ โดยการวัดประสิทธิภาพทางเทคนิคแบบเส้นพรมแดนเชิงเฟ้นสุ่ม (stochastic frontier) เพื่อจะตรวจดูประสิทธิภาพทางเทคนิคของการผลิตถั่วลิสง การวิเคราะห์โดยใช้เส้นพรมแดนเชิงเฟ้นสุ่ม (stochastic frontier) ถูกแยกวิเคราะห์ออกเป็น 2 ส่วน ในพื้นที่มณฑลมันดาเลย์และมณฑลมะเกว เนื่องด้วยเทคโนโลยีที่ใช้สำหรับการผลิตถั่วลิสงใน 2 มณฑลนั้นแตกต่างกัน

ผลการประมาณค่าพารามิเตอร์ความน่าจะเป็นสูงสุดของพรมแดนการผลิตจากสมการพรมแดนการผลิตในรูปแบบ Cobb-Douglas พบว่าคุณภาพของดินเป็นปัจจัยที่มีผลต่อผลผลิตต่อเฮคเตอร์ในทั้งสองพื้นที่ คุณภาพที่ดีของดินสามารถที่จะเพิ่มผลิตผลสำหรับการผลิตถั่วลิสงได้ทั้งสองพื้นที่ นอกจากนี้ ยังพบว่า เฉพาะในมณฑลมะเกว ขนาดพื้นที่การผลิตมีผลกระทบที่เป็นบวกต่อผลผลิตต่อเฮคเตอร์ที่ระดับนัยสำคัญ 0.01

ผลการศึกษายังชี้บอกว่า มีความแปรปรวนอย่างมีนัยสำคัญในประสิทธิภาพทางการผลิตระ

หว่างครัวเรือนตัวอย่างในทั้งสองมณฑล โดยมณฑลมันดาเลย์ระดับประสิทธิภาพทางเทคนิคเฉลี่ยมีค่าเท่ากับ 89 % ในช่วงความแปรปรวนจาก 45% ถึง 97% ส่วนมณฑลมะเกวระดับประสิทธิภาพทางเทคนิคเฉลี่ยมีค่าเพียง 73% ในช่วงความแปรปรวนจาก 16% ถึง 94% ผลลัพธ์เหล่านี้ชี้ให้เห็นว่า ภายใต้ทรัพยากรและเทคโนโลยีที่มีอยู่เกษตรกรยังสามารถเพิ่มประสิทธิภาพทางเทคนิคในการผลิตถั่วลิสงหรือผลผลิตได้อีก 11% สำหรับมณฑลมันดาเลย์และ 27% สำหรับมณฑลมะเกว ถ้าเกษตรกรใช้ทรัพยากรที่มีอย่างมีประสิทธิภาพเพิ่มขึ้น

ส่วนผลการศึกษาปัจจัยที่มีผลต่อความไม่มีประสิทธิภาพทางเทคนิค พบว่า ในมณฑลมะเกว ระดับของการศึกษาของหัวหน้าครัวเรือนซึ่งเป็นผู้ทำการตัดสินใจหลักในระดับครัวเรือนและการเข้าถึงเครดิตของครัวเรือนมีผลกระทบที่เป็นบวกต่อประสิทธิภาพทางเทคนิคของการผลิตถั่วลิสงที่ระดับนัยสำคัญ 0.01 ขณะที่อายุของหัวหน้าครัวเรือนและการมีอยู่ของกำลังแรงงานในครัวเรือนมีผลกระทบที่เป็นลบต่อประสิทธิภาพทางเทคนิคที่ระดับนัยสำคัญ 0.10 และ 0.05 ตามลำดับ

จากการศึกษาครั้งนี้ นโยบายที่น่าส่งเสริมสำหรับเพิ่มการผลิตผลของการปลูกถั่วลิสงคือ โครงการปรับปรุงคุณภาพที่ดินเพื่อการเกษตรและสนับสนุนเกษตรกรให้มีการลงทุนเพื่อปรับปรุงที่ดินของตนเอง นอกจากนั้นการลงทุนในการศึกษาขั้นพื้นฐานในเขตชนบทก็เป็นสิ่งที่ควรทำเพราะว่าการเพิ่มการลงทุนทางมนุษย์นั้นจะสามารถเพิ่มศักยภาพของเกษตรกรในอนาคต ให้มีความสามารถในการจัดสรรและเลือกปัจจัยการผลิตที่เหมาะสมได้ดียิ่งขึ้น นอกจากนี้

รัฐบาลยังควรจัดให้มีโครงการสินเชื่อสู่ชนบทควบคู่ไปกับการบริการด้านส่งเสริมเทคโนโลยีการผลิตสำหรับเกษตกรผู้ปลูกถั่วลิสงเพื่อที่จะปรับปรุงการเข้าถึงปัจจัยการผลิตด้วย

Thesis Title: Technical Efficiency of Groundnut Production Systems in Central Region of Myanmar

Author: Mrs Soe Soe Win

Degree: Master of Science (Agriculture)

Thesis Advisory Committee: Lecturer Dr. Jirawan Kitachaicharoen Chairman
Lecturer Dr. Yaovarate Chaovanapoonphol Member

Abstract

This study focuses on technical efficiency of groundnut production in main production areas of Myanmar. The specific objectives of this study are as follows: (1) to characterize the groundnut production systems in central region of Myanmar, (2) to estimate stochastic frontier production for technical efficiency of groundnut production in central region of Myanmar, and (3) to identify factors affecting technical inefficiency in groundnut production for growers in central region of Myanmar. Mandalay and Magway divisions were selected as the study areas because they were the largest groundnut production areas of Myanmar. Farm-level survey for the 2006-2007 crop year with 269 samples in total, 118 samples from Mandalay and 151 samples from Magway, was carried out for this study.

The analysis was divided into 2 parts, descriptive analysis using a basic statistical approach to describe the groundnut production system and socio-economic characteristics of farm households and quantitative analysis using stochastic frontier production method to examine technical efficiency of groundnut production. The stochastic frontier analysis was performed separately for two divisions; Mandalay and Magway, as technology used for groundnut production in these two divisions were different.

The results of the maximum likelihood parameter estimates of the stochastic production frontier from Cobb-Douglas frontier functions for both Mandalay and Magway divisions indicate that quality of soil was the significant factor that affected the yield per hectare in both regions. Good quality of soil for groundnut production can increase groundnut yield in both areas. In Magway division, production area showed positive effect on the yield per hectare at the 0.01 significant level.

The results also indicate that there was significant variation in production efficiency among sample households in two divisions. The average technical efficiency level was 89 % with the range from 45% to 97% in Mandalay and was 73% with the range from 16% to 94% in Magway. These results indicate that under existing resources and technology, farmers could increase their technical efficiency or output by 11% for Mandalay and 27% for Magway through better use of available resources.

The findings from technical inefficiency equation showed that in Magway, the level of education of household heads as the main decision-makers at family level and access to credit each has a positive impact on technical efficiency of groundnut production at 0.01 level of significant whereas age of household head and availability of labor force has a negative impact on technical efficiency at 0.1 and 0.05 level of significant, respectively.

The policy implication for increasing groundnut production yield based on this study results should be a program to improve the soil quality and encourage farmers to improve their soil quality. Also, an investment in education in rural areas should be performed because increase in human capital will increase the potential of future farmers as education is expected to increase their capability in resource allocation and selection of appropriate inputs. In addition, government should establish the rural credit program with extension service for groundnut farmers to improve better access to external inputs.

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Soe Soe Win

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

1.1. Background

Agriculture plays a crucial role in the country of Myanmar with about 75 percent of its total population residing in rural areas. It is a mainstay of Myanmar's economy. Over 65 percent of foreign exchange earnings come from agriculture. As such, future economic development will also be based upon agricultural production. The total cultivated area under various crops cultivation is about 11.33 million hectares (i.e.16.9 percent of the total area) (MOAI, 2008). Due to variations in agro-ecological conditions, there are seven major crops grown in Myanmar. Rice is the major crop and 57 percent of the total cultivated area was under rice production in 2006-07. Other important crops are oilseed crops, legumes, beans and sugarcane.

Among these crops, oilseed is the second most important crop after paddy rice in the diet of the people of Myanmar. Oilseed crops comprise around 16 percent (8.4 million hectares) of total sown area of 21.98 million hectare, for agriculture in 2004-2005 (CSO, 2006). The most important oil crops, based upon a three year average (1999/2000-2002/03), are sesame (53 percent of the total area), groundnut (22.2 percent of the total area) and sunflower (18.8 percent of the total area) (Aye Aye Mon, 2004). The edible oils traditionally consumed are groundnut and sesame oil. Sesame oil is estimated to account for between 5 percent and 10 percent of total edible oil consumption, while groundnut oil accounts for the remaining 90-95 percent. Hence, groundnut is one of the most important oilseed crops in Myanmar.

The mean groundnut productivity in Myanmar is approximately 1145 kg per hectare in the rainy season and 1573 kilogram per hectare in the post rainy season. In 2004-05, the average groundnut yield in Magway division (1478.08) kg per ha) was about 36 percent higher than the average yield in Mandalay (1161.84) kg per ha) (CSO, 2006).

The largest groundnut crop production area was Mandalay Division and Magway Division, with 149,639 hectares and 120,648 hectares in cropping seasons.

Groundnut area in this region is predominantly grown under rain fed conditions with different levels of production across divisions (CSO, 2006).

Table.1.1 Sown area and yield of groundnut production in Myanmar.

Year	Sown area(000,ha)	Yield (kg/ha)
2000-01	569	1261.28
2001-02	581	1284.00
2002-03	655	1350.62
2003-04	685	1394.66

Source: Central Statistics Organization, 2006

Oilseeds play a vital role in the edible oil consumption for the Myanmar population. People in Myanmar are suffering from a serious edible oil shortage. Myanmar's annual average production of edible oils, mainly groundnut and sesame oils is estimated at about 500,000 tones. The demand for edible oil in the country is on the increase and palm oil is imported from neighboring countries to bridge the gap between the supply and demand. Based on the existing population, this average around 160,000 tons per year of oil palm is imported by neighboring countries (Aye Aye Mon, 2004).

In Myanmar, technology transfers mechanisms are generally slow and limited resources available for research and development are mostly utilized for food crops. Thus, research and development programs for continuous improvement in technology generation and its adoption are obviously important to be balance in demand-supply equation. Myanmar’s edible oil crop is set to expand in order to increase productivity and quality. This will be supported by technical assistance from research fields and will improve oil crop production by expanding the availability of improved seeds and genetic material to oil crop farmers.

1.2. Rational of study

Myanmar is suffering from a serious edible oil shortage and the government is unwilling to allocate scarce and valuable foreign exchange to import such oils. To respond to this issue, the Ministry of Agriculture and Irrigation (MOAI) has laid down the three main objectives to improve the agricultural sector. These are: **1)** increase of crop production, **2)** meet the needs of local consumption and **3)** assist rural development through agricultural development (MOAI. 2006). To fulfill the state's objective, oilseed crop production, as the second important food of the country, needs to be increased.

Even though oilseed production in Myanmar has been increasing, it is still insufficient for domestic consumption. 16 million tons of edible palm oil (equivalent to 24 percent of total oilseed production) has been imported annually, mainly from Malaysia, to fulfill the domestic requirement (MOAI, 2005). However, the country implemented the plan for autonomy in oil crops production as one of national goals for the increase in production area and yield per hectare of oil crops to substitute imported palm oil since 1989.

Among the oilseed crops, groundnut is the highest oil-yielding crop per hectare. At the current level of production, production costs of groundnut are gradually getting higher due to the high seed cost. The profitability and quality of groundnut seeds are an important consideration for farmers in growing groundnut. Consequently, the important elements (production technologies and operational constraints) need to be considered when aiming to increase productivity of groundnut, which will finally raise the farm income for growers. Thus, technical efficiency becomes a major issue in groundnut cultivation in Myanmar.

A few studies on technical efficiency towards the improved production efficiency of agricultural systems in Myanmar are available**.** Therefore**,** this study will examine the groundnut production system and measure the level of technical efficiency of groundnut production and factors affecting technical inefficiency. It will help to find a way to improve groundnut production at the farm level and finally the oil production at the national level. Therefore, this study is expected to enhance rural incomes in Myanmar, where 75% of the population lives and depends on agriculture for its livelihood, as well as improve national food security.

1.3. Objectives of the study

This study focuses on technical efficiency of groundnut production across sections of farmers and among farmers categorized by social characteristics and other relevant characteristics in main groundnut production areas of Myanmar. The specific objectives of this study are as follows:

1. To characterize the groundnut production systems in central region of Myanmar.
2. To estimate stochastic frontier production for technical efficiency of groundnut production in central region of Myanmar.
3. To identify factors affecting technical inefficiency in groundnut production for growers in central region of Myanmar.

1.4. Usefulness of the study

This study contributes to the productivity level of efficiency in groundnut production of farmers from the central region of Myanmar. This study is expected to benefit both policy makers and researchers in improving farm production compared to other areas. Researchers will be provided systematic documents and methods for estimating efficiency. The result estimated by quantitative method to answer the question and identified factors affecting on groundnut production would have policy implication.

This study will first focus on individual farmers and secondly on the national effort to improve production. This is likely to help extension officers predict crop management needs, objectives and communicate new production technologies to farmers to have a high adoption rate in a resource efficient manner of crop productivity.

This study aims to enhance farmers’ efficient use of land and other resources through innovative production systems in the central region of Myanmar and enhance understanding of factors affecting groundnut production. It will be appropriate good basic information new technologies for groundnut production systems. Poor farmers will have their yield and income increased by using new production techniques developed from the results of this study. Thus, it could be improve the accuracy, viability, reliability and feasibility of groundnut production systems in Myanmar. This will increase groundnut production and also boost Myanmar's edible oil sector.

Moreover, from this study, expected outcomes will describe gaps between the potential outputs and actual output from groundnut production system and technical efficiency gains that can be made to reduce the size of this gap. This study will have important ramifications to the economy of the country in general and living standards for all farmers in the particular study area. In brief, the results from this study are expected to identify factors influencing technical efficiency, characterize the factors associated with changes in productivity and outline the possible influence of these factors on the management of groundnut production systems. Therefore, this will serve as a basis for the future studies of groundnut production systems in Myanmar. In addition to, it may help agricultural policy makers formulate strategies to increase agricultural productivity.

CHAPTER II

LITERATURE REVIEW

2.1.Groundnut Production Systems in Myanmar

Groundnut production was an important production in Myanmar. About 75 percent of production comes from Central Myanmar, mainly Sagaing, Magway and Mandalay divisions (Aye Aye Mon, 2004). Groundnut is grown in a year throughout the country, however, Mandalay division and Magway division are grown the popular largest production areas in Myanmar.

The production of food crops in Myanmar is sufficient to meet domestic requirement, except oilseed crops. The total edible oil consumption is based on the average consumption rate of 4.5 viss per person. Groundnut provides 45 percent of the edible oils, followed by sesame and sunflower.

In Myanmar, the sown and harvested area of groundnut gradually increased from 1990 to 2000(Table 4.2). After 2000, rate of increase was significantly high and 756 thousand hectare was cultivated in 2006-2007.

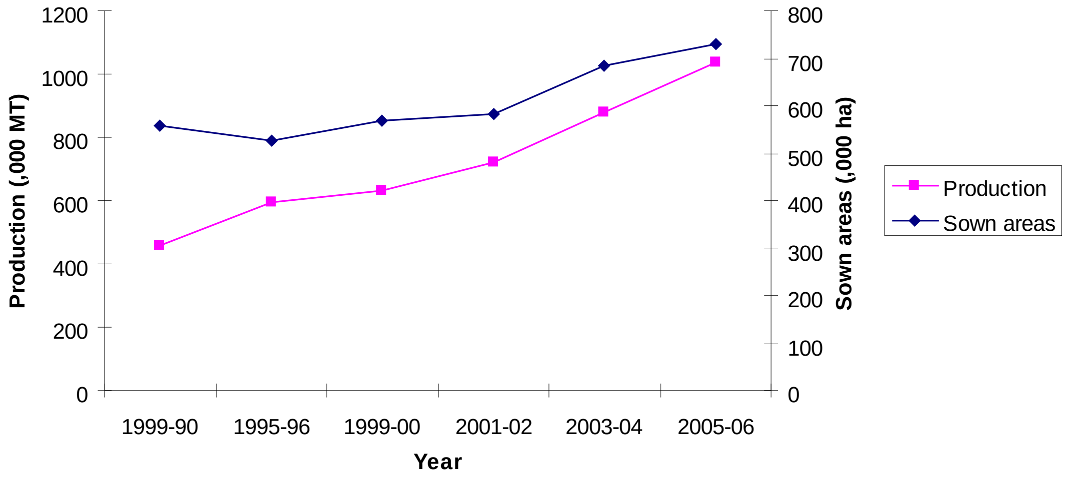


Figure 2.1The sown area, harvest area and production of groundnut in central region of Myanmar.
Source: Central Statistical Organization, 2006

The productivity of groundnut in Myanmar is still low compared to the Asian countries. The national average yield per hectare has been about 560.20 kg per hectare in 2004 (CSO, 2006). Magway and Mandalay division, major growing areas in Myanmar, during the rainy season in 2004-05, an average yield per hectare was 598.75 kg per hectare for Magway and 470.38 kg per hectare for Mandalay(CSO, 2006).

Thus, groundnut is one of the most important oilseed crops which have been grown both in both rainfed and irrigated areas and there is a need to conduct research on technology transfer mechanisms to improve production.

2.2. Concepts of Technical Efficiencies

Agricultural productivity can be defined as a measure of the efficiency with which an agricultural production system employs land, labor, capital and other resources. Among them, land is the primary and most important factor. Due to the rapid increase in population pressure in recent decades, special attention has been focused on land productivity. It is mainly by increasing yield per unit area that the growing need for food can be met. Productivity may be raised also by replacing the pattern of productivity by more intensive systems of cultivation or by cultivating higher valued crops. Sharif (1996) stated that in developing countries, where land is relatively scarce and labor abundant, yield per unit area is more important while in countries where land is abundant and labor is scarce, yield relative to labor invested may constitute a more suitable measure for determination of agricultural productivity.

Agricultural technologies are vital to agricultural development, although it cannot be transferred directly as is commonly done for industrial technology. Also it can’t be transferred from one region to another region because of its biological nature and sensitive change to different ecological conditions. Each country has developed local agricultural research and is trying to find appropriate technologies for their local conditions. In addition, new technologies should be transferred through extension workers to the farmers. As a result, the role of extension workers becomes more important in the diffusion of technology to the farmers in agricultural research.

Technical efficiency is defined in terms of distance to a production frontier. Technical efficiency is defined as the ability of a firm to obtain maximal output from a given set of inputs. A simple ratio of output to input provides a measure of productivity. An increase in this ratio from one time period to another demonstrates improvement in the efficiency of the process. One firm is more technically efficient if it produce higher than another firm at the same level of input usage and technology.

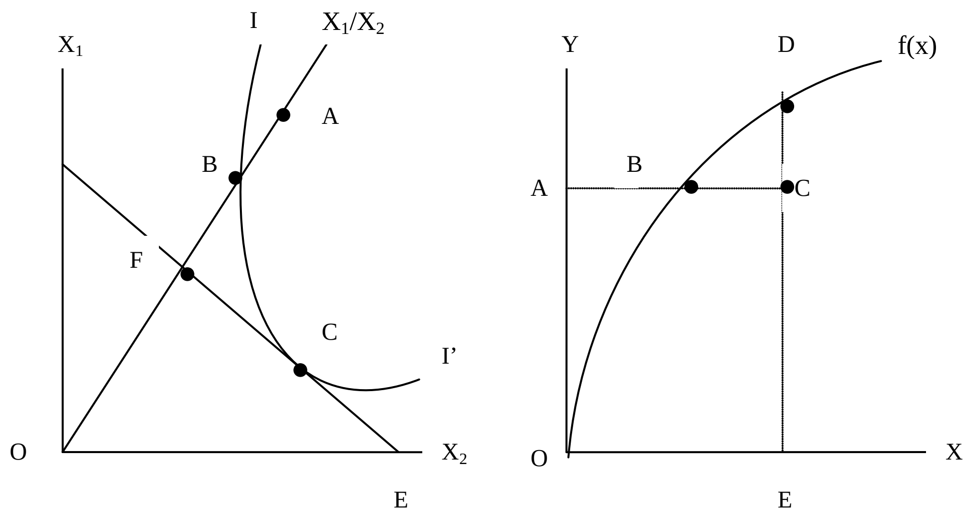
Technical efficiency is a purely physical notion that can be measured without resource to price information and without having to impose a behavioral objective on producers, cost, and revenue. Technical efficiency is a measure of how well the individual transforms inputs into a set of outputs based on a given set of technology and economic factors (Kumbhakar and Lovell, 2000).

There are two concepts in measuring technical efficiency; input-oriented measures and output-oriented measures. The measurement of technical efficiency assumes that multiple inputs are used to produce a single output, and output-oriented technical efficiency is defined relative to a production frontier.

Technical efficiency in terms of microeconomics of production is the maximum attainable level of output for a given level of production inputs, given the range of alternative technologies available to the farmer. A technically efficient firm produces the maximum possible output from the inputs used, given locational and environmental constraints, and it minimizes resource inputs for any given level of output (Kibaara, 2005).

Efficiency analysis is conducted not only at the farm level but also at the household level of a country. Technical inefficiency obtained in this manner is a *relative* measure where the production frontier is defined by the farmers' plots included in its estimation. The determinants of inefficiency are then analyzed using farmer-specific explanatory variables that are expected to influence it.

For the input-oriented measures, Farewell (cited by Coelli. Tim., 1998) illustrated that the use of two inputs (X_1 and X_2) to produce a single output (Y) allows a particular technology to isoquant. In Figure 1(a), the isoquant II' represented fully efficient firms. If firm produce a unit of output at the A point on X_1/X_2 line with certain quantities of input, the distance BA is the represented amount of all inputs proportionally reduced without affecting the output as ratio BA /OA, which shows the percentage by which all inputs need to be reduced to achieve technically efficient production. Therefore, technical efficiency (TE) of a firm can be measured by the ratio as TE = OB/ OA, between zero and one in value and then gives the degree of technical inefficiency of the firm as (1- TE) or BA/OA. A value of one shows that the firm has full technical efficiency in which point A lies on the efficient isoquant (Coelli.Tim., 1998). For the output-oriented measures, it can be illustrated using one input (X) and one output (Y). In Figure 1(b), the output-oriented measure of TE would be EC/ED. It will take a value between zero and one. The value of one indicates the firm is fully technically efficient.



(a) Input-oriented measure (b) Output-oriented measure

Figure: 2.2 Input and output-oriented technical efficiency measures.

Source; Coelli.T, 1998

To measure the technical efficiency in practice, a production frontier function has to be estimated from sample data using either a non –parametric piece-wise firm technology or parametric function, such as the Cobb-Douglas form, fitted to the sample data (Farrell, 1957, cited in Coelli, 1998).

2.3. Stochastic Frontier Production Function

Stochastic Frontier Production Function (SFA) is the most commonly used method to estimate the efficient frontier and calculate the firm's technical efficiency relative to it. The SFA requires a functional form to be specified for the frontier production function.

Aigner, Lovell, and Schmidt (1977) (cited in Coelli, 1998) independently proposed a stochastic frontier production function in which the error term has two components, one accounts for random effects and the other accounts for technical inefficiency. In sample terms, the stochastic frontier approach amounts to specifying the relationship between output and input levels using two error terms. One error terms is the traditional normal error in which the mean is zero and the variance is constant. The other error term represents technical inefficiency and may be expressed as a half-normal, truncated normal, exponential, or two-parameter gamma distribution. Technical efficiency is subsequently estimated via maximum likelihood of the production function subject to the two error terms.

This model can be expressed as follows;

$$Y_i = f(x_{i\,;}\,\beta)+e_i \qquad where,\ i= 1,2,\ldots,N \qquad (1)$$

Where, Y_i= the output level of the *i*th sample firm,

$f(x_{i\ ;}\ \beta)$ = a suitable function such as Cobb-Douglas or translog production functions of vector, x_i, of inputs for the *i*th farm and a vector, β, unknown parameter.

e_i= composed error term which can be defined by

$$e_i= (v_i - \mu_i) \qquad (2)$$

Where, v_i = independently and identically distributed (i.i.d) are assumed as normal random variables which zero mean and unknown variance, σ_v^2

μ_i = non-negative unobservable random variables are assumed to account for technical inefficiency in production and are often assumed to be i.i.d. exponential or half-normal random variables.

The random effects can be represented by f(x) e^{v}. The index of technical efficiency can be modified to:

$$e^{-u} = Y / f(x)e^{v} \qquad (3)$$

The parameter of the stochastic frontier production function can be estimated using either the maximum-likelihood (ML) method or a variant of the Corrected Ordinary Least Square (COLS) (Richmond, 1974 cited in Coelli, 1998). The ML is the preferred method for estimation of the parameters of stochastic frontier models. The ML estimator is asymptotically more efficient than the COLS estimator when the contribution of technical inefficiency effects to the variance terms is large. Technical inefficiency effects have been frequently assumed in empirical applications that it has the half normal distribution.

Aigner, Lovell and Schmidt (1977) (cited in Coelli, 1998) defined the log-likelihood function for the model, defined by equation 4,

$$ln\ (y_i) = x_i\, \beta + v_i - \mu_i\ ; \qquad i=1, 2, \ldots, N \quad \ldots\ldots \qquad (4)$$

Where,

Y_i = the production of the *i*-th firm,

X_i = inputs used of the ***i*** th firm,

β = estimated parameters,

v_i= a symmetric error term that shown statistical noise,

μ_i = non- negative random variable.

and in term of two variance parameters,

$$\sigma_s^2 = \sigma_v^2 + \sigma^2 \quad \text{and} \quad \gamma = \sigma^2 / \sigma_s^2$$

Where,

σ_s^2 = Total variance,

σ_v^2 = Variance of measurement error variable

σ^2 = Variance of non-negative random variable

The parameter γ has a value between zero and one ($0 \leq \gamma \leq 1$), where the value of zero indicates that the deviations from the frontier are due entirely to noise, while a value of one would indicate that all deviations are due to technical inefficiency (Coelli, 1998).

The concept of technical efficiency using stochastic frontier production fuction is illustrated in Figure.2.2. The random error term v allows frontier output values vary around the deterministic production frontier Y= f(X).

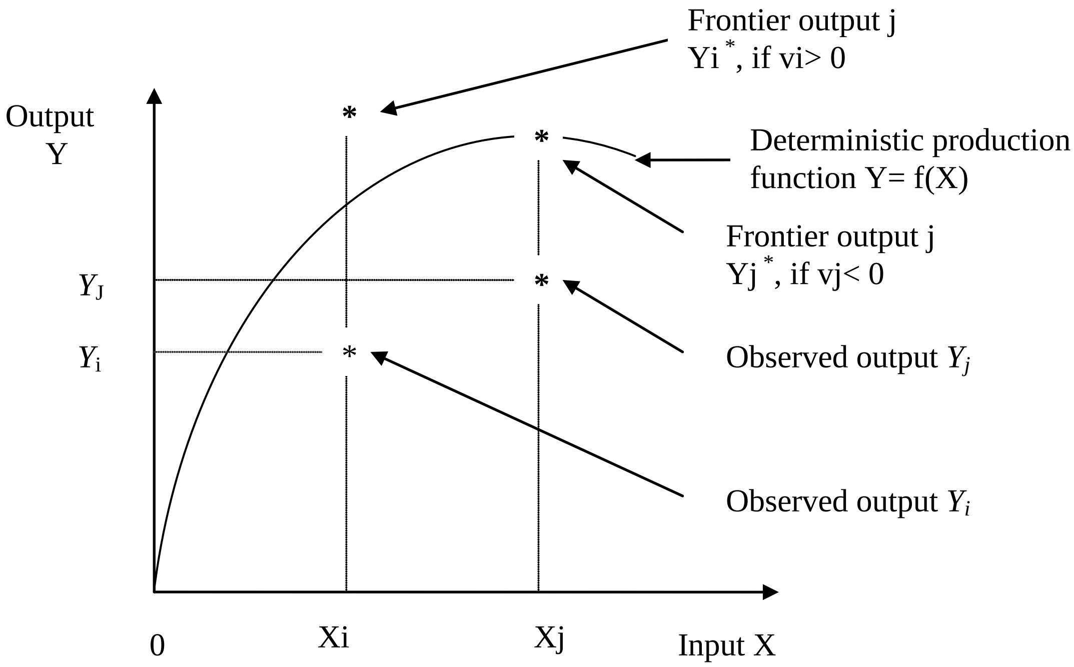


Figure 2.3 Stochastic frontier production functions.

There are two approaches to estimating the inefficiency models. These may be estimated with either a one-step or two-step process. For the two-step procedure the production frontier is first estimated and the technical efficiency of each farm is derived. These are subsequently regressed against a set of variables, Zi, which are hypothesized to influence the farms' inefficiency. A problem with the two-stage procedure is the inconsistency in the assumption about the distribution of the inefficiencies. In the first stage, the inefficiencies are assumed to be independently and identically distributed in order to be a function of a number of farm specific factors, and hence are not identically distributed unless all the coefficients of the factors are simultaneously equal to zero (Coelli, Rao and Battese, 1998). For the one step procedure, the most commonly used package for estimation of stochastic production frontier in the literature is FRONTIER 4.1 (Coelli, 1996).

FRONTIER estimates all of the parameters in one stage to overcome the inconsistency. The inefficiency effects are defined as a function of the farm specific (as in the two-stage approach) but they are then incorporated directly into the maximum likelihood estimation (MLE). The specification has been widely applied. The specification has also been altered and extended in a number of ways. The series of data is applied not only in cross-sectional data, but considered for panel data and time varying technical efficiencies, and so on.

Letting u be the technical inefficiency error term, technical efficiency is estimated as the ratio of the expected value of the predicted frontier output conditional on the value of *u* to the expected frontier output conditional on the value of *u* being 0;

And then, average level of technical efficiency was estimated as;

$$E(u) = -\sigma 1\sqrt{\frac{2}{\pi}} \qquad (5)$$

Jondrow et al.,(1982) and Kalirajian and Flinn(1983) had developed a specification for the expected firm- specific inefficiency, $E(U_i)$, conditional on the random disturbance, V_i. A frontier model was first estimated using the MLE or COLS method. The residuals from this frontier were used to isolate the inefficiency part from the random error.

The expected firm-specific inefficiency can be written as;

$$\varepsilon(Ui/\varepsilon i) = \sigma * \left[\frac{f(\varepsilon i\lambda/\sigma)}{1 - F(\varepsilon i\lambda/\sigma)} - \frac{\varepsilon i\lambda}{\sigma} \right] \qquad (6)$$

Where f(.) and F(.) are respectively the standard normal density function and cumulative distribution estimated at $(\varepsilon i.\lambda/\sigma)$.

Where,

$$\lambda = \sigma_u/\sigma_v$$

$$\sigma 2 = \sigma 2_u + \sigma 2_v \qquad \text{and}$$

$$\sigma^* = \sigma_u\sigma_v/\sigma$$

The variance ratio parameter is estimated by

$$\gamma = \frac{\sigma 2_u}{\sigma 2_u + \sigma 2_v}$$

The term e_i is computed by

$$e_i = \ln Y_i - [\ln \alpha_0 + \sum i\alpha_i \ln X_i]$$

The standard normal density function was give by

$$f((u_i / e_i) = \frac{1}{1-F} * \frac{1}{\sqrt{2\pi\sigma *}} \exp\left\{ \frac{-1}{2\sigma *^2} [ui + \frac{\sigma^2 u_i \varepsilon_i}{\sigma^2}]^2 \right\}$$

Where; $u_i \geq 0$

The technical efficiency of the firm I was then directly given by e^{-u} or technical inefficiency given by $(1-e^{-u})$

$$TE_{(i)} = \frac{Y_{i\,(actual)}}{f(x_i, \beta)} = \exp(-u_i) \qquad (7)$$

Where Y_i =an actual output obtained by farm i ;

$f(x_i, \beta)$=a maximum possible output (on frontier) of farm i.

2.4. Researches and studies relating to technical efficiency

Aye Aye Khin (2002) analyzed the farm-specified technical, allocative and economic efficiencies of the sample sugarcane farmers in Pyinmana, Tatkone and Yedashe townships. The application of urea fertilizer, the total labor and draught power used by the farm from land preparation to transporting to the sugar-mill and the farmers' experience in sugarcane cultivation were the most important explanatory variables in frontier estimate. All sample farmers were not fully economically efficient in sugarcane production. About 40-70% of all sample farmers achieved moderate economic efficiency in sugarcane production. Therefore, the results pointed out the encouragement for reaching optimal allocation of resources in their farms was necessary to improve their income and welfare.

Tadesse and Krishnamoorthy (1997) examined the level of technical efficiency in paddy farms of the southern Indian state of Tamil Nadu. The study showed that 90% of the variation in output among animal power and fertilizers had a significant influence on the level of paddy production. The results showed that, with the use of more fertilizers and land, rice production could be increased. The contribution of land in increasing production was more prominent. Farmers were overusing animal power in rice cultivation. The study further indicated that small-sized paddy farms in zone II and medium-sized paddy farms in zone Ill are represented by ecologically size-biased production techniques; thus achieving higher technical efficiency.

In carp pond culture in Peninsula Malaysia, technical efficiency was examined the productive performance and its determinants by Iinuma and Sharma and Leaung (1999). The results showed that the mean technical efficiency for sample carp farms was estimated to be 42%, indicating a great potential for increasing carp production in Peninsula Malaysia through improved efficiency. Seed ratio has a significant effect on fish production; therefore, the proper choice of species composition is important to improving productivity in carp polyculture. Because the intensive/ semi-intensive system is found to be technically more efficient than the extensive system, efforts should be made to promote the intensive/semi-intensive carp culture.

Mwakalobo (2000) estimated coffee production levels of different farmers and their efficiency in resource use. The results showed that the farmers displayed inefficient use of available resources used and were using adequate capital-intensive input levels in order to maximize their output. The result showed that the coffee farmers need to improve their resource use efficiency and productivity. This was shown using a Cobb- Douglas production function, using the Ordinary Least Square techniques.

Abdulai, and Eberlin (2001) examined technical efficiency of maize and bean farmers in two selected regions of Nicaragua using farm-level survey data for the 1994–1995 crop year. The results expressed that the average technical efficiency levels are 69.8 and 74.2% for maize and beans, respectively. The maize and beans translog frontier functions show that farmers’ human capital represented by the level of schooling, access to formal credit and farming experience represented by age contribute positively to production efficiency, while farmers’ participation in non-farm employment tends to reduce production efficiency.

Wiboonpogse and Sriboonchitta (2001) analyzed the factors affecting technical inefficiency jointly with production frontiers estimated using maximum likelihood method by Frontier 4.1. They stated that the technical inefficiency in jasmine rice and in the non- jasmine rice could be significantly improved. To enhance the yield per rai of jasmine and non- jasmine rice, increased use of chemical fertilizer could be achieved by lowering the fertilizer price or providing more credit. They recommended using more male labor relative to the total labor to reduce the technical inefficiencies for jasmine rice production. However, to reduce the jasmine and non-jasmine rice technical inefficiencies, besides increasing the male labor, technical training to enhance experience in place of age and education must be added for the short-run. They found that the average technical efficiencies (70%) in both kinds of rice imply substantial gaps for the rice yields improvement by increasing their technical efficiencies.

Rahman (2003) analyzed the profit efficiency by its three components-technical, allocative, and scale efficiency. He provided a direct measure of the efficiency of Bangladesh rice farmers using a stochastic profit frontier and inefficiency effects model. The results indicated that rice farmers have more experience in growing modern varieties, better access to input markets, are located in fertile regions and rice farmers who have less off-farm work tend to be more efficient. The results showed that the average profit efficiency score is 0.77 implying that the average farm producing modern rice could increase profits by about 30% by improving their technical, allocative and scale efficiency.

Binam and Tonye et.al (2004) indicated farm-specific variables causing inefficiencies for smallholder farmers in slash and burn using a stochastic production frontier model. The results showed that distance of the plot from the main access road, the soil fertility index, the credit access and the variable club have a significant impact on technical inefficiency of farmers among farming systems in slash and burn agriculture. Educational level has a significant impact on the technical inefficiency in maize mono cropping systems.

Iraizoz, Rapun, and, Zabaleta, (2003) analyzed separately technical efficiency for Tomato and asparagus production in Navarra (Spain). Both a non-parametric and a parametric approach to a frontier production function are used. The results indicated that both tomato and asparagus production are relatively inefficient, with potential in both cases for reducing input and increasing output. The results estimated measures of technical efficiency were positively related with the partial productivity indices and negatively related with the cultivation costs per hectare although were not obtained for the relation between size and efficiency.

Kibarra (2005) measured the level of technical efficiency in maize production in Kenya using the Stochastic Frontier Approach. Results indicated that the mean technical efficiency of Kenya's maize production was 49 percent. There was distinct intra and interregional variability in technical efficiency in the maize producing regions. In addition, technical efficiency varied by cropping system; the mono-cropped maize fields have a higher technical efficiency than the intercropped maize fields. The education, age, head and health of the household head, gender of the household, use or non use of tractors and off-farm income were impacted on technical efficiency.

Margono and Sharana (2006) estimated the technical efficiencies and total factor productivity (TFP) growth in industries of Indonesia by using the stochastic frontier model. Data analyzed showed the determinants of inefficiency and TFP growth were related to technological progress. Technical efficiency was estimated with the maximum likelihood method in Frontier software. The results showed that average technical efficiencies could increase in all sectors by 55.87% and the results also identified the factors contributing to technical inefficiencies. The results indicated that annual growth rates of technical efficiencies of all four sectors were affected by the Asian crisis. Moreover, in general, they also indicated that private firms were more efficient than the public firms except for the textile sector, but the age of a firm had no effect on the efficiencies. This indicates that output growth in textiles, chemical and metal or labor are more capital oriented as compared to the food sector.

Khanna (2006) used the stochastic production frontier to estimate technical efficiency using maximum likelihood estimation techniques in irrigation for sugar cane farmers using primary survey data. It revealed that the Cobb Douglas model is the appropriate model to explain the production process. An advantage of the Cobb Douglas production function is that coefficient estimates can be interpreted as measures of elasticity, allowing an analysis of the responsiveness of output to each of the input variables used in the production process.

Theingyi Myint (2001) measured the technical efficiency and profitability of different farm sizes and different yield levels of irrigated rice farmers in Pyinmana Township. Data on 144 rice farmers were stratified into small, medium, large strata based on farm size. Enterprise budget was used for cost and return analysis of different farm size groups and two yield level groups. Stochastic frontier production function was applied to estimate the technical efficiencies of different farm size groups. From the analysis of enterprise budget, small farm size group was more financially attractive than medium and large farm size groups. In the estimation of stochastic frontier production function, increasing use of not only family labor but also urea fertilizer would lead to increases in the yield level of the small farm size group. In the medium farm size, level of education was negatively and significantly related to technical inefficiency at 55%. Therefore, more educated medium farmers seem to be more technically efficient in irrigated rice production. The large farm size group had the highest technical efficiency score of 0.77 followed by medium and small farm size groups under the present technology.

Production efficiency of high-income and low-income pre-monsoon cotton farmers (2002-2003) in Kyaukse and Meikhtila townships was estimated by Tun Win (2004) through technical efficiency measurement to find out factors affecting the production of cotton. Indicating the mean efficiency of pre-monsoon cotton farmers was 0.67, the result implied that in the short run, there was a scope for increasing cotton production by 33% by adopting the technology and techniques used by the best practice cotton farms.

The profitability and technical efficiency of sugarcane farmers in private sectors of Katha, Hteegyaint and Thabeikkyin townships was examined by War War Shein (2004). The empirical result stated that Thabeikkyin Township was more financially attractive than other townships for both new plant and ratoon. All ratoon farms were more financially attractive than all of new plant farms. The technical efficiency estimates varied from 56% to 100% with a mean value of 77% for new plant and from 52% to 94% with an average of 69% for ratoon. There was a scope for increasing syrup production by 23% for new plant, and 31% for ratoon with the present technology. The study concluded that improvement in technical efficiency was still possible in the private sector. This kind of syrup cottage industry would assist the raw material for syrup-based industry and generate income for private sugarcane farmers.

CHAPTER III

RESEARCH METHODS

This chapter discussed the topics on how the study areas as well as samples were selected, what kind of data was collected and how the data collection was carried out as well as what kind of method and model will be used for data analysis.

3.1. Site selection of the study

The central region of Myanmar was chosen for conducting research. The selection of the study area is based on the areas where groundnut has been widely grown. Magway and Mandalay divisions were selected as the study areas because they are the largest groundnut growing areas of the country. Out of these two divisions, two districts with the largest groundnut production area in each division were selected which are Yamethin Township and Tattkhone Township in Mandalay Division and Magway Township and Aunglan Township in Magway Division. The study area is shown in Figure 3.1.

3.2. Sampling techniques

The cross-sectional data was used to express the groundnut production in central region of Myanmar. A two-stage sampling procedure was used to selected farmers for the study. Firstly, two villages in each selected township, for four townships, were randomly selected. After that, sample firms from a list of groundnut production firms were randomly selected. In total, there were 269 sample groundnut production farm households in two divisions.

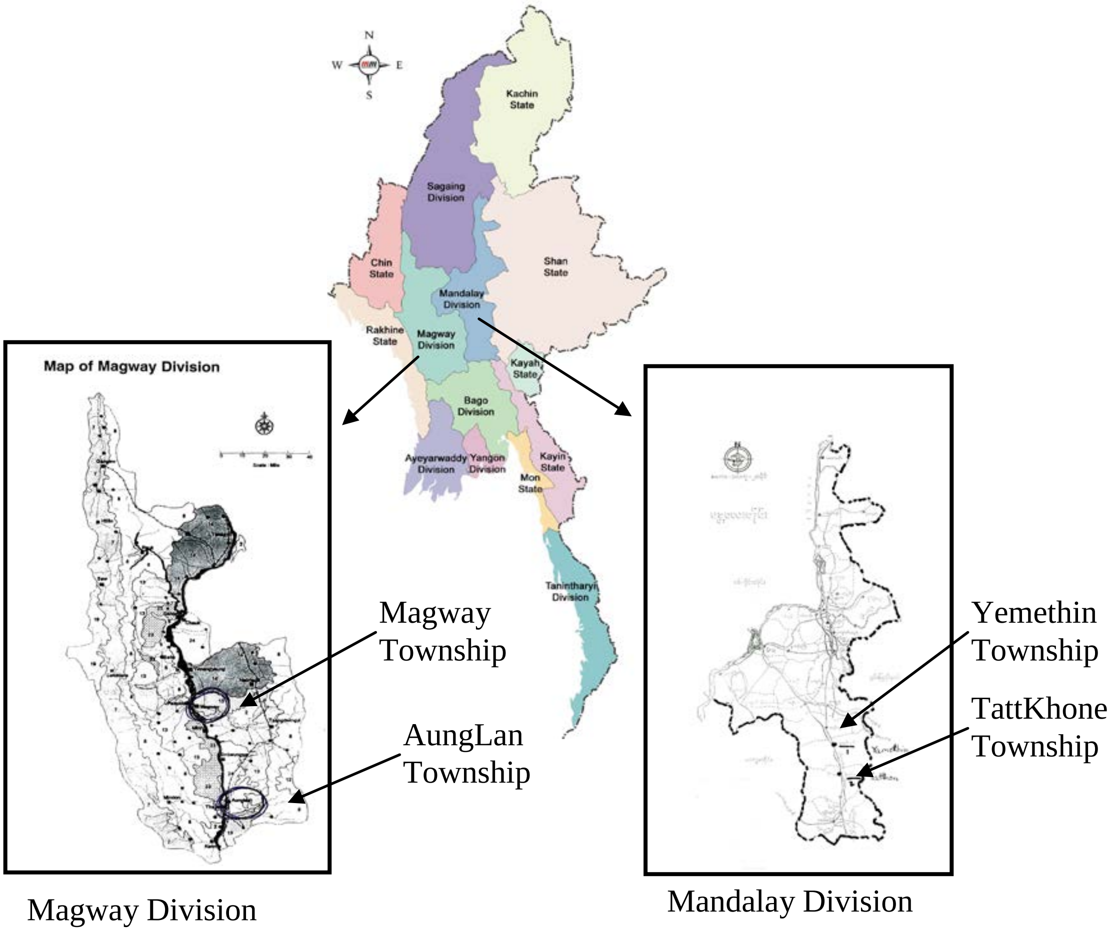


Figure 3.1 Study sites in the central region of Myanmar.

3.3. Data collection

The information used for this study was collected from both primary and secondary sources. Relevant information on groundnut production systems and socio-economic of groundnut production farm households were gathered on seasonal year 2006-07 using methods as below.

3.3.1. Primary Data

Primary data, gathered in this study, includes biophysical and socio-economic information of groundnut production farm households in the study area. Semi-structured interviews and formal survey were employed to gather the data in this study. Formal survey using structured questionnaires were constructed to gather major part of information needed to substantiate the objective of the study. In particular, farming practices such as total cultivated area, the groundnut grown area, the cropping pattern, the land preparation methods, the cultural practice, the crop yields obtained, the credit from agricultural banks, the seed varieties, the constraints of groundnut production such as biological constraints and socioeconomic constraints for yield increase and area expansion and the use of input level such as seed, fertilizers, insecticides and pesticides, etc.

Key informants such as village headmen, school teachers, extension agents etc. were consulted for the overview information of the area. Data collected from survey can be separated to two types as follows.

1) Production data

Production data consist of cropping pattern, total area cultivated, groundnut area cultivated, groundnut varieties, groundnut yields, input utilization and other farm management.

2) Socio-economic data

Socio-economic data consist of land holding, land type, as well as land distribution, farm size, household composition by age and family size, education status and distribution, farm and off farm income, credit and source of credit, labor used on groundnut farms.

3.3.2 Secondary data

Secondary data were drawn from relevant ministerial reports of Ministry of Agriculture and Irrigation Central Statistical Organization. To have a better understanding of the groundnut production system in the study area, the related publications were reviewed. Research studies on groundnut growing, biophysical, socio-economic and demographic characteristic of the study sites were collected from various resources.

3.4. Data Analysis

After completing the field survey, the data were transferred from the questionnaires into Microsoft Excel worksheet as a data base file. The detail of data analysis can be explained as follows.

To achieve the first objective, the data collected from the survey were analyzed using descriptive statistics. The results from descriptive analysis of groundnut production system and socio-economic characteristic of farm households were presented and compared between different divisions by using contingency tables, with percentage, mean, standard deviation values.

To address the second and third objectives, stochastic frontier production for technical efficiency of groundnut production was estimated. The factors affecting technical inefficiency in groundnut production were identified for growers in central region of Myanmar. The stochastic production frontier was used to estimate technical efficiency using maximum-likelihood methods. At the same time, frontier production function was expressed technical inefficiency in groundnut production at the farm level using cross-sectional data.

Determinant of production function included information of input utilization such as production hectares, seed rate per hectare, chemical fertilizer application, manure application, and cost of pesticides and insecticides application. In addition, it was also included the information of socio-economic aspects of the farmer such as educational level, age of household heads, labor availability, credit, and extension services to groundnut production.

In this study, the technical efficiency effects in the stochastic frontier production function specified by using the flexible trans-log specification. The specified model is assumed to be the appropriate model for analysis of the data.

The model to be estimated is defined by:

$$\ln Y_i = \beta_0 + \sum_j \beta_j \ln X_{ji} + \frac{1}{2}\sum_j \sum_k \beta_{jk} \ln X_{ji} \ln X_{ki} + \nu_i - \mu_i, \qquad (1)$$

Where**Error! Bookmark not defined.Error! Bookmark not defined.** ,

i   indicate an observation for the i-th farmer in the survey, i=1,2,3,…..,269

ln   = natural logarithms,

β_0 = parameters to be estimated production function.

Y_i = groundnut yield (kg/ha)

X_{ji} = all *j* input variables per ha,

X_{1i} = total groundnut production area (ha)

X_{2i} = seed rate used in groundnut production (kg/ha)

X_{3i} = amount of chemical fertilizer application (kg/ha)

X_{4i} = amount of manure application (tons/ha)

X_{5i} = insecticides and pesticides cost in the application (kyat/ha)

X_{6i} = human labor use (man-day /ha) in groundnut production.

X_{7i} = good in soil quality in groundnut production; dummy variable is used that value is 1 if the soil condition is the best, 0 is otherwise.

X_{8i} = fair in soil quality; dummy variable is used in groundnut production, the value was 1 and if he does not planted, value will be zero.

The error term is defined as

$\varepsilon_i = \nu_i - \mu_i$,

Where,

i   = 1,2,…,n farms,

ν_i = an error term, independent and identically distributed (iid with N (O, σ_v^2);

μ_i = a non-negative random term, accounting for inefficiency, iid, with N (O, σ_v^2), truncated half normal.

For the inefficiency terms, variation in efficiency was estimated at the firm level due to farmer-specific characteristics. The inefficiency model was estimated base on the equation given below;

$$\mu_i = \delta_0 + \sum \delta_m Z_i \qquad (2)$$

Where,

δ_m unknown parameters to be estimated

Z_i the vector of observable explanatory variables

In this study, the inefficiency equation is as follows;

$$\mu_{i=} \quad \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_4 Z_{5i} + e_i \qquad (3)$$

Where,

δ_0 = constant

Z_{1i} = years in school of the household head (years),

Z_{2i} = age of the household head (years)

Z_{3i} = availability of labor force in the household (in the Man-equivalent unit),

Z_{4i} = dummy variable for credit access. If the farmer has access to credit, the value was 1 and if not, the value was 0.

Z_{5i} = dummy variable for access to extension officers. If farmer adapt to extension officers, the dummy variable was 1 and 0 if otherwise.

The production function defined by equation (1) has the explanatory variables; land area, family labor, use of the seed rate, use of chemical fertilizer, manure application and cost of pesticides and insecticides involved in farming. These variables were assumed to explain the output of groundnut at Magway division and Mandalay division. It is further hypothesized that the output might also be influenced in this level by the existence of age and education differences between farmers and differences in extension contact offered by the government institution.

The technical inefficiency effects outlined by equation (3) indicated that these effects in a stochastic frontier (1) are expressed in terms of various explanatory variables which include the age of the farmer, the education of the farmer described by dummy and extension contact as dummy. It was expected that a high level of education increases technical efficiency more than contact with extension agents.

Batteese and Coelli (1998) stated that the technical efficiency of production of the i^{th} farmer was estimated as

TE_i $= \exp(X_i \beta + \nu_i - \mu_i) / \exp(X_i \beta + \nu_i)$

TE_i $= \exp(-\mu_i)$

If $\mu_i = 0$, the farms were 100% efficient.

Therefore,

TE_i $= e*p(-U_i)$

The technical efficiency of a farmer is between zero and one and is inversely related to the level of the technical inefficiency.

Technical efficiency was obtained from equation (1) and (3) using the method of maximum likelihood estimation to estimate the production frontier jointly with the inefficiency equation by using the computer program FRONTIER Version 4.1.

FRONTIER version 4.1 is the most commonly used package for predicting for stochastic production frontiers. The estimation process consists of three main steps in estimating the maximum-likelihood estimates (MLE) of the parameters of a stochastic frontier production function. At the first step, the model is applied to estimate the parameters of the production function with Ordinary least-squares (OLS) method. This provides unbiased estimators for the β's with the exception of the intercept, β_0. The OLS estimates are used at the beginning of estimating values to the final MLE model. At the second step, the values for the likelihood function is estimated for different value of γ between 0 and 1 given the values for β's are derived in the OLS. Finally, an iterative algorithm calculates the final maximum-likelihood estimates, using the values of the β's from the OLS and the value of γ from the intermediate step as starting values in an iterative procedure (Coelli, T. 1996).

CHAPTER IV

GENERAL INFORMATION AND CHARATERISTICS OF THE GROUNDNUT PRODUCTION SYSTEMS IN CENTRAL REGION OF MYANMAR

Differences in agricultural productivity are observed among nations and regions. Significant productivity difference also show among firms from within region and from different region of same country. A part of these differences can be explained by the differences in the conventional inputs such as area, fertilizer, and natural endowments such as soil condition, climate, etc. Other institutional organizations, and so on are very important for the smooth and viable existence of groundnut production systems. However, these factors can't capture all. It is relied to the farmer's capacity ability to produce more output from given resources use in firms (Neuyen, 1997).

In this chapter, general information of the central region of Myanmar was presented to provide an understanding of the study areas. As well, inputs used for groundnut production such as varieties, seed rate, labor used, fertilizer, pesticides and insecticides application in groundnut production as well as socio-economic characteristics of sample groundnut farmers such as age and education of household head as decision-maker, ownership of farmland and natural endowment such as soil quality and climate condition were presented. The information would help in understanding the farmers' socio-economic condition in relation to their performance of the cultivation of groundnut in the central region of Myanmar. Institutional factors, access to credit and access to extension services, hypothesized to have effected on technical efficiency were also presented in this chapter.

4.1. General information of the central region of Myanmar

4.1.1 General Physical description and land use

Myanmar can be divided into three agricultural zone; (1) the delta zone, where rice cultivation predominates, (2) the dry zone, where a combination of rice and a wide variety of other crops are grown, (3) the hill and plateau regions, where forestry and shifting agriculture are the most important. The central region of Myanmar is classified in the dry zone where there are three divisions, namely Magway, Mandalay and Sagaing divisions. Groundnut is produced mainly in the Mandalay and Magway divisions.

Mandalay division is situated between latitudes 19°20' north and 23°45 ' north and longitudes 94°45' east and 97°00' east. It is in the central region of Myanmar with the total area of 37935 km^2. Mandalay, the second most populous division in Myanmar, has 6,313,938 inhabitants. The average population density is 164 persons per km^2. In Mandalay, paddy fields and annual crop fields are the majority of farms. There are over 2.024 million hectares of irrigated farm lands. Mandalay division annually put over 0.407 million hectares under edible oil seed crops including groundnut, nearly 0.364 million hectares under beans and pulses, over 0.122 million hectares under cotton and over 2.024 million hectares under paddy (*http://www.yadanabon.com/around_mandalay.htm*).

Magway division has a common boundary with Mandalay and Bago divisions as well as Rakhine and Chin States. Magway division is situated between North Latitude 18° 50' and 22° 47' and East Longitude between 93° 47' and 95° 55' and has an area of 44820 km^2. The population of Magway division is 4,218,699. It occupies an area of 459218.67 km^2. Farmland occupies 0.65 million hectares of about 1.01 million hectares of total arable land in the division and the rest are paddy land, silt land (Kaing-kyunmyar), hill-side cultivated land (taungya-myay) and vegetable land. Multiple cropping is practiced at paddy land and farmland. In Magway division, 0.203 million hectares is put under paddy. The major oilseed crop is sesame and over 0.405 million hectares is put under this crop. As Magway division produces a large quantity of groundnut and sesame edible oil, it is also known as the oil pot of Myanmar. *(http://www.yadanabon.com/magway.htm).*

4.1.2. Climate

There are three seasons in the central region of Myanmar; namely summer, rainy and winter seasons. Average temperatures of the central region are between 37°C and 40°C in summer, especially April which is the hottest month. In the winter, the average temperature is 21°C and lowest temperature is 18°C. Range of the total annual rainfall of the central region is from 812.8 mm to 863.6 mm. The average relative humidity is about 67.5 percent in Mandalay and 72.2 percent in Magway.

For Mandalay, the highest temperature is 34.3°C and lowest temperature is 22.1°C. The total annual rainfall is about 1164.4 mm in 2006. Figure 4.1 presents the rainfall pattern for 12 months in Mandalay in 2006. It shows that rainfall starts from March to ends in November with the highest level of rainfall in September.

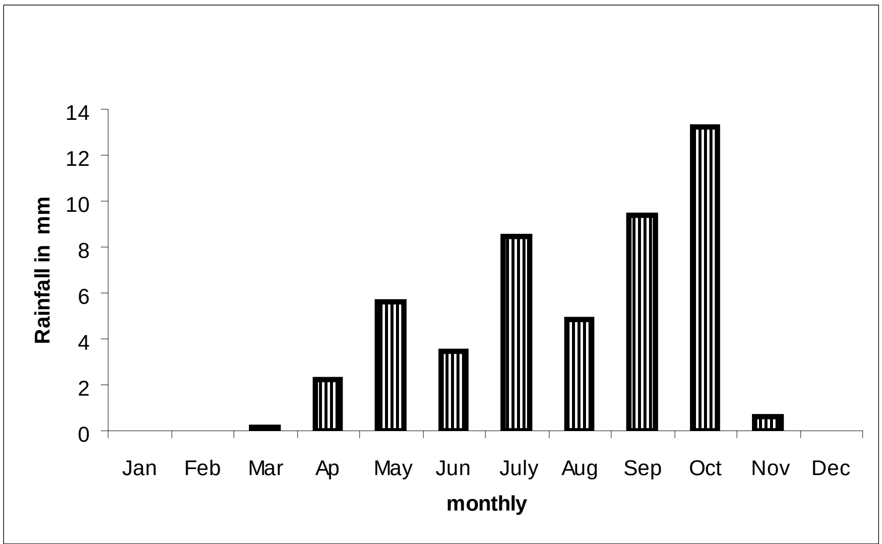


Figure: 4.1 Monthly Rainfall distributions in Mandalay Division in 2006.
Source: Department of Meteorology and Hydrology, Mandalay division, 2006.

As the majority part of Magway division falls within the Dry Zone, it is very hot during the hot season and is relatively cold during the cold season. The highest temperature is 33.9ºC and the lowest temperature is 20.1ºC. The total annual rainfall of Magway division is about 1219.96 mm in 2006. Figure 4.2 presents the rainfall pattern for 12 months in Magway in 2006. It shows that rainfall starts from March to ends in November with the highest level of rainfall in the month of October (http://www.yadanabon.com).

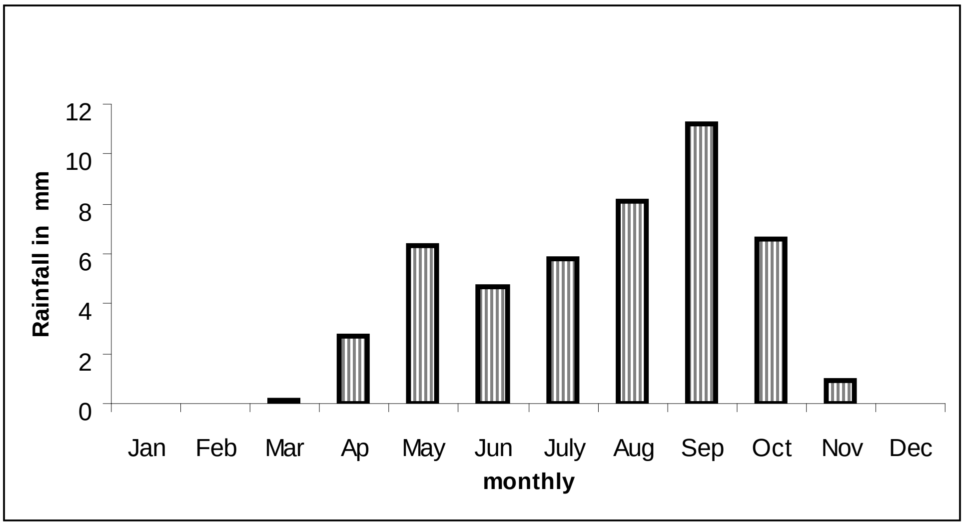


Figure 4.2 Monthly rainfall distributions in Magway Division in 2006.
Source: Department of Meteorology and Hydrology, Magway Division, 2006.

4.1.3. Groundnut production in the central region of Myanmar

The groundnut is widely distributed in the most cropping regions within Myanmar. Temperatures in central region are warm enough for the growth of groundnut. Well drained soil is easy to till and has a suitable texture for groundnut production. In addition, the soil in this region is favored for the cultivation of groundnut. Moreover, where conditions are suitable for growing groundnut, it has greater profitability due to groundnut seed quality must be good for oil contents, high yielding for productivity and lack of seed dormancy than other oil seeds (Aye Aye Mon, 1996).

Mandalay and Magway divisions have favorable natural and socio-economic condition for agricultural development, especially for groundnut production. Crop production is performed mostly under the rain–fed condition with 17% of irrigation rate of arable–land in 1999/2000 (Aye Aye Than, 2006). That is why; adverse or favorable weather situation can affect the production levels of groundnut.

In 2007, among of total oilseed crop sown area in the country, which is 865,000 hectares, total groundnut production area in the central region was 467,643 hectares, more than a half of total oilseed production area in Myanmar. Magway division, the largest groundnut production, is grown 149,000 hectares of oilseed crops and 120,650 hectares is grown in Mandalay division (CSO, 2006). Only sample farmers produced groundnut with a range 0.40 to 28.33 hectares per farm household in which they owned the land for the groundnut production.

4.2. Groundnut Production System of Sample Farms

In this study, groundnut production systems was characterized through groundnut-based cropping patterns, production area, land use and ownership, soil quality, other input uses, farm practice as well as socio-economic characteristics of sample groundnut production farms.

4.2.1. Groundnut –based cropping patterns

Groundnut is a dominant crop in the cropping systems of the central region of Myanmar. Locally groundnut in which under the rainfed area is called "Yar**"** that means dry land.

In the study area, farmers usually grow two sequential crops per year, namely, the monsoon and winter crops. Crops grown in the central region (part of dry zone), in addition to rice, include millet, maize, groundnuts, sesame, legumes, and other crops. To cultivate much of this land successfully, however, irrigation is required. The portions of this area that are not irrigated and utilized for the production of crops that are less sensitive to the seasonality or irregularity of rainfall than rice such as pulses, beans, maize, sesame , chilies, and others. The major groundnut-based cropping patterns in the study area were as follow:

1. Groundnut/Mungbean – Chili /pulses
2. Groundnut – Chilies / Groundnut/ Rice / Sorghum/ Sugarcane
3. Groundnut /Mung bean – Sesame/ Pulses
4. Groundnut– Groundnut
5. Groundnut/Sesame- Groundnut/ Maize

6. Groundnut/Sesame/Mungbean-Sesame/Pulses
7. Groundnut / Sesame – Sesame / Pulses / Maize

According to these patterns, the pattern 1, 2 and 4 can be found in Mandalay and the most popular pattern in Mandalay was groundnut/Mungbean-Chilies/Pulses (see Table 4.1) which means groundnut was grown in the same time with Mungbean but in different plots and they were the first two crops and chilies and pulses were grown after harvesting groundnut and Mungbean and they were considered as the second crop. The patterns of Groundnut-Sesame were mainly found in Magway and the most popular pattern found from the survey was groundnut/Mungbean/Sesame-Sesame/Pulses.

Table.4.1 Number of sample farmers for each cropping pattern in the central region of Myanmar, 2007.

Cropping Pattern	Mandalay		Magway	
	No.	%	No.	%
Groundnut/Mungbean-Chilies/Pulses	93	78.81	-	-
Groundnut/Chilies-Groundnut/Rice/Maize/Sugarcane	15	12.71	-	-
Groundnut- Groundnut	10	8.48	7	4.65
Groundnut/Sesame-Groundnut/Maize	-	-	51	33.75
Groundnut/Mungbean/Sesame-Sesame/Pulses	-	-	83	54.98
Groundnut/Sesame-Sesame/Pulses/Maize	-	-	10	6.62
Total	118	100.00	151	100.00

Source; Field survey, 2007.

In Mandalay, groundnut was grown two times a year as monsoon and winter crops. Groundnut is grown as a first crop in the calendar cropping seasons. It is planted before the end of May and harvesting is finished in August. After harvesting groundnut, farmers usually grow chilies and pulses as second crop from end of September to January and beginning of February. Also, some farmers grow groundnut and mungbean together as integrated crop in the beginning of rainy season. (see Figure 4.3).

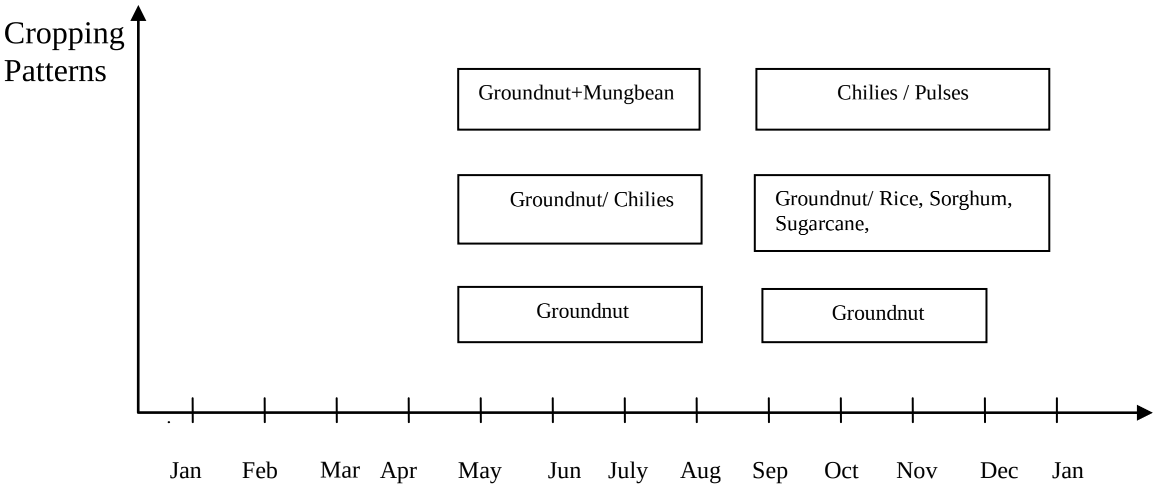


Figure 4.3 Groundnut-based cropping patterns in Mandalay division
(Source: Field survey, 2007)

In Magway, groundnut is also grown as the first crop but a little bit earlier compare to Mandalay. Farmers prepared their land and grow the groundnut in the end of April and groundnut is harvested in the end of July. Most of farmers also grew sesame as a first crop. After the groundnut harvesting is finished, some farmers grown beans, mainly mung bean, during July to the end of August as a second crop before growing sesame and pluses as the third crops. Integrated crop between groundnut and other crops were not found in Magway during the field survey in 2007. Most farmers have only two crops a year. After the first crop, groundnut, sesame, pulses, maize were grown as the second crop during September to December-January (see Figure 4.4).

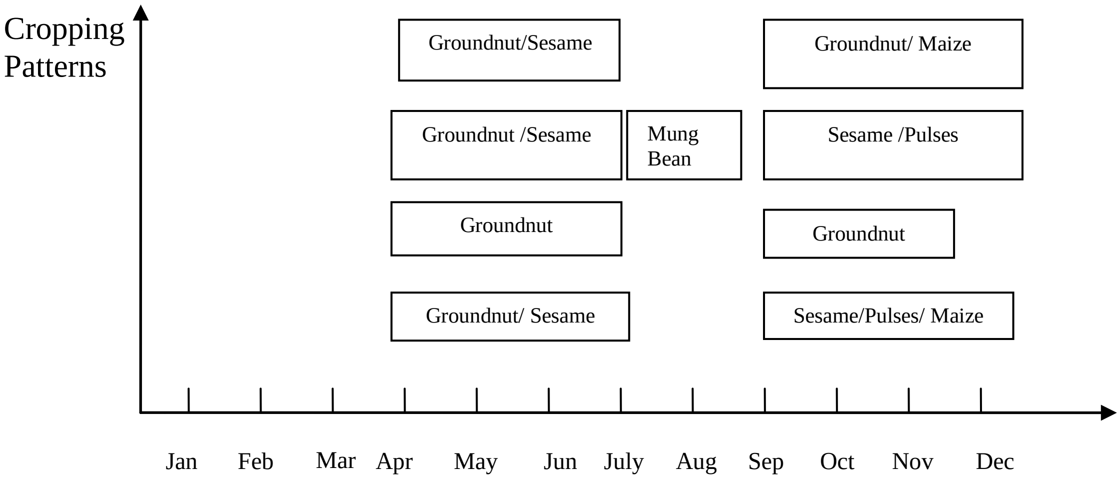


Figure 4.4 Groundnut-based cropping patterns in Magway division.
(Source: Field survey, 2007)

4.2.2 Farm size and land characteristic for groundnut production

4.2.2.1 Farm size and ownership

Farmers in the study area generally had different cultivated groundnut areas according to farm size with a range from 0.4 hectare to 8.09 hectare per household in Mandalay division and ranging from 0.81 hectare to 28.33 hectare per household in Magway division. The range is quite wide in Magway division. The average size of farm in Mandalay division was 2.32 hectare per household which was only a half of the average farm size, 5.45 hectare per household, in Magway division. Even though all land in the country owned by Union of Myanmar, farmers are allowed by government to grow the crops. There is no official land renting system in the study area but some sample farmers shared land with their relatives. Two third of farmers in Magway have land more than 3 hectares, whereas two third of farmers in Mandalay have land between 1.0-3.0 hectares (see Table 4.2).

Table 4.2 Classification of farm size in Mandalay and Magway

Farm size	Mandalay (n=118)		Magway (n=151)	
	Count	%	Count	%
Less than 1.0 ha	18	15.3	1	0.7
1.0 - 2.0 ha	42	35.6	21	13.9
2.0 - 3.0 ha	38	32.2	29	19.2
More than 3.0 ha	20	16.9	100	66.2
mean	2.32		5.45	
std	1.66		4.35	
max	8.09		28.33	
min	0.4		0.81	

Source: Field survey, 2007

4.2.2.2. Groundnut production areas

In Mandalay, groundnut production area ranged from 0.20 hectare to 7.30 hectare with an average of 0.95 hectare per household. Compared to Mandalay, the average groundnut production area in Magway was larger (1.64 hectare per household) and it ranged from 0.4 hectare to 12.14 hectare (see Table 4.3). Considering the proportion of groundnut planted areas to total farm areas, it was found that in average about 41 percent of total farm area was used for groundnut production for Mandalay and about 30 percent of that for Magway during cropping year 2007.

Table 4.3 Groundnut production areas in Mandalay and Magway

Production area	Mandalay (n=118)		Magway (n=151)	
	Count	%	Count	%
Less than 1.0 ha	78	66.10	67	44.37
1.0 - 2.0 ha	31	26.27	44	29.14
2.0 - 3.0 ha	6	5.08	26	17.22
More than 3.0 ha	3	2.54	14	9.27
mean	0.95		1.64	
std	0.82		1.70	
max	7.30		12.14	
min	0.20		0.40	

Source: Field survey, 2007

4.2.2.3. Soil

Generally quality of soil is an important factor that affected to the output of production. In the study area, it was found that soil were mainly sandy loan and sandy soil on the surface layer. According to farmers' view, only 55 percent of total 151 sample farm households in Magway considered that their soil quality was good for groundnut production, whereas only 26 percent of total 118 sample groundnut farmers in Mandalay thought that they have good quality of soil for groundnut production. Percent of farmers considered that their soil was fair and poor in Mandalay are higher than that in Magway. (see Figure 4.5 and 4.6).

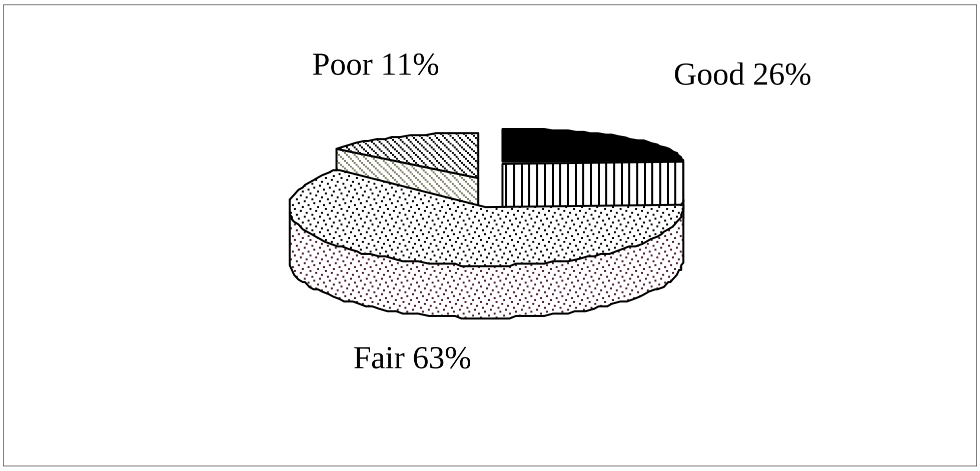


Figure.4.5 Soil quality based on farmers' view in Mandalay division.

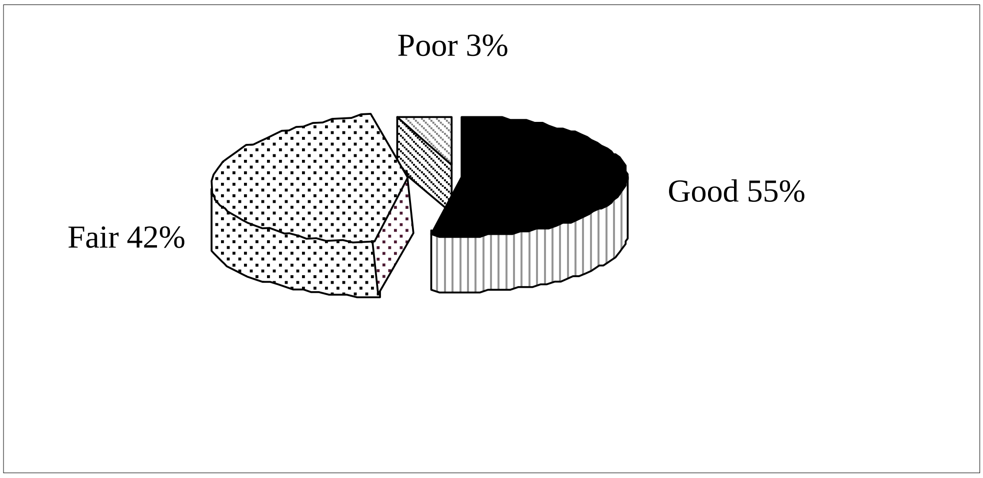


Figure. 4.6 Soil quality based on farmers' view in Magway division.

4.2.3 Land preparation

Land preparation generally starts from the end of April or early May for rainy season. Farmers prepared and ploughed their lands about a range 7 to 10 days before cultivating under rainfed condition. The time used for land preparation was very due to ploughing at a distance of 3 to 4 m from each other. From the survey, it was found that all sample farmers longer use only cattle for ploughing and harrowing in both study areas. There are no sample farmers using any machine for land preparation in the groundnut production under the rainfed area. It takes about 2 days per hectare to prepare land with a pair of cattle for groundnut production. The owned equipment and machine for groundnut production were still poor in the central region because groundnut production was firstly for household consumption; only small amount of surplus was exchanged in the market. As a result, farmers had no money from groundnut production to invest for machine.

4.2.4. Input use

Input use for groundnut production in this sub-section refers to labor, seed rate, chemical and manure fertilizer application as well as insecticide and pesticide application. The detail of each input use for groundnut production of sample farm households in the central region of Myanmar are presented as follows.

4.2.4.1. Labor use

There are two sources of labor used for groundnut production. The main source of labor is family labor. Hired labor is also used as additional labor for land preparation, planting, weeding and harvesting activities in selected study areas. However, hired labor is scarce during the harvesting period as all farmers are occupied in their own production. Especially, the households who produced large groundnut were not able to get adequate hired labors although they were willing to pay the wage at the market price.

The average labor used for all activities in Mandalay was 60.1man-day per hectare. The wage for hiring a labor was ranged from nearly 600 to 2000 kyats per day in groundnut production, depending on activity. In Magway, the average labor used was 61.9 man-day per hectare which was so much different from labor use in Mandalay. The wage of hiring a labor was also similar to Mandalay which ranged from 800 kyats per day to 2000 kyats per day.

When it time for harvesting, all farmers used simple tools like sickle for harvesting. Additional labor is hired for harvesting. The average labor used for harvesting is 13.75 man-day per hectare in Mandalay and 20.58 man-day per hectare in Magway.

Table 4.4. Labor used per hectare for groundnut production in central region of Myanmar

Activities	Mandalay(n=118)		Magway (n=151)	
	man-day/ha	percent	man-day/ha	percent
Land preparation	28.96	48.12	29.73	48.59
Planting	10.20	16.97	10.71	17.51
Chemical application	0.96	1.60	0.16	0.26
Harvesting	19.98	33.24	20.58	33.64
Total	60.10	100.00	61.18	100.00

Source; Field survey, 2007.

4.2.4.2. Seed variety and seed rate

From the survey, there are only two different seed varieties of groundnut in the study area which are SP-121 and MG-15. The SP-121 is grown in Mandalay division and MG-15 is grown in Magway division. These two varieties is the erect type which usually will mature in 90-105 days. The most important traits that farmers considered in selecting a variety were the crop vigor, short duration, high yield potentials. Seed, therefore, must be lack of dormancy as groundnut grows as soon as it is possible to prepare the land after first raining of premoonsoon.

There, however, is no difference in seed rate per hectare used in groundnut production between sample farmers as well as between divisions. The average seed rate used in groundnut production was 53.47 kg /ha in Mandalay and 54.50 kg /ha in Magway.

One problem faced by the farmers is the high seed cost of groundnut production in the study areas. Average groundnut production cost of farmers in both areas was 69,863 kyats per hectare. Therefore, most farmers in both areas stored their seed for the next planting season, less farmers purchased seed from market (see table 4.5).

As groundnut planting depends, heavily on rainfall when pod become to sprout into land, if there is drought in that year, groundnut yield will be decreased and it is often found that the seed cost cannot be covered in such year.

Table 4.5 Percentage of purchasing groundnut seed of farmers in central region of Myanmar

Seed variety	Mandalay (N= 118)		Magway (N= 151)	
	no of sample	percent	no of sample	percent
No purchasing seed	109	92.37	139	92.05
Purchasing seed	9	7.63	12	7.95

Source; Field survey, 2007.

4.2.4.3. Chemical fertilizer and manure application

In both Mandalay and Magway, it is found that most farmers applied chemical or organic fertilizer in their groundnut production (see Table 4.6). About one third of farmers in both divisions used integrated fertilizer management. They usually put manure in their soil during land preparation and applied chemical fertilizer in two weeks after planting.

It seems like that the fertilizer application rate, both chemical and manure, of farmers in Mandalay is lower in Magway. The average rate of chemical fertilizer application in Mandalay was 32.5 kilogram per hectare which is a bit lower than that of Magway farmers which applied at the rate of 35.5 kilogram per hectare. For manure, the average application rate was about 3.9 tons per hectare in Magway and 3.3 tons per hectare in Mandalay. The maximum rate of manure application was 37.1 tons per hectare in Mandalay and 39.1 tons per hectare in Magway (see Table 4.7)

Table 4.6 Application of chemical and manure fertilizer in groundnut production

Fertilizer	Mandalay (n=118)		Magway (n=151)	
	No of samples	percent	No of samples	percent
Not used both fertilizer	2	2	8	5
Applied chemical fertilizer	46	39	78	52
Applied manure	34	29	15	10
Applied both fertilizer	36	30	50	33
Total	118	100	151	100

Source: Field survey, 2007.

Table 4.7 Chemical and manure application in groundnut production areas

Amount of fertilizer application	Total amount of chemical fertilizer (kg/ha)		Total amount of manure fertilizer (tons/ha)	
	Mandalay (n=118)	Magway (n=151)	Mandalay (n=118)	Magway (n=151)
Mean	32.5	35.5	3.3	3.9
Std	35.5	38.8	4.7	7.2
Max	164.7	247.1	37.1	39.1
Min	0.0	0.0	0	0.0

Source; Field survey, 2007.

4.2.4.4. Insecticide and pesticide application

Farmers usually make decision on the pest and diseases management activities by themselves. After planning, farmers visited their field once a day or at least once every two days. When they find the appearance of pest or disease in the field, they will apply pesticides or insecticides suddenly. Mostly, yellow leaf spot, rust, mites, and beetles are the pest and insect attack the groundnut production in the study areas. More than a half of farmers (56 %) in Magway applied insecticide and pesticides for their groundnut production but only 25 % of farmers in Mandalay applied insecticide and pesticides in their groundnut production (see Figure 4.7 and Figure 4.8).

Farmers usually applied insecticides and pesticides for crop protection at least once in crop season by using sprayer. Most popular insecticides and pesticides applied for groundnut production in the study areas were Forwafuran, Dizinon, Malarthion, Kyan kyaung EC and Cypermethrin.

The average cost of insecticide and pesticide was approximately 767 kyats per hectare in Mandalay and 1933 kyats per hectare in Magway. However, there is no serious damage by pests and diseases in groundnut production in both Mandalay and Magway in the crop year 2007(see Table 4.8).

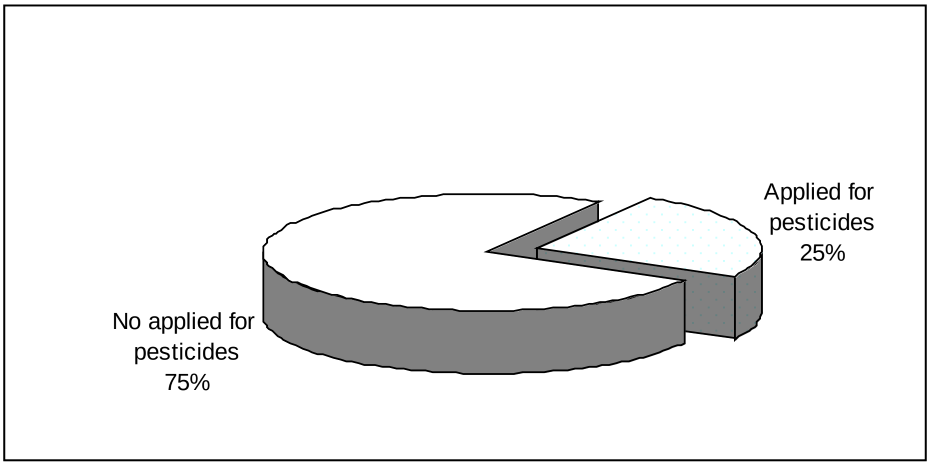


Figure 4.7 Percent of farmer applied pesticide for groundnut production in Mandalay
Source: Field survey, 2007.

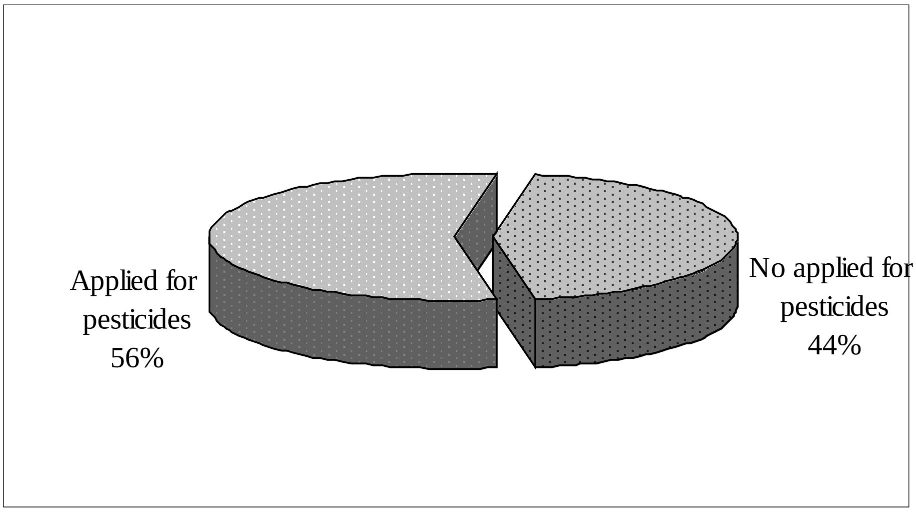


Figure 4.8 Percent of farmer applied pesticide for groundnut production in Magway
Source: Field survey, 2007.

Table 4.8 Insecticide and pesticides cost per hectare in groundnut production.

Insecticide and pesticides applied	Insecticide and pesticide cost (kyats/ha)	
	Mandalay (n=118)	Magway (n=151)
Mean	767.21	1933.27
Std	153.81	297.21
Max	2200.00	2300.00
Min	0	0

Source: Field survey, 2007.

Moreover, farmers usually do weeding by hand before using chemical. The frequency of hand weeding is at least two times per season. The first weeding is done about two weeks after planting and second weeding is done about two weeks after first weeding.

4.2.5. Productivity

4.2.5.1. Yield

The results show that the average yield of groundnut for Mandalay division was 649 kilogram per hectare with the wide range from 210 kilogram per hectare to 1681 kilogram per hectare. The average yield in Magway was higher, at the average of 993 kilogram per hectare with the wider range from 290 kilogram per hectare to 2428 kilogram per hectare (see Table.4.9).

The low productivity may be explained by two reasons. One is the seed quality as farmers used their own stored seeds for many seasons. Another reason might be low rainfall when groundnuts start to sprout into soil layer.

Table 4.9. Average yield per hectare in Mandalay and Magway

Yield(kg/ha)	Mandalay(n=118)		Magway(n=151)	
	No of sample	Percentage	No of sample	Percentage
Less than 500	29	25	16	11
500-1000	78	66	78	52
1001-1500	8	6.78	34	21
More than 1500	3	2.54	23	16
Total	118	100	151	100
Mean	649		993	
Max	1681		2428	
Min	210		290	

Source; Field survey, 2007.

4.2.5.2. Change of yield

Over 40% of the groundnut area as monsoon crop lies in the dry region where the rainfall during the growing season is very irregular and it affect the groundnut yield.

In general, yield level of groundnut in Mandalay division and Magway division is considered as moderate level. From the survey, farmers were asked about the change of yield in last three years from 2005-2007. About 23% of farmers in Mandalay responded that their yield had been increased during last three years while about 37% of farmers in Magway responded the same. In both areas, least farmers stated that their yields have been decreased in the last three years. However, some farmers did not have the records in which their groundnut yields were increase or decrease, especially in Manday where almost a half of farmers could not recognize.

Table 4.10 Change of yields in last three years 2003-2005

Change of yields	Mandalay (n=118)		Magway (n=151)	
	Count	Percentage	Count	Percentage
Increase of yields	27	22.88	56	37.09
Decrease of yields	21	17.80	10	6.62
Same in yields	12	10.17	60	39.74
Farmers can not answer	58	49.15	25	16.55
Total	118	100	151	100

Source; Field survey, 2007.

4.2.6 Socio-economic characteristic of farm households

4.2.6.1. Age of household heads

All respondents were household heads. Most of household heads were male in both divisions. The average age of total household heads was 49 years old in both divisions with the range of 23 years and 83 years in Mandalay and 24 years and 75 years in Magway division. Most farmers have experiences in groundnut production longer than 20 years in both divisions.

The survey results show that the age structure of household head in Magway and Mandalay are similar. Almost a half of the sample household heads are between 30 and 49 years old and about 40-44% of household heads are between 50-69 years (see Table 4.11).

Table 4.11 Age of household heads in Mandalay and Magway areas.

Age of households (years)	Mandalay (n=118)		Magway (n=151)	
	Count	percent	Count	percent
Less than 29 years	4	3.39	6	4.00
30- 49 years	56	47.46	73	48.34
50- 69 years	48	40.68	67	44.37
More than 70 years	10	8.62	5	3.31
Mean	49.30		48.65	
Max	83.00		75.00	
Min	23.00		24.00	

Source; Field survey, 2007.

4.2.6.2. Education of household heads

In general, education is one of the important factors for adoption of new technologies. Usually farmers who have high education level are likely to adopt a new technology to increase their production efficiency.

The education system in Myanmar can be classified into 3 levels. First, the primary school, it takes 4 years to finish primary school. Second is the middle school. It takes 6 years after primary school to finish secondary school. The third level is the high school which takes another 5 years to finish it.

The survey results show that most farmers are in the middle school level. From the mean value, it is shown that they didn’t finish the middle school as the average years in school are 5 years for Mandalay and 7 years for Magway. A few farmers educated at the high school. In average, Mandalay farmers have fewer years in school than Magway farmers (see Table.4.12).

Table4.12. Education of households in two study areas of Myanmar.

Level of education	Mandalay (n=118)		Magway (n=151)	
	count	percent	count	percent
1-5 years (primary school)	34	29	27	18
6-8 years (middle school)	80	68	99	66
9-15 years (high school)	4	3	25	16
Mean (years in school)	5		7	
min	1		4	
max	11		15	

Source; Field survey, 2007.

4.2.6.3. Experience in groundnut production

Farmers were asked how many years they have grown groundnut in their farms. The results show that almost a half of farmers in Mandalay have experience with groundnut production in the range of 11-20 years whereas in Magway, farmers' experience of groundnut production is quite equally distributed from less than 10 years to not more than 40 years. A half of farmer in Magway have experience less than 20 years and another half is more than 20 years (see Table.4.13). However, considering the average years of experience, it is found that farmers have experience in groundnut production about 26 years for Mandalay and 28 years for Magway.

Table 4.13 Experience in groundnut production, in Mandalay and Magway.

Experiences	Mandalay		Magway	
years in GP	No of sample	percent	No of sample	percent
Less than10	13	11	32	21
11-20	51	43	42	28
21-30	35	30	40	26
31-40	16	14	31	21
More than 40	3	2	6	4
Total	118	100	151	100
Mean	26		28	
Max	57		52	
Min	2		2	

Source; Field survey, 2007.

4.2.6.4. Labor force availability

Labor force availability in a household was calculated using adult-equivalent unit. A half of sample household in Mandalay has labor force in the range of 2-4 adult-equivalent units whereas a half of sample household in Magway has labor force more than 4 adult-equivalent units. However, the average labor forces per household of both areas were not so much different that was 4.12 in Mandalay and 4.40 in Magway (see Table 4.14)

Table 4.14. Labor force availability in groundnut production of study areas, Myanmar.

Labor force availability	Mandalay (n=118)		Magway (n=151)	
	No of sample	percent	No of sample	percent
Less than 2	7	5.93	21	13.91
2-4	60	50.85	53	35.10
4-6	42	35.59	62	41.06
More than 6	9	7.62	15	9.93
mean	4.12		4.40	
min	1.00		1.00	
max	9.00		9.50	

Source; Field survey, 2007.

4.2.7. Capital use

In these study areas, groundnut farmers grew the groundnut production cost by borrowing from the agricultural and co-operatives and private lenders. Cost of production for oilseeds is the cost paid for labor, cost of varieties, and input resources. Farmers usually use the capital to invest in the groundnut production including activities such as land preparation, cultural practices, harvesting, and to purse the inputs like seed, cow dung, fertilizers and insecticides.

4.2.7.1 Own capital

Only 11 percent of farmers who produce the groundnut production in Mandalay can afford the production cost by their own capital whereas more than one third of farmers in Magway used their own capital for groundnut production. Most firms in this area needed to borrow money to operate groundnut production because they could not afford the high capital use in their firms. From the survey, it was found that the most firms borrowed money from the Myanmar agricultural development bank at an interest rate of 1.50 percent per month.

The Rural Credit Scheme was implemented by the Myanmar Agricultural Development Bank (MADB) under the Ministry of Agriculture and Irrigation. The Myanmar Agricultural Development Bank gives credit to farmers as seasonal credit for growing crops with a reasonable interest rate.

Table 4.15 Source of capital used for groundnut production in central region of Myanmar

Source of capital	Mandalay (n=118)		Magway (n=151)	
	No of sample	Percent	No of sample	Percent
Own capital	13	11.02	56	37.09
Taking credit	105	88.98	95	62.91
Total	118	100	151	100

Source; Field survey, 2007.

4.2.7.2 Credit access

In the study areas, there are two types of credit which are in cash and in kind. There are several credit sources available for farmers. In Mandalay, most farmers borrowed money from private lenders such as shoppers in the villages, broker-men and crop traders and about 38 percent borrow money from the Agricultural Development Bank of Myanmar (see Table 4.16). In Magway, the proportions of famers borrowed money from private lender and the Agricultural Development Bank are not so much different, about 36-38 percent. Some farmers also borrowed money from the Myanmar pawnshop. Farmers usually borrow cash to purchase inputs for groundnut production such as seed, chemical fertilizer and pesticides in their village. The interest rate from private lender is much higher than from the government bank. They have to pay money back after harvesting with interest rate of 7 to 15 percent per month.

Table-4.16 Source of credit of groundnut farmers in central region of Myanmar

Source of credit	Mandalay (n= 118)		Magway (n= 151)	
	No of samples	percent	No of samples	percent
Agricultural Development Bank	40	38	34	36
Myanma pawnshops	4	4	25	26
Broker men , crops traders , and shopkeepers in village	61	58	36	38
Total	105	100	95	100

Source; Field survey, 2007.

The average amount of credit was 10171.2 kyats per hectare in Mandalay and 8763.3 kyats per hectare in Magway. There were 11 percent of groundnut farmers in Mandalay that took credit more than 20,000 kyat per hectare but 31 percent of farmers in Magway (see Table.4.17). Therefore, the rural credit is imperative role to groundnut farmers in the study areas

Table4.17 Amount of Credit in groundnut production in study areas, Myanmar.

Amount of credit (kyats/ha)	Mandalay (n=118)		Magway (n=151)	
	No.of sample	Percentage	No.of sample	Percentage
Less than 10000	89	75	97	64
10000-20000	16	14	8	5
More than 20000	13	11	46	31
Average		10171.2		8763.3
Max		100000.00		80000.00
Min		0		0

Source; Field survey, 2007.

4.2.8 Extension services

The agricultural extension division is responsible for disseminating information on technical progress to farmers, providing training on crop management, conducting agricultural development programs for hybrid varieties and others.

Firms in the study area had opportunity to access to new technologies through participation in training courses held by the agricultural extension division. As the training courses were not organized regularly, the main source of agricultural information were still from newspapers, agricultural journals, television and radio.

Farmers were asked whether they have received extension services about groundnut production in the study area. The results showed that most of farmers in Mandalay (87.29%) and Magway (66.23%) have not received extension service about groundnut production (see Table 4.18). This showed that agricultural extension services are quite limited in the study area. This may be due to lack of extension staff.

For some farmers who had access to extension service, they might have chance to participate a training program such as training how to apply an available technology more efficiently in their farms (see Figure 4.9 and 4.10). The agricultural extension division also has a program to improve the capacity (ability) of farmers for developing the farmers' analytical skills, critical thinking, and creativity to make better decisions. However, this program is still weak in Myanmar.

Table-4.18 Access to extension services, in Central of Myanmar.

Extension contacts	Mandalay		Magway	
	No of samples	percentage	No of samples	percentage
No contact to	103	87.29	100	66.23
Access to extension	15	12.71	51	33.77
Total	118	100	151	100

Source; Field survey, 2007.

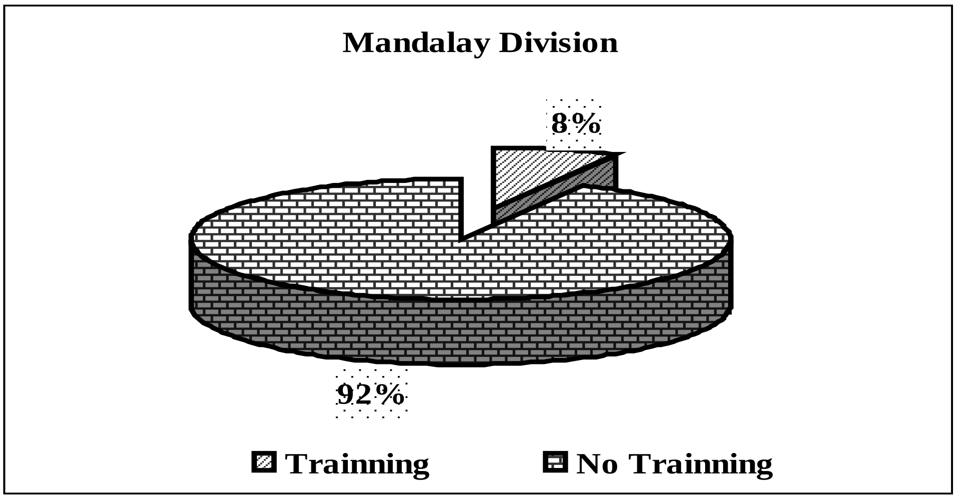


Figure 4.9 Training participation of household heads in Mandalay division, Myanmar.
Source; Field survey, 2007.

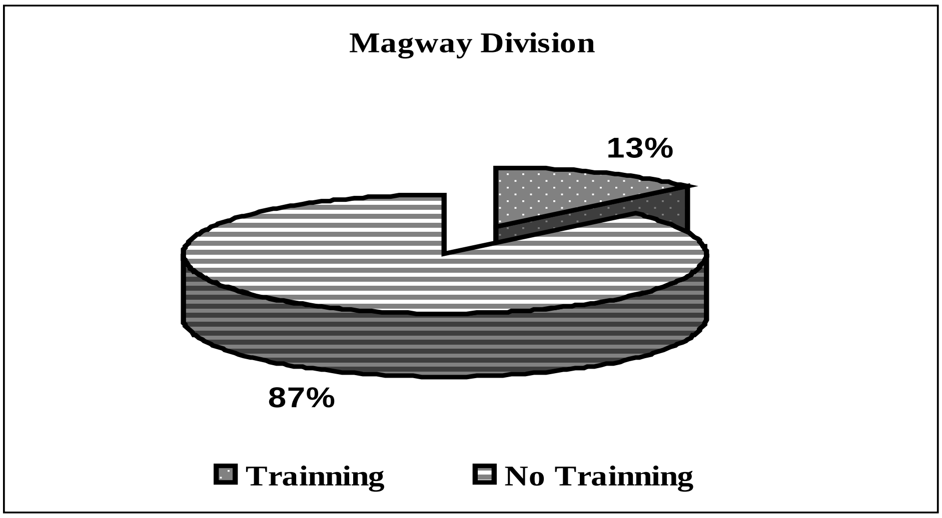


Figure 4.10 Training participation of household heads in Magway division, Myanmar.
Source; Field survey, 2007.

4.2.9. Farmers' view on problems of groundnut production

Farmers were asked about problems of groundnut production. The results showed that most groundnut farmers faced with drought in the crop year 2006-07. This information would help to explain why yield per unit area was not increased over the year. Other problems that farmers faced were pests and disease such as beetles, aphides and leaf spot. Only few farmers had no problem with groundnut production (see Table 4.19).

Table- 4.19 Problems of groundnut farmers in central region of Myanmar.

Sorts of Problems	Mandalay (n= 118)		Magway(n=151)	
	No of samples	Percent	No of samples	Percent
No problems	8	6.78	6	3.97
Drought	86	72.88	117	77.48
Pest and Disease	12	10.17	14	9.27
Both drought and pest, diseases	12	10.17	14	9.27

Source: Field survey, 2007.

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APPENDIX A

QUESTIONNAIRE

Name of interviewed farmer …………… Date of interview………
Name of household head…………
Division………………..
Village……………..
House No. ………………. District…………………

A. Household information.

1. What is the information of your household?

No	Household member	Related with HH	Age	Sex	Years in school	Year in farming	Occupation	Work in farm (Full time)	
								Yes	No
1									
2									
3									
4									
5									

Codes;
Occupation (1) Farming (2) Business (3) Student (4) Government Officer (5) trader (6) Other (specify)

2. How many people in your family work in the farm? Male...... (Persons)
Female..... (Persons)

3. How many people in you family work off-farm? Male........ (Persons)
Female........ (Persons)

B. Land use and land ownership and cultivation.

4. The total agricultural land = ______________ (acre)

plot	Crop	Area(acre)	Ownership	Rent rate	Water source	Soil quality
1						
2						
3						
4						
5						

Notes;
Ownership; 1=own, 2= rent in, 3= rent out,
Water source; 1= rain, 2=irrigation,
Soil quality; 1 = good, 2 = fair, 3 = poor, 4 = very poor

APPENDIX A.1

C. Cropping Pattern.

5. Cropping calendar? (Cropping Pattern)

Plot	Months											
	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
1												
2												
3												
4												
5												

D. Groundnut Production Systems.

1. What is purpose of growing groundnut crops?

☐ 1. Cash ☐ 2. Home consumption ☐ 3.Others (specify)……………

2. Total production area of groundnut =…………………... acre

3. What kinds of seed variety did you use? ___________________

3.1. From where the seed come. ☐ 1. Own ……kg ☐ 2.purchase……... kg

4. Land Preparation.

4.1. Months of land preparation = ………………

4.2. Method of land preparation

☐ 1. Machine ☐ 2. Labor ☐ 3.labor and animal

☐ 4. Others (specify) _________________

4.3. If using machine, please answer following question.

4.3.1. Is it your own machine or rent machine? ☐ 1. Own ☐ 2.Rent

4.3.2. If own, what kind of machine did you use?

____

4.3.3. How much was the cost of machine? ______________ kyats

4.3.4. How many years can it be used? ______________ Years.

APPENDIX A.2

4.3.5. How much did you spend per year for maintenance cost for groundnut production? ____ .

4.3.6 How many days did you used the machine for land preparation for the groundnut production ______________days.

4.3.7. Did you use this machine also for other crop? ☐ 1. Yes ☐ 0.No

4.3.8. If yes, how many days in a year was it used for other crop. _____ days.

4.3.9. How much did you pay for the petrol used with the machine for land preparation? ____________ kyats.

4.4 **Labor use for land preparation.**

4.4.1 Family labor = __________ persons, ____________days.

4.4.2. Exchange labor = ___________ persons, ___________ days.

4.4.3. Hired labor =__________ persona, ___________ days.

5. Cost of Fertilizer in Groundnut Production.

Types of fertilizer	Total amount of fertilizer(bag=kg)	Price of fertilizer (Kyat/bag)	Purchased place	Transportation cost

- Labor use for fertilizer application in groundnut production.

Hired labor = _________________ persons, ___________ days.

Family labor = _________________ persons, ___________ days.

Exchange labor = ________________ persons, ___________ days.

APPENDIX A.3

6. **Cost of Pesticides and Insecticides is used in Groundnut Production.**

Types of insectides,pesticides	Total amount of insecticides, pesticides (specified unit)	Price of fertilizer (Kyat/unit)	Purchased place	Transportation cost

- Labor use for insecticides and pesticides application in groundnut production.

  Hired labor = _____________ persons, ___________ days.

  Family labor = _____________ persons, ___________ days.

  Exchange labor = _____________ persona, ___________ days.

7. Harvesting.

- How many times did you harvest the groundnut? ------------- Times.
- Labor use for harvesting groundnut

  Hired labor = --------------- persona, ------------ days.

  Family labor = --------------- persons, ------------ days.

  Exchange labor = -------------- persons,-------------- days.

- Total yield _________ (kg)

Yield (kg) 2006	Distribution		
	consumption (kg)	Seed for next year (kg)	Amount of sale for total yield (Kg)

Sale of output

- Where did you sell the output? ____________________
- How much in total did you pay for transporting the output to the sale place?

  _______________ kyats.

APPENDIX A.4

- Labor use for transporting

  Hired labor = -------------- persons, ------------ days.

  Family labor = -------------- persons, ------------ days.

  Exchange labor = ------------- persons,------------- days.

- Is there any additional cost for groundnut production? If yes, how much?______kyats

8. Source of money used for Groundnut Production.

8.1. Did you take a credit or borrow money for groundnut production?

☐ Yes ☐ No

8.1.1. If yes, how much did you borrow in total amount of money?

Source of credit	Amount of money (kyats)	Interest rate (%/ month)	How many months did you borrow?

8.1.2. If no, from where did you use the money for groundnut production?

____

8.2. Did you borrow in kinds? ☐ Yes ☐ No

8.2.1. If yes, what did you borrow? _________________________

8.2.2. How did you pay back? ______________________________

9. Assessment of Production Techniques provided by Agricultural Extension Officer

9.1. Do you think do you have enough knowledge for groundnut production?

☐ 1. Yes. ☐ 2. No.

9.1.1. If yes, where did you get the knowledge? _______________________

9.1.2 If no, what kinds of knowledge about groundnut production do you want?

____

APPENDIX A.5

9.2 **Training participation in groundnut production**

9.2.1 Have you ever participated in training course for groundnut production?

☐ 1. Yes ☐ 0. No

9.2.2 If yes, when did you have? ________________ What was the topics?

from which institution? ___________________

9.2.3. Is there any officer come to introduce you about the technique for groundnut production?

☐ 1. Yes ☐ 2. No

9.2.4 If yes, what did they introduce to you? Please, explain;

____

____

____

9.3. Do you follow the suggestion of the officer? ☐ 1. Yes ☐ 2. No

If no, why? ---

9.4. Do you want to be trained for groundnut production? ☐ Yes ☐ No

9.5. What kinds of topic do you want for …..?

10. **Changes of groundnut yield.**

How many years do you have experience in groundnut production? --------- Years.

10.2. What is the trend of the groundnut yield?

☐ 1. Increase ☐ 2.Decrease ☐ 3.Same

1. What was the yield in 2005 ---------------- and production area -------------

10.2.2 What was the yield in 2004 ---------------- and production area ----

10.2.3 What was the yield in 2003 -------------- and production area ------

APPENDIX A.6

10.3 If the yield increased. Can you explain why increased?

10.4 If the yield decreased. Can you explain why decreased?

----

11. Problems of groundnut production.

What kinds of problem do you have?

____

____

Can you solve the problem by yourself? Yes ☐ No ☐

If yes, how? ____

If no, how the problem can be solved? _________________________

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