UNIVERSITY OF CO-OPERATIVE AND MANAGEMENT, SAGAING
DEPARTMENT OF STATISTICS
MASTER OF APPLIED STATISTICS

PADDY PRODUCTION IN PANDAUNG VILLAGE, SHWEBO TOWNSHIP

KHIN THIDAR PYAE
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This is to certify that this paper entitled "**Paddy Production in Pandaung Village, Shwebo Township**" submitted as a partial fulfillment towards the degree of Master of Applied Statistics has been accepted by Board of Examiners.

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ABSTRACT

Paddy production is a major source of employment, income generation as well as nutrition for rural households, and the growth of increasing paddy production is extremely important. The objectives of this paper are to investigate socio-economic characteristics of paddy farmers in Pandaung village, to examine the factors affecting on the income of paddy farmers in Pandaung village and to analyze the factors affecting the paddy production of farmers in Pandaung village. A simple random sampling method was used to select 150 paddy farmers. Descriptive analysis is used to study the socio-economic characteristics of paddy farmers. Multiple regression analysis and Cobb-Douglas production function are applied in this study. The results of multiple regression model show that the more increase expenses of paddy farmers per acre, the more income farmers can earn from paddy production. When the uses of organic fertilizer are increases 1%, the paddy income of that household will increase by 18.8%. When use of threshing machine more increase, the income of paddy farmers per acre will decreases by 23.7%. This result of Cobb-Douglas production function analysis shows that 1% increase in the paddy land applied would increase the paddy production at 0.740% by holding other factors constant. And then, 1% increase of capital could increase the paddy production at 0.171% by holding other factors constant. Therefore, the expenses and uses of organic fertilizer are the most influential factors to increase household's income. And also land and capital are the influential factors to increase the paddy production. Therefore, Department of Agriculture and other concerning institutions should provide to increase paddy production more than currently for training and educational programs which seed production, capacities in mechanization and good agricultural practice.

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LIST OF ABBREVIATIONS

ADP	Agricultural Development Programme
DEA	Data Envelopment Analysis
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
INM	Improved Nutrient Management
IRRI	International Rice Research Institute
ISB	Improved Seedbed Management
MOAI	Ministry of Agriculture and Irrigation
OECD	Economic Cooperation and Development
OLS	Ordinary Least Square
SFA	Stochastic Frontier Approach
SFP	Single Factor Productivity
TFP	Total Factor Productivity
USDA	United States Department of Agriculture
VIF	Variance Inflation Factor
WTO	World Trade Organization

CHAPTER 1

INTRODUCTION

Agriculture remains a dominant economic sector in many developing countries (Anang et al., 2016). Rice is an important economic crop because it is the staple food for a large part of the world's human population, especially in Asia. It is significantly impact on the country's food security. Rice is cultivated in more than a hundred countries with a total cultivated area in 2013 of approximately 162 million hectares by producing more than 700 million tons annually. This volume is approximately around 470 million tons of milled rice. Furthermore, over 90% of the world's rice is produced and consumed in Asia (Hossain and Narciso, 2004).

The major source of income in rural areas comes from rice production. Therefore, rice production is a major source of employment, income generation as well as nutrition for rural households, and the growth of increasing rice production is extremely important. Rice is by far the most economically important food crop in many developing countries, providing two third of the calorific intake of more than 3 billion people in Asia, and one third for nearly 1.5 billion people in Africa and Latin America (FAO, 1995a).

Agricultural ecosystems are important for both humans and animals as they provide food, forage, bioenergy, and medicines (Power, 2010; Saelee, 2017). The majority of global land and fresh water is used for agriculture (Power, 2010; Saelee, 2017). Nearly 40% of the world's surface is used for agriculture (Power, 2010). Two major constraints on agricultural production are the scarcity of farmland and water resources (Power, 2010). Inorganic fertilizer and pesticides have become important factors in increasing agricultural productivity. However, the intensive use of chemical fertilizer and pesticides not only increases agricultural production, but also increases the cost of production and generates severe environmental problems, especially pollution, biodiversity loss, and changes to the ecosystem (Luh and Liao, 2001; Saelee,2017).

The global population is projected to be 9.1 billion by 2050 (34% higher than today), which will result in increased demand for food (FAO, 2009), and Tilman et al. (2011) project that global crop demand will increase 100% - 110% from 2005 to 2050. Thus, the challenge for the future growth of agricultural systems is to simultaneously produce enough food to accommodate the demand of future growth.

Rice is a critical issue in the developing countries in the world and nearly half the world's populations are dependent on rice for survival. Much of the population in Asia consumes rice in every meal (Jirawut, 2012).

1.1 Rationale of the Study

Agriculture plays a major role in Myanmar’s society by ensuring food security, at both the community and national levels, as well as providing employment and income for a growing population. Among agricultural crops, rice plays an essential role not only in food security but also in the nation’s economic development. In 2016-2017, rice production was reported at more than 19 million metric ton, and the country’s exports were 1.5 million metric ton (USDA, 2017), which was worth about USD 439 million in 2016 (WTO, 2018). The country’s average rice yield amounted to about 3.84 metric ton per hectare (metric ton /ha), while the yield of Southeast Asian countries like Vietnam was about 5.58 metric ton /ha in 2016 (FAO, 2017). In 2016, Myanmar was ranked seventh among paddy producing countries in the world (Statista, 2017). However, rice yield and production in Myanmar remain low compared to neighboring countries, which poses a high potential for productivity increases (Zorya, 2016). Rice, paddy production of Myanmar went down by 4.45 % from 26,269,814 tons in 2019 to 25,100,000 tons in 2020. Since the 3.87 % climb in 2018, rice and paddy production dropped by 8.97 % in 2020.

Myanmar is a typical agriculture country, and possesses moderately natural resources which have underpinned the agricultural production (Tun and Kang, 2015). According to the published data in 2012, agricultural sector contributed 13.7% of total export earnings, shared GDP accounted for 37.8%, and employed 61.2% of the labour force in Myanmar (Department of Agricultural Planning, 2012). Several agricultural products have been produced abundantly, due to the various agro-ecological conditions and large land area of Myanmar. Among them, rice is the major crop for both economy and food security of the country (Tun and Kang, 2015). Therefore, efficient rice production would give more income and export revenue for the country because paddy production alone accounted about 35% of the total crop area in Myanmar. It would in turn allow Myanmar to make an important step for construction of a developed country through reducing poverty, improving food security for all farms, fostering a more dynamic rural sector and making agriculture as a dynamic contributor to the national economy (Tun and Kang, 2015). Surely, all of these outcomes will be achieved only after framing and executing more effective policies at the sectorial and national levels (Tun and Kang, 2015).

Myanmar is an agricultural country that country's economy is mainly depending on exporting agricultural products to other countries. It is also a country which is rich in natural resources. The development of economy plays a vital role in building a modern and developed nation. In Myanmar, the basic economy is agriculture. Agriculture is a conventional business which has been done since the time of forefather.

As the development of country's economy is mostly depending on the development of agricultural sector, implementing the availability of sufficient edible crops for the increasing population plays an important role. The agricultural sector is an important part for the economy of Myanmar.

Paddy is grown in monsoon and summer seasons with cultivated acres of 19 million or 33% of total crop sown areas. Monsoon rice is grown in 16 million acres and summer paddy is grown in 3 million acres (Hlaing, 2014). The total production of rice is 31.45 million tons including average production of 25.80 million tons from monsoon paddy and 5.65 million tons of the summer with an average production of 3.93 tons ha-1 (MOAI, 2010). Paddy yields (4 tons ha-1) in Myanmar are lower than in many other Asian countries such as Japan (6.7 tons ha-1) and Vietnam (5.7 tons ha-1) (FAO, 2014). The major agronomic and environmental factors stagnating in growth and yield are thought to be mismanagement in the use of inputs such as fertilizer application, lack of potential varieties, and poor-quality seeds. Among these factors, fertilizer application is one of the most important variables affecting growth and yield (Muhammad, 2008).

Farming is the major employment in rural areas of Myanmar and a greater portion of rural communities' income is derived from agriculture. It contributes 22.1% of GDP and employs 61.2% of the labour force in 2014-2015 (MOAI, 2015). However, average crop production per hectare is still low due to poor soil, inadequate water supply, improper application of fertilizers, infestation by the pests, and lack of technical know-how on crop production. Therefore, farmers' income is very low and farmers face limitations, such as timely and appropriate field operations and the input like quality inputs such as seeds, labour, pesticides and fertilizer with high labour use and poor support of agricultural services (World Bank, 2016). On the other hand, irregular rainfall patterns, poor natural resources management, and increased rural population are creating land degradation and fragile biophysical environment resulting in a decrease of crop yield (Helvetas, 2015). Therefore, there are a number of local and international organizations like the International Rice Research Institute, Myittar Foundation that are helping to improve the income of Myanmar farmers by sharing technology and knowledge about inputs and crop cultivation practices.

In Myanmar, many kinds of crops such as paddy, wheat, cotton, various beams and pulses and other oilseeds are cultivated. Among them, paddy plays an important role because almost everyone is using rice as an essential ingredient for cooking and it is the essential foods which are consumed every day by the Myanmar people. Myanmar is depending mainly on agricultural sector, the government is striving its effort to expend cultivable land and improve the yield of crops per acre. Moreover, the government is also carrying out the projects by using modern technologies for expending cultivable land, sufficient water for cultivating and raising the yield of crops per acre.

Paddy is Myanmar’s most important agricultural commodity. Both small and large farms in Myanmar produced monsoon paddy as the crop, through Myanmar paddy production has fluctuated substantially in recent years, over 27 million tons produced in 2019, and Myanmar accounted for more than 3 million metric tons of milled production in this year. The largest paddy production in Myanmar is in the Ayeyarwady Delta, according to the Department of Agriculture, the Ayeyarwady, Bago and Yangon regions make up more than half of the country’s harvested rice area. Myanmar’s major paddy ecosystem includes rainfed lowland paddy, irrigated lowland paddy, deep water paddy and upland paddy.

Rice is not only the main food in Myanmar traditionally diet but also one of the major foods for export. It occupies about 40% of the total agricultural area and is grown on over 8 million hectares (MOAI, 2014). The country’s average yield is about 4.1 tons per hectare (MOAI, 2010). The major limiting factors for Myanmar rice production are low seed quality and other agronomic practices such as inappropriate soil, water, nutrients, pest and diseases management (Naing et al., 2008). Not only rice has been the focus in the history of Myanmar economic development but also Myanmar's Paw San rice is one of the world's most recognized high-quality rice. It can be seen that there is the most cultivated land of Paw San in Shwebo district.

Shwebo has attained national farm for Paw San, the premium paddy of choice across Myanmar. First grown by a local farmer, Paw San has a distinctive fragrance and taste, leading it to surpass the Irrawaddy region-cultivated Paw San as Myanmar's most favored paddy. Shwebo land is suitable for irrigated paddy, the cultivation rate of which has increased after Thaphanseik Dam was built in 2003 (Thiha, 2019). There are about a million paddy fields in Shwebo, which is among the main producers of high-grade Paw San paddy in Myanmar (Thiha, 2019). There are about 300,000 acres worth of paddy fields in Shwebo that harvest only the Paw San variety (Thiha, 2019).

In the Shewbo district, rice is the mostly grown crop during the monsoon season. Farmers in Shwebo areas usually face water scarcity due to drought, and poor drainage system in conducting farmer’s activities. Therefore, it is hard to get the optimum yield and the income of the farmers was low. According to the results of the field research conducted by the International Rice Research Institute (IRRI), farmers can get more yield and income by choosing suitable varieties Paw San, Ayeyarmin, together with good cultivation practices such as improved seedbed management (ISB) and improved nutrient management (INM). On the other hand, it is important to get the appropriate technologies and knowledge to the farmers. Therefore, it is an urgent need to study the cultivation practices, productivity, and income and profits of rice farmers.

In this thesis, the condition of paddy production in Pandaung village, Shwebo township, Sagaing region is studied with statistical methods. The people of Pandaung village do agriculture as a major business. It can be said that agriculture is the life blood of Pandaung because most of the households are depending mainly on the agriculture. The farmers in Pandaung village mainly grow rice. Therefore, the village can increase income by selling paddy in wholesale center in Shwebo township.

1.2 Objectives of the Study

The objectives of the study are

(i) to investigate socio-economic characteristics of paddy farmers in Pandaung village

(ii) to examine the factors affecting on the income of paddy farmers in Pandaung village

(iii) to analyze the factors affecting the paddy production of farmers in Pandaung village.

1.3 Methods of Study

This study is based on the primary data to find production function of the paddy production in Pandaung village, Shwebo township by using household questionnaires with simple random sampling method. Descriptive analysis is used to study the socio-economic characteristics of paddy farmers. Multiple regression analysis and Cobb-Douglas production function are used to analyze factors affecting of paddy production in Pandaung village.

1.4 Scope and Limitations of the Study

The total households in Pandaung village are 330 households. There are 240 paddy growing households in Pandaung village. Among them, 150 households are selected by using simple random sampling to obtain the required data. Multiple regression analysis is used to examine the factors affecting on the income of paddy farmers in Pandaung village. There are various methods to find the production function. These methods are fixed proportion production function, variable proportion production function, linear homogeneous production function, Cobb-Douglas production function and constant elasticity of substitution. Among them, Cobb-Douglas production function is used in this study.

1.5 Organization of the Study

The study is divided into five chapters. Chapter 1 is introduction which is comprised of five sub-headings: rationale of the study, objectives of the study, method of study, scope and limitations of the study and organization of the study. The literature review is presented in Chapter 2. Methodology has been described in Chapter 3. Chapter 4 is analysis of paddy production in Pandaung village. And the last Chapter 5 discusses the conclusion based on findings and suggestions.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews both theoretical and empirical literature on the analysis of paddy production.

2.1 Theoretical Review

The focus of theoretical review is on theory rather than on application. The theoretical literature review of definition of production, definition and measurement of agricultural productivity, factors that influence agricultural productivity such as land area, labour and capital are as follows:

2.1.1 Definition of Production

Production is activity to combine various inputs to produce output. According to Ari Sudarman in Iskandar (2004), commonly the production processes are utilized variety of inputs or production factors.

Production is the organized activity of transforming resources into finished products in the form of goods and services; and the objective of production is to satisfy the demand of such transformed resources (Bates and Parkinson, 2019).

Production is any activity directed to the satisfaction of other peoples' wants through exchange (Hicks, 2019). Production is the process of coordinating and regulating inputs to create output goods or services (Mai Ngoc Cuong, 1997).

Production is the process of making or manufacturing goods and products from raw materials or components. In other words, production takes inputs and uses inputs to create an output which is fit for consumption- a good or product which has value to an end-user or customer (Carbon Collective, 2021).

2.1.2 Definition and Measurement of Agricultural Productivity

Productivity is generally defined as the ratio of output to input (OECD, 2001). Usually, inputs and outputs are measured in a standard unit. For agricultural productivity, it is the value of agricultural output per unit value of input(s) employed in production (OECD, 2001).

Agricultural productivity measures are twofold, such as single factor productivity (SFP) and total factor productivity (TFP) (Wiebe et al, 2001; OECS, 2001). Single factor productivity measure is a measure of output to one input and total factor productivity is a measure of output to a collection of inputs (Wiebe et al., 2001). Land productivity is the most common indicator of agricultural productivity and is defined as the quantity of output per unit land area employed in the production of a given agricultural product (Wiebe et al., 2001). Conversely, labour productivity is the quantity of agricultural output per unit of labour used in production. Another important measure of agricultural productivity is gross profit although it is not very common in the literature because of unavailability of data required for its computation (Kelly and Murekezi, 2000).

2.1.3 Factors of Agricultural Productivity

The factors influencing the productivity of a farmer can be divided into three, namely the physical inputs employed (capital, land and labour), characteristics of farm and farmers and factors that are external to the farmer such as climatic conditions as well as government and institutional policies (Wiebe et al., 2001). Capital inputs employed consist of herbicide, fertilizer, seed, pesticide as well as farm tools and implements. On the other hand, characteristics of the farm and farmer comprise factors such as topography and size of land cultivated, distance of farm from input and output markets, level of education, age, gender, family size, access to credit and extension contact. Soil conditions and weather factors including temperature, rainfall and humidity constitute the climatic conditions (Michele, 2001).

Fertilizer is one of the important inputs in crop production, especially paddy. It has been confirmed by most studies in developing countries to have a positive significant effect on crop productivity (World Bank, 2007), even though there are mixed results on the influence of fertilizer on total revenue (Kelly, 2006). Agricultural productivity studies by Reardon et al (1997), Evenson and Mwabu (1998), Strasberg et al (1999), Fan and Chan-Kang (2005) and Tittonell (2007) revealed that there was a positive relationship between fertilizer input and crop productivity. Decisive factors of paddy production are land area, labour and capital.

(i) Land Area

Land area was one important factor because the remuneration received from the land is very large when compared to other factors. High or low of land rent are caused by the difference in soil fertility (Mubyarto, 1989). In additionally, Von

Thunen's theory stated that a location is a dependent variable that affects various other independent variables, such as urban growth, economy, politics, and community culture (lifestyle). This theory is based on area of residence is agricultural land. On the other hand, the assumptions in this theory in analyzing the location of agricultural activity based on the lease of land such as approaching the city center or where the concentration of demand, then the lease of land will higher. Land rent determined by the productivity of the land or the ability of the land to produce output by issuing a certain amount of cost and the cost of transport.

In agricultural, especially land production factors have the most important position in view of the size of the remuneration received by the land when compared to other factors of production. High and low repayment received by the land almost same as with another production factors, such as capital and labour. It's been seen from profit sharing rents in accordance with the demand and supply of land or land in certain areas. In additionally, other interesting things in form of ownership land in agricultural production are not only recognized as individual land, but also joint land or village land. Village land is alleged as joint capital to be cultivated jointly for the common good. Therefore, every villager has right to control land in villager's territory which is called ownership right and communion right.

Land is the factor of production not only of importance to agriculture but also importance for industrial and service production. Land is a fixed element again limited by size, so people have to invest more capital and labor in an area to improve the efficiency of land use. Other types of underground resources such as minerals, forest resources and marine resources. Therefore, proper and adequate land use will increase the productivity and efficiency of land use in production.

(ii) Labour

Labour in agriculture must be differentiated into labour issues in smallholder farming and labour issues in large-scale agricultural enterprises, such as plantations, forestry, livestock, etc. (Mubyarto, 1989). The differentiation of the definition of labour is very important, considering that labor in farming cultivation is not similar as labour in big companies, such as plantation labour. In farming cultivation, most of labour comes from within family member of the farmers. That labour is family's contribution in agricultural production as a whole without paying with money. But sometimes farming cultivation still pays additional labour. For instance land cultivation, both in livestock farming or direct labour. The labour use is declared by amount of labour. Work scale will affect requirement of labour. In deciding labour use in family scope does not need experts. Meanwhile in scale-large agricultural enterprises utiling more skilled labour (Sukartawi, 1989). Progress of a country also greatly determines productivity of labour. If in developed country the labour factor is a limited number of inputs, then in a developing country like Indonesia, the labour is abundant when compared to capital and land. Facing it, necessary to use machinery or technology to improve labour productivity and agriculture in general.

An important element of the production process, all production activities are determined by human labour, especially those with technical skills, experience and good skills. Therefore, the quality of labour determines the result and the efficiency of production.

(iii) Capital

Capital was in second position after land area as the most important production factor in agricultural in terms of contributing to production value (Mubyarto, 1989). In economic sense, capital is goods or money all together with land and labour to produce new goods, in this case is agriculture's yield. Capital can be divided into several categories, as like (i) own capital (equity capital), (ii) loan capital (credit), (iii) physical capital, (iv) human capital, and (v) technology. There are differences between human and physical capital. The importance of capital role as it can help to increase agricultural production. However not many people know that increasing of skill and farmer's ability will be increasing farmer's productivity.

The production capital includes machinery, equipment, transport, warehouses, infrastructure and technical. Capital plays a decisive role in the scale of production and the investment role of enterprises in production. In the case of a constant yield, increasing the total amount of capital will increase the yield. With the large capital resources, producers have the ability to expand production in the right conditions and can increase investment in science and technology and apply it to production, helping rapidly production developing.

2.2 Empirical Review

The empirical reviews of the study is shown in Table 2.1

Table 2.1 Empirical Reviews of the Study

Author	Title	Objectives	Methodology	Finding
Abeysekara (1976)	Production Function Analyze of Paddy Farming in Sri Lanka	The main objective is to analyze the economics of production on paddy farmers in Sri Lanka and ascertain in the nature of corrective measures for increasing paddy output in the major area.	Production function analysis was applied in this study. Factors shares and least squares regression methods were used to estimate production function.	This paper results showed that the paddy output can be increased by more intensive application of fertilizers and labour.
Gelaw & Bezabih (2004)	The Analysis of Technical Efficiency of Wheat Production in Ethiopia	The main objective is to analyses efficiency of farmers in the production of wheat using cross sectional data collected from 120 sample farmers.	The Cobb-Douglas production frontier model estimated with inefficiency variables show that size of the plot, amounts of DAP, Urea, and seed inputs significantly explained the frontier.	Identification of the determinants of efficiency shows that sharecroppers and those farmers who managed a large number of fragmented plots were less efficient.
Kuria (2004)	An Economic Analysis of Rice	The broad objective is to carry out an economic	Data collected was fitted to a stochastic frontier production function model of the	The results of the study showed that labour, mechanized tractor power,

Author	Title	Objectives	Methodology	Finding
	Production in Mwea Irrigation Scheme	analysis of rice production in Mwea Rice Irrigation Scheme.	Cobb-Douglas type. Regression coefficients and farm specific technical efficiency levels were estimated using the Maximum Likelihood Estimate (MLE) technique.	chemical fertilizer, pesticides, seeds, land and irrigation water significantly influenced rice output.
Inthavong (2006)	Analyzed the Factors Influencing Rice Production Efficiency in Ban Home, Laos.	The main objective is to identify important technical and economic factors in order to suggest strategies of sustainable agriculture in Ban Home and to improve the standard of living of farmers.	Cobb-Douglas frontier production function was estimated for each season using two approaches, deterministic and stochastic.	During the wet season, several factors were statistically significant and positive effect on rice yield: area in rice production, level of fertilizer use, total labor, the use of a modem variety, sandy soil and contact with a professional agricultural advisor. During the dry season, only area in rice production and fertilizer were significant.
Abedullah et al. (2007)	analysis of technical efficiency of	The key objective is to estimate technical	The Cobb Douglas stochastic frontier production function	The results of stochastic production function indicate that

Author	Title	Objectives	Methodology	Finding
	rice production in Punjab (Pakistan): Implications for future investment strategies.	inefficiency of rice farmers that could contribute in explaining the yield gap and to determine the role of institutes in improving technical efficiency and rice productivity.	model was used to analyze data.	coefficient of pesticide is non-significant probably due to heavy pest infestation while fertilizer is found to have negative impact on rice production mainly because of improper combination of N, P, and K nutrients. The results of inefficiency model suggest that investment on tractor (mechanization) could significantly contribute to improve farmer's technical efficiency.
Dharmasiri & Datye (2011)	The Cobb-Douglas Function for Analyzing the Process of Agricultural Production: A Case Study from Sri Lanka.	The objective is to examine from different perspectives, such as producitivity of land, labour and capital.	Cobb-Douglas production function has been used in the analysis of agricultural production process.	Cobb-Dougles Coefficient results, there is a positive relationship between the market price of crop production and its yield and there is no significant relationship between the harvested area and the yield.

Author	Title	Objectives	Methodology	Finding
Nwaobiala & Adesope (2013)	Economic Analysis of Small Holder Rice Production Systems in Ebonyi State South East, Nigeria.	This study tends to analyze the economics of smallholder rice production systems in Ebonyi State, Nigeria.	The four functional multiple regression models were employed to select the one that has provided the best fit.	The Cobb Douglas regression estimates of the determinants of output of Swamp rice showed that the coefficients of education, labour cost, farm size, variable inputs and farm income were positively signed and significant at given levels of probability as well as capital inputs which was negative.
Htwe (2014)	The Technica l Efficiency and Profitab-ility of Rice Production: A Case Study in Thazi Township, Mandalay Region.	The main objective is to examine the factors affecting technical inefficiency of rice farmers.	The stochastic frontier production function method was applied to estimate the technical efficiencies of the two farmer groups.	In the estimation of the stochastic frontier production, the elasticity of frontier production in respect to the variable 'seed rate', there is a positive and statistically significant influence on rice yields.
Mustefa Buti (2014)	Economic Efficiency in Barely Production: the Case of	The objective is to analyze the economic efficiency of barley production	Cobb-Douglas production function was fitted using stochastic production frontier approach to	The results indicated that there was a significant inefficiency in barley production in the

Author	Title	Objectives	Methodology	Finding
	Chole District, East Arsi Zone, Oromia National Regional State, Ethiopia.	in Chole district.	estimate technical, allocative and economic efficiency levels, whereas Tobit model was used to identify factors affecting efficiency levels of the sample farmer.	study area.
Tun & Kang (2015)	An Analysis on The Factors Affecting Rice Production Efficiency in Myanmar.	The objective is to obtain a better understanding of the current rice production condition in Myanmar through efficiency analysis, especially, to examine the impact of farm mechanization on production efficiency.	This paper used both the data envelopment analysis (DEA) and the stochastic frontier approach (SFA) with variable returns to scale on Myanmar rice production.	the estimated results from non-parametric approach indicate that the inefficient samples farmers can improve the rice production efficiency to catch up the efficient sample farmers in these regions.
Mokgalabone (2015)	Analyzing the Technical and Allocative Efficiency of Small-Scale Maize Farmers in	The aim of the study was to analyse the technical and allocative efficiency of small-scale maize farmers in	This study employed the Cobb-Douglas production function and the logistic regression model to analyze data.	The Cobb-Douglas production function results revealed that small-scale maize farmers in Tzaneen municipality are technically efficient in the production of

Author	Title	Objectives	Methodology	Finding
	Tzaneen Municipality of Mopani District: A Cobb-Douglas and Logistic Regression Approach.	Tzaneen Municipality.		maize with the highest mean technical efficiency value of 0.71%.
Wongnaa (2016)	Economic Efficiency and Productivity of Maize Farmers in Ghana.	The main objective of this study is to investigate the factors that influence use of productivity enhancing technologies and economic efficiency of maize farmers in Ghana.	Multinomial logit model and the stochastic frontier production function were used.	The study revealed that an increase in educational level, credit, extension contact, experience, price of maize, group membership and ready market would increase use of maize productivity enhancing technologies. Also, fertilizer, pesticides, manure, herbicide, seed and land inputs were found to be positively related to maize output.
Kummanee et al. (2018)	Input Factor Affecting Rice Seed Production in Thamai Sub-	The objectives of this study were to determine existing condition of rice seed	Cobb-Douglas production function by means of ordinary least square (OLS) was employed to test	The findings of OLS analysis confirmed that the positive combination input factors affecting rice

Author	Title	Objectives	Methodology	Finding
	District, Nakhon Sawan Province, Lower Northern, Thailand.	production in the study areas and also input factor affecting rice seed production.	the hypothesis of input factor affecting yield.	seed production were fertilizer and rice seed land at the statistically significant level of 0.001 and 0.01, respectively.
Lama (2018)	Agricultural Productivity and Its Determinants in Arunachal Pradesh: An Application of Cobb-Douglas Type Production Function.	The objectives are to analyse the trend and growth in productivity of different crops, to identify various inputs used in hill agriculture and to estimate the elasticity of output with respect to inputs used.	The Cobb-Douglas type production function was applied to analyse the relationship between output and inputs.	The results showed that outputs of crops were responsive to both manure and fertilizer.
No No Aung (2019)	The Rice Production and Use Among Beneficiaries and Non-Beneficiaries of the Gulf of Mottama Project, Myanmar	The objectives of this paper are to explore current situation of rice production and socio-economic characteristics and to asses the rice cultivation practices, constraints faced on rice	Descriptive analysis, multiple linear regression analysis was used for data analysis.	There was no significant influence of establishment methods, use of herbicide and seed rate on rice productivity.

Author	Title	Objectives	Methodology	Finding
		production, rice yield, profit of GOMP project beneficiary and non-beneficiary household.		
Assaye et al. (2020)	Technical Efficiency of Lowland Rice Production in Northwest of Ethiopia.	This study aims to fill the paucity of information pertaining to the level and determinants of farm-level technical efficiency of a sample of small-holder rice producers in Ethiopia by taking the case of the Amhara region.	The econometric model, stochastic frontier approach (SFA) that takes the log-linear Cobb-Douglas production form was used to estimate the production function.	The results of the study showed that soil fertility is a crucial factor in determining the technical efficiency of rice producers.
Sary et al. (2020)	The Factors Influencing the Rice Production of Farmers in Rural South-Eastern Cambodia.	The main objective is to analyze inputs of dry seasons rice production and to determine the main factors influencing the growth in rice yield and productivity.	The Cobb-Douglas production function was applied.	The findings show that seed, fertilizer, hire labor and income off-farm are a major determinant of paddy in both seasons.

Author	Title	Objectives	Methodology	Finding
Zevaya (2021)	The Analysis of Rice Production in Rice Production Center Area Muaro Jambi Regency.	This research aims to analyze the determinants affecting rice production in rice production center area Muaro Jambi Regency.	Data analysis used multiple regression and Cobb-Douglass function to calculate efficiency of economy and decisive factors that affecting rice production.	The results show that land area, seeds, and fertilizer are significant factors in influencing rice production in rice production center area Muaro Jambi regency.
Saepudin & Amalia (2022)	Analysis of Rice Production Approach to Cobb Douglas Production Function in Tambakdahan Sub-District Subang District.	This study aims to determine the effect of land area ownership, use of labor, use of seeds, fertilizers, and technical irrigation (irrigation) on rice production and the scale of business results.	Cobb Douglas production function is used.	The results of this study indicate that the three input variables have significant influence, namely, ownership of land area, fertilizers used, and technical irrigation (irrigation) on rice production, for the use of seed input, and technical irrigation (irrigation) have a positive effect, while the input of land area ownership has a negative impact.

Source: Various Studies

CHAPTER 3
METHODOLOGY

This chapter provides the methodology used for the analysis of paddy production in Pandaung village, Shwebo township.

3.1 Description of the Study Area

The study is conducted in Pandaung village of Shwebo township, Sagaing region. It is situated over 3 miles south of Shwebo township. The area of Pandaung village is 24 acres. Pandaung village has 330 households. Among them, there are 240 households that grow paddy. The cultivated area of the village is 1200 acres. The most of the households are paddy farmers. To the south of Pandaung village is Phwint Hlaing village and to the north is Taung Tin village.

3.2 Determination of Sample Size

There are several approaches to determining the sample size based on the following criteria. They are the level of precision, the confidence or risk level and the degree of variability in the attributes being measured. Among them, the level of precision criteria is used in this study. The following formular represents, the sample size (n) from the population size.

Yamane (1967) suggested another simplified formula for calculation of sample size from a population which is an alternative to Cochran's formula. According to him, for a 95% confidence level and p = 0.5, size of the sample should be

$$n = \frac{N}{1+Ne^2} \qquad (3.1)$$

where, N is the population size

e is the level of error.

$$n = \frac{240}{1+240(0.05)^2} = \frac{240}{1.6} = 150$$

The above result is that sample is 150 from the total population households of 240 which the lower number of responses from the respondents to maintain a 95% confident interval.

After calculating the representative sample size, the main aim of an investigator is to find the proper method of selecting samples. Sampling is simply the process of learning about the population on the basis of sample collected from the population. Sample is constituted by a part or fraction of the population. Thus, in the sampling technique, instead of every unit of the population, only a part of it is studied and the conclusions are drawn for the entire population on the basis of the sample.

3.3 Research Design

This study used a descriptive research design and a survey research design to examine the analysis of paddy production approach to Cobb Douglas production function. When it combines observation, household research of relevant documents and literature, and in- person interview, it can get more in-depth information. A household survey appears to be a rather simple ways to gather meaningful information., and the statistical data collected can more actually represent the survey findings.

This is one of the fundamental justifications for selecting quantitative research as the main research method. This thesis conducted a further qualitative study based on the quantitative analysis. The study conducts inconspicuous observation and had a few brief chats with a random sample of 150 paddy farmers from 240 paddy farmers household during the process of completing the questionnaire.

3.4 Methods of Data Collection

Various types of sample design exits. Simple random sampling, stratified sampling and cluster sampling, are the most widely used in sampling design. This research utilizes a simple random sample technique for the analysis of data collection. Data for this survey were collected through field research. The information was gathered by a questionnaire survey to get the most observation, in 2019.

The questionnaire was constructed by analyzing preceding research literature in order to analyze of paddy production among rice farmers as well as the current environment of the study area. The socio demographic profile of the respondents, which included gender, age and occupation, which was concerned with examining the analysis of paddy production. The respondents chose one of the options as one’s view of each question.

A standardized questionnaire, which was hand-delivered to 150 houses by one of the investigations throughout the months of June 2019, was used to collect the data. The well- trained student interviewers provided the person answering the door a brief summary of the study and extended an invitation to participate. Each household was limited to one participant due to the likelihood of shared opinions among members of the same household. 150 paddy farmers households out of 240 paddy farmers households were surveyed and responded positively and agreed to participate.

3.5 Methods of Data Analysis

The data were analyzed by multiple regression model and Cobb-Douglas production function.

3.5.1 The Multiple Linear Regression Model

The multiple linear regression models are an extension of a simple linear regression model to incorporate two or more independent variables in a prediction equation for a response variable. The use of two or more independent variables regression analysis is an extension of the basic principles used in two-variable regression analysis. It is necessary to determine the equation for the average relationship between the variable.

The multiple regression models with k independent variables is

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2+}\beta_3 X_{i3} + \cdots + \beta_k X_{ij} + \varepsilon_i, \qquad i = 1,2,\ldots,n \qquad (3.2)$$

Where

Y_i = value of the dependent variable in the i^{th} observation

β_0 = intercept

$\beta_{1,}\beta_{2,\ldots\ldots,}\beta_k$ = regression coefficient associated with each of the X_{ij}, k independent variables

X_{ij} = value of the j^{th} independent variable in the i^{th} observation

e_i = random error terms

It is often more convenient to employ matrix nation:

$$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{e} \qquad (3.3)$$

Where

Y is a n x 1 vector:

$$Y = \begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix}$$

X is (k+1) x 1 vector:

$$X=\begin{bmatrix} 1 & x_{11} & \cdots & x_{1k} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & \cdots & x_{nk} \end{bmatrix}$$

β is (K+1) x 1 vector:

$$\beta=\begin{pmatrix} \beta_0 \\ \vdots \\ \beta_k \end{pmatrix}$$

e is n x 1 vector:

$$e=\begin{pmatrix} e_1 \\ \vdots \\ e_n \end{pmatrix}$$

(i) The Coefficient of Multiple Determination (R^2)

The coefficient of determination or R^2, w hich is based on the ANOVA table's sum of squares, can be calculated by using the error sum of squares (SSE) or regression sum of squares (SSR), and total sum of squares (SST). The coefficient of multiple determinations is defined as:

$$R^2 = 1 - \frac{\text{SSE}}{\text{SST}} \tag{3.4}$$

or equivalently

$$\text{R}^2 = \frac{\text{SSR}}{\text{SST}} \tag{3.5}$$

The coefficient of determination R^2 measures the variation in Y that is explained by the independent variable X in the simple linear regression model. In multiple regressions, the coefficient of multiple determinations represents the proportion of the variation in Y that is explained by the set of independent variables. The value of coefficient of multiple determinations will be between zero and one.

(ii) The Adjusted Coefficient of Multiple Determination (${R_{adj}}^2$)

In multiple regressions, it is generally possible to increase the coefficient of determination $R^2$by including additional predictors. To prevent from over fitting of the model, an adjustment can be made in the R^2 statistics to penalize the inclusion of useless predictors. The adjust coefficient of determination using n observations and k predictors is

$$\bar{R}^2 = \frac{\sum(y_i-\hat{y})}{n-k-1} \Big/ \frac{\sum(y_i-\bar{y})}{n-1} \tag{3.6}$$

${R_{adj}}^2$ is always less than or equal to R^2. Reporting the adjusted R^2 is extremely important in comparing two or more regression models that predict the same dependent variable but have a different number of independent variables.

(iii) Test of the Overall Significance of a Multiple Regression Model

In multiple regression analysis, one is often concerned with the nature and significance of the relation e between the dependent variable and independent variables. One needs to find out the relative importance of the effects of the different independent variables and the magnitude of the effect of a given independent variable on the dependent variable.

The F test is used to determine whether there exists a significant relationship between the dependent variable and the entire set of independent variables in the model. The overall F-test is used to test for the significance of overall multiple regression models. The ANOVA producer tests the null hypothesis that all the βvalues are zero against the alternative that at least one β is not zero.

Table 3.1 ANOVA Table for General Linear Regression Model

Source of variation	Sum of Squares	Degree of Freedom	Mean Square	F
Regression	SSR=$\sum(\widehat{Y}_1-\bar{Y})^2$	k	MSR=$\frac{SSR}{k}$	${MSR}/{MSE}$
Residual	SSE=$\sum(Y_i-\widehat{Y}_\iota)^2$	n-k-1	MSE=$\frac{SSE}{n-k-1}$	
Total	SST=$\sum(Y_i-\bar{Y})^2$	n-1		

$$F = \frac{\text{MSR}}{\text{MSE}} \tag{3.7}$$

SSR = Regression Sum of Squares

SSE = Error Sum of Squares

SST = Total Sum of Squares

k = the number of independent variable in the regression model

n-k-1 = the degrees of freedom for residual

MSE = the mean squares of error

MSR = Mean Square Error

If F≥ $F_{\alpha,k,n-k-1}$, reject $H_{0,}$ otherwise H_0 do not reject it, where $F_{\alpha,k,n-k-1}$ is the critical F value at the α level of significance and k numerator df and (n-k-1) denominator df.

If the null hypothesis is rejected, it can be concluded that one or more of the parameters in the model is not equal to zero. Thus, the overall relationship between the dependent variable Y and the independent variables $X_1,\ X_2, \dots, X_k$is significant. However, if the null hypothesis is not rejected, it can be concluded that there is an overall significant relationship and estimated regression equation cannot explain the variation in the dependent variable.

(iv) Test of Individual Partial Regression Coefficient, $\boldsymbol{\beta_j}$

A t- test is a common way of hypothesis testing. In regression it is used to confirm whether the covariates x_i are significant. More precisely the aim in backward elimination is to find a model where all covariates are significant. Hence, the t- test is done for each individual covariate.

In a test, the null hypothesis$H_{0,}$ is that the covariate x_j is explanatory for the dependent variable and thus the respective coefficient β_j is zero. The alternative hypothesisH_a is that the coefficient explains a part of the dependent variable and thus β_j is not zero.

The t statistics for$\widehat{\beta_J}$ are simple to compute given $\widehat{\beta_J}$ and its standard error:

$$t = \frac{\widehat{\beta_J}}{\mathrm{Set}(\widehat{\beta_J})} \quad (3.8)$$

If $\lfloor t \rfloor \geq t\alpha/_{2,n-k-1,}$reject H_0 do not reject it, where $t\alpha/_{2,n-k-1,}$ is the critical t-value at the α level of significance.

(v) Assumption of the Multiple Linear Regression Model

Firstly, the multiple linear regression requires that the relationship between the independent and dependent variable to be linear.

Secondly, it requires that the errors between observed and predicted values (i.e. the residuals of the regression) should be normally distributed.

Thirdly, multiple linear regressions assumed that there is no multicollinearity in the data. Multicollinearity occurs when the independent variables are too highly correlated with each other.

The last assumption of multiple linear regressions is homoscedasticity. A scatter plot of residuals versus predicted values is good way to check for homoscedasticity. There should be no clear pattern in the distribution; if there is a cone-shaped pattern, the data is heteroscedasticity.

Linear Relationship

Multiple linear regression assumes that there is a linear relationship between each predictor variable and the response variable. The easiest way to determine if this assumption is met is to create a scatter plot of each predictor variable and the response variable. This allows you to visually see if there is a linear relationship between the two variables. If the points in the scatter plot roughly fall along a straight diagonal line, then there likely exists a linear relationship between the variables.

For example, the points in the plot below look like they fall on roughly a straight line, which indicates that there is a linear relationship between this particular predictor variable (x) and the response variable (y):

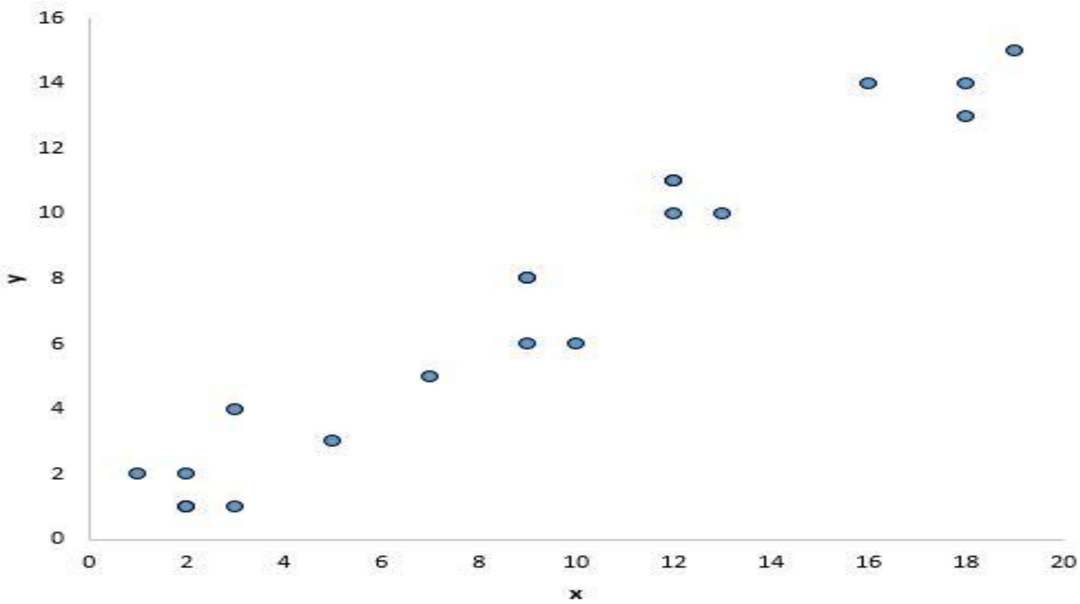


Figure 3.1 Scatter Plot

If there is not a linear relationship between one or more of the predictor variables and the response variable,

1. Apply a nonlinear transformation to the predictor variable such as taking the log or the square root. This can often transform the relationship to be more linear.

2. Add another predictor variable to the model. For example, if the plot of x vs. y has a parabolic shape then it might make sense to add X^2 as an additional predictor variable in the model.

3. Drop the predictor variable from the model. In the most extreme case, if there exists no linear relationship between a certain predictor variable and the response variable then the predictor variable may not be useful to include in the model.

Multivariate Normality

Multiple linear regression assumes that the residuals of the model are normally distributed. There are two common ways to check if this assumption is met: check the assumption visually using Q-Q plots.

A Q-Q plot, short for quantile-quantile plot, is a type of plot that we can use to determine whether or not the residuals of a model follow a normal distribution. If the points on the plot roughly form a straight diagonal line, then the normality assumption is met.

The following Q-Q plot shows an example of residuals that roughly follow a normal distribution:

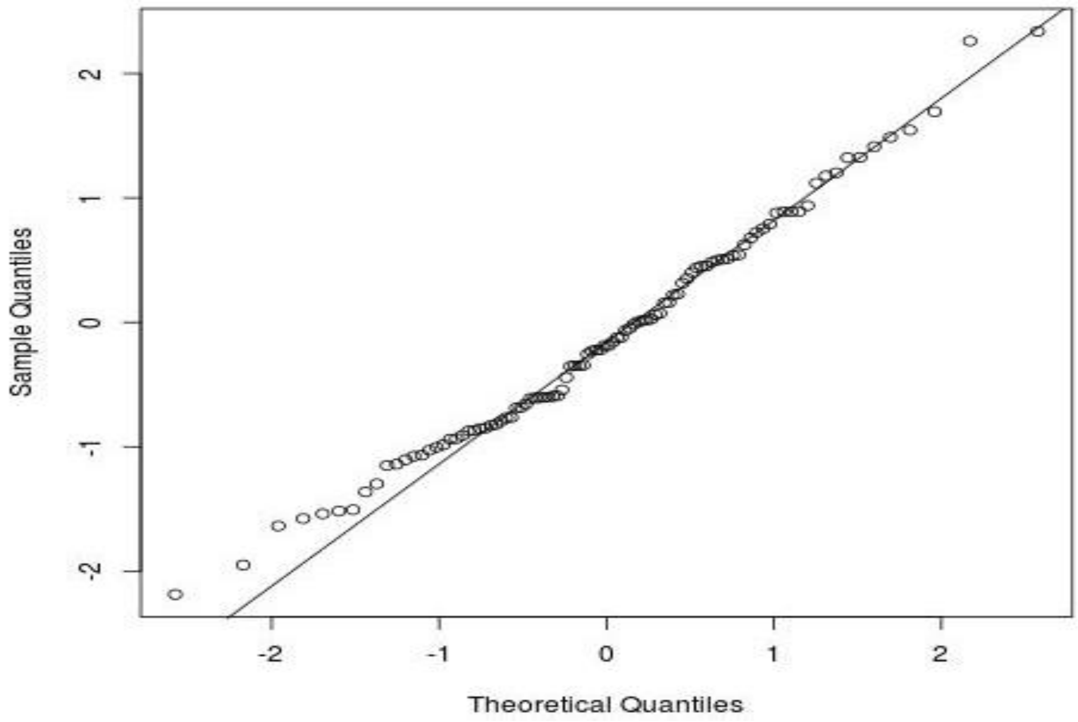


Figure 3.2 Normal Q-Q Plot

However, the Q-Q plot below shows an example of when the residuals clearly depart from a straight diagonal line, which indicates that they do not follow normal distribution:

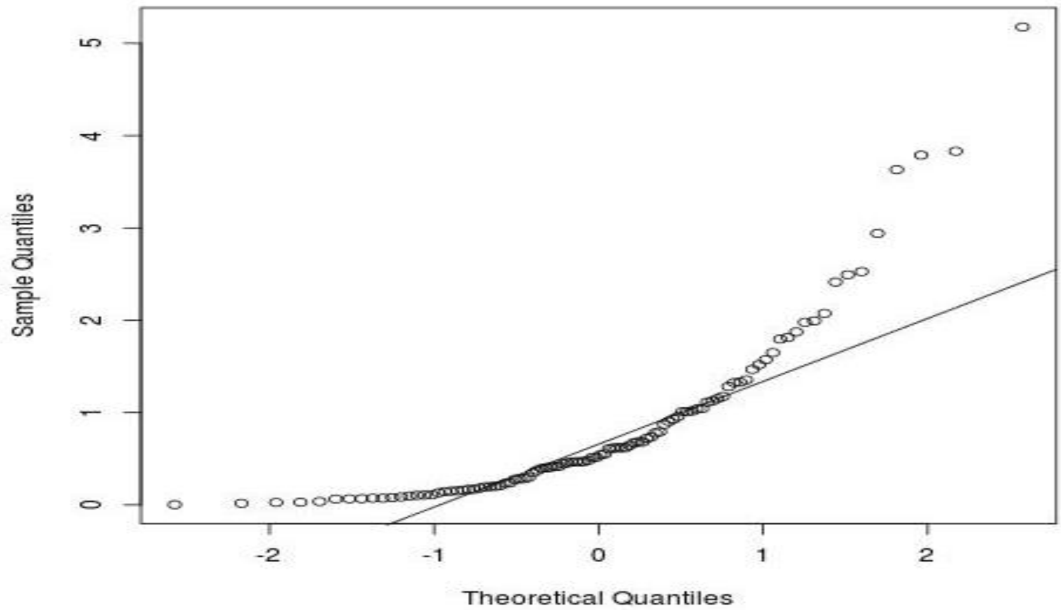


Figure 3.3 Normal Q-Q Plot

Check the assumption using a formal statistical test like Shapiro-Wilk, Kolmogorov-Smironov, Jarque-Barre, or D'Agostino-Pearson.

If the normality assumption is violated, first, verify that there are no extreme outliers present in the data that cause the normality assumption to be violated and next, you can apply a nonlinear transformation to the response variable such as taking the square root, the log, or the cube root of all of the values of the response variable. This often causes the residuals of the model to become more normally distributed.

Multicollinearity

Multicollinearity refers to the case in which two or more independence variables in the regression model are highly correlated, making it difficult or impossible to isolate their individual effects on the dependent variable. With multicollinearity, the estimated OLS coefficients may be statistically insignificant even though may be "high". Multicollinearity can be tested with three central criteria.

Correlation matrix- when computing the matrix of Pearson's Bivariate Correlation among all independent variables, the correlation coefficient r is greater than 0.7. If correlation is less than 0.5, it can be correlated that muticollinearity is not problem.

Tolerance- the tolerance measures the influence of one independence variable on all other independent variables; the tolerance is calculated with an initial linear regression analysis. Tolerance is defined as T = 1-R^2 for this first step regression analysis. With T<0.1 there might be multicollinearity in the data.

Variance Inflation Factor (VIF) – the variance inflation factor of the linear regression is defined VIF = $\frac{1}{T}$. With VIF>10 there is an indication that multicollinearity may be present.

Homoscedasticity

A critical assumption of the classical linear regression model is that the disturbances u_i have all the same variance. When this condition holds, the error terms are homoscedastic, which means the error have the same scatter regardless of the value of X. When the scatter of the errors is different, varying depending on the value of one or more of the independence variables, the error terms are heteroscedastic.

The opposite of homeoscedasticity is the phenomenon of the heteroscedasticity, where the error term can be formulated as a function of x_i. This can be described in mathematical terms as Var ($^{e_i}/_{x_i}$) = σ where e_i is the error term and x_i is the measure of some covariate.

Multiple linear regression assumes that the residuals have constant variance at every point in the linear model. When this is not the case, the residuals are said to suffer from heteroscedasticity. When heteroscedasticity is present in a regression analysis, the results of the regression model become unreliable.

Specifically, heteroscedasticity increases the variance of the regression coefficient estimates, but the regression model doesn't pick up on this. This makes it much more likely for a regression model to declare that a term in the model is statistically significant, when in fact it is not.

The simplest way to determine if this assumption is met is to create a plot of standardized residuals versus predicted values.

Once you fit a regression model to a dataset, you can then create a scatter plot that shows the predicted values for the response variable on the x-axis and the standardized residuals of the model on the y-axis. If the points in the scatter plot exhibit a pattern, then heteroscedasticity is present.

The following plot shows an example of a regression model where heteroscedasticity is not a problem:

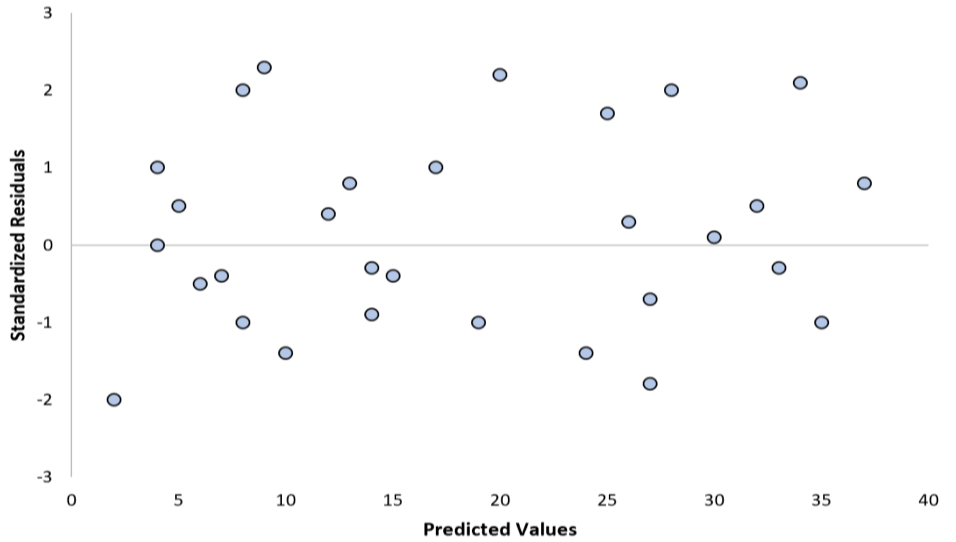


Figure 3.4 Standard Residuals vs. Predicted Values

Notice that the standardized residuals are scattered about zero with no clear pattern. The following plot shows an example of a regression model where heteroscedasticity is a problem:

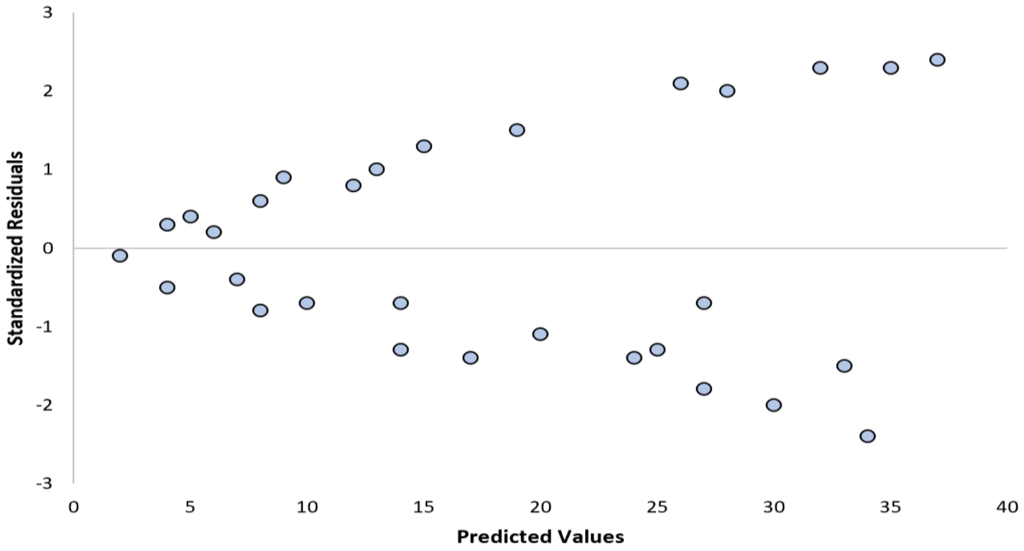


Figure 3.5 Standard Residuals vs. Predicted Values

Notice how the standardized residuals become much more spread out as the predicted values get larger. This “cone” shape is a classic sign of heteroscedasticity:

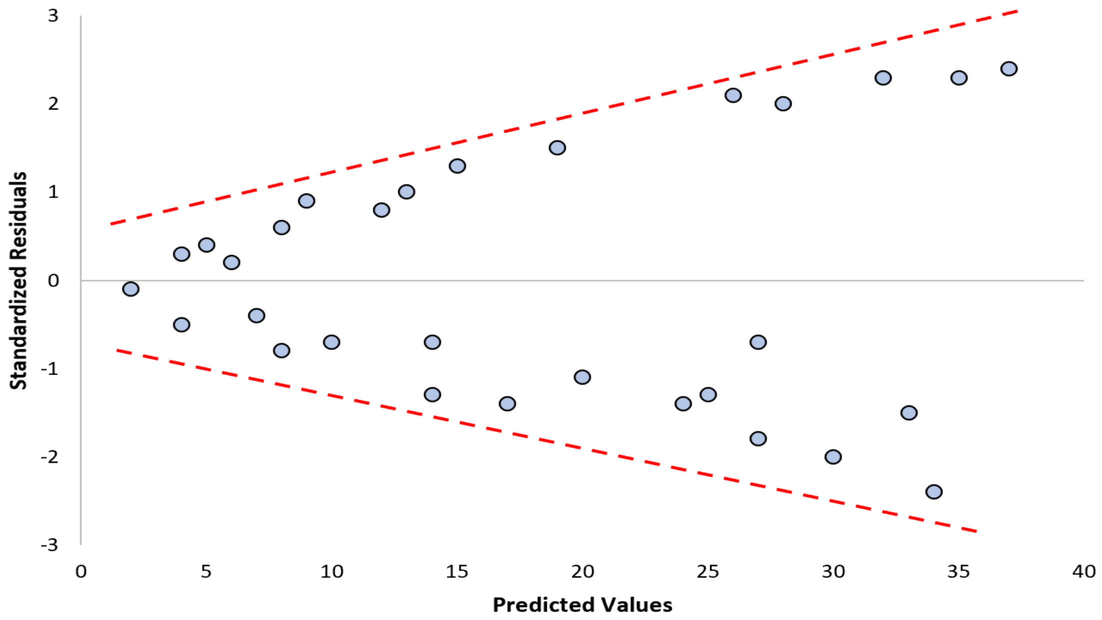


Figure 3.6 Standard Residuals vs. Predicted Values

There are three common ways to fix heteroscedasticity:

1. Transform the response variable. The most common way to deal with heteroscedasticity is to transform the response variable by taking the log, square root, or cube root of all of the values of the response variable. This often causes heteroscedasticity to go away.

2. Redefine the response variable. One way to redefine the response variable is to use a *rate*, rather than the raw value. For example, instead of using the population size to predict the number of flower shops in a city, population size to predict the number of flower shops per capita may be used. In most cases, this reduces the variability that naturally occurs among larger populations since we're measuring the number of flower shops per person, rather than the sheer amount of flower shops.

3. Use weighted regression. Another way to fix heteroscedasticity is to use weighted regression, which assigns a weight to each data point based on the variance of its fitted value. Essentially, this gives small weights to data points that have higher variances, which shrinks the squared residuals. When the proper weights are used, this can eliminate the problem of heteroscedasticity.

3.5.2 Production Function

Production function is the equation that expresses the relationship between the quantities of productive factors (labour, capital) used and the amount of product obtained. It states the amount of product that can be obtained from every combination of labours, assuming that the most efficient available methods of production are used. Production is the results of four factors of production i.e., land, labour, capital and organization support. This is evident from the fact that no single commodity can be produced without the help of one of these four factors of production. Therefore, the manufacture combines all four factors of production to technical ratios. Profit maximization is the only aimed of the producer. For this, the producer decides to maximize production at the lowest cost through the best combination of the factor of production.

A production function shows the technological relationship between inputs and outputs. The output of a firm can be a final commodity or and intermediate commodity. Input are the resources used in the production of output. Inputs include labor, capital and land. Inputs can be classified into two categories: fixed and variable (Dominick 2004). A firm produces goods and services through combining land, labour and capital and raw material to maximize its profits or maximizing sales or growth. How much of the land, labour and capital is to be used has always been a question for the organization to produce the output most efficiently. The firm needs technological and engineering data on production possibilities to product the efficient output. These possibilities are summarized in the production function.

Banaeian (2011) has defined production function as "specification of the minimum of the input requirements to produce an output, at available technology. Philips (1894) was considered as the pioneer of the production function because he was the first economist who algebraically expressed the production function in a formula i.e. $P = f(x^1, x^2, \dots, x^m)$.

Production function is used not only at micro level, for firms, but also at the macro level, on whole economy. At the firm's level it is used for cost effectiveness and input demands. At macro level it is used to find the contribution of inputs, income and technology in the economic growth (Thomas 1997). In general terms any production function can be expressed as:

$Q = f(x_1, x_2, x_{3,} \dots)$

Where Q represents output of a product and X_1, X_2, X_3 represents the various inputs (Nick 2005).

If it is assumed that only one type of product is produced by firm with two inputs, labor and capital, then the formula will be:

$Q = f(L, K)$

The above equation means that the production is a function of or depends on the inputs: labour and capital. Here it can be assumed that L and K are homogenous or identical. Where Q is the production, L is labour employed and K is capital invested. This equation depicts the maximum output produced depends on the amount of human resource or capital employed by the firm (Dominick 2004).

The production function is estimated as:

$$Q = A\, K^a L^b \quad (3.9)$$

Where, Q is the quantity of output, K is capital invested and L is the labour and A, a, b are the parameters which are to be estimated empirically. The above equation is often referred as Cobb Douglas production function.

Production function can sometimes be written as $Q \le f(L, K)$ which means that the quantity produced by the firm is theoretically less than the maximum level of output (Eric 2008).

3.5.3 The Features of Production Function

The main features of production function are as follows:

(i) Substitutability - Thus quantity of any output can very with change in the quantity of even one input while keeping other factors constant.

(ii) Complementary - A producer can produce the output by mixing the factors input together. If the quantity any input is zero, the output cannot be produced.

(iii) Specificity - Raw materials, specialized labour, machines and equipment can be used for the production of the specific product. Of these factors of production are not completely specialized at they can also be used in the production of other products

(iv) Production Time - Production of any time of product requires time. Production can only be possible in the long run. In the production function, the variation in total output is due to the variation in input quantity. The quantity of a single input may be possible in a short period of time.

3.5.4 Fixed Proportion Production Function

The fixed proportion production function also known as a Leontief production function implies that fixed factors of production such as land, labour, raw materials are used to produce a fixed quantity of an output and these production factors cannot be substituted for the other factors. In other words, fixed quantity of inputs of used to produce the fixed quantity of outputs. All the factors of production are fixed and cannot be substituted for one another.

The fixed-proportions production function is a production function that requires inputs be used in fixed proportions to produce output. It has the property that adding more units of one input in isolation does not necessarily increase the quantity produced.

The marginal product of an input is just the derivative of the production function with respect to that input. This is a partial derivative, since it holds the other inputs fixed. Partial derivatives are denoted with the symbol δ. An important property of marginal product is that it may be affected by the level of other inputs employed. For example, in the Cobb-Douglas case with two inputs. The symbol α is the Greek letter "alpha." The symbol β is the Greek letter "beta." These are the first two letters of the Greek alphabet, and the word alphabet itself originates from these two letters. and for constant A,

$$f(K,L) = AKaL\beta \qquad (3.10)$$

the marginal product of capital is

$$\partial f \partial K(K,L) = \alpha AK\alpha - 1L\beta.$$

If α and β are between zero and one (the usual case), then the marginal product of capital is increasing in the amount of labour, and it is decreasing in the amount of capital employed. For example, an extra computer is very productive when there are many workers and a few computers, but it is not so productive where there are many computers and a few people to operate them.

The value of the marginal product of an input is the marginal product times the price of the output. If the value of the marginal product of an input exceeds the cost of that input, it is profitable to use more of the input.

3.5.5 Variable Proportion Production Function

The variable proportion production function implies that the ratio in which the factors of production such as labour and capital are used is not fixed, and it is variable. Also, the different combination of factors can be used to produce the given quantity, thus, one factor can be substituted for the other.

In the case of variable proportion production function, the technical coefficients of production is variable, i.e. the required quantity of output can be achieved through the combination of different quantities of factors of production, such as these factors can be varied by substituting other factors in its place.

The law of variable proportions which is a new name given to the old classical concept of law of diminishing returns has played a vital role in modern economic theory. Assume that a firm production function consists of fixed quantities of all inputs (land, equipment, etc.) except labour which is a variable input when the firm expands output by employing more and more labour it alters the proportion between fixed and variable inputs.

The law can be stated when total output or production of a commodity is increased by adding units of a variable input while the quantities of other inputs are held constant, the increase in total production becomes after some point, smaller and smaller. If equal increments of one input are added, the inputs of other production services being held constant, beyond a certain point the resulting increments of the product will decrease i.e. the marginal product will diminish. As the proportion of one factor in a combination of factors is increased, after a point, first the marginal and then the average product of that factor will diminish.

The law of variable proportions refers to the behaviour of output as the quantity of one Factor is increased keeping the number of other factors fixed and further, it states that the marginal product and average product will eventually do cline. This law states three types of productivity an input factor - total, average and marginal physical productivity.

Assumptions of law of variable proportions are the state of technology remains constant. If there is any improvement in technology, the average and marginal output will not decrease but increase. Only one factor of input is made variable and other factors are kept constant. This law does not apply to those cases where the factors must be used in rigidly fixed proportions. All units of the variable factors are homogenous.

3.5.6 Linear Homogenous Production Function

The linear homogenous production function implies that with the proportionate change in all the factors of production, the output also increases in the same proportion. Such as, if the inputs factors are doubled the output also gets doubled. This is also known as constant returns to a scale.

The production function is said to be homogenous when the elasticity of substitution is equal to one. The linear homogenous production function can be used in the empirical studies because it can be handled wisely. It is widely used in linear programming and inputs-outputs analysis. This production function can be shown symbolically.

$$nP = f\ (nK, nL) \qquad (3.11)$$

where, n = number of times

nP = number of times the output is increased

nK = number of times the capital is increased

nL = number of times the labor is increase

Thus, with the increase in labor and capital by “n” times the output also increases in the same proportion. The concept of linear homogeneous production function can be further comprehended through the illustration given below: In the case of a linear homogeneous production function, the expansion is always a straight line through the origin, as shown in the figure. This means that the proportions between the factors used will always be the same irrespective of the output levels, provided the factor prices remain constant.

3.5.7 History of Cobb Douglas Production Function

In economics, Cobb Douglas production function is widely used to show the relationship between inputs and outputs. This model was proposed by Knut Wicksell in 1851-1926, and then Charles Cobb and Paul Douglas tested it against statistical evidence in 1928. In 1928 a study was conducted by Charles cob and Paul Douglas in which the growth of the US economy during the period 1899-1922 was modeled. In the model production output was determined by the amount of labour and capital used. The model performed very well, since then many economists used this model for solving economic problems. (Bao Hong, 2008). (Eric Miller, 2008). The Cobb Douglas production function has various useful properties:

1. First, the marginal product of capital and the marginal product of labour depend on both the quantity of capital and quantity of labour used in production, as is often the case in the real world.
2. Second, the exponents of K and L: a, b represent, the output elasticity of labour and capital, (EK and EL) and in the sum of the exponents (i.e. a + b) measures the returns to scale. If a + b = 1, we have constant returns to scale; if a + b > 1, we have increasing returns to scale, and if a + b, we have decreasing returns to scale.
3. Third, Cobb Douglas production function can be estimated by regression analysis by transforming it into

$$\ln Q = \ln A + a \ln K + b \ln L$$

This is linear in the logarithms. Therefore, the Cobb-Douglas production function can easily be extended to deal with more than two inputs (say capital, labour, and natural resources or capital, production labour, and nonproduction labour).

3.5.8 Cobb-Douglas Production Function

Nonlinear relationships can be converted into linear ones within the framework of the classical linear regression model. The various transformations discussed there in the context of the two-variable case can be easily extended to multiple regression models.

The Cobb-Douglas production function, in its stochastic form, may be expressed as

$$Y_i = \beta_1 X_{2i}^{\beta_2} X_{3i}^{\beta_3} e^{ui} \qquad (3.12)$$

where Y = output

X_2 = labour input

X_3 = capital input

u = stochastic disturbance term

e = base of natural logarithm

From equation (3.12) it is clear that the relationship between output and the two inputs is nonlinear. The log-transform this model is

$$\ln Y_i = \ln \beta_1 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i \qquad (3.13)$$

$$= \beta_0 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i$$

where, $\beta_0 = \ln \beta_1$.

In the Cobb-Douglas production function, β_0, β_2 and $\beta_3$are the parameters. It is nonlinear in the variables Y and X but linear in the logs of these variables. Equation (3.13) is a log-log, or double-log, or log-linear model, the multiple regression counterpart of the two-variable log-linear model.

The properties of the Cobb-Douglas production function are quite well known:

1. β_2 is the (partial) elasticity of output with respect to the labour input, that is, it measures the percentage change in output for, say, a 1 percent change in the labour input, holding the capital input constant.
2. Likewise, β_3 is the (partial) elasticity of output with respect to the capital input, holding the labour input constant.
3. The sum $(\beta_2 + \beta_3)$ gives information about the returns to scale, that is, the response of output to a proportionate change in the inputs. If this sum is 1, then there are constant returns to scale, that is, doubling the inputs will double the output, tripling the inputs will triple the output, and so on. If the sum is less than 1, there are decreasing returns to scale - doubling the inputs will less than double the output. Finally, if the sum is greater than 1, there are increasing returns to scale–doubling the inputs will more than double the output.

Returns to scale are concerned with how output varies with the use of inputs. For example, how will output change if each of the inputs double? More generally, let t be scale factor. The *elasticity of scale* measures proportional output change in y as a function of x and a positive scale factors *t* of *x:*

$$E(X) = \frac{\frac{dy(t)}{y(t)}}{\frac{dt}{t}} = \frac{df\ (tx)}{dt}\frac{t}{f(x)} \mid t = 1 \quad (3.14)$$

Elasticities are convenient because they are measured as proportions or percentages rather than with unit measures. A scale elasticity equal to one implies constant returns to scale. Increasing and decreasing returns to scale are indicated by scale elasticities greater than or less than one. Thus, the following characterize constant, increasing and decreasing returns to scale for production functions;

Constant Returns to Scale: $f(tx) = tf\ (x)$ for all $t \geq 0$

Increasing Returns to Scale: $f(tx) > tf\ (x)$ for all $t > 1$

Decreasing Returns to Scale: $f(tx) < tf\ (x)$ for all $t < 1$

Constant returns to scale imply that the production function is homogeneous of degree 1; scaling the inputs of production by a constant lead to the same proportional change in output.

CHAPTRE 4
ANALYSIS OF PADDY PRODUCTION IN PANDAUNG VILLAGE

Socio-economic condition, agricultural conditions and land tenure of paddy farmers and rice production of Pandaung village in Shwebo township are shown with descriptive method, multiple regression analysis and Cobb-Douglas production function according to the survey data of this village.

4.1 Profile of Pandaung Village

Pandaung village is located at the South of Shwebo township and it is far from there over 3 miles. This village is surrounded by Chaung Sone village in East, Shar Taw in West, Phwint Hlaing in South and Taung Tin in North. This village has a total population of 1820 inhabitants distributed in 330 households. Among them, 240 households are growing monsoon and summer paddy and the major commercial crop is paddy. The cultivated areas of the village are 1200 acres. The most of the households are paddy farmers. The majority of Burmese people live in Pandaung village. For education, there is a middle school for 203 students in this village. Pandaung village with housing plots are moderately wide and the houses are moderately spaced from one another.

The main water source in the studied area is Kar Boe dam, which receives water from Thaphanseik dam, the biggest dam in the country. Pandaung village receive water from the irrigation channel that comes from Kar Boe Dam. Most households at Pandaung village are farming as their livelihoods which are mainly based on agriculture. In addition to agriculture, they also work in raising chickens, pigs, cows, goats, sheep, etc. Farmland indicates the social and economic status and it enhances their position in the society. Growing paddy does not earn income for year round and all members of social classes have alternative livelihoods on farm and off farm activities. In so doing, the upper and middle classes were chosen based on affordability of financial investment, gardening, paddy marketing, collecting and selling of sand, shop keeping, or commerce. In rice farming recess, the lower class goes for fishing, setting traps for eels, mouse trapping and taking any available job, works as a daily-wage earner or working as migrant elsewhere.

4.2 Demographic Characteristics of Paddy Farmers in Pandaung Village

The table 4.1 shows some characteristics of paddy farmer households head with total sample of 150 paddy farmers in Pandaung village.

Table 4.1 Demographic Characteristics of Paddy Farmers in Pandaung Village

Variables	Category	Frequency	Percent
	Total respondents	150	100.0
Gender	Male	135	90.0
	Female	15	10.0
Age	25-34	5	3.3
	35-44	15	10.0
	45-54	46	30.7
	55-64	46	30.7
	65-74	29	19.3
	75-84	9	6.0
Family Size	1	2	1.3
	2	10	6.7
	3	19	12.7
	4	40	26.7
	5	19	12.7
	6	26	17.3
	7	22	14.7
	8	6	4.0
	9	4	2.7
	10	1	0.7
	11	1	0.7
Student Size	0	72	48.0
	1	44	29.3
	2	29	19.3
	3	5	3.3
Education	Monastery	21	14.0
	Primary	90	60.0
	Middle	21	14.0

Variables	Category	Frequency	Percent
	Total respondents	150	100.0
	High	16	10.7
	Graduate	2	1.3

Source: Survey Data (2019)

According to the results in table 4.1, household heads are males which accounts for 90.0% and the remaining 10.0% are females. The ages of household heads have been categorized in to six groups. The age group between 25-34 years includes 3.3%, the age group between 35-44 years includes 10.0%, the age group between 45-54 years includes 30.7%, the age group between 55-64 years includes 30.7% and the age group between 65-74 years includes 19.3%, the age group between 75-84 years includes 6.0%, respectively. The age group between 45-64 years is the largest and the age group between 25-34 years is smallest.

According to the table 4.1, about 26.7% of paddy farmers have 4 family members, 17.3% of paddy farmers have 6 family members and 0.7% of paddy farmers have between 10 to 11 family members. Therefore, most of paddy farmers are found that 4 family members.

The above table shows there has the number of students in a household. The sample households have one to three students in a family. There are also households without students. According to above Table 4.1, 72 households do not have students and its percentage is 48 %. Fourty four households have only one student, it is 29.3%. Twenty nine households have two students, it is 19.3%. Five households have three students, it is 3.3%. According to this data, the highest of the households do not have students and second highest of the households have one student. Fewer households have three students, which is 3.3 percent. The majority of household head, about 48% do not have students currently.

The table stated that 14% of households have monastic education, 60% of households have primary education, 14% of households have secondary education, 10.7% of households have high education and 1.3% of households have graduate. This indicates that most of the paddy farmers have low levels of education (below secondary) and that may hinder farmer's understanding and application of improved paddy farming technologies.

4.3 Farmland Ownership and Size of Farmland of Paddy Farmers in Pandaung Village

Table 4.2 shows farmland ownership and size of farmland of paddy farmers in Pandaung village.

Table 4.2 Farmland Ownership and Size of Farmland of Paddy Farmers

Variable	Category	Frequency	Percent
Farmland Ownership	Land Owner	149	99.3
	Tenant	1	0.7
Size of Farmland	1-5	80	53.3
	6-10	48	32.0
	11-15	16	10.7
	16-20	5	3.3
	21-25	1	0.7
	Total	150	100.0

Source: Survey Data (2019)

According to the above table, the paddy farmers can be classified into two groups based on ownership of farmland as land owner and tenant. Majority of paddy farmers had traditional farmland ownership 99.3% and the rest of 0.7% used as tenant from other farmers.

Most of 53.3 % of the paddy farmers have 1 acre to 5 acres farmland. 32% of the paddy farmers have 6 acres to 10 acres farmland, 10.7 % of the paddy farmers have 11 acres to 15 acres farmland, 3.3 % of the paddy farmers have16 acres to 20 acres farmland and the remaining 0.7 % of the paddy farmers have 21 acres to 25 acres farmland.

4.4 Input and Output Factors for Paddy Production

Table 4.3 contains information about input and output factors. The most important factor concerning to paddy production are land, labour and capital. The summary measures of input and output factors for paddy production of Pandaung village are shown in the following table.

Table 4.3 Summary Measures of Input and Output for Paddy Production

	Mean	**Median**	**Mode**	**Range**	**Minimum**	**Maximum**
Production	913.08	775	750	2910	90	3000
Land (Acre)	6.34	5	5	23	1	24
Labour	4.55	4	4	9	0	9
Capital (Kyat)	2239180	1650000	500000	8850000	150000	9000000

Source: Survey Data (2019)

According to Table 4.3, it was found that, the average paddy production for 150 samples is 913.08 baskets. The median of paddy production is 775 baskets. The minimum and maximum of paddy production are 90 and 3000 baskets. And then, the average land used for paddy production is 6.34 acres. The median land used for paddy production is 5 acres. The minimum and maximum lands used for paddy production are 1 acre and 24 acres, respectively. In addition, the average number of family labour for paddy production is 4.55 persons. The median number of family labour for paddy production is 5 persons. The minimum and maximum numbers of family labour for paddy production are 0 and 9 persons, respectively. Finally, the average capital for paddy production is 2239180 kyats. The median capital for paddy production is 1650000 kyats. The minimum and maximum capitals of input factors (use of technology, fertilizer) for paddy production are 150000 kyats and 9000000 kyats.

4.5 Factors Affecting on the Income of Paddy Farmers in Pandaung Village

Multiple regression analysis was applied to investigate the factors affect to income per acre of farmers. To develop the multiple regression models, the dependent variable is income of paddy farmers per acre. Expenses of paddy farmers per acre, use of organic fertilizer and use of threshing machine were used as independent variables. In this study, three independent variables used to explain dependent variable.

The estimated multiple regression model

$$\ln\hat{Y}_i = b_0 + b_1 \ln X_{1i} + b_2 X_{2i} + b_3 X_{3i} \quad (4.1)$$

In constructing the model, the variables noted as:

Y_i = ln income of paddy farmers per acre

X_{1i} = ln expenses of paddy farmers per acre

X_{2i} = use of organic fertilizer

X_{3i} = use of threshing machine

Table 4.4 Results of Multiple Regression Model

Independent variable	Coefficient	Standard error	t	Sig	VIF
Constant	2.752	0.560	4.919	0.000	
Ln expenses of paddy farmers per acre	0.599***	0.101	5.934	0.000	1.014
Use of organic fertilizer	0.188***	0.070	2.700	0.008	1.065
Use of threshing machine	-0.237**	0.095	-2.495	0.014	1.065
F-value	15.470***				
R	0.491				
R^2	0.241				
Adjusted R^2	0.226				

Source: Survey Data (2019)

***, ** and, * statistically significant at 1%, 5% and 10% level, respectively.

Multiple Regression equation is

$$\hat{Y} = 2.752 + 0.599X_1 + 0.188X_2 - 0.237X_3 \quad (4.2)$$

According to table 4.4, the results show that the value of F test, overall significance of the model, is highly significant at 1% level. The specified models explain the variation of income of paddy farmers per acre is predicted by three independent variables as the value of adjusted R^2 is 22.6%.

ln expenses of paddy farmers per acre and use of organic fertilizer were founded as important in explaining the farmer's income per acre, as variables are statistically significant at 1%. Use of threshing machine also affects to the income of farmers with significant at 5%.

According to the multiple regression equation, when the expense of paddy farmers per acre increases 1%, the income of paddy farmers per acre will increase by 0.599%. It implies that the more increase expenses of paddy farmers per acre, the more income farmers can earn from paddy production.

Use of organic fertilizer is positively relationship with income of paddy farmers per acre. When the uses of organic fertilizer are increases 1%, the paddy income of that household will increase by 18.8%. This means that as there is low cost by using organic fertilizer, the income of paddy farmers per acre is more increased.

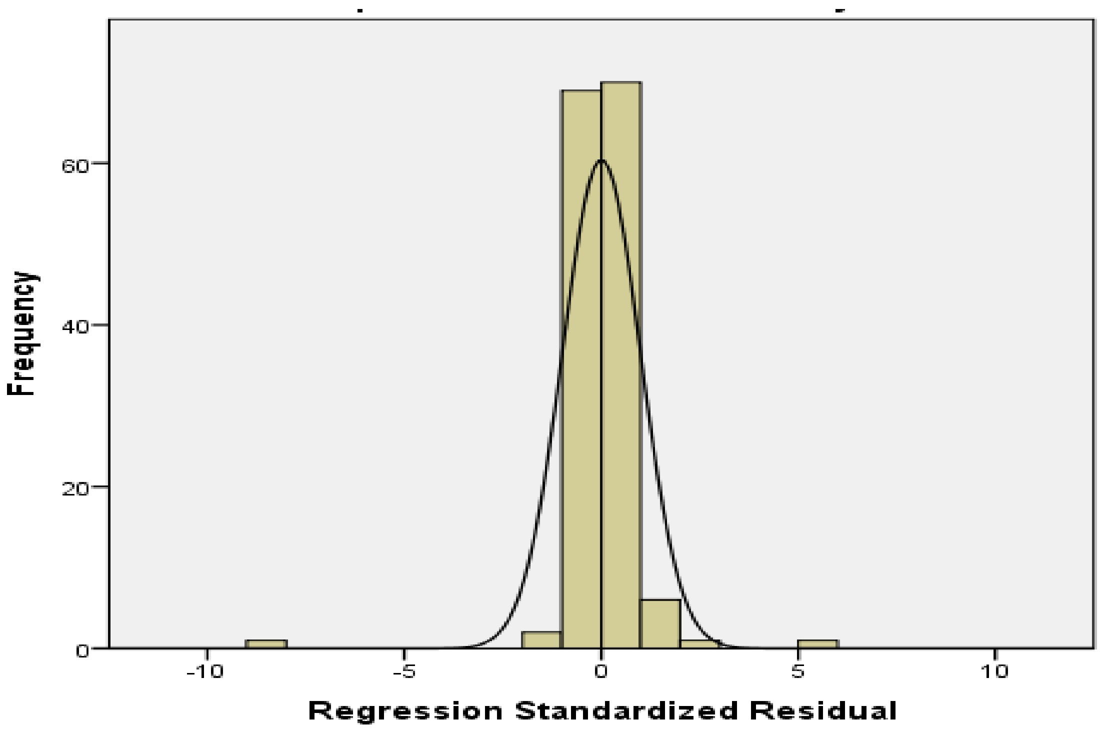
Uses of threshing machine are statistically negative significant impact on income of paddy farmers per acre. When uses of threshing machine more increase, the income of paddy farmers per acre will decreases by 23.7%. This means that the income of paddy farmers per acre will be decrease because of the cost of threshing machine will be more increased for renting.

4.5.1 Testing for the Assumption of Multiple Regression

To determine the required assumption from multiple linear regression model for paddy production, the following procedures have been used.

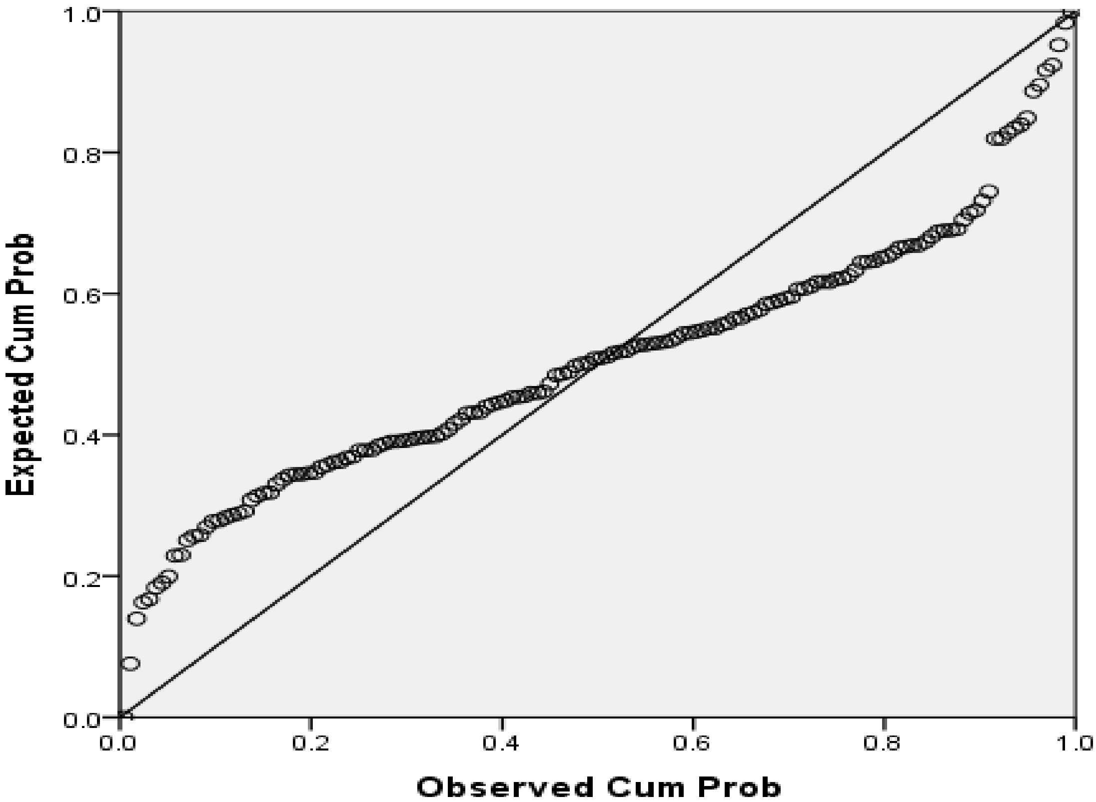
(i) Test for Normality of Disturbances

The first assumption of the Ordinary Least Squares (OLS) model is that disturbances are a normal variable and is normally distributed with mean zero and variance constant. To check whether the disturbances are normally distributed, Histogram and Normal plot of the disturbances of paddy production can be constructed. The Histogram of disturbances and the Normal plot of disturbances for paddy production are shown in figure 4.1 and 4.2.



Source: Survey Data (2019)

Figure 4.1 Histogram of Disturbances of Paddy Production



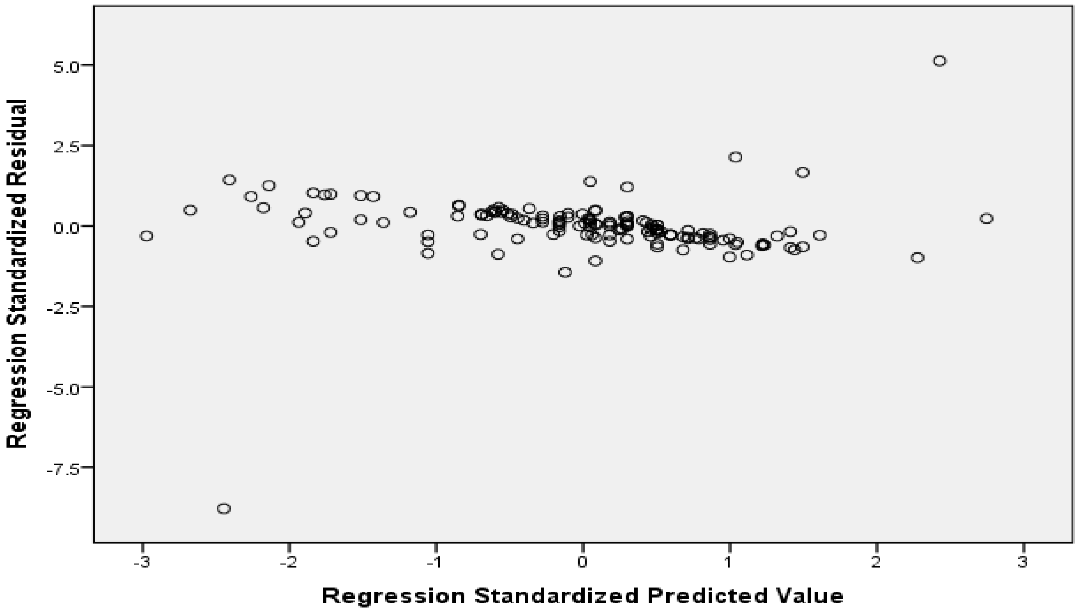
Source: Survey Data (2019)

Figure 4.2 Normal Plot of Disturbances for Paddy Production Normal Plot of Regression Standardized Residual

According to histogram and normal plot, it can be concluded that the normality assumption appears to be generally reasonable.

(ii) Testing for Equal Variance (Homoscedasticity)

Another basic assumption of the multiple regression model is homoscedasticity. In the presence of heteroscedasticity the regression coefficients become less efficient. Heteroscedasticity can often be detected by plotting the estimated Y values against the disturbances. Figure 4.3 present the predicted paddy production on x axis and the disturbance for paddy production on y axis.



Source: Survey Data (2019)

Figure 4.3 Residual Pattern for Heteroscedasticity

The figure can be seen that there is no residual pattern. Therefore, it can be concluded that residuals in paddy production have on equal variance or homoscedasticity.

(iii) Detecting Multicollinearity

The problem of multicollinearity, which is a problem of higher correlation among the independent variables in the model, is also assessed.

This problem can also be deleted from the value of Tolerance and VIF (variance inflation factor). If the correlation among the independent variables, weak association and the value of the Tolerance is not less than 0.1 and the value of the VIF is not above 10, it is the indication of absence of multicollinearity problem. According to the findings from this study, Tolerance and VIF value of independent variables are shown in following table.

Table 4.5 Tolerance and VIF of Independent Variables

No.	Independent variable	Tolerance	VIF
1.	Ln expenses of paddy farmers per acre	0.986	1.014
2.	Use of threshing machine	0.939	1.065
3.	Uses of organic fertilizer	0.939	1.065

Source: Survey Data (2019)

According to the table 4.5, among the independent variables, it is found that the collinearity statistics of the value of Tolerance is not less than 0.1. Based on the coefficient, output collinearity statistics, variance inflation factor (VIF) value of each predictor variable is obtained 1.014, 1.065 and 1.065, respectively. Thus, since VIF values are less than 10, there is no multicollinearity.

4.6 Cobb-Douglas Production Function for Paddy Production

The Cobb-Douglas production function model is demonstrated on the basis of primary data which is collected of Pandaung Village in Shwebo Township. Sample of 150 paddy growers are used in this study. The model is constructed by using three independent variables such as land, labour, and capital. Paddy production is used as dependent variable. To fit the model, land, labour, and capital are used as independent variables.

In constructing the model, the variables are noted as

PROD	=	Paddy Production
LAND	=	Land
LAB	=	Labour
CAP	=	Capital

Cobb-Douglas production function takes the following form,

$$Y_i = \beta_0 X_{1i}^{\beta_1} X_{2i}^{\beta_2} X_{3i}^{\beta_3} e^{u_i} \qquad (4.3)$$

The log-transform this model is

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i \qquad (4.4)$$

The Cobb-Douglas production function is given as:

$$\text{Ln PROD} = \beta_0 + \beta_1 \text{ Ln LAND} + \beta_2 \text{ Ln LAB} + \beta_3 \text{ Ln CAP} + u \qquad (4.5)$$

where, u is disturbance term and unknown parameters β_0, β_1, β_2, and β_3 in Cobb-Douglas production function are estimated. The calculated results are described in the Cobb-Douglas production function of paddy production in the following Table 4.6.

Table 4.6 Result for Cobb-Douglas Production Function of Paddy Production

Independent Variables	Coefficient	Standard error	t	Sig
Constant	2.893	0.405	7.138	0.000
Ln LAND	0.740***	0.039	19.096	0.000
Ln LAB	0.051	0.049	1.026	0.307
Ln CAP	0.171***	0.030	5.743	0.000
F - ratio	245.252***			
R	0.914			
R^2	0.835			
Adjusted R^2	0.832			

Source: Survey Data (2019)

***, ** and, * statistically significant at 1%, 5% and 10% level, respectively.

A regression analysis was conducted to evaluate how well the linear combination of log of land, labour and capital was significantly related to the production of paddy F = 245.252, p < 0.01. The R^2 value of 0.835 means that about 83.5 percent of the variation in the log of paddy production is explained by the logs of land, labour and capital. The Cobb-Douglas function for paddy production is

$$\ln\hat{y}_i = 2.893 + 0.740 \ln LAND + 0.051 \ln LAB + 0.171 \ln CAP \quad (4.6)$$

In equation 4.6, two factors positive affecting paddy production were land and capital at the statistically significant level of 1%. According to the Cobb-Douglas production function analysis, the findings revealed that the coefficient of land was 0.740. It implied that 1% increase in the paddy land applied would increase the paddy production at 0.740% by holding other factors constant. The coefficient of capital was 0.171. It indicated that 1% increase of capital could increase the paddy production at 0.171% by holding other factors constant. Labour has found insignificant impact on paddy production because of other factors than labour have a greater impact on paddy production.

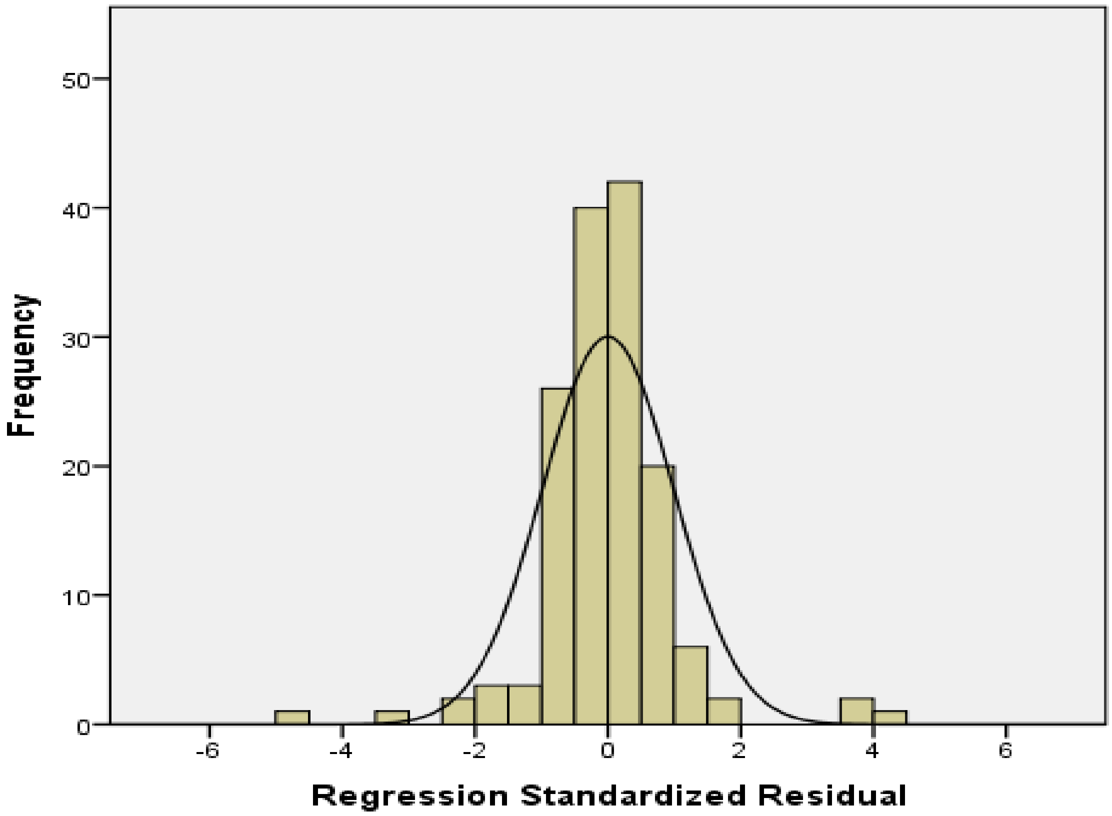
Return to scale was estimated by summing production such as land and capital in rice production. The value of return to scale was which 0.911 which implies the presence of decreasing return to scale. It means that a percentage increase in capital and land will produce a smaller percentage increase in output.

4.6.1 Testing for the Assumption of Cobb-Douglas Production Function

To determine the required assumption from Cobb-Douglas production function for paddy production, the following procedures have been used.

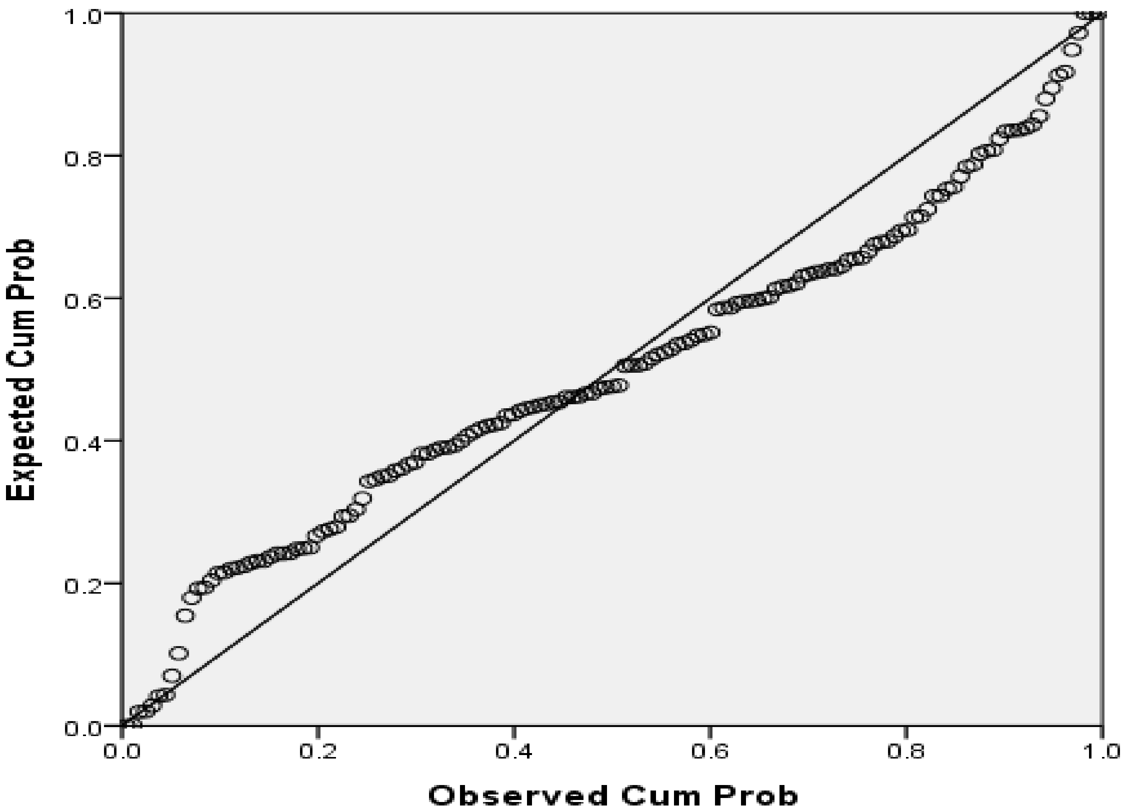
(i) Test for Normality of Disturbances

The first assumption of the Ordinary Least Squares (OLS) model is that disturbances are a normal variable and is normally distributed with mean zero and variance constant. To check whether the disturbances are normally distributed, Histogram and Normal plot of the disturbances of paddy production can be constructed. The Histogram of disturbances and the Normal plot of disturbances for paddy production are shown in figure 4.4 and 4.5.



Source: Survey Data (2019)

Figure 4.4 Histogram of Disturbances of Paddy Production



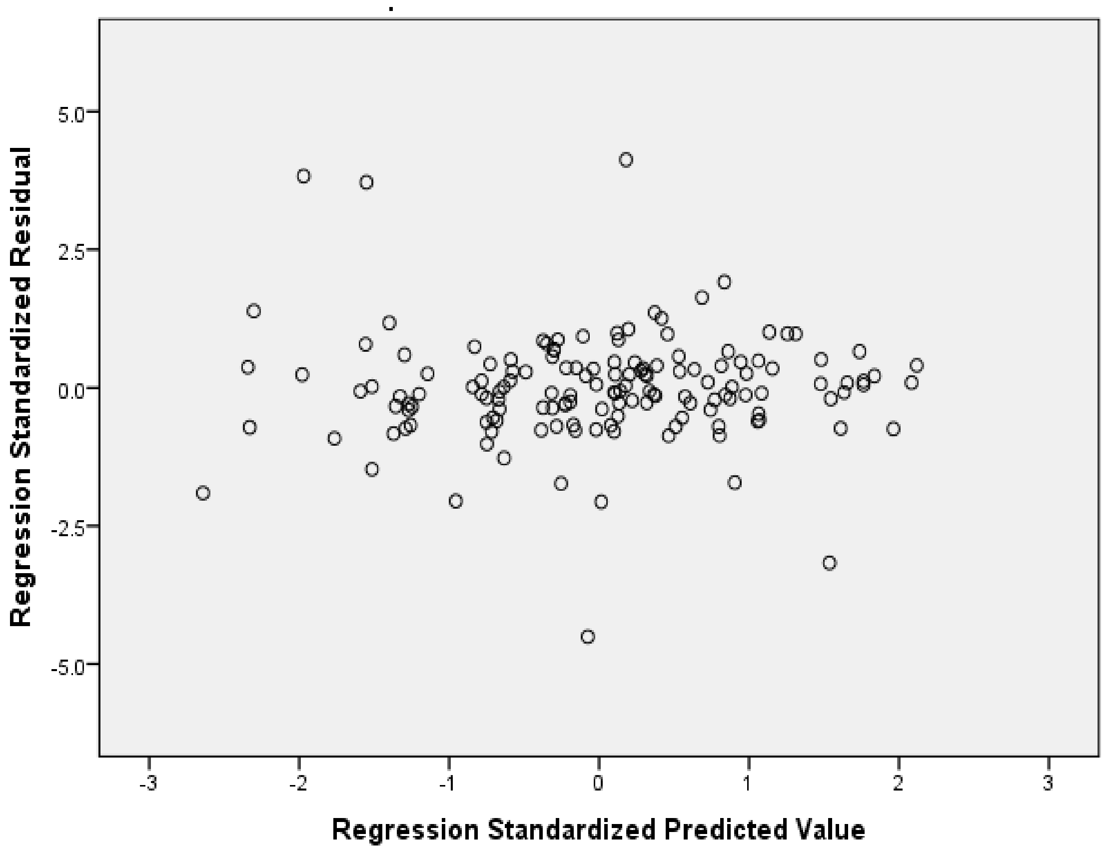
Source: Survey Data (2019)

Figure 4.5 Normal Plot of Disturbances for Paddy Production Normal Plot of Regression Standardized Residual

According to histogram and normal plot, it can be concluded that the normality assumption appears to be generally reasonable.

(ii) Testing for Equal Variance (Homoscedasticity)

Another basic assumption of the multiple regression model is homoscedasticity. In the presence of heteroscedasticity the regression coefficients become less efficient. Heteroscedasticity can often be detected by plotting the estimated Y values against the disturbances. Figure 4.6 present the predicted paddy production on x axis and the disturbance for paddy production on y axis.



Source: Survey Data (2019)

Figure 4.6 Residual Pattern for Heteroscedasticity

The figure can be seen that there is no residual pattern. Therefore, it can be concluded that residuals in paddy production have on equal variance or homoscedasticity.

(iii) Detecting Multicollinearity

The problem of multicollinearity, which is a problem of higher correlation among the independent variables in the model, is also assessed.

This problem can also be deleted from the value of Tolerance and VIF (variance inflation factor). If the correlation among the independent variables, weak association and the value of the Tolerance is not less than 0.1 and the value of the VIF is not above 10, it is the indication of absence of multicollinearity problem. According to the findings from this study, Tolerance and VIF value of independent variables are shown in following table.

Table 4.7 Tolerance and VIF of Independent Variables

No.	Independent Variable	Tolerance	VIF
1.	Ln LAND	0.704	1.420
2.	Ln LAB	0.990	1.011
3.	Ln CAP	0.709	1.410

Source: Survey Data (2019)

According to the table 4.7, among the independent variables, it is found that the collinearity statistics of the value of Tolerance is not less than 0.1. Based on the coefficient, output collinearity statistics, variance inflation factor (VIF) value of each predictor variable is obtained 1.420, 1.011 and 1.410, respectively. Thus, since VIF values are less than 10, there is no multicollinearity.

CHAPTER 5

CONCLUSION

This chapter includes three sections which are findings and discussions, suggestions and recommendations and needs for further study.

5.1 Findings and Discussions

This study was an attempt to investigate socio-economic characteristics and to examine the factors affecting on the income of paddy farmers in Pandaung village. In addition, this study also analyzed the factors affecting the paddy production of farmers in Pandaung village.

According to research objective one, it can be found that there are more male household head than female household head. The number of persons in working age group was larger than that of dependents in this village. One can also say that the volume of labour force was high in this village. The age distribution of the sample household heads grouped into some class intervals have examined and it is found that most of the household head are between 45-64 years. The size of the family is examined and it can be found that the most of the sample households have 4 members. The sample households have one to three students in a family. It can be found that the most households do not have students. Therefore, the schooling rate is low. As the education attainment of the household heads in the study area, it is found that most of the paddy farmers are primary level education. The most of paddy farmers are land owner and most of the households have 1 to 5 acres of size of farmland.

According to research objective two, the results of multiple regression model show that the value of F test, overall significance of the model, is highly significant at 1% level. The specified models explain the variation of income of paddy farmers per acre is predicted by three independent variables as the value of adjusted R^2 is 22.6%.

It can be concluded that when the expenses per acre of paddy farmers increases 1%, the income per acre of paddy farmers will increase by 0.599%. It implies that the more expenses per acre of paddy farmers increase, the more income per acre of farmers can earn from paddy production. The use of organic fertilizer is positively relationship with income per acre of paddy farmers. When the use of organic fertilizer increases 1%, the household income of paddy farmers will increase by 18.8%. This means that as there is low cost by using organic fertilizer, the income per acre of paddy farmers is more increased. The use of threshing machine is statistically negative significant impact on income of paddy farmers per acre. When use of threshing machine is more increased, the income per acre of paddy farmers will decrease by 23.7%. This means that the income per acre of paddy farmers will decrease because the renting cost of threshing machine is more increased.

According to research objective three, the results of Cobb-Doubglas production function show that R^2 value of 0.835 means that about 83.5 percent of the variation in the log of paddy production is explained by the logs of land, labour and capital. The results show that the coefficient of land was 0.740. This means that 1% increase in the paddy land applied would increase the paddy production at 0.740% by holding other factors constant. The coefficient of capital was 0.171. It indicated that 1% increase of capital could increase the paddy production at 0.171% by holding other factors constant.

Therefore, the expenses and uses of organic fertilizer are the most influential factors to increase household’s income. And also land and capital are the influential factors to increase the paddy production.

5.2 Suggestions and Recommendations

The government should support the paddy farmers in Pandaung village in Shwebo township in testing soil to differentiate the types of land. Modern technology should be taken to control for superior labour cost. The policy makers and researcher’s considerations of climate change effect on paddy production. Effort should be made by the concern services, agencies to create more awareness about improved verity and adoption of plant protection measures in paddy in the study area. Timely proper guidance to the paddy farmers from the concern person is needed as paddy in perishable crop.

To encourage application of quality seeds by farmer’s participation in seed production programs this would be promoted by the Department of Agriculture in collaboration with private sectors. Department of Agriculture and other concerning institutions should provide to increase paddy production more than currently for training and educational programs which seed production, capacities in mechanization and good agricultural practice. It is needed to coordinate between public and private sectors in order to combine available harvester and machines in time for farmers.

5.3 Needs for Further Study

This study focused the analysis on paddy production of paddy farmers in Padaung village. There are many variables to measure paddy production and needs to observe the highest level to be completed. Due to the available data, there is a need for review the empirical evidence of the impact of several determination on paddy production such as type of settlement drought prone, irrigation, income, etc. Further research on the effect of determinants of paddy production should be carried out to find the different impacts based on the primary data.

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APPENDIX (A)

QUESTIONNAIRE
SOCIO-ECONOMICS AND AGRICULTURAL CONDITIONS OF HOUSEHOLDS IN PANDAUNG VILLAGE

Date ………………....   Questionnaire No. ……………

1. Address

   Township……………   Village………………

2. Respondent

   (a) Name……………   (b) Age …………

   (c) Male/Female………….   (d) Education………..

   (e) Occupation………….   (f) Kinship with householder………

3. Head of Household

   (a) Name…………   (b) Age………………   (c) Male/Female…………

   (d) Education………   (e) Occupation………

4. Family Topics

   (a) Number of family

Sir No.	Name	Gender	Religion	Relation with Household Head	Age	Education	Marital Status	Occupation	Income

   (b) Number of Student

Level of Education	No. of Students		Total
	Male	Female	
Primary			
Middle			
High			
University			
Total			

5. Questions concerned with Cultivation/Farming

   (a) (1) land owner   (2) tenant   (3) lease   (4) Others

(b) Land Ownership

Farmland (acres)	Yar (acres)	Others	Total

(c) Paddy Cultivation

No.	Type of Paddy	Dura -tion	Cultiva- tion acres	Yield per acre (basket)	Total Yield (basket)	Total income	Total expenses	Net income (one month)

(d) Materials used in cultivation

(1) Human

(2) Cattles

(3) Hand Tractor

(4) Tractor

(5) Rice Trans planter

(6) Harvester

(7) Threshing Machine

(8) Grain Dryer

(e) Condition use of fertilizers and pesticides

(1) Fertilizers

(2) Pesticides

(3) Organic fertilizers

6. Livestock Condition

No.	Animal	Duration	Total Income	Total Expense	Net Income per Month

7. Difficulties of production

☐ Capital

☐ Labor shortage

☐ Insects and viruses

☐ Irrigated Farming System

◻ Cultivation Technique

◻ Weather/ climate condition

8. How type of support does you get from government and other organization?

◻ Technical Support

◻ Machine

◻ Irrigated Farming System

◻ Seeds

9. Have the farmers support from Government and NGO?

◻ Yes ◻ No

If have, which type of support?

……………………………………………………………………………………

……………………………………………………………………………………

10. Properties of Sample Households

(a) Car (b) Cycle (c) TV (d) VCD, DVD, EVD

(e) Satellite (f) Radio, Cassette (g) Sewing machine

(h) Transformer (i) Bicycle (j) Rice Cooker (k) Iron

(l) Telephone (m) Others

11. Expenditure

<table>
<tr><th rowspan="2">No.</th><th colspan="5" rowspan="2">Type of Expenditure</th><th colspan="3">Expenses (kyats)</th></tr>
<tr><th>One week</th><th>One month</th><th>One year</th></tr>
<tr><td rowspan="4">1.</td><td colspan="3">Expenses for kitchen</td><td>Price</td><td>Amount</td><td></td><td></td><td></td></tr>
<tr><td>1.</td><td colspan="2">Rice</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.</td><td colspan="2">Oil</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td colspan="2">Market
(one week)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">2.</td><td rowspan="3">Fruits/
Beverages</td><td colspan="3">Fruits</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Juice</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Beverages</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3.</td><td colspan="8">Shoes/ Clothes</td></tr>
<tr><td rowspan="2">4.</td><td colspan="2" rowspan="2">Education</td><td colspan="3">School fees</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Books</td><td></td><td></td><td></td></tr>
</table>

5.	Repair Cost	Home			
		Car			
		Cycle			
		Bicycle			
6.	Recreation	Vacation			
		Pilgrim			
		Movies			
		TV			
7.	Social Cost	Compassionate			
		Donation			
8.	Health Cost	Man			
		Children			
9.	Allowance	Man			
		Children			
		Student			
10.	General Expenses	Phone			
		Electric			
		Soap			
		Drinking Water			
		Toothpaste			
		Beauty expenses			
Total					

12. Did you get loan? ◻ Yes ◻ No

If you get loan; describe detail

Name of organization	Amount of loan	Interest	Reason of getting loan	Period

(a) Does income support by getting loan? ◻ Yes ◻ No

If not support, please tick the following:

Less amount	High interest rate	Short loan period	Not use with correctly

13. Housing Condition

(a) Own ☐ (b) Rent ☐ (c) Others ☐

Housing Type		R.C	Brick	Wooden	Bamboo
Toilet Type			Water closet	Normal	No

14. Distance Condition

Distance	Near	Far
School from home		
Shop from home		
Clinic from home		
Hospital from home		

15. Drinking Water

Please tick	Well	Tube well	River	Lake	Others

16. Condition of Cooking

Please tick	Electricity	Wooden	Charcoal	Gas	Others

17. Energy Condition

Please tick	Electricity	Battery	Solar	Generator	Others

18. Garbage System

Please tick	Dust-cart/dustbin	Fire/Underground	River	No Stable	Others

APPENDIX (B)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.491[a]	.241	.226	.414

a. Predictors: (Constant), Use of organic fertilizer, LnExpensePerAcre, Use of threshing machine

b. Dependent Variable: LnPaddyIncomePerAcre

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.939	3	2.646	15.470	.000[b]
	Residual	24.974	146	.171		
	Total	32.913	149			

a. Dependent Variable: LnPaddyIncomePerAcre

b. Predictors: (Constant), Use of organic fertilizer, LnExpensePerAcre, Use of threshing machine

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	2.752	.560		4.919	.000		
LnExpensePerAcre	.599	.101	.431	5.934	.000	.986	1.014
Use of threshing machine	-.237	.095	-.186	-2.495	.014	.939	1.065
Use of organic fertilizer	.188	.070	.201	2.700	.008	.939	1.065

a. Dependent Variable: LnPaddyIncomePerAcre

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.914[a]	.835	.832	.118

a. Predictors: (Constant), Log Land, Log Labour, Log Capital

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.220	3	3.407	245.252	.000[b]
	Residual	2.014	145	.014		
	Total	12.234	148			

a. Dependent Variable: Log Yield

b. Predictors: (Constant), Log Land, Log Labour, Log Capital

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.256	.176		7.138	.000
	Log Labour	.051	.049	.035	1.026	.307
	Log Capital	.171	.030	.230	5.743	.000
	Log Land	.740	.039	.767	19.096	.000

a. Dependent Variable: Log Yield