YANGON UNIVERSITY OF ECONOMICS

DEPARTMENT OF STATISTICS

A STUDY ON PADDY PRODUCTION IN AYEYARWADDY REGION (2018-2019)

BY

KHIN HNAUNG

M.Econ (Statistics)

Roll No.10

NOVEMBER, 2019

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This thesis is submitted to board of Examination as partial fulfillment of the requirement for degree of M. Econ (Statistics)

Approved by the Board of Examiners

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This is certify that the thesis entitled "**A STUDY ON PADDY PRODUCTION IN AYEYARWADDY REGION (2018-2019)"** submitted as a partial fulfillment towards the requirements of Master of Economics (Statistics) has been accepted by the Board of Examiners.

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ABSTRACT

The objective of this study is to analyze the effects of labour and capital on production of paddy in Ayeyarwaddy Region. Cobb-Douglas production function is used to analyze the paddy production in Ayeyarwaddy Region based on labour and capital. The cross-sectional data on production, labour and capital of paddy for the year (2018-19) are obtained from the Agricultural Department in Ayeyarwaddy Region. Capital is considered as a combination of fertilizers. According to findings, Pathein District has the highest paddy production, labour cost and capital of paddy. Followed by Pyapon has the second highest paddy production. In addition, Myaungmya has the third highest paddy production. According to the results of linear production function, there is no relationship between paddy production and labour cost. There is also no relationship between paddy production and capital. But the results of Cobb-Douglas production function shows the coefficients of labour and capital are statistically significant at 1% and 5%, respectively. The sum of the elasticities is less than one. This means that there is decreasing returns to scale. . It means that paddy production increases by decreasing the proportional change in both labour and capital. Therefore, good quality seeds should be used to increase paddy production. The government should support the transforming from traditional farming to mechanized farming. Moreover, there are also needed to improve the education and training programs for effective use of fertilizers and pesticides to farmers by local government.

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LIST OF ABBREVIATIONS

GDP	Gross Domestic Product
MIS	Management Information System
MPHC	Master of Primary Health Care
GAD	Genetic Association Database
WUA	Water User Association
HYVs	High Yield Varieties
FAO	Food and Agriculture Organization
MOAI	Ministry of Agriculture and Irrigation
GAP	Good Agriculture Practice
UMEH	Union of Myanmar Economics Holdings
MEC	Myanmar Economic Coorperation
MFIs	Micro Finance Institutions
MADB	Myanmar Agricultural Development Bank
EU	European Union
MLE	Maximum Likelihood Estimation
OLS	Ordinary Least Squares

CHAPTER I

INTRODUCTION

1.1 Rationale of the Study

Myanmar (formerly known as Burma) is an agricultural country and agricultural sector is the backbone of its economy. Myanmar still remains one of the developing countries and its economy mainly depends on agricultural production. Paddy production is dominated by Myanmar's economy and is extensively interwoven into the social and economic fabric of its people's lives. It is the most important crop in Myanmar. Moreover, it is the majority production of Myanmar. It dominates the agricultural sector, which is the largest and most productive part of the economy; changes in rice production have a direct and profound influence on the entire population. Myanmar's rice output must continually increase to feed the growing populations and boost the country's economy. Agricultural development is given priority in Myanmar's socio-economic development as an essential crop of the economy. The agriculture sector contributes 43 percent of GDP; 41 percent of export earnings; and employs 63 percent of the labour force.

In Myanmar, major paddy producing areas were categorized by ecological zones such as the delta, dry zone, coastal zone, and mountainous areas. Among the ecological zones, the delta region is the largest cultivated in both seasons. The population in Myanmar reached 47.62 million in 2003. The annual population growth rate was 0.89 per cent between 2003 and 2014. It was 51.4 million in 2014. More and more food will be necessary for the country's growing population. Paddy production is the main career for the people of Myanmar and paddy is also a principle crop in the agriculture sector. Myanmar was the dominant rice exporting country in the world during the first half of this century, accounting for nearly three-fourths of the world rice exports.

Myanmar government has promoted high yielding varieties (HYVs) of paddy seed in 1977. However, the performance of HYVs in the country is frequently undermined by factors such as relying on harvested paddy for seed, which leads to seed degeneration over time, improper fertilizer use, insufficient irrigation and lack of drainage facilities. The use of fertilizer is prevalent among Myanmar's paddy farmers but generally in low amounts, with the quality, cost and availability of fertilizers as

frequent constraint. The situation is compounded by a lack of knowledge on the part of many farmers with potential negative implication for local ecosystems.

The paddy landscape in Myanmar is currently being transformed by mechanization. While mechanization can improve productivity, it can also be counterproductive without complementary upgrades along the value chain. The fertilizer shortages are resulting from a decreased use of cattle in the Myanmar's agriculture. Intervention would need to target the challenges faced by different actions simultaneously, with a broad understanding of how different actions and stages of the value chain interact with each other. In many cases, multiple stages of the value change may be subject to common constraints such as lack of access to credit.

Paddy cultivation is placed the largest area of crops grown in Myanmar. It is central to the economy and essential production for the people of Myanmar. On the other hand, it is also the way to increase national income. Therefore, the paddy production in Ayeyarwaddy Region is studied in this study.

1.2 Objective of the Study

The objective of the study is to analyze the effects of labour and capital on production of paddy in Ayeyarwaddy Region.

1.3 Method of Study

In this study, cross-sectional data on production, labour and capital of paddy per acre for the year (2018-19) are obtained. The descriptive analysis, linear production function and Cobb-Douglas production function are used to investigate the influence of labour and capital on the production of paddy.

1.4 Scope and Limitations of the Study

This study covers production of paddy in Ayeyarwaddy Region for the year (2018-19). Capital is considered as a combination of fertilizers. The data are obtained from Pathein District Agriculture Department which is under the Ministry of Agriculture, Livestock and Irrigation. In this study, the production is considered as the function of labour and capital of paddy.

1.5 Organization of the Study

This thesis consists of five chapters. Chapter one is introduction which includes rationale of the study, objectives of the study, method of study, scope and limitations of the study, and organization of the study. Chapter two concerns with Literature Review. Chapter three describes theoretical background of Cobb Douglas production function. Chapter four presents the analysis of paddy production with Cobb Douglas production function. Finally, conclusion with discussions, recommendations and further study is presented in chapter five.

CHAPTER - II
LITERATURE REVIEW

2.1 Agriculture Policies in Myanmar

The agricultural policies in Myanmar are

- To emphasize production and utilization of high-yielding and good quality seeds.
- To conduct training and education for farmers and extension staff on advanced agricultural techniques.
- To implement research and development activities for sustainable agricultural development.
- To protect farmers rights and benefits.
- To assist farmers to get fair price on their produce.
- To assist in lowering price production costs, increasing high quality crop production, developing and strengthening of markets.
- To encourage transformation from conventional to merchandised agriculture, production of crops appropriate with climate and extension of irrigated area.
- To undertake renovation and maintenance works on old irrigation, pumping and underground water systems.
- To support rural development and poverty reduction activities through development of agriculture sector.
- To encourage local and international investment in agriculture sector for the development of advanced agricultural technology and commercial agricultural production.
- To justify and amend existing agricultural laws and regulations in line with current economic situation. (FAO in Myanmar)

2.2 Irrigation System in Myanmar

Irrigation works in Myanmar since King era. Irrigation systems in Central Myanmar had regulations and good practice for systematic management. During the colonial period, traditional rules and regulations were strengthened. Most of old irrigation systems in Central Myanmar have farmer groups for irrigation. (Zaw Lwin Htun)

The Irrigation Policies are as follows:

- To develop the upstream (resource) and downstream (canal system) including the on-farm facilities simultaneously by participation of farmers in construction and maintenance of tertiary units.
- To establish the water user association (WUA) in each level of newly developed irrigation system, to strengthen the existing water users' association and to support the farmers' autonomous irrigation system for sustainable development of irrigation.
- To support the farmers to have more efficient and effective water use practice in on-farm level and to have an equity of water allocation or adoption of farmers preferable water allocation system.

2.3 Current Development of Rice Production in Myanmar

Myanmar remains an economy dependent on agriculture to a large extent. Agriculture contributes 30% to Myanmar's GDP, 25% of the country's exports and is the leading employer in the economy, employing 56% of workers. Over 60 different types of crops are grown in Myanmar on 12.8 million hectares – equivalent to 19% of Myanmar's total land mass.

Between 2010-11 and 2016-17, Myanmar's agricultural GDP has grown on average at 3.2% per year. The sector experienced no growth in 2016-17 after four years of expansion, contributing to a slowdown in overall economic growth, which dipped from 7% in 2015-16 to 5.9% in 2016-17. According to the Ministry of Agriculture, Livestock and Irrigation, Myanmar exported $2.7 billion of agricultural products in 2016-17, down from $3.1 billion in 2015-16.

Crop production accounts for 72% of agricultural output. The three main crop groups are paddy, beans and pulses and oilseed crops. Rice paddy remains the dominant production crop, accounting for 45.7% of the harvested area and 53.4% of production value amongst major crops. While rice has also been historically the major agricultural export, beans and pulses now generate the higher export earnings, contributing $1,046 million in 2015-16, with the three other major exporters; rice, livestock and fisheries providing between $200 and $500 million each.

Myanmar contains three main agro-ecological zones: the delta (which includes the coastal zone), the central dry zone, and the hilly regions. The delta has a population of 22 million people, provides easy access to water, and predominantly engages in rice

and fish production. The central dry zone has a population of 19 million people and with less rain than the other areas, farmers mostly dwell in river valleys where they produce rice, oilseeds, beans and pulses. The hilly regions contain 6.5 million people and are amenable to a wide range of tree and horticulture crops, as well as rice, maize and pulses.

The estimated total 1993-94 planted paddy area for the different rainfall zones of Myanmar has increased only about 16 percent since the early 1930's. The 1993-94 area was 5.7 million ha compared with 4.9 million ha from 1931-32 to 1933-34. Virtually all of the 1930s rice crops were rain-fed crops in the wet monsoon season whereas nearly 0.9 million ha of the reported 5.7 million ha total sown ha in 1993-94 were irrigated second crops in the dry season after the monsoon crop. The only land area used for rainy-season rice that had increased substantially since the 1930s is in the Northern Wet Zone. The rain-fed area had declined in all other rainfall zones except for a slight increase in the Ayeyarwaddy Delta. Yield in 1993-94 was about half larger than in the early 1930s. About half (53 percent) of the rice produced in 1993-94 was high-yield varieties (HYVs). Average national rice yield is still very low compared to other Asian countries because of low input use. (Agriculture Guide 2019)

2.4 Rice Ecosystems in Myanmar

The major rice-producing regions of Myanmar are in the delta. Ayeyarwaddy, Bago and Yangon regions make up almost half of the country's harvested rice area (MOAI, 2011). Myanmar's major rice ecosystems include rain-fed lowland rice, irrigated lowland rice, deep-water rice and upland rice.

Rice is grown in Myanmar during the monsoon (June to November) and summer (December to May) seasons. There are two dominant rice production systems: rain-fed lowland and irrigated lowland. During the monsoon season, Myanmar's rainfall in the delta and coastal region is sufficient for growing rice without supplemental irrigation from dams, river and stream diversions or groundwater. Where available, irrigation coupled with drainage structures, improves stability of production and reduces the risks of flooding stagnant water.

Large areas of delta are subject to flooding ranging in duration from a few days to 2 or 3 months, presenting significant risks to farmers. Some areas, though declining in importance, are suitable for deep-water rice, a low yielding rice type that elongates to stay above the rising water.

Rice grown in the dry zone can be productive when grown under irrigated conditions because of the increased hours of sunshine, especially during the summer season. Upland rice is grown in the hilly areas under a shifting cultivation known as *taungya*. Upland rice is direct seeded into moist soil with the first rains. As little as 200,000 hectare of upland rice is planted in Myanmar, more than half of which is grown in Shan State. Farmers reported using traditional varieties though some used fertilizers. As on most of Asia, upland rice has reduced in importance as productivity in lowland areas has increased and market access to the uplands has improved. These developments favor the adoption of higher value agricultural enterprises. (Glenn Denning, Kye Baroang, Tun Min Sandar and other MDRI and MSU colleagues)

2.5 Government Intervention of Agriculture in Myanmar

The Myanmar Rice Federation (MRF) called for government intervention, including regulation with policy and laws, subsidies and exploration of markets, in a bid to promote the rights and benefits of farmers, according to a recent press release from MRF. To tackle problems being faced by farmers by means of price drop and difficulties, MRF members have been travelling to farms to purchase summer paddy. However, they are limited by storage capacities to dry the rice, as well as by logistic problems, coupled with power cuts. As exports through border gates are plummeting, the private sector's sole efforts cannot deal with this.

Government intervention is needed, and MRF has already forwarded requests to the government. MRF is declared it would purchase long-grain rice with 90-day yields which have no demand in the market at the set price of Ks 19,500 per bag starting from 8 April. The MRF had urged merchants, millers, agents, private companies, and MRF members to buy paddy at the basic rate, if the paddy met the prescribed criteria of having 14-per-cent moisture content and a fixed percentage of impurities, such as sand, weed, and small stones. Members were also urged to purchase paddy if the market price falls below the basic price, the federation stated in a press release. Rice trade to china through the Sino-Myanmar border trade channels was halted in October, 2018 as China began cracking down on illegal goods, leading to steep drops in rice exports to China and a stockpile of some 500,000 tons Muse gate.

The drastic plunge in rice exports through the border trade resulted in some two million tons of rice being stockpiled in the market, according to the Myanmar Rice and Paddy Trades Association. Over 1.3 million tons of rice and broken rice were

exported to foreign countries during the seven months of the current fiscal year, which is a significant drop of 800,000 tons, compared with the corresponding period in the last Fiscal Year, according to MRF. Myanmar shipped 3.68 million tons of rice to foreign countries during the 2017-18 Fiscal Year, which was a record amount for the past 50 years. -*GNLM (Translated by Ei Myat Mon)*

2.6 Background of Ayeyarwaddy Region

Ayeyarwaddy Region is also known as the Delta region, is a coastal region between the Bay of Bengal to the west, and the Andaman sea to the east. The capital city is Pathein. Ayeyarwaddy Region consists of 26 townships, covering a total of 35,140 square kilometres. Ayeyarwaddy is Myanmar's most populated region with an estimated population of 6.32 million (2011 MIS data) and population density of 176 people per square kilometer in Ayeyarwaddy Region, 88% of people are living in rural areas and 12% of people are living in urban areas. This region was the severely affected by Cyclone Nargis in 2008. (https//themimu.info/states_regions/ayeyarwady)

The 2014 MPHC shows that Myanmar had a total population of 51,486,253 persons as of 29 March 2014. Of these, 24,824,586 were males and 26,661,667 were females. The total population for Ayeyarwaddy Region as of 29 March 2014 was 6,184,829 persons. Of these, 3,009,808 were males and 3,175,021 were females. The total population of Ayeyarwaddy Region represents 12 percent of the total population in Myanmar. (Ayeyawady Region Census Report)

Since 1973, the population of Ayeyarwaddy Region has increased from 4,156,673 to 4,994,061 in the 1983 census and 6,184,829 in the census of 2014. This means that the population of Ayeyarwaddy Region has increased by about 24 percent between 1983 and 2014 censuses. Ayeyarwaddy Region has second largest population size when compared with other States and Regions in Myanmar. It is only surpassed by the population of Yangon Region. In terms of the proportion of the total population, the population of Ayeyarwaddy Region has decreased from 14 percent in 1983 to 12 percent in 2014. (Ayeyawady Region Census Report)

The population density of Ayeyarwaddy Region in March 2014 was 176.5 persons per square kilometre. The population density of Ayeyarwaddy Region has increased from 118 persons per square kilometre in 1973 to 142 persons per square kilometre in 1983, to 176.5 persons per square kilometre in 2014. (Ayeyawady Region Census Report)

The Census results show that for every 100 persons in Ayeyarwaddy Region, 86 persons live in rural areas while 14 persons live in areas that are classified as urban by GAD. At the Union level, 70 percent of the total population live in rural areas while 30 percent live in urban areas. Ayeyarwaddy has the lowest proportion of urban population compared to other States/Regions. (Ayeyawady Region Census Report)

The population of females in Ayeyarwaddy Region exceeds the population of males by 165,213. The sex ratio of the population (number of males for every 100 females) is 95. This sex ratio is slightly higher than the sex ratio for the Union which is 93 males for every 100 females. (Ayeyawady Region Census Report)

There are six districts in Ayeyarwaddy Region. They are Pathein district, Hinthada district, Myaungmya district, Labutta district, Maubin district and Pyapon district.

Pathein District

Pathein, formerly known as Bassein, is the largest city and the capital of Ayeyarwaddy Region, Myanmar. It is located 190 km west of Yangon on the bank of the Pathein River, which is a western branch of the Ayeyarwaddy River, the city has a population of 237,089 (2017 census). Although once part of the Mon Kingdom, Pathein has few ethic Mon Residents today. The majority are Bamar, Burmese Indian and Karen ethnicity. The minority are Rakhine nationalities. (https://en.m.wikipedia.org/wiki/Pathein)

Hinthada District

Hinthada is a city located on the Ayeyarwaddy River in Ayeyarwaddy Region, Myanmar. In the 1983 census, the city itself had a population of 82005. It had grown to 170,312 in 2010. The trade of locally grown rice and grain goes through the port of Hinthada. (https://en.m.wikipedia.org/wiki/Hinthada)

Myaungmya District

Myaungmya district is a district of Ayeyarwaddy Region in South western Myanmar. It consists of five cities. Myaungmya is the chief town of the district. Myaungmya district was formed in 1893 out of a portion of Bassein district, and reconstituted until 1903. It has an area of 2,663 square miles and a population of

280,000 and density of 104 inhabitants to the square mile. The district is a deltaic tract, bordering south on the sea and traversed by many tidal creeks. Rice cultivation and fishing occupy practically all the inhabitants of the district. The district contains three townships: Myaungmya Townships, Einme Township, and Wakema Townships. In the townships, there are 50 wards, 489 villages groups and 2557 villages. (https://en.m.wikipedia.org/wiki/Myaungmya_district)

Labutta District

Labutta District is a district in Ayeyarwaddy Region, Myanmar. It was established in 2008 after the region was hit by Cyclone Nargis in May 2008. Labutta is the town of this district. (https://en.m.wikipedia.org/wiki/Labutta_district)

Maubin District

Maubin District is a district of the Ayeyarwaddy Region in South western Myanmar. It contains 4 cities: Maubin, Patanaw, Nyaungdon, and Danubyu. It consists of 39 wards, 235 village groups and 1642 villages. Pyapon is the town of the district. (https://en.m.wikipedia.org/wiki/Ma_ubin_district)

Pyapon District

Pyapon District is a district of the Ayeyarwaddy Region in south eastern Myanmar. It consists 4 cities. They are Pyapon, Bogalay, Kyaitlat and Dedaye. The town of this district is Pyapon. (https://en.m.wikipedia.org/wiki/Pyapon_District)

2.7 Paddy Production in Ayeyarwaddy Region

Paddy is the country's staple crop. In 2017, paddy production for Myanmar was 25.6 million tonness. Though Myanmar rice, paddy production substantially fluctuated in recent years, it tended to increase through 1968-2017.

Agriculture is very important in Myanmar's economy: it employs 70% of the country's labor force and comprises 38.2% of its GDP. Paddy is considered both a major food crop and major export food item. It can be grown across the country throughout the year and is grown on over 7.53 million hectares, or more than half of its arable land.

Paddy is often stored in open piles for long time periods at procurement centers. It is transported mostly from procurement depots to warehouses by truck or by cargo

barges. Prices vary based on different types of paddy. It is grown during the monsoon (80%) and summer seasons (20%) in four growing zones: the delta, dry zone, coastal zone, and mountainous areas. In delta area, paddy land development project supported by World Bank and the Asian Development Bank from 1976 to 1988. The yields doubled with the application of improved techniques, such as the use of chemical fertilizers and pesticides, as well as proper water management. It has been designated as a national crop and a priority crop for area expansion and yield increase. In 1992, summer paddy was introduced to regions across the country where irrigation facilities were available by using short-duration varieties HYVs (Thihtutyin, Shwethweyin etc.). The government of Myanmar strongly supported summer paddy. The monsoon paddy is sown in May to October and summer paddy in November to March. New irrigation dams, weirs, and reservoirs were established; existing irrigation facilities were improved; and groundwater was explored to further paddy production.

Myanmar started hybrid seed production in 2011; support to the Development of Hybrid Rice in Myanmar Project with FAO. In 2011, the country opened the door to democratic economic transformation. One of the development goal is to increase rice exports while maintaining domestic food security, and open borders trade (MRF 2014).

Myanmar's agriculture sector is still recovering from the effects of Cyclone Komen in the summer of 2015, the agriculture sector still accounts for 29% of value-added in Myanmar and is projected to grow at 4% from 2016-2017, compared to 3% in 2015-2016. Crop production accounts for 72% of agricultural output; Myanmar's three main groups include paddy, beans and pulses, and oilseed crops.

Myanmar's lands can be divided into three agro-ecological zones: the delta and coastal zone, the dry zone, and the hill regions. The delta and the coastal zone is the densely populated, provides easy access to water, and predominantly engages in rice and fish production. Agriculture production generally take place in river valleys in the dry zone, where rain-fed upland crops and paddy are produced. The hill regions are amenable to tree and horticultural crop and less suitable for intensive farming.

In 2011, government had sold its rice mills and removed restrictions on private sector domestic trade and export. Government exit from these markets has been replaced by government-approved commercial enterprises - the Union of Myanmar Economic Holding Company (UMEH) and the Myanmar Economic Cooperation (MEC), have become the largest economic enterprises in the country.

In Myanmar, total area of paddy was 7.63 million hectares, comprising 6.45 million hectares under monsoon paddy and 1.18 million hectares under summer paddy in 2014–2015. Actual paddy sown area was 7.17 million hectares. Production was reached at 28.19 million metric tons. In Myanmar, pulses and oilseeds are more profitable and less costly to produce than paddy.

2.8 Factors of Paddy Production

There are two main factors in paddy production. They are labor and capital. The following are explained these factors.

2.8.1 Labour on Agriculture

Agriculture in Myanmar accounts for a large percent (50%–60%) of Gross Domestic Product and supports upward of 70% of the labor force. As in neighbouring countries, smallholder paddy production dominates Myanmar's agricultural economy: paddy production accounts for roughly half of all cropped area. Pulses and oilseeds account for a further 20% each, whereas horticulture crops, root crops and other cereals account for the remaining part. Farmers generally grow staple crops such as paddy, pulses and oilseeds on relatively large surfaces, while high-value horticulture and fruit crops take place on much smaller plots. Paddy, pulse and oilseed farmers cultivate an average of 1.5 – 2.0 hectare per holding. In contrast, onions, garlic and potato fields are average about 0.6 hectare each, while vegetables and cut flowers are grown on plots ranging between 0.25 and 0.3 hectare in size.

Over the past decade, the Government of Myanmar has allocated nearly 0.8 million hectare of land in large concessions to local agribusiness companies and, since 2010, to foreign investors. Some of the large concessions have proven commercially successful as farming businesses. Other concessionaires appear to have limited interest in farming and seem to have obtained land rights instead for speculation purposes or land rental to smallholder sharecroppers.

2.8.2 Capital of Paddy Production in Current Market Situation

Myanmar was one of the most important crop producers and exporters in the region. More recently its agricultural production has been characterized by low productivity and high volatility, though strong opportunities remain in the sector. (Agriculture Guide 2019)

The sector still suffers from a lack of effective infrastructure, financing and public agricultural services. This is compounded by issues such as complex and unresolved land issues, low levels of sector research and vulnerability to natural disasters and weather events. (Agriculture Guide 2019)

Compared with international standards or even regional peers, agriculture in Myanmar is very labor-intensive. Most agricultural activities are carried out on small farms, typically manually with low levels of mechanisation, which results in low productivity and agricultural output and, consequently low agricultural wages and farm profits. About 80% of farm-holders have less than 10 acres and a farmer in Myanmar only earns about $1.80 – $2.50 per day in monsoon season compared to $10.00 – $16.50 per day in Thailand and $7.80 per day in the Philippines. (Agriculture Guide 2019)

Farmers are applying fertilizers inefficiently or not using fertilizer with the correct nutrient balance, partly due to lack of knowledge and training, despite spending $650 million on fertilizers annually. In October 2018, the Upper House of Parliament launched the first parliamentary inquiry into chemicals used in agriculture and their effects on the industry, as an acknowledgement that improvements are needed. (Agriculture Guide 2019)

Farmers lack access to irrigation systems. In 2015–16, only 16.2% of crop area was connected to public irrigation systems, less than all regional neighbours besides Cambodia. Issues linked to low irrigation coverage is further exacerbated as government systems allow water to be supplied only for paddy due to its status as a staple crop. Attention is not provided to other more lucrative crops. (Agriculture Guide 2019)

Poor quality seeds hinder the agricultural sector's ability to reach its full potential. Although the government has seed distribution schemes, they are under-resourced. According to the World Bank, the supply of certified paddy seeds only meets about 1% of the demand. Furthermore, due to a poor enabling environment in Myanmar, private seed providers have not been able to produce enough to meet demand, nor import the required amounts of quality seeds. As a result, many Myanmar farmers use saved seeds, thus producing low yields. (Agriculture Guide 2019)

Agricultural land is currently under-capitalised and farmers must borrow capital at subsidised interest rates. At the end of 2017, the Myanmar Agriculture Development Bank (MADB) had $1.98 trillion in outstanding loans, mostly to smallholder farmers. MADB loans only cover a fraction of production costs for up to 10 acres; the bank does

not support medium or large holder farmers. In total, 88% of those loans are provided to small farmers engaged in paddy production and are only large enough to purchase inputs for the following cropping season; they are often insufficient for the purchase of farm tools and equipment. MFIs are looking to bridge this gap and provide farmers with access to finance, however their capacity to assist is limited. (Agriculture Guide 2019)

In May 2018, MADB started issuing individual monsoon loans rather than group loans. Paddy farmers will be able to receive MMK150,000 per acre and farmers of other crops MMK50,000 per acre. The interest rate in 2018 at the MADB is 8%. (Agriculture Guide 2019)

Other sources of funding are;

- The government has also been providing low interest loans to farmers under cooperatives.
- Private microfinance institutions (MFIs) offer loans at low interest rates. However, they are limited by geographical reach and caps in loan size.

Informal sources of credit, such as private money lenders, have become a major source of capital for many farmers. Money lenders usually charge a monthly interest rate of 10–20%.(Agriculture Guide 2019)

Despite these challenges, the agricultural sector has the potential for rapid growth. With better access to capital, improved infrastructure and technology, as well as proximity to better seeds and fertilizer, farmers can be empowered to produce a greater amount of more diversified crops. The livestock and fishery markets are examples of recent successes in the agricultural sector. Despite employing only a fraction of agriculture's workforce, livestock and fisheries contribute 26% to the total agricultural GDP. Fish is the country's main source of protein. (Agriculture Guide 2019)

Future growth is also expected in the livestock market, as domestic demand for meat grows, particularly in urban areas, and international opportunities are explored. Late last year, the Ministry of Commerce allowed the export of live cattle to China, generating $150 million in revenue as a result of this change. (Agriculture Guide 2019)

Private sector investment in agriculture and in agrobusinesses has also started picking up, including in fertilizer manufacturing and seeds and production of animal feed. Livestock and fishery sectors would benefit from better quality animal feed, while fish processors have already gained from improved quality of supply, and have accreditation for export from the EU. (Agriculture Guide 2019)

2.9 Some Empirical Reviews

The Southeast Asia is composed of eleven countries of impressive diversity in region, culture, and history namely; Brunei, Myanmar, Cambodia, Timor-Leste, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam. It is also one of the most dynamic areas of the world economically, a factor which largely accounts for its growing international significance. The staple food of people in eleven Asian Countries are fish and rice.

An article in Journal of the International Society for Southeast Asian Agricultural Sciences expressed that "Profit Efficiency in Rice Production in Brunei Darussalam: A Stochastic Frontier Approach" by Fadil Galawat and Mitsuyasu Yabe (2012). It attempts to study the production efficiency among rice farmers in Brunei. It is found that factors are related to profit loss and profit inefficiency on rice production are non-membership of cooperative, no irrigation, lack of training and low yield variety. (Fadil Galawat and Mitsuyasu Yabe, 2012)

In Cambodia, the paper namely "Rice Production Response in Cambodia" by Bingxin Yu and Shenggen Fan (2009) analyzed that how Cambodian farmers and the government can respond to the rise of rice price. The results indicate that agricultural productivity is far from its potential and can be increased substantially by using modern technology and inputs such as fertilizers and irrigation. (Bingxin Yu and Shenggen Fan, 2009)

In Timor-Leste, the paper "Introduction System of Rice Intensification in Timor-Leste Experiences and Prospects" is conducted by Georg Deichert, Jose Barros and Martin Noltze. This paper outlines prospects and challenges for further promotion of SRI (System of Rice Intensification) in Timor-Leste. It is found that introducing SRI in Timor-Leste has been a remarkable achievement so far, in spite of the partly difficult specific circumstances. (Georg Deichert, Jose Barros and Martin Noltze)

In Indonesia, an article "Rice Production in Indonesia: Policy and Performance" is conducted by Joko Mariyono (2014). This study addresses its performance in accordance with several determining factors, underlying which is the concept of technical efficiency. It is concluded that there is considerable room for productivity improvements through increases in efficiency. Training in relevant agricultural methods, the creation of wetlands, and an improvement in irrigation infrastructure are the best ways to enhance rice production. (Joko Mariyono, 2014)

In Laos, the report "Productivity and Technical Inefficiency of Paddy Rice Production in Laos: A Case Study of Farm Household" is conducted by Vanxay Sayavong (2018). This research examines paddy rice production as well as factors hindering its efficiency with stochastic frontier and inefficiency models. Production factors such as farmland, labour, capital, inputs and other spending are analyzed in the production model while the specific factors such as water availability, quality of soil, seeds per hectare, fertilizers per hectare, size of a plot, education and extension services related to technical efficiency are examined in the inefficiency model. The result identifies knowledge transfer on new technologies and skills to farmers via rice association and training is the most effective way to improve or reduce the efficiency or inefficiency whereas public extension service needs more attentions. Also, investing in water control systems such as a large scale of canals and drainage is necessary. (Vanxay Sayavong, 2018)

The rice cultivation in Malaysia was closely associated with the rural population and traditional farmers. A conference paper "A Study on Factors Affecting Rice Production in Malaysia" is conducted by Afizan Amer (2010) to analyze the factor that most affecting the rice production. It is found that the important factor of rice such as labour availability, the demand for the commodity need to be distressed to improve the production of rice where it can help the government to reduce expenses on subsidies and reduce the import of rice to open up more room of survival for local rice growers. (Afizan Amer, 2010)

In Philippines, a dissertation "The Impacts of Research on Philippine Rice Production" is conducted by Flordeliza Bordey (2010). The objective of this dissertation is to analyze the contributions of conventional and non-conventional inputs, and residual total factor productivity to the production growth. Results indicate that research and development has generated cost-savings and has improved productivity of rice. (Flordeliza Bordey, 2010)

As there is little local agricultural production, Singapore is almost entirely dependent upon imports for its food requirements. The country's economy is mainly driven by financial services, manufacturing and tourism. (Singapore – Agriculture Sector)

The rice production in Thailand has long played a vital role in the country's socio-economic development. A paper "Efficiency Measurement on Rice Production in Thailand" is conducted by Anupong Wongchai (2015). The aim of this paper is to

assess (i) technical efficiency and technology gap ratios (ii) trend of rice productivity's change (iii) factors affecting the technical efficiency of rice production in Thailand. The findings showed that the factors of the trend of rice productivity change in Thailand had a productivity progression because the increasing trend of higher technical change. Since the factors that had a significant effect to the efficiency were irrigated land, farming experience, rainfall, and land tenure, the policymakers should issue some relevant strategies to support the increasing number of these factors to reach the highest efficiency on rice production in Thailand. (Anupong Wongchai, 2015)

In Vietnam, a paper "Climate Change, Rice Production, and Migration in Vietnamese Households" is conducted by Adelaide Barinchelli and Roberto Ricciuti (2018). This paper analyzes the relationship between climate and migration in rural households in Viet Nam. The results show that the rise in minimum temperature during the core month of the growing season (i.e. June) does cause a reduction in rice production which, in turn, has a positive impact on people propensity to migrate. (Adelaide Barinchelli and Roberto Ricciuti, 2018)

CHAPTER – III
THEORETICAL BACKGROUND

3.1 Production Function

The production function is defined as technical relationship between physical quality of output of inputs and physical quantity of output of any sector. This functional relationship can be specified as follows:

$$Y = f(X_1, X_2, X_3, \dots, X_n)$$

Where

Y = Physical quantity of output

$X_1, X_2, X_3, \dots, X_n$= Physical quantities of outputs employed.

If X_1 is labour and X_2 is capital in the function then the following economic relationships will be obtained. (M.UPENDER)

Marginal Product of Labour [MPX_1], MP$X_1 = \Delta Y / \Delta X_1$, whose value is always supposed to be positive. The Marginal Product of Labour goes on declining with the increase in X_1 . (M.UPENDER)

The Marginal Product of Capital [MPX_2], MP$X_2 = \Delta Y / \Delta X_2$, whose value is also always supposed to be positive. The Marginal Product of Capital also goes on declining with the increase in X_2 . (M.UPENDER)

The elasticity of output with respect to labour or capital is the ratio of the marginal product of the concerned input [MPX_1 or MPX_2] to the average product of the same [APX_1 or APX_2]. (M.UPENDER)

The elasticity of output with respect to [$e_{Y.X_1}$] will be estimated as follow:

$$e_{Y.X_1} = \Delta Y / \Delta X_1 \,.\, X_1 / Y$$

(1) If it's value is less than unity, then the proportionate change in output will be lower than the proportionate change in input X_1 .

(2) If it is more than unity, then the proportionate change in output will be higher than the proportionate change in input X_1.

(3) If it is unity, then the proportionate change in output will be equal to the proportionate change in input X_1. (M.UPENDER)

The above statements implies that:

(1) $MPX_1 < APX_1$ and APX_1 declines with an increase in labour input.

(2) $MPX_1 > APX_1$ and APX_1 increases with an increase in labour input.

(3) $MPX_1 = APX_1$ and APX_1 will be constant with an increase in labour input. (M.UPENDER)

The elasticity of output with respect to capital $[e_{Y.X_2}]$ will also be estimated as follows:

$$e_{Y.X_2} = \Delta Y/\Delta X_2 \,.\, X_2/Y$$

(1) If it's value is less than unity, then the proportionate change in output will be lower than the proportionate change in input X_2 .

(2) If it is more than unity, then the proportionate change in output will be higher than the proportionate change in input X_2.

(3) If it is unity, then the proportionate change in output will be equal to the proportionate change in input X_2. (M.UPENDER)

The above statements implies that:

(1) $MPX_2 < APX_2$ and APX_1 declines with an increase in capital input.

(2) $MPX_2 > APX_2$ and APX_1 increases with an increase in capital input.

(3) $MPX_2 = APX_2$ and APX_1 will be constant with an increase in capital input. (M.UPENDER)

The returns to scale will be estimated to know the responsiveness of output to the changes in all the inputs simultaneously. This will be estimated by taking the sum of the elasticities of output with respect to different inputs included in the production function shown below:

$$\sum[\partial Y/\partial X_1 \,.\, X_1/Y + \partial Y/\partial X_2 \,.\, X_2/Y + \cdots + \partial Y/\partial X_n \,.\, X_n/Y] = \sum[\partial Y/\partial X_i \,.\, X_i/Y]$$

If the sum of the elasticities is more than unity, then there will be increasing returns to scale; [Non-linear homogeneous production function]; If the sum of the elasticities is less than unity, then there will be decreasing returns to scale; [Non-linear homogeneous production function]; If the sum of the elasticities is equal to unity, then there will be constant returns to scale [Linear homogeneous production function]. (M.UPENDER)

3.2 Linear Production Function

On the assumption of a linear relationship between the output and the set of inputs, the following relationship (model) will be specified:

$$Y = b_0 + b_1X_1 + b_2X_2 + \cdots + error$$

The partial derivative of Y with respect to X_1 is

$\partial Y/\partial X_1 = b_1$, which is constant marginal product of labour $[MPX_1]$, all else equal.

The partial derivative of Y with respect to X_2 is

$\partial Y/\partial X_2 = b_2$, which is constant marginal product of labour $[MPX_2]$, all else equal.

Similarly the partial derivative of output with respect to other inputs will also be estimated.

The elasticity of output with respect to X_1 will be estimated as follows:

$$e_{Y.X_1} = [\partial Y/\partial X_i \,.\, X_i/Y] = \; b_1 * Y/X_1$$

The value of elasticity of Y with respect to X_1 goes on changing with the change in Y or X_1, if the individual values are considered. Therefore it is referred to as variable elasticity. (M.UPENDER)

Similarly the elasticity of output with respect to X_2 will be estimated as follows: $e_{Y.X_2} = [\partial Y/\partial X_2 \,.\, X_2/Y] = \; b_2 * X_2/Y.$

The value of the elasticity of Y with respect to X_2 goes on changing with the change in Y or X_1. Therefore it is referred to as variable elasticity, if the individual values are considered. The elasticities of output with respect to different inputs $[X_1 \; or \; X_2]$ in the linear production function will be inversely related to the increase in $X_1 \; or \; X_2$, all else equal. In empirical production function studies, the elasticities of output with respect to different inputs will be evaluated at the mean values of Y, X_1 and X_2. Therefore they will be referred to as the average elasticities. (M.UPENDER)

If the $e_{Y.X_1}$>1, then the proportionate change in Y will be higher than the proportionate change in X_1. If the $e_{Y.X_1}$<1, then the proportionate change in Y will be less than the proportionate change in X_1. If the $e_{Y.X_1}$=1, then the proportionate change in Y will be equal to the proportionate change in X_1. (M.UPENDER)

From the linear production function, the estimate of returns to scale [Responsiveness of output to the changes in all the inputs] can be obtained by taking the sum of the elasticities [evaluated at the mean value] as shown below:

$$\sum [b_1X_1/Y + b_2X_2/Y + \cdots + b_nX_n/Y]$$

If it is more than 1, then there will be increasing returns to scale. If it is less than 1, then there will be decreasing returns to scale. If it is equal to 1, then there will be constant returns to scale. If the linear function fitted to the cross-section or time series observations is not found to be appropriate, then other form of equation such as power function will be attempted. (M.UPENDER)

3.3 Cobb-Douglas Production Function (Log-Log Model)

The specification of a power function, which is well known as Cobb-Douglas Production Function [double log or log linear or constant elasticity model], will be as follows:

$$Y = b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n}$$

The partial derivative of Y with respect to X_1, keeping other variables constant

$\partial Y/\partial X_1 = b_1[b_0 X_1^{b_1-1} X_2^{b_2} \dots X_n^{b_n}]$

$= b_1[b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n}] X_1{}^{-1}$

$= b_1[Y] X_1{}^{-1}$

$= b_1\, Y/X_1$, is known as marginal product of labour. This is inversely related to increase in labour input, all else equal. Therefore, the marginal product of labour goes on diminishing with the increase in labour input. (M.UPENDER)

The partial derivative of Y with respect to X_2, keeping other variables constant

$\partial Y/\partial X_1 = b_1[b_0 X_1^{b_1} X_2^{b_2-1} \dots X_n^{b_n}]$

$= b_1[b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n}] X_2{}^{-1}$

$= b_1[Y] X_2{}^{-1}$

$= b_1\, Y/X_2$, is known as marginal product of capital. This is inversely related to increase in capital input. Therefore, the marginal product of capital also [or any input] goes on diminishing with the increase in capital input all else equal. Thus, the marginal products of labour and capital will be in line with the theory according to which, if the variable input labour or capital is successively employed in the operation of production, all else equal, the marginal product of that variable inputs goes on diminishing. In order to examine whether the production function curve [emerged out of the power production function or Cobb-Douglas production function] has concavity to the input [If labour input is considered] axis, it is necessary to consider the second derivative [derivative of the first derivative] of the function. (M.UPENDER)

First derivative of the function with respect to labour input

$\partial Y/\partial X_1 = b_1[b_0 X_1^{b_1-1} X_2^{b_2} \dots X_n^{b_n}] <$ unity

$\partial^2 Y/\partial X_1^2 = [b_1 - 1] b_1[b_0 X_1^{b_1-1-1} X_2^{b_2} \dots X_n^{b_n}]$

$\partial^2 Y/\partial X_1^2 = [b_1 - 1] b_1[b_0 X_1^{b_1-2} X_2^{b_2} \dots X_n^{b_n}]$

$\partial^2 Y/\partial X_1^2 = [b_1 - 1] b_1[b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n}] X_1{}^{-2}$

$\partial^2 Y/\partial X_1^2 = [b_1 - 1] b_1[Y] X_1{}^{-2}$

$\partial^2 Y/\partial X_1^2 = [b_1 - 1]b_1[Y]/{X_1}^2 < 0$ subject to condition that $b_1 < 1$.

Thus if $\partial Y/\partial X_1 < 1$ and $\partial^2 Y/\partial X_1^2 < 0$, then the power function will have concavity to labour input axis implying that marginal product of labour diminishes with increase in labour. (M.UPENDER)

The regression coefficients of different inputs in the Cobb-Douglas production function will be constant partial elasticities as shown below:

$$e_{Y.X_1} = \partial Y/\partial X_1 \,.\, X_1/Y$$
$$= b_1 b_0 X_1^{b_1 - 1} X_2^{b_2} \dots X_n^{b_n} \,.\, X_1/Y$$
$$= b_1 b_0 X_1^{b_1} {X_1}^{-1} X_2^{b_2} \dots X_n^{b_n} . X_1/Y$$
$$= b_1 b_0 X_1^{b_1}\, 1/X_1\, X_2^{b_2} \dots X_n^{b_n} \,.\, X_1/Y$$
$$= b_1 b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n} \,.\, 1/Y$$
$$= b_1\, Y/Y$$
$$= b_1$$

Thus, b_1 is the constant partial elasticity of output with respect to input (labour). The elasticity of output with respect to capital will also be constant as shown below:

$$e_{Y.X_1} = \partial Y/\partial X_2 \,.\, X_2/Y$$
$$= b_2 b_0 X_1^{b_1} X_2^{b_2 - 1} \dots X_n^{b_n} \,.\, X_2/Y$$
$$= b_2 b_0 X_1^{b_1} X_2^{b_2} {X_2}^{-1} \dots X_n^{b_n} . X_2/Y$$
$$= b_2 b_0 X_1^{b_1} X_2^{b_2}\, 1/X_2 \dots X_n^{b_n} \,.\, X_2/Y$$
$$= b_2 b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n} \,.\, 1/Y$$
$$= b_2\, Y/Y$$
$$= b_2$$

Thus, b_2 is also constant elasticity of output with respect to input (capital). (M.UPENDER)

3.4 Returns to Scale [Homogeneous Production Function]

The estimate of returns to scale can be estimated from the Cobb-Douglas production function by taking the summation of the regression coefficients [constant elasticities] of various inputs. In other words it is the sum of elasticities of output with respect to different inputs. In case of two inputs X_1 and X_2,

i.e. $\sum[b_1 + b_2] = \sum[\partial Y/\partial X_i \,.\, X_i/Y]$

If the sum is more than 1, then there will be increasing returns to scale [Non-Homogeneous Production Function]. If the sum is less than 1, then there will be decreasing returns to scale [Non-Homogeneous Production Function]. If the sum is equal to 1, then there will be constant returns to scale [Linear Homogeneous Production Function]. (M.UPENDER)

3.5 Assumptions of Production Function

The assumptions of production function are

(1) The production function is related to a particular period of time.

(2) There is no change in the technology.

(3) The producer is using the best techniques available.

(4) The factors of production are divisible into the most viable units.

(5) Production function can be fitted to a short run or long run.

(6) There are only two factors of production, labour and capital.

CHAPTER – IV

Analysis of Paddy Production with Cobb-Douglas Production Function

4.1 Introduction

In this chapter, the descriptive statistics, linear production function and Cobb-Douglas production function are applied on the basis of secondary data of paddy production in Ayeyarwaddy Region.

4.2 Descriptive Statistics

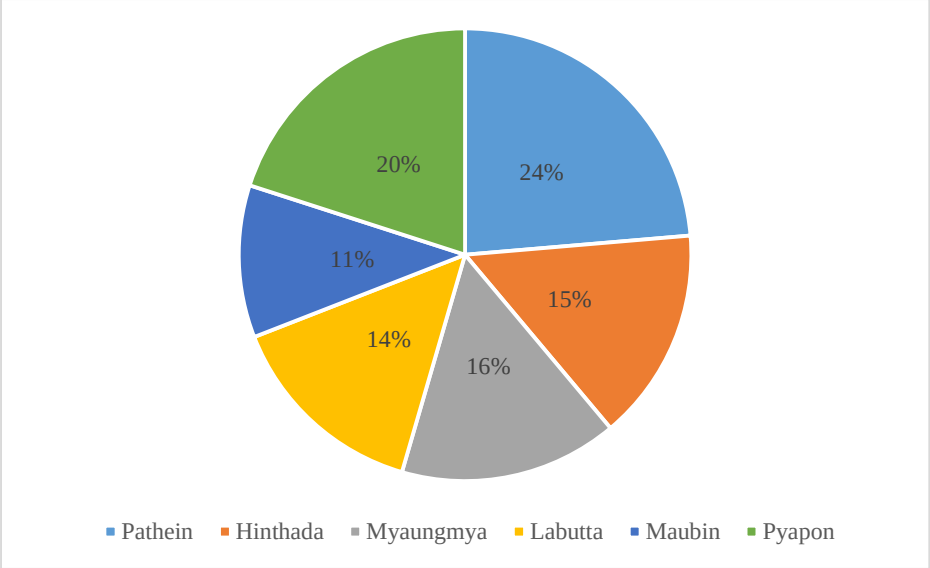
In this section, presents the percentage of paddy production, labour and capital by districts, then shows the percentage of production, labour cost and capital of paddy for each township.

The following Table (4.1) shows the percentage of paddy production, labour cost and capital by districts.

Table (4.1) Paddy Production, Labour Cost and Capiatl by Districts (2018-19)

Districts	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Pathein	62001.47 (23.65%)	1.76E+08 (24.85%)	53885577 (27.05%)
Hinthada	39964.76 (15.24%)	1.09E+08 (15.36%)	28329469 (14.22%)
Myaungmya	40924.57 (15.61%)	1.01E+08 (14.31%)	36025638 (18.08%)
Labutta	38231.29 (14.58%)	90629347 (12.82%)	22288141 (11.19%)
Maubin	28538.96 (10.88%)	85221469 (12.07%)	24009391 (12.04%)
Pyapon	52530.59 (20.04%)	1.46E+08 (20.59%)	34697740 (17.42%)
Total	262191.6	706759703.7	199235955.5

Source: Department of Agriculture in Pathein



Source: Table (4.1)

Figure (4.1) Paddy Production by Districts

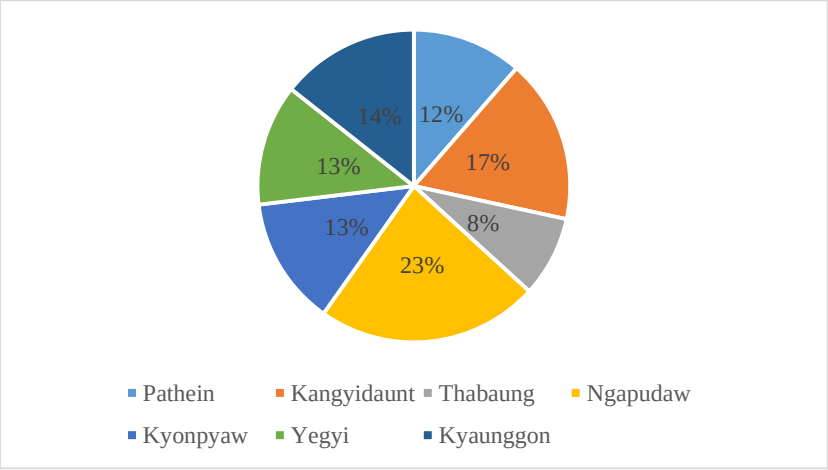
As shown Table (4.1), Pathein has highest paddy production (23.65%), labour cost (24.85%) and capital (27.05%) of paddy per acre. Followed by Pyapon has the second highest production (20.04%) and labour cost (20.59%) of paddy, and it has the third highest capital with (17.42%). Hinthada has the third highest labour cost (15.36%). In addition, Myaungmya has the third highest paddy production (15.61%) and the second highest capital with (18.08%).

The following Table (4.2) shows the percentage of paddy production, labour cost and capital by Patthein District.

Table (4.2) Paddy Production, Labour Cost and Capital by Pathein District

Townships	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Pathein	7078.316 (11.42%)	6137870 (9.78%)	17176875 (11.39%)
Kangyidaunt	10532.77 (16.99%)	14424500 (16.99%)	29858715 (26.77%)
Thabaung	5186.135 (8.36%)	4080540 (7.75%)	13601800 (7.57%)
Ngapudaw	14284.2 (23.04%)	7656600 (22.67%)	39814320 (14.21%)
Kyonpyaw	8238.81 (13.29%)	6693664 (17.38%)	30519646 (12.43%)
Yegyi	7778.942 (12.54%)	6867315 (12.16%)	21364980 (12.74%)
Kyaunggon	8902.307 (14.36%)	8025088 (13.27%)	23308160 (14.89%)
Total	62001.47	1.76E+08	53885577

Source: Department of Agriculture in Pathein



Source: Table (4.2)

Figure (4.2) Paddy Production by Pathein District

As shown in Table (4.2), Ngapudaw has the highest production (23.04%) and labour (22.67%) of paddy, and the third highest capital with (14.21%). Kangyidaunt has the second highest production of paddy (16.99%), the third highest labour with

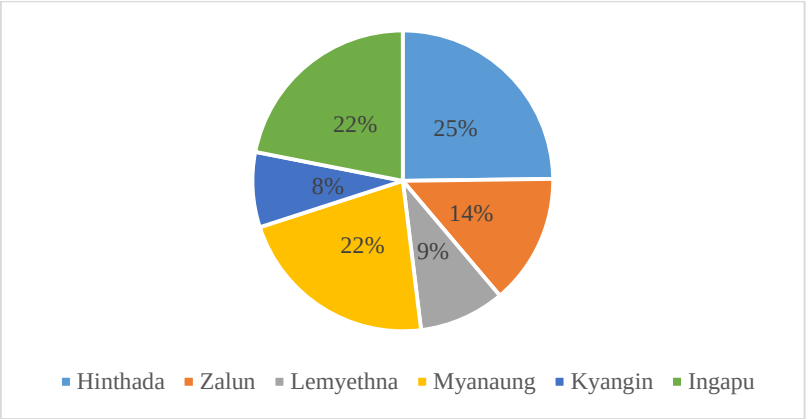
(16.99%) and the highest capital with (26.77%). Followed by Kyongpyaw has the second highest labour cost with (17.38%). Kyaunggon has the third highest paddy production with (14.36%) and the second highest capital with (14.89%).

The following Table (4.3) shows the percentage of paddy production, labour cost and capital by Hinthada District.

Table (4.3) Paddy Production, Labour Cost and Capital by Hinthada District

Townships	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Hinthada	9908.642 (24.79%)	25313008 (23.31%)	5811660 (20.51%)
Zalun	5608.142 (14.03%)	17123688 (15.77%)	4716270 (16.65%)
Lemyethna	3688.016 (9.23%)	9521309 (8.77%)	3409835 (12.04%)
Myanaung	8774.631 (21.96%)	27782586 (25.59%)	7123740 (25.15%)
Kyangin	3228.442 (8.08%)	8558336 (7.88%)	2097216 (7.4%)
Ingapu	8756.885 (21.91%)	20283434 (18.68%)	5170748 (18.25%)
Total	39964.76	1.09E+08	28329469

Source: Department of Agriculture in Pathein



Source: Table (4.3)

Figure (4.3) Paddy Production by Hinthada District

Table (4.3) presents that Hinthada Township has the highest paddy production with (24.79%), and has the second highest labour cost and capital with (23.31%) and

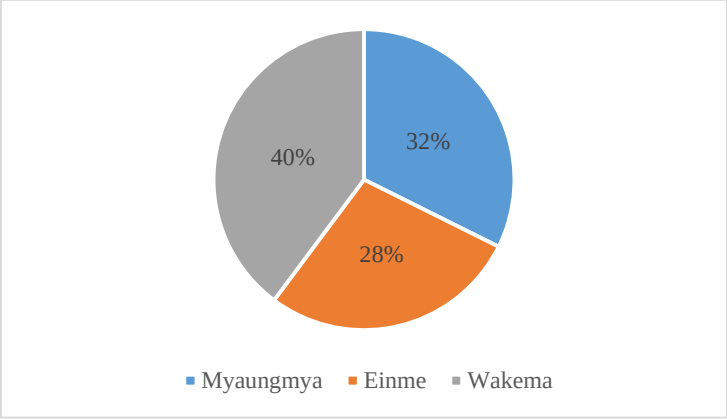
(20.51%). Followed by Myanaung has the second highest paddy production with (21.96%) and has the highest labour cost and capital with (25.59%) and (25.15%), respectively. In addition, Ingapu has the third highest production, labour cost and capital of paddy with (21.91%), (18.68%) and (18.25%).

The following Table (4.3) shows the percentage of paddy production, labour cost and capital by Myaungmya District.

Table (4.4) Paddy Production, Labour Cost and Capital by Myaungmya District

Townships	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Myaungmya	13240.81 (32.35%)	0.323542 (33.64%)	34026011 (12.42%)
Einme	11394.82 (27.84%)	0.278435 (18.3%)	18519795 (30.17%)
Wakema	16288.94 (39.81%)	0.398024 (48.06%)	48613248 (57.41%)
Total	40924.57	1.01E+08	36025638

Source: Department of Agriculture in Pathein



Source: Table (4.4)

Figure (4.4) Paddy Production by Myaungmya District

As shown in Table (4.4), Wakema Township has the highest paddy production, labour and capital with (39.8%), (48.06%) and (57.41%), respectively. Followed by Myaungmya has the second highest paddy production (32.35%) and labour cost (33.64%), but it has the third highest capital (12.42%). In addition, Einme has the third

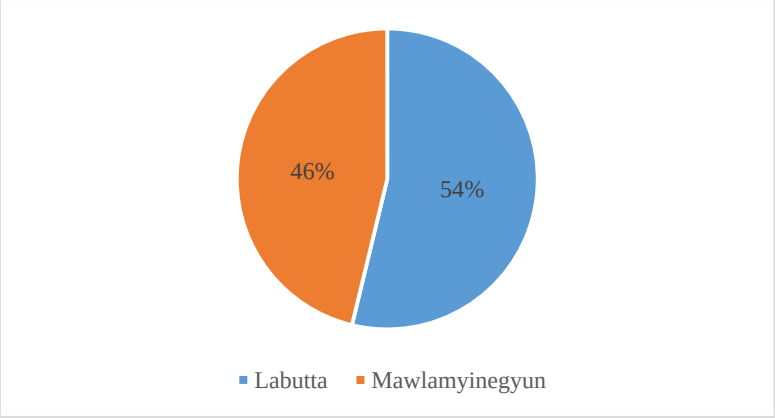
highest paddy production and labour cost with (27.84%) and (18.31%), but it has the second highest capital (30.17%).

The following Table (4.5) shows the percentage of paddy production, labour and capital by Labutta District.

Table (4.5) Paddy Production, Labour Cost and Capital by Labutta District

Townships	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Labutta	20557.89 (53.77%)	38693245 (42.69%)	19514854 (87.56%)
Mawlamyinegyun	17673.4 (46.23%)	51936102 (57.31%)	2773287 (12.44%)
Total	38231.29	90629347	22288141

Source: Department of Agriculture in Pathein



Source: Table (4.5)

Figure (4.5) Paddy Production by Labutta District

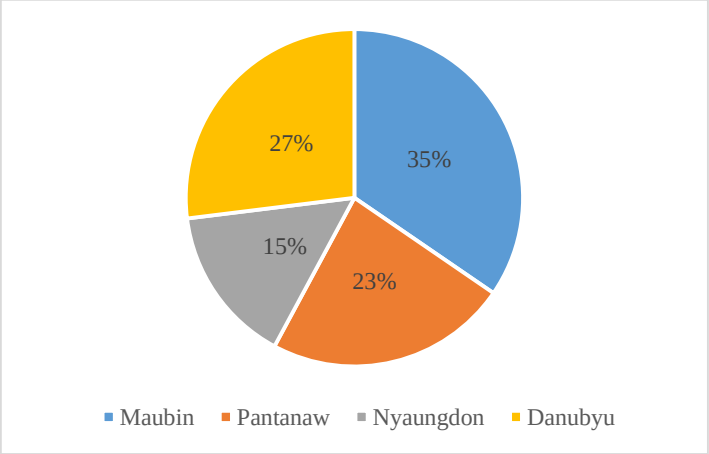
As shown in Table (4.5), Labutta Township has the highest paddy production and capital with (53.77%) and (87.56%), but it has the second labour cost with (42.69%). Mawlamyinegyun has the highest in labour cost with (57.31%) and the paddy production and capital are lower than Labutta Township. It might be due to the effect of Nargis. After the period of Nargis, the majority of people in Mawlamyinegyun were migrant to other regions. There was caused the scarce of labour. The cost of labour in Mawlamyinegyun may be expensive. Therefore, it has the highest labour cost.

The following Table (4.6) shows the percentage of paddy production, labour and capital by Maubin District.

Table (4.6) Paddy Production, Labour Cost and Capital by Maubin District

Townships	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Maubin	9863.074 (34.56%)	31092380 (36.48%)	10034359 (41.79%)
Pantanaw	6649.237 (23.3%)	21579290 (25.32%)	5160265 (21.49%)
Nyaungdon	4331.916 (15.18%)	10673475 (12.53%)	3936938 (16.4%)
Danubyu	7694.731 (26.96%)	21876324 (25.67%)	4877829 (20.32%)
Total	28538.96	85221469	24009391

Source: Department of Agriculture in Pathein



Source: Table (4.6)

Figure (4.6) Paddy Production by Maubin District

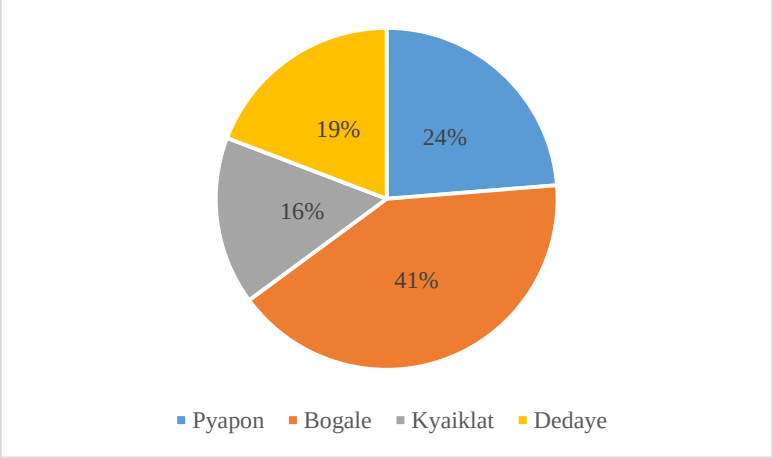
As shown in Table (4.6), Maubin Township has the highest paddy production, labour cost and capital with (34.56%), (36.48%) and (41.79%). Followed by Danubyu has the second highest paddy production with (26.96%), labour cost with (25.67%) and the third highest capital with (20.32%). Moreover, Pantanaw has the third highest paddy production with (23.3%), labour cost with (25.32%) and the second highest capital with (21.49%).

The following Table (4.7) shows the percentage of paddy production, labour cost and capital by Pyapon District.

Table (4.7) Paddy Production, Labour Cost and Capital by Pyapon District

Townships	Paddy Production (baskets in thousands)	Labour cost (kyats in thousands)	Capital (kyats in thousands)
Pyapon	12464.97 (23.73%)	27379560 (18.81%)	11162436 (32.17%)
Bogale	21624.85 (41.17%)	59438610 (40.84%)	14229243 (41.01%)
Kyaiklat	8356.375 (15.9%)	20831231 (14.32%)	3051709 (8.8%)
Dedaye	10084.4 (19.2%)	37873576 (26.03%)	6254352 (18.02%)
Total	52530.59	1.46E+08	34697740

Source: Department of Agriculture in Pathein



Source: Table (4.7)

Figure (4.7) Paddy Production by Pyapon District

As shown in Table (4.7), Bogale has the highest paddy production, labour cost and capital with (41.17%), (40.84%) and (41.01%). Followed by Pyapon has the second highest paddy production with (23.73%), capital with (32.17%) and the third highest labour cost with (18.81%). In addition, Dedaye has the third highest paddy production with (19.2%), capital with (18.03%) and has the second highest labour cost with (26.03%).

4.3 Linear Production Function of Paddy Production

The linear production function of paddy production is

$$Y = b_0 + b_1X_1 + b_2X_2 + \varepsilon \qquad (4.1)$$

where, $b_0, b_1 \; and \; b_2$ = unknown parameters

X_1 = labour of paddy

X_2 = capital of paddy

ε = error term

Table (4.8) shows the regression results of linear production function.

Table (4.8) Regression results of linear production function

Independent variables	Coefficients	t	Sig.	Std. Error
Constant	398512.312	0.461	0.648	863644.751
$\ln X_1$	0.00***	8.414	0.00	0.00
$\ln X_2$	0.00***	2.784	0.011	0.00
F-ratio	75.93***		0.00	
R	0.932			
R square	0.868			
Adjusted R square	0.857			
Durbin-Watson	2.179			
n	26			

*** is statistically significance in 1%.

Source: Agricultural Department in Pathein

The estimated multiple linear regression model is as follows

$$Y = 398512.312 + (0 \times X_1) + (0 \times X_2)$$

Se = (863644.751) (0.00) (0.00)

P – value = (0.0648) (0.00) (0.011)

R^2=0.868, F = 75.93

According to the regression results of linear production function, R^2=0.868 reveals that 86.8 percent of the change in paddy production is explained by changes in labour and capital of paddy. The value of F is 75.93, p = 0.00 < 0.01. This means that the whole regression coefficient is significance at 1% level. But, there is zero value in the coefficients of both labour and capital of paddy. This means that there is no relationship between paddy production and labour cost. There is also no relationship between paddy production and capital.

4.4 Cobb-Douglas Production Function of Production Function

The Cobb-Douglas production function of paddy production is

$$Y = b_0 X_1^{b_1} X_2^{b_2} \dots X_n^{b_n} \qquad (4.2)$$

where, $b_0, b_1, \dots, b_n$ = unknown parameters

ε = the disturbance term

The following Table (4.9) shows the regression results of Cobb-Douglas production function for paddy production.

Table (4.9) Regression Results of Cobb-Douglas Production Function for Paddy Production

Independent variables	Coefficients	t	Sig.	Std. Error
Constant	-6.72***	-4.031	0.001	1.667
$\ln X_1$	0.809***	9.672	0.00	0.084
$\ln X_2$	0.15**	2.102	0.047	0.071
F-ratio	94.061***		0.00	
R	0.944			
R square	0.891			
Adjusted R square	0.882			
Durbin-Watson	1.879			
n	26			

** and *** is statistically significance in 5% and 1%, respectively.

Source: Agricultural Department in Pathein

The estimated log-log regression model (or) Cobb-Douglas production function is

$$\ln \hat{Y}_i = -6.72 + 0.809 \ln X_1 + 0.15 \ln X_2 \qquad (4.3)$$

Se = (1.667) (0.084) (0.071)

P-value = (0.001) (0.00) (0.047)

F = 94.061, R^2= 0.891, R = 0.944

If the capital remains unchanged, one unit increases in the labour led on the average to about a 0.809 percent increase in the paddy production. Then, if the labour remains unchanged, one unit increases in the capital led on the average to about a 0.15 percent increase in the paddy production. According to the p-value, it can be said that the variable, (logs) of labour and capital are statistically significant at 1% and 5% level, respectively. R^2=0.891 reveals that 89.1 percent of the change in paddy production is explained by changes in labour and capital of paddy. The value of F is 94.061, p = 0.00 < 0.01. This means that the whole regression coefficient is significance at 1% level.

The elasticity of labour is $e_{Y.X_1} = b_1 = 0.809$. Similarly, the elasticity of capital is $e_{Y.X_2} = b_2 = 0.15$. The sum of the elasticities, estimate of returns to scale is 0.959 showing that there are decreasing returns to scale.

Decreasing return to scale might be due to the following reasons:

(1) The sample data are secondarily collected data, which is usually collected by someone else than the one who uses it. Then, the data are available only estimate.

(2) Generally the secondary data is biased in the favor of one who collected it and might not necessarily meet with the requirements of another researcher.

(3) The data are available only high yield varieties such as Sin Thu Kha, Paw San Yin, Sin Thwel Lat and the data on other varieties are not obtained.

(4) The data of Capital has been included only the varieties of fertilizer.

Hence, decreasing returns to scale might be due to the above reasons.

CHAPTER V
CONCLUSION

5.1 Discussions

Paddy is the main crop production in agricultural sector of Myanmar. It is also the career of the people of Myanmar. The paddy producing areas in Myanmar are the delta, dry zone, coastal zone and mountainous area. Among them, the delta region is the largest cultivated in both monsoon and summer seasons. In descriptive statistics, Pathein is the most productive District among six districts. It might be due to there has not only good transportation but also knowledge dealing with agriculture since Pathein is also the capital of Ayeyarwaddy Region. By computing the linear production function, there is no relationship between paddy production and labour cost. Similarly, there is no relationship between paddy production and capital. Hence, the Cobb-Douglas production function (or) Log-Log model for the paddy production of Ayeyarwaddy Region is considered. In this study, the paddy production in monsoon season of Ayeyarwaddy Region (delta) was chosen to fit the Cobb-Douglas production function.

In Ayeyarwaddy region, the high yield varieties of paddy are Sin Thu Kha, Paw San Yin, Sin Thwel Lat. The Cobb-Douglas production function was applied for the high yield varieties of paddy in Ayeyarwaddy Region. The labour and capital of paddy are used as the inputs of paddy production.

According to R^2 = 0.891, 89.1% of the variation in paddy production is explained by the (logs) of labour and capital. In Cobb-Douglas production function, the coefficients of labour and capital are 0.809 and 0.15, respectively. If the capital remains unchanged, one unit increases in the labour led on the average to about a 0.15 increases in paddy production. If the labour remains unchanged, one unit increases in the capital led on the average to about a 0.809 increases in paddy production. The elasticities of labour and capital are 0.809 and 0.15, respectively. The sum of elasticities is 0.959. Since the value of the sum of the elasticities is less than one, there is decreasing returns to scale. It means that paddy production increases by decreasing the proportional change in both labour and capital.

5.2 Recommendations

According to findings, it can be suggested that the government should support the transforming from traditional farming to mechanized farming. There are also needed to improve the education and training programs for effective use of fertilizers and pesticides to farmers by local government. Good quality seeds should be used to increase paddy production. The seed production sector should be strengthened to supply quality seeds at reasonable prices to farmers throughout the country. Moreover, farmers should be trained to carefully select and manage their own seed production fields. Utilization of good land is also vital for increasing the paddy production. Irrigation project in Myanmar is mainly supplied water for paddy cultivation. Irrigation system is one of the most important factors in paddy production. The government should be paid effort to the construction of irrigation facilities. There is necessary to improve weed management practices, especially to use hoes for more effective removal. In the current situation, it appears that most pesticide applications are unnecessary or counterproductive. Especially, insecticides usually have a higher human toxicity than fungicides and herbicides, and when considering the basic understanding of pesticides should be expressed the potential for health hazards.

5.3 Further Study

If the data for land of paddy production is available, the production will be taken into account function of land, labour and capital. If the costs and revenues of other crops are obtained, then a profit function will be analyzed for further studies.

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APPENDICES

APPENDIX A

Table (A) Paddy production, Labour and Capital of Paddy (per acre) in Ayeyarwaddy Region

Districts	Paddy production per acre (baskets in thousands)	Labour per acre (Kyats in thousands)	Captal per acre (Kyats in thousands)
Pathein District			
Pathein	7078.316	17176875	6137870
Kangyidaunt	10532.77	29858715	14424500
Thabaung	5186.135	13601800	4080540
Ngapudaw	14284.2	39814320	7656600
Kyonpyaw	8238.81	30519646	6693664
Yegyi	7778.942	21364980	6867315
Kyaunggon	8902.307	23308160	8025088
Total	62001.47	175644495.6	53885577
Hinthada District			
Hinthada	9908.642	25313008	5811660
Zalun	5608.142	17123688	4716270
Lemyethna	3688.016	9521309	3409835
Myanaung	8774.631	27782586	7123740
Kyangin	3228.442	8558336	2097216
Ingapu	8756.885	20283434	5170748
Total	39964.76	108582360.7	28329469
Myaungmya District			

Myaungmya	13240.81	34026011	4474926
Einme	11394.82	18519795	10868760
Wakema	16288.94	48613248	20681952
Total	40924.57	101159054.4	36025638
Labutta District			
Labutta	20557.89	38693245	19514854
Mawlamyinegyun	17673.4	51936102	2773287

(Cont'd)

Total	38231.29	90629347	22288141
Maubin District			
Maubin	9863.074	31092380	10034359
Pantanaw	6649.237	21579290	5160265
Nyaungdon	4331.916	10673475	3936938
Danubyu	7694.731	21876324	4877829
Total	28538.96	85221469	24009390.5
Pyapon District			
Pyapon	12464.97	27379560	11162436
Bogale	21624.85	59438610	14229243
Kyaiklat	8356.375	20831231	3051709
Dedaye	10084.4	37873576	6254352
Total	52530.59	145522977	34697740

Source: Department of Agriculture in Pathein

APPENDIX B

Table (B) Regression results of Linear Production Function

Descriptive Statistics

	Mean	Std. Deviation	N
Paddy production	10084.29362	4826.594524	26
Labour	27183065.53	12948487.884	26
Capital	7662921.37	4885526.219	26

Correlations

		Paddy production	Labour	Capital
Pearson Correlation	Paddy production	1.000	.908	.681
	labour	.908	1.000	.558
	capital	.681	.558	1.000
Sig. (1-tailed)	Paddy production	.	.000	.000
	labour	.000	.	.002
	capital	.000	.002	.
N	Paddy production	26	26	26
	labour	26	26	26
	capital	26	26	26

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.932[a]	.868	.857	1825.015959	2.179

a. Predictors: (Constant), Ln X2, Ln X1

b. Dependent Variable: Ln Y

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	505794652.624	2	252897326.312	75.930	.000[b]
	Residual	76605714.740	23	3330683.250		
	Total	582400367.364	25			

a. Dependent Variable: Ln Y

b. Predictors: (Constant), Ln X2, Ln X1

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	398.512	863.645		.461	.649
	Labour	.000	.000	.766	8.414	.000
	Capital	.000	.000	.254	2.784	.011

a. Dependent Variable: Ln Y

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3368.98389	20944.56250	10084.29362	4497.975779	26
Residual	-3179.305420	4216.135742	.000000	1750.493813	26
Std. Predicted Value	-1.493	2.414	.000	1.000	26
Std. Residual	-1.742	2.310	.000	.959	26

a. Dependent Variable: Ln Y

APPENDIX C

Table (C) Regression results of Cobb-Douglas Production Function

Descriptive Statistics

	Mean	Std. Deviation	N
Ln Y	16.0164	.48812	26
Ln X1	23.9130	.49856	26
Ln X2	22.5903	.58428	26

Correlations

		Ln Y	Ln X1	Ln X2
Pearson Correlation	Ln Y	1.000	.933	.669
	Ln X1	.933	1.000	.593
	Ln X2	.669	.593	1.000
Sig. (1-tailed)	Ln Y	.	.000	.000
	Ln X1	.000	.	.001
	Ln X2	.000	.001	.
N	Ln Y	26	26	26
	Ln X1	26	26	26
	Ln X2	26	26	26

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.944[a]	.891	.882	.16797	1.879

a. Predictors: (Constant), capital, labour

b. Dependent Variable: paddy

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.308	2	2.654	94.061	.000[b]
	Residual	.649	23	.028		
	Total	5.957	25			

a. Dependent Variable: paddy

b. Predictors: (Constant), capital, labour

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-6.720	1.667		-4.031	.001
	labour	.809	.084	.826	9.672	.000
	capital	.150	.071	.180	2.102	.047

a. Dependent Variable: paddy

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	15.0037	16.8589	16.0164	.46076	26
Residual	-.28212	.37360	.00000	.16111	26
Std. Predicted Value	-2.198	1.829	.000	1.000	26
Std. Residual	-1.680	2.224	.000	.959	26

a. Dependent Variable: paddy