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ANALYSIS OF GROUNDNUT SOWN ACRE, HARVESTED ACRE AND PRODUCTION IN MYANMAR

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MAS - 39 (1st Batch)

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This thesis is submitted to the Board of Examination as partial fulfillment of the requirements for the Degree of Master of Applied Statistics

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ABSTRACT

Groundnut is the basic requirement crop in Myanmar. This study concentrates on the estimated trend equations like linear, quadratic, cubic models for groundnut sown acre, harvested acre and production in Myanmar. In this thesis, the sown acre, harvested acre and production of groundnut over the last 30 years (1988-89 to 2017-18) are studied and forecast values for next three years (2018-2019 to 2020-20201) are made using best fitted cubic model. The required annual time series data are obtained from the Central Statistical Organization (CSO) of Myanmar. This study is intended to be able to choose the best model among models namely Linear, Quadratic, Cubic. The best fitted model for the future projection was chosen based upon the highest coefficient of determination (R^2), and the values of smallest MSE, RMSE and MAPE by comparing with other models. The cubic model was chosen as the best fitted model for sown acre, harvested acre and production of groundnut data series. Using the cubic model, the values of groundnut production were predicted. It was also found that the assumptions concerned with the production function model are satisfied. In addition, the multiple regression model for groundnut production was also obtained using sown acre, yields per harvested acre and irrigation. The double log multiple linear regression model was chosen for the analysis.

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LIST OF ABBREVIATIONS

APE	-	Absolute Percent Error
BC	-	Before Christ
BIC	-	Bayesian Information Criterion
CDZ	-	Central Dry Zone
CSO	-	Central Statistical Organization
MAPD	-	Mean Absolute Percent Deviation
MAPE	-	Mean Absolute Percent Error
MOAI	-	Ministry of Agricultural and Irrigation
MSE	-	Mean Square Error
MSR	-	Mean Square Regression
RMSE	-	Root Mean Square Error
SSE	-	Error Sum of Square
VIF	-	Variance Inflation Factor

CHAPTER I
INTRODUCTION

This chapter includes rationale of the study, objectives of the study, method of study, scope and limitations of the study and organization of the study.

1.1 Rationale of the Study

Groundnut, or peanut, is commonly called the poor man's. It is an important oil seed and food crop. This plant is native to South America. The botanical name for groundnut, Arochishypogaea Linn., is derived from two Greek words. It is generally distributed in the topical, sub-topical and warm temperature zones (Nautiyal, 2002).

Groundnut is the 6^{th} most important oil seed crop in the world. It involves 48-50%, oil, 26-28% protein and 11-27% carbohydrate, minerals and vitamin (Mukhtar, 2009). In 2011, groundnut was cultivated in more than 60 countries in the world. Groundnut was grown on 26.4 million hectare worldwide, with a total production of 37.1 million metric tons. Developing countries in Asia Africa and South America constitute 97% of world groundnut area and 94% of the global production of this crop (FAO, 2011).

Asia has the largest area of groundnut cultivation in the world. In 2007, Indio held the largest acreage filled by China, Indonesia, Myanmar, Pakistan and Thailand. Harvested area has been an important increase in Asia over the past two decades. The average productivity of groundnut in Asia was 1739 kilogram per hectare (Prasad, Kakani & Upadhyaya, 2020).

Nowadays, the famous supplies of food, groundnuts are eaten as peanut butter and a confectionary snack by roasting and salting. In addition, the groundnut oil can be made from it. Groundnuts are particularly grown in most of the countries to get profits in economy as it can be used in various ways.

In the same way, in Myanmar, groundnut is the country staple meals and significantly essential for agriculture. In Myanmar, the agriculture sector contributes 27.5 % of GDP, 17.5 %of total export earnings, and employs 61.2 % of the labour force (MOAI 2012). In Myanmar, 70 percent of the country's populations live in a rural area and their live hood drive the agriculture sector as an important growth of rural development. For the economy of Myanmar, the agriculture sector is one of the most important sectors because Myanmar is one of the developing countries which are obviously required to rely on agriculture to achieve progress in many fields. Another reason why the agriculture is of vital importance to our country is that our second largest export commodity is agricultural goods. Myanmar's top agriculture exports are rice, maize, black gram, green gram, pigeon pea, chick pea, sesame, onion, tamarind, raw rubber, vegetables, and fruits.

In Myanmar, more than 60 different crops are grown based on the prevalence of different agro-ecological zones. The crops are generally classified into eight groups: cereals, pulses, oilseeds, industrial crops, fruits, vegetables, culinary crops and other crops. Other important crops are pulses, sesame, groundnuts and sugarcane. Around twenty percent of the agriculture land is completely covered by oil crops. Myanmar two fundamental oil crops are sesame and groundnut. Eighty five percent of the groundnut and 96% of sesame seeds are grown in Sagaing, Mandalay and Magway (Wijnands et al., 2014). Oilseed crops utilize a vital role according to Myanmar's high consumption for cooking oil. The largest oil seeds crop production areas are Mandalay and Magway Division. Among of oil seed crops, groundnut is one of the most important oil seed crops which has been grown not only in rain fed but also in irrigation area. Groundnut is grown in dominantly under rain fed condition which different level of production across division. In 2004-2005 the average yield in Magway division was about 36% higher than the average yield in Mandalay. The national average yield per harvested hectare has been about 560.20 kg per hectare in 2006 (Htun, 2013).

Myanmar has been an agricultural country since time immemorial perhaps due to its favorable agro-climate conditions and rich natural resources. So before embarking upon the analysis of the agricultural development, a brief introduction of the characteristic features of Myanmar agricultural would deem necessary for comprehension for later analysis. For the purpose of agricultural development in Myanmar, three main components of national agricultural policy of Myanmar have been set as food security, export promotion and enhancing incomes and welfare the farmer. To achieve these goals, the Ministry of Agriculture and Irrigation (MOAI) set three main policy objectives of the agriculture sector are as follows;

a. To increase surplus in rice production

b. To achieve self-sufficiency in edible oil; and

c. To step up the production of exportable pulses and industrial crops.

In line with objectives, government expanded agricultural land in order to encourage the private sector participation in large scale commercial farming and to distribute firm machineries and other inputs to achieve agriculture objectives.

Groundnut production in Myanmar is facing with raising costs of production coupled with declining productively. The production of groundnut gradually increase due to the high seed cost. The profit and quality of groundnut seed are important consideration for farmers in growing groundnut. Production Technology and operational constraints are important elements to increase productivity of groundnut.

Groundnut becomes a major marketable crop and plays as major item in the local area. The groundnut sown acre, harvested acre and the groundnut production in Myanmar are needed to analyze in order to predict their future values. So, the production of groundnut in Myanmar will be investigated in this study.

1.2 Objectives of the Study

The objectives of the study are as follows:

(i) To find out the best fitted trend models for the sown acre, harvest acre and production of groundnut in Myanmar.

(ii) To forecast the production of groundnut in Myanmar by using best fitted model.

(iii) To analyze the relationship between groundnut production and other related input variables.

1.3 Method of Study

The time series analysis and multiple regression analysis are used in this thesis. The best fitted models for sown acre, harvested acre and production of groundnut are found using time series analysis. Moreover, the best fitted model for each data series is applied to forecast its future values. In addition, multiple linear regression analysis is used to examine the relationship between dependent variable (production) and independent valuables (sown acre, yield per harvested acre and irrigation).

1.4 Scope and Limitations of the Study

The secondary data are used for this study. This study uses the annual time series data on sown acre, harvested acre, yield per harvested acre, irrigation and production of groundnut in Myanmar from 1989-89 to 2017-18. Data are obtained from Myanmar Statistical Year Book published by Central Statistical Organization, Ministry of Planning and Finance.

1.5 Organization of the Study

The study is organized into five chapters. Chapter I introduces rationale of the study, objectives of the study, method of study, scope and limitations of the study and organization of the study. Chapter II illustrates history and benefits of groundnut. The research methodology is explained in the Chapter III. Analysis of groundnut sown acre, harvested acre and production in Myanmar is presented in Chapter IV. Finally, conclusions of this study have been summarized in the Chapter V.

CHAPTER II
HISTORY AND BENEFITS OF GROUNDNUT

This chapter provides overview of groundnut, types of groundnut, utilization of groundnut; groundnut oil processing and nutrition facts of groundnut. Moreover, it presents related literature reviews with various methodologies commonly used in analysis of the study.

2.1 Overview of Groundnut

The plant groundnut is an ancient crop of the World, which come from in South America. Groundnut was originated as early as 1000 B.C. Distribution of the crop to Africa, Asia, Europe the Pacific Islands occurred presumably in the sixteenth and seventeenth centuries with the discovery voyages of the Spanish, Portuguese, British and Dutch. Today, groundnuts are the second important crop after rice. Moreover, groundnut is an important oil, food and forage crop (Nautiyal and Mejia, 2002).

In Myanmar, maximum of humans are eaten beans and pulses a ramification manner of every day intake pattern. Since bean gives protein better than exceptional kind of crops. It is also a critical role nourishment of Myanmar residents. Moreover, it performs already a foreign marketplace and it must be grown sustainably. Myanmar is richly endowed with renewable and non-renewable power resources which can be being exploited by way of the kingdom area with the participation of neighborhood and overseas traders. It is likewise a rustic with a huge land area wealthy in natural and human resource.

In Myanmar, groundnuts are particularly grown within the Central Dry Zone (CDZ).Thousands of smallholder farmers in Myanmar develop groundnuts for family meals and as a cash crop. The groundnut is classed as an oilseed due to the excessive oil content material of the grain. Sesame and groundnuts are extensively grown as climate-resilient crops inside the CDZ because they may be fairly proof against drought. Groundnuts are grown on approximately 0.7 million hectares in Myanmar, mainly in the CDZ.

2.2 Types of Groundnut

There are four main types of groundnut: Runner, Spanish, Virginia and Valencia. Each of the groundnut type is distinctive in size, flavor and nutritional consumption (Arya et al., 2016).

1. Runner: Runner type has uniform medium- sized seeds, usually two seeds per pod, growing from a low bush. Runner types are harvest 130 to 150 days from planning. The uniform sizes of the seed make these a good choice for roasting.
2. Spanish: Spanish type has small, roundish seeds covered with reddish with a reddish–brown skin, growing on a low bush. Spanish types are ready for harvest 120 days from planning. The uniform sizes of the seed make these a good choice for roasting.
3. Virginia: Virginia type has the largest seed of the four groundnut types; the seed is most often roasted. There are commonly two and sometime three seeds per pod, The Virginia type groundnut stand to 24 inches tall and spread to 30 inches wide and it’s ready for harvest 130 to 150 days from planting.
4. Valencia: Valencia type has three to six small, oval seed crowed into each pod; each seed is covered with bright-red shin. Valencia groundnuts are often roasted in the shell or boil fresh. The plant grows to about 50 inches tall and spread about 30 inches; most of the pods are clustered around the base of the plant.

2.3 Utilization of Groundnut

The uses of groundnut are all several of the plant can be used. The seed is a rich sources of edible oil, containing 36 to 54% oil and 25 to 32% protein (Wijnands et al.,2014). About two thirds of world production is compressed for oil, which makes it an important oil seed crop. The oil is utilized primarily for cooking, manufacture of margarine, shortening and soaps. Seeds are eaten directly either raw or roasted, chopped in confectioneries, or groundnut into groundnut butter. Young pods may be consumed as a vegetable, while young leaves and tips are used as a cooked green vegetable.

Nonfood products such as soaps, medicines, cosmetics, emulsions for insect control can be create from groundnut. The oil cake, a high protein livestock feed, may be utilized for human consumption.

Groundnut shells may be used for fuel as a soil conditioner, for sweeping compounds, as filler in cattle feed, as a raw source of organic chemicals, as an extender of resin, as a cork substitute, and in the building trade as blocks or hardboard(Subrahmanyam et al., 1989).

2.4 Health Benefits of Groundnut

Groundnuts are as popular as they are healthy. They are an excellent plant-based source of portion and high in various vitamins, minerals and plant compounds. Groundnuts are rich in protein, fat and various healthy nutrients. They can be used for weight loss and are linked to a reduced risk of heart disease.

1. Rich in Energy: Groundnut contains vitamin minerals, nutrients and anti-oxidants and thus is rich energy sources.
2. Cholesterol: It lowers bad cholesterol and increase good cholesterol in the body.
3. Growth: Groundnuts are rich in proteins. The amino acid present in them are good for proper growth and development of body.
4. Fight Stomach Cancer: Poly-phenolic anti-oxidants presents in the groundnuts in high concentrations. P-comedic acid has the ability to reduce the risk of stomach cancer.
5. Fights against Heart Diseases, Nerves Diseases, Alzheimer's Disease and Infection; Apoly-phenolic anti- oxidant, Resveratrol present in groundnuts prevents heart diseases, cancers, nervous diseases and viral or fungal infections efficiently.
6. Anti-oxidants: Groundnuts contain anti-oxidants in high concentration.
7. Protect Skin: Vitamin E in groundnuts help in maintaining the integrity of cells of mucous membrane and the skin. This protects them from free radicals which cause great damage.
8. Colon Cancer: Groundnuts can reduce colon cancer especially in women. This is one of the best benefits of groundnuts for women.
9. Helps in Fertility: If taken before and during early pregnancy. The folic acid lowers the risks of body begin of groundnut for women.
10. Regulates Blood Sugar: Manganese in groundnuts help in calcium absorption, fats and sugar level regulation blood.
11. Fights Depression: Groundnuts increase the release of this chemical and thus help you fight depression.

2.5 Groundnut Oil Processing

Groundnut oil, additionally known as peanut oil, is a moderate tasting vegetable oil expressed from groundnut kernels. Groundnut oil is extensively utilized in cooking, including frying, basting, and the manufacture of margarines and shortenings. Groundnut oil processing process, based on mechanical pressing technology, is generally grouped into three stages: groundnut seeds preparation, groundnut pressing and rude groundnut oil refining**.**

First of all, the groundnut seeds need a thorough cleaning process to put off sand, stalk, plant debris and any other impurities. And then for the post cleaning, the groundnut seeds have to be prepared for pressing, which usually involves size reduction of the groundnut seeds by breaking them and then conditioning by adjusting their moisture content and temperature, while retaining the seeds hot for a period of certain minutes.

Second, the properly prepared seeds are conveyed to the screw pressing machine, which is the most popular method of groundnut oil production. The machine’s screw warm pressed the groundnut seeds as it moves to advance where the space is smaller and smaller. Due to strong frication and high pressure, groundnut oil is pressed out. Besides, as the temperature in the machine’s pressing chamber rises, the output rate of groundnut oil also increases. Finally, the fresh groundnut oil seeps out through the small openings in the bottom of the pressing chamber.

Third, the fresh rude groundnut oil received from the pressing machine is clarified in a setting tank and then pumped via the filter press. The filtered crude groundnut oil will be pumped to the refinery for three stages of refining: neutralization, bleaching and deodorization.

Groundnut is marked for two different purposes: (1) to be consumed as groundnut oil and, (2) to be used as traditional snack. Groundnuts are mainly sold as edible groundnuts, crushed groundnuts, seeds and for the animal feed industry. Raw groundnuts are basically used as seed, transformed into ‘prepared’ groundnuts (roasted, salted, flavored, etc.) used in food industries to produce groundnut butter and groundnut intensive goods such as snacks and sweets, or crushed for oil and groundnut meal. Groundnut butter is one such product consumed in large quantities especially in western countries since many years.

Food processing constitutes a major economic sector in developing countries, especially in urban areas where low- income families are not equipped to carry out the basic processing of agricultural and animal products. Food processing also allows the consumption of seasonal agricultural products over the whole year. In Myanmar, groundnuts are sold mainly as a groundnut brittle. Brittle is a type of confection consisting of flat broken pieces of hard sugar embedded with groundnut seed (lone san). It has many variations around the world. Groundnut brittle widely produced in Magway Township by the name of Kaung – Mon on the domestic market.

Edible oil processing has an important role in transforming oilseed crops into edible oil products for consumers. In Myanmar, the private sector plays a major position in the milling of oilseed crops such as sesame, groundnut and sunflower. Edible oil processing is a peak activity after harvesting the oilseed crop. The miller collect the crops and distribute the processed edible oil by using their own investment or sometimes while palm oil is the cheapest on the market. However, prices of edible oils in general fluctuate widely.

Myanmar is currently a deficit producer of edible oil and oilcake, and significant quantities of palm oil are imported to partially meet domestic demand. Outright bans on imports of exports cannot be fully enforced. Informal imports allow the country to meet domestic demand of oil and oilcake, while informal exports of groundnuts for the snacks market allowed groundnut price to be sustained on the domestic market(Htun, 2013).

2.6 Nutrition Facts of Groundnut

Groundnut is an excellent source of many vitamins and minerals. These include biotin, copper, niacin, manganese, vitamin E, thiamin, phosphorus, and magnesium. As a source of many heart-healthy nutrients, groundnuts may help prevent heart disease. Groundnuts consumption may cut the risk of gallstones. However, being high in fat, peanuts are a high-calorie food and should not be eaten in excess.

The following vitamins and minerals are in particularly high amounts in groundnut

- **Biotin:** Groundnuts are one of the richest dietary sources of biotin, which is mainly important during pregnancy.
- **Copper:** A nutritional trace mineral that is often low in the Western diet. Copper deficiency may have adverse effects on heart health.
- **Niacin:** Also known as vitamin B3, niacin has various important functions in the body. Niacin has been linked with reduced risk of heart disease.

- **Manganese:** A hint element observed in drinking water and most foods.
- **Vitamin E:** A powerful antioxidant, often found in high amounts in fatty foods.
- **Thiamin:** One of the B-vitamins, also known as vitamin B1. It helps the body's cells convert carbs into energy, and is essential for the function of the heart, muscles, and nervous system.
- **Phosphorus:** Peanuts are a good source of phosphorus, a mineral that plays an essential role in the growth and maintenance of body tissues.
- **Magnesium:** An essential dietary mineral with various important functions. Magnesium intake is believed to protect against heart disease.

2.7 Reviews on Related Studies

The available literature on the subject has been reviewed and presented under the following.

Taru et al. (2008) highlighted that the economic efficiency of resource use in groundnut production in Michika local government area of Adomowa State. It focuses on the relationship between groundnut out and the various inputs used by groundnut farmers, elasticity and economic efficiency of resource used in production of groundnut. Primary data were collected on 143 farmers using a simple random technique. The regression model is used to analyze the data and the Eobb. Douglas function gave the best fit. The study found that three out of the eight independent variables were significant at 1% level. Farm size, seed and labour input are positively affected the groundnut production.

Ekunwe et al. (2013) studied that economics of groundnut production in Estako west local Government Area of Edo State. Primary data were collected from 60 groundnut farmers using a simple random sampling technique. Data were analyzed with the use of regression analysis. The linear, semi-log and double-log a rithmic funditonal farms were tried out and the best model was selected on the bases of economic, statistical and economic criteria. It is found that the Double log functional form provided the best fit. The coefficients of farm size, farmer’s experience, labour and ages were positive and family size was negative.

Zekeri and Tijjani (2013) analyzed measure the resource use efficiency in groundnut production in Ringim Local Government Area, Jigawa State. A stratified sampling technique was employed to select 58 respondents. The data were analyzed using multiple regressions. The results showed that among the unriables, seed, hiredlabour and pesticide use in the groundnut production were significant while fertilizer, family labour and farm size were not significant. For resource use efficiency, seeds, family labour and hired labour were under – utilizers and pesticides were over utilized.

Mazumdar (2015) studied that groundnut production of India with a non-linear growth models. Monomolecular, logistic and Gomperiz models have been employed for modeling of India's total groundnut production during the period 1950-51 to 2011-12. Compared the models based on various GOF criteria, it was found that Monomolecular and logistic models are better than Gompertz model. India's total groundnut production for 2014-15 to 2019-20 has been forecasted by using the Monomolecular and logistic models.

Win (2019) studied the technical efficiency of groundnut production in main production areas of Myanmar. Mandalay and Magway divisions were selected as the study area. Farm-level survey for the 2006-2007 crop year was collected. In this study, 269 samples were collected from a total, 118 samples from Mandalay and 151 samples from Magway. The cobb – Douglas frontier functions was used for both Mandalay and Magway division. The results also indicate that there was significant variation in production efficiency among sample households in two divisions. In Magway division, production area showed positive effect on the yield per heat are at the 0.01 significant level.

Wai (2019) studied that value-added processing opportunities and profit function of groundnut farmer in Myanmar Township, Sagaing Region. A total of 150 sample groundnut farmers from three villages were selected by using purposive random sampling method. Descriptive statistics, multiple linear regression and log linear regression were used in this study. The results found that the highest benefit cost ratio was observed in selling seed (1.64) and the lowest in selling pods (0.96) in winter season. The largest benefit cost ratio and the smallest benefit cost ratio were 2.30 and 1.24 of selling seed and pod in raining season. The profit per cost price of seed was the higher profit share than the other types of groundnut product. In the regression analysis, the groundnut profit was positively and significantly influenced by groundnut profit was positively and significantly influenced by groundnut yield, while family labour cost, hired labour cost and total material cost were negatively and significantly influenced on profit of groundnut production. The profit of high purified grain, total material cost was negatively and significantly influenced on profit of groundnut production. The profit of high purified grain, total material cost, family labour cost and hired labour cost were negatively and significantly influenced, and price and processing cost were positively and significantly influenced. The profit of low purified gain, total material cost and family labour cost were negatively and significantly influenced, and price and processing cost were positively and significant the influenced.

CHAPTER III
RESEARCH METHODOLOGY

This chapter describes the research methodology of the thesis. It includes statistical models, multiple linear regression model, the assumptions of this model, tests for the significance of this model.

3.1 Statistical Models

The trend equations were fitted by using different linear and non-linear model for identifying the trend. They are very quick to estimate and less expensive, although less efficient. They are very good in many situations for describing the growth pattern and the future movement of a time series (Pindyck and Rubinfeld, 1991) these models are widely used to estimate the rate of time series data. The models taken under consideration here are as follows:

3.1.1 Linear Model

The mathematical equation is given by

$$Y = \beta_0 + \beta_1 t \quad (3.1)$$

where,

'Y' is the dependent variable i.e., sown acre or harvest acre or production.

't' is the time taking integer values starting from 1.

'β_0' is the intercept

'β_1' is the coefficient of the models.

The 'β_0' and 'β_1' are estimated by applying the ordinary least squares approach.

3.1.2 Quadratic Model

This model is useful when there is peak or trough in the data of past periods. Quadratic fit is given by the equation

$$Y=\beta_0 + \beta_1 t + \beta_2 t^2 \quad (3.2)$$

where,

'Y' is the dependent variable i.e., sown acre or harvest acre or production.

't' is the time taking integer values starting from 1.

'β_0' is the intercept

'β_1' and 'β_2' is the coefficient of the models

The 'β_0','β_1'and'β_2' are estimated by applying the ordinary least squares approach.

3.1.3 Cubic Model

This model is useful when there is, two peaks or two troughs in the data of past periods. Cubic fit or third degree curve is given by the equation:

$$Y=\beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3 \qquad (3.3)$$

where,

Y' is the dependent variable i.e., sown acre or harvest acre or production.

't' is the time taking integer values starting from 1.

'β_0' is the intercept

'β_1','β_2' and 'β_3' is the coefficient of the models

The 'β_0','β_1','β_2' and 'β_3' can be estimated by the method of applying the ordinary least squares (OLS).

3.2 Multiple Linear Regression Model

Multiple linear regression analysis is one of the most widely used by all statistical tools. Multiple regression analysis is a statistical tool that utilizes the relationship between two or more quantitative variable that one variable can be predicted from other variables. Regression analysis was first developed by Sir Francis Galton in the latter part of the 19^{th}century. The primary objective of regression analysis is to estimate the value of a random variable (the dependent variable) given that the value of an associated variable (the independent variable) is known. The dependent variable is also called the response variable, while the independent variable is also called the predictor variable. The regression equation is the algebraic formula by which the estimated value of the dependent or response variable is determined.

Regression and correlation analyses will show to determine both the nature and strength of relationship between two variables. To carry on the regression and correlation analysis, the value of an unknown variable based on past observation of that variable and others. In regression analysis, the estimation models are constructed.

That is, a mathematical formula that related the known variable to the unknown variable. Then, after the pattern of relationship, correlation analyses are needed to determine the degree to which the variables are related.

Multiple regression analysis is an extension correlation. The result of regression is an equation that represents the best prediction of a dependent variable from several independent variables. Regression analysis is used when independent variables are correlated with one another and with the dependent variable. In regression, dependent variables have only one in proposed estimating equation. However, the independent variables are used more than one variable. The independent variables are adding to the model, improve the accuracy of prediction that is being studies.

The introduction of a model in multiple regression model is very similar to introduce this concept in simple regression analysis. The equation which describes how the dependent variable Y is related to the independent variables $X_1, X_2, \ldots, X_k$ and an error term *e* is called the multiple regression model.

The multiple regression models take the following form;

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik} + e_i \tag{3.4}$$

where

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

β_0 = intercept

$\beta_1,..,\beta_k$ = regression coefficients associated with each of the X_k independent variable

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

e_i = the random error in the i^{th} trial or observation, associate *with* the process of sampling.

If the values of β_0, $\beta_1, \beta_2, \ldots, \beta_k$ are unknown, the previous equation is used to calculate the mean value of Y_i at the given values of X_{i1}, X_{i2}, …, X_{ik}. In general, these parameter’s values will not know and will have to estimate them from sample data. Using the sample, an estimated multiple regression equation can develop which takes the following form;

$$\hat{Y}_i = b_0 + b_1 X_{i1} + b_2 X_{i2} + \ldots + b_k X_{ik} \tag{3.5}$$

where $b_o, b_1, \dots, b_k$ are the estimated values for the parameters $\beta_0, \beta_1, \beta_2, \dots, \beta_k$ and $\hat{Y}_i$ is the estimated value of the dependent variable. The estimation procedure for multiple linear regression models is nearly identical to simple regression.

3.3 Assumptions of the Multiple Linear Regression Model

Multiple regression is an analysis that assess whether more than one predictor variables explain the dependent variable. The multiple regression have the following key assumptions:

(1) Linear Relationship

First, multiple linear regression is a linear relationship between the dependent variable and each of the independent variables. The best way to check the linear relationships is to create scatterplots and then visually inspect the scatterplots for linearity. If the relationship displayed in the scatterplot is not linear, then the analyst will need to run a non-linear regression or transform the data. Violations of this assumption may result in the estimates obtained from the analysis, such as R^2, regression coefficients, standard errors, and statistical significance. The results from the analysis will underestimate the true relationship between the independent variables (predictor variables) and dependent variable if the relationship is not linear. This underestimation of the results could lead to two areas of concern; first, an increase risk of Type II error could occur for that predictor variable, and second, an increase risk of Type I error (which is an overestimation) for the other predictor variable(s) that share variance with that predictor variable could occur.

The linearity assumption can be tested through the visual examination of residual plots. A residual scatterplot is a figure that depicts one axis for the standardized residuals and the other axis for the predicted values. If the linearity assumption is met, the standardized residuals will scatter randomly around a horizontal line which represents the standardized residuals equaling zero. When linearity is violated, the residual plot portrays a c-curved or u-curved shape of distribution around the horizontal line.

(2) Normality

Second, the multiple linear regressions analyzed that the error between observed and predicted values should be normality distributed. To test this assumption, look at how the values of residuals are distributed. Non-normal distributions that are positively or negatively skewed, contain large kurtosis, or have extreme outliers can distort the obtained significance levels of the analysis, resulting in the standard errors becoming biased. Outliers may have stronger influence on normal distribution when the sample size is small, whereas standard errors for both skewness and kurtosis decrease with larger samples, as there will most likely be only minor deviations from normality.

This assumption may be checked by a histogram or Q-Q plot. Normality can also be checked with a goodness of fit test. Histograms can provide important information about the shape of a distribution. If most of the scores are gathered around the middle of the continuum and a gradual, symmetric decrease of frequency on either side of the center score occurs, it is considered a normal distribution. However, it the scores are not symmetric and are spread out away from the majority it is considered skewed. If the 'tail' (a small number of the distribution) is spread out to the right, it is considered positively skewed, and if the 'tail' is spread out to the left, it is considered negatively skewed. Kurtosis is the shape of any or lack of peaks within a distribution. Though no distribution can be considered 'perfect', a distribution is regarded as normal when the values of both skewness and kurtosis are zero; however a suggested acceptable range for both is between -2 and +2.

(3) Multicollinearity

Third, multiple linear regression assumes that there is no multicollinearity in the data. Multicollinearity occurs when the independent variables (explanatory variables) are highly correlated with each other. When independent variables show multicollinearity, there will be problems figuring out the specific variable that contributes to the variance in the dependent variable. The best method to test for the assumption is the Variance Inflation Factor method. Multicollinearity refers to a situation in which two or more explanatory variables in a multiple regression model are highly linearly related. In this situation the coefficient estimates of the multiple regression may change erratically in response to small changes in the model or the data. Multicollinearity reduces the precision of the estimate coefficients. The presence of multicollinearity, changed in the model by adding or dropping some variables.

The multicollinearity between variables measured by the variance inflation factor (VIF) is as follows:

$$\text{VIF} = \frac{1}{1-R_j^2} \tag{3.6}$$

where, R_j^2 = the coefficient o0f determination of a regression of the jth independent variables. The VIF equals 1 indicate that there is no correlation between x_i and remaining the independent variables. The VIF should be less than 10.

(4) Independence

Multiple regression assumes that the errors, which are the residuals between the actual score and the estimated score obtained through the regression equation, are independent and there is no serial correlation. Having no serial correlation between the residuals implies that the size of the residual for one variable has no impact on the size of the residual for another variable. Therefore, the independence assumption requires that the variables and residuals are independent and the subjects are responding independently of each other. The independence assumption is a significant assumption that should be investigated prior to any interpretation of multiple regression analysis, as violation of this assumption could hold critical implications. Even a slight violation of the independence assumption should be taken seriously, as it can greatly increase the risk of Type I error, resulting in the risk of falsely rejecting the null hypothesis several times greater than the level of error assumed for the test. The Durbin-Watson statistic is a test for autocorrelation in the residuals from a statistical regression analysis. The hypotheses usually considered in the Durbin-Watson test are

$$H_0 : \rho \ = o$$

$$H_1 : \ \rho > o$$

The test statistic is

$$\text{d} = \frac{\sum_{i=2}^{n}(e_i - e_{i-1})^2}{\sum_{i-1}^{n} {e_i}^2} \tag{3.7}$$

where; $e_i = Y_i - \hat{Y}_i$ and Y_i and $\hat{Y}_i$ are, respectively, the predicted values of the response variable for individual i. The test statistic d becomes smaller as the serial correlations increase. d_l and d_u are upper and lower critical values from the Durbin-Watson table.

Critical value of DW:

Reject H_0 : Positive autocorrelation	Inconclusive	Do not reject H_0 : No evidence of autocorrelation	Inconclusive	Reject H_0 : Negative autocorrelation

0 d_l d_u 2 4-d_u 4-d_l 4

The Durbin-Watson statistic will always have a value between 0 and 4. If a value of 2 means that there is no autocorrelation detected in the sample. Values from 0 to less than 2 indicate positive autocorrelation and values from 2 to 4 indicate negative autocorrelation. The mid-point, i.e., a value of 2, shows that there is no autocorrelation.

(5) Homoscedasticity

The last assumption of multiple linear regression is homoscedasticity. It assumes that the amount of error in the residuals is similar at each point of the linear model. There should be no clear pattern in the distribution; if there is a cone-shaped pattern. If the data are homoscedasticity a non-linear data transformation or addition of a quadratic term might fix the problem. The assumption of homoscedacity indicates that the variance of errors is equal and constant across all levels of the variables. Homoscedasticity is related to the assumption of normality because when the assumption of normality is met, the relationship between the variables is homoscedastic. Heteroscedasticity occurs when the variance of errors differs at different values of the independent variables. Slight heteroscedasticity has little effect on significance tests; however when heteroscedasticity is marked it can lead to serious distortions of findings and seriously weaken the analysis thus increasing the possibility of a Type 1 error for small sample size.

3.4 Testing for Significance

The significance tests for the simple regression model were the *t* test and the F test. In the sample regression model, these tests always generated the same conclusion. If the null hypothesis was rejected, concluded that $\beta_i \neq 0$. In multiple regressions, thus *t* test and the *F* test have different purposes.

1 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; thus the F test is a test of the overall significance of the regression

2 If the F test shows that the regression has overall significance, the t test is then used to determine whether each of the individual independent variables is significant. A separate t test is used for each of the independent variables; thus the t test is a test for individual significance.

3.4.1 Test for the Significance of Overall Multiple Regression Model

The test for significance of regression in the case of multiple linear regression analysis is carried out using the analysis of variance. The test is used to check if the linear statistical relationship exists between the response variable and at least one of the predictor variables. The statements for the hypotheses are:

Null Hypothesis : $\beta_0 = \beta_1 = \beta_2 = \ldots = \beta_k = 0$

Alternative Hypothesis : At least one $\beta_j \neq 0$

The test for H_0 is carried out using the following statistic:

$$F = \frac{MSR}{MSE} \tag{3.8}$$

where, MSR is the regression mean square and MSE is the error mean square. To calculate the regression mean square and error mean square are as follows:

Table (3.1)

ANOVA Table for Multiple Linear Regression Model

Sources of Variation	**Sum of Square**	**Degree of Freedom**	**Mean Square**
Regression	SSR= $\sum(\hat{Y}_i - \bar{Y})^2$	k	MSR =$\frac{SSR}{k}$
Error	SSE =$\sum(Y_i - \hat{Y}_i)^2$	n-k-1	MSE =$\frac{SSE}{n-k-1}$
Total	SST =$\sum(Y_i - \bar{Y})^2$	n-1	

Source: Mendenhall and Sincich (2012)

where; SSR = Regression Sum of Square

SSE = Error Sum of Square

SST = Total Sum of Square

n = the number of observations

k = the number of predictor variables in the model

If F ≥ $F_{\alpha,k,n-k-1}$; reject H_0 ; Otherwise do not reject H_0 . The statistic F-distribution at the α level of significance and k degree of freedom in the numerator and n-k-1 degrees of freedom in the denominator.

3.4.2 Test for the Significance of Individual Independent Variables

The t distribution is used to test the two-sided hypothesis that the true slope,β_i, is significant or not. The statements for the hypothesis test are expressed as:

Null Hypothesis : $\beta_i = 0$

Alternative Hypothesis : $\beta_i \neq 0$

The test statistic used for this test is:

$$t = \frac{b_i - 0}{S_{b_i}} \tag{3.9}$$

where; b_i is the least-square estimate of β_i and $S_{b_i}$is its standard error. The value of S_{b_i}can be calculated as follows:

$$S_{b_i} = \frac{S_e}{\sqrt{\sum(X_i - \bar{X}_i)^2 (1 - r_{ij})^2}} \tag{3.10}$$

If t≥ $t_{\alpha/2,n-1}$; reject H_0. Otherwise do not reject H_0. The test statistic, t distribution with (n-2) degree of freedom, where n is the total number of observations and α is the significance level.

3.5 Functional forms of Linear Regression Model

In the linear regression models, the relationship between the response and the predictors is at least roughly linear. One situation that villate this assumption can be handled: the possibility of polynomial relationship. Another possibility is possibly of polynomial relationships. Another possibility is possibility of polynomial relationships. Another possibility is the existence of an inherently nonlinear relationship between the response and the predictors. These two extreme are called linearizable models. If the relationship between the response and the predictors is nonlinear, the transformation can be used into a linear relationship.

3.5.1 Semi-log Model (Log – Lin and Lin Log Models)

Semi-log models used either the response variable or a predicting variable is logged, but not both. There are two types of semi-log models: log-lin and lin-log. Log-lin models is a regression model where the response variable (Y) is logged. The functional relationship between y and x is

$$Ln\, Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik} + e_i \qquad (3.11)$$

Lin-log model is a regression model where the response variable (Y) is not logged, but the predictor variable (X) is logged. The functional relationship between y and X is

$$Y_i = \beta_0 + \beta_1\, LnXi_1 + \beta_2\, LnXi_2 + \ldots + \beta_k\, LnXi_k + e_i \qquad (3.12)$$

where,

Y_i	=	value of the dependent variable in the i^{th} observation
β_0	=	constant in the regression equation, which indicates the value of Y when all X_{ik} =0
$\beta_1,..,\beta_k$	=	regression coefficients associated with each of the X_k independent variable
X_{ij}	=	value of j^{th} independent variable in the i^{th} trial, or observation, associate with the process of sampling.
e_i	=	the random error in the i^{th} trial or observation, associate *with* the process of sampling.

3.5.2 Log-Log Model or Double Log-Model

The model used natural logs for variables on both sides of equation is called a log-log model. This model is handy when the relationship in nonlinear in parameters. Generally, any log transformation (natural or not) can be used to transform a nonlinear model in parameters in to a linear one. All log transformations generate similar results. The piratical advantage of the natural log is that the interpretation of the regression coefficients is straightforward.

The double log model, in its stochastic form, may be expressed as

$$Ln\, Y_i = \beta_0 + \beta_1\, LnX_{i1} + \beta_2\, LnX_{i2} + \ldots + \beta_k\, LnX_{ik} + e_i \qquad (3.13)$$

where,

Y_i	=	value of the dependent variable in the i^{th} observation
β_0	=	constant in the regression equation, which indicates the value of Y when all X_{ik} =0
$\beta_1,..,\beta_k$	=	regression coefficients associated with each of the X_k independent variable
X_{ij}	=	value of j^{th} independent variable in the i^{th} trial, or observation, associate with the process of sampling.
e_i	=	the random error in the i^{th} trial or observation, associate *with* the process of sampling.

3.6 Criteria Use for Selection of Model

To select the best type of growth model for forecasting the data for a particular time series, the available model selection criteria are R^2, MSE,MAPE and RMSE.

3.6.1 Coefficient of Determination (R^2)

The coefficient of determination, proposed by Theil (1961), is the ratio of the regression sum of square to the total sum of square

$$R^2 = \frac{\text{Regression sum of squares}}{\text{Total sum of squares}} = \frac{\text{RSS}}{\text{TSS}} = 1 - \frac{\text{ESS}}{\text{TSS}} \qquad (3.14)$$

In interpretingR^2,itis generally considered that the more the value of R^2, the better is the fit. But there are some limitations in interpreting it in this way. One of the major objectives is that can overstate the value of a regression fit since the error sum of squares (ESS) can be reduced simply by adding further explanatory variables even, if they are not relevant to explaining the dependent variable.

3.6.2 Mean Square Error (MSE)

The mean square error(MSE) or mean square deviation (MSD) is the squared difference between the estimated values and the actual values. The formula is defined as:

$$\text{MSE} = \frac{\sum(e_t^2)}{\text{n-k}} \qquad (3.15)$$

where, MSE is the difference between the actual value and forecast value, n is the sample size. The MSE is an always non- negative and its values closer to zero are better.

3.6.3 Mean Absolute Percentage Error (MAPE)

The mean absolute percentage error (MAPE), also known as mean absolute percentage deviation (MAPD), is a statistical measure of how accurate a forecast system. It measures the accuracy as a percentage, can be calculated as the absolute percent error divided by the sample size, the formula is as follows:

$$\text{MAPE} = \frac{\sum \text{APE}}{n} \quad (3.16)$$

where, APE = $\frac{|e_i|}{Y_i} = \frac{|Y_i - \hat{Y}_i|}{Y_i}$ X 100, n is the sample size. It cannot be used if there are zero values root of mean square would be a division by zero.

3.6.4 Root Mean Square Error (RMSE)

The root mean square error (RMSE) or root mean square deviation (RMSD) is the square root of mean square error (MSE).The formula is described as follows:

$$\text{RMSE} = \sqrt{\text{MSE}} \quad (3.17)$$

where, MSE = $\frac{\sum (e_t^2)}{n-k}$ .The RMSE is always non-negative. The model with minimum *RMSE* is assumed to describe the data series more adequately.

CHAPTER IV

ANALYSIS OF GROUNDNUT SOWN ACRE, HARVESTED ACRE AND PRODUCTION IN MYANMAR

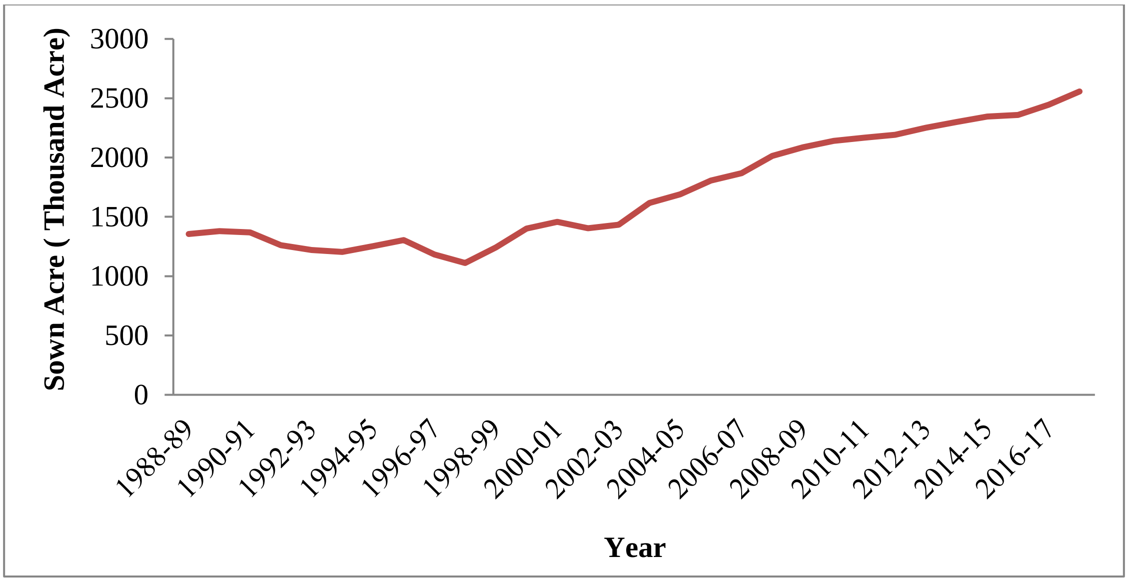
This chapter presents the best fitted models for sown acre, harvested acre and production of groundnut in Myanmar. Moreover, it also presents the forecasting of sown acre, harvested acre and production of groundnut and multiple linear regression model for groundnut production in Myanmar.

4.1 The Best Fitted Models for Sown Acre, Harvested Acre and Production of Groundnut in Myanmar

In this study, linear and non-linear models include linear, quadratic and cubic models have been fitted on sown acre, harvested acre and production in Myanmar by considering 30 years data from 1988-89 to 2017-18. The results are presented as follows.

4.1.1 Sown Acre of Groundnut

The sown acre of groundnut in Myanmar during 1988-89 to 2017-18 is shown in Appendix-A, Table (1) and Figure (4.1).



Source: Statistical Year Books

Figure (4.1) Observed Sown Acre of Groundnut in Myanmar

Figure (4.1) shows that, the average sown acre for the period 1988-89 to 2017-18 was1367.5 thousand acres in Myanmar. The area of groundnut crop has increased from 1204 thousand acres in 1993-94 to 2557 thousand acres in 2017-18.The maximum sown acre was 2557 thousand acres in 2010-11 and minimum sown acre was 1111 thousand acres in 1997-98.

The result presented in Table (4.1) for sown acre under the cultivation of groundnut crop revealed that among the linear, quadratic and the cubic time series models are fitted. The model summary statistics is described in Table (4.2).

Table (4.1)

Linear and Non-linear Models of Groundnut Sown Acre in Myanmar

Model	**Parameters**				**Criteria**			
	β_0	β_1	β_2	β_3	R^2	**MAPE**	**MSE**	**RMSE**
Linear	951.73	49.17			.87	0.09	29737	172.95
Quadratic	1250.31	-6.8	1.80		.94	0.06	278871.7	528.08
Cubic	1547.18	-113.47	10.27	-0.18	.98	0.0336	4605.91	67.87

Source: Statistical Year Book

The value of the bold number shows that the model is better than the other models with respect to that criterion in Table (4.1).

Forecast Cubic model is $\hat{Y}_{sown}$= 1547.18–113.47t +10.27t^2-0.18t^3

Table (4.2)

Model Summary and Parameter Estimates of Groundnut Sown Acre

Model	**Parameter Estimate**			
	Constant	β_1	β_2	β_3
Linear	951.73 (0.00)***	49.17 (0.00)***		
Quadratic	1250.31 (0.00)***	-6.8 (0.507)	1.80 (0.00)***	
Cubic	1547.18 (0.00)***	-113.47 (0.00)***	10.27 (0.00)***	-0.18 (0.00)***

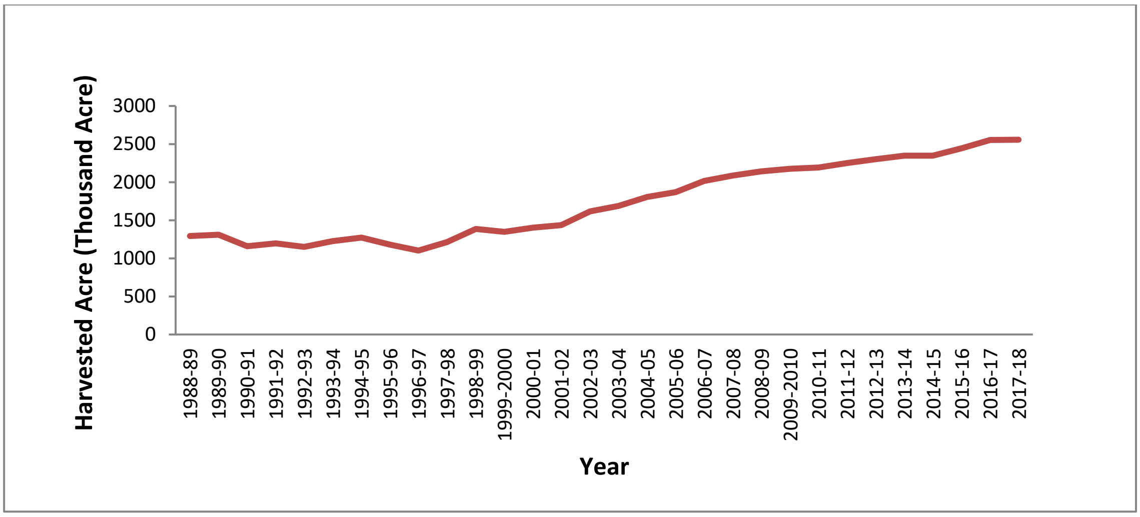
Source: SPSS Output

*** Statistically significant at 1 percent level

The analysis shows that the coefficients of linear and cubic models are significant at 1% level. The coefficient of quadratic model is not significant. According to the results of Table (4.1), it appears that the maximum R^2 of 98% was observed in case of cubic model with minimum values of MAPE (0.03), RMSE(67.87) and MSE (4605.91) in comparison to that of the other models.

4.1.2 Harvested Acre of Groundnut

The harvested acre of groundnut in Myanmar during 1988-89 to 2017-18 is as shown in Appendix-A, Table (1) and Figure (4.2).



Source: Statistical Year Books

Figure (4.2) Observed Harvested Acre of Groundnut in Myanmar

From the Figure (4.2), it was recorded that the average harvested acres for the entire period 1988-89 to 2017-18 was 1283 thousand acres. The volume groundnut harvested acres slightly increase from fiscal year 1997-98 to 2000-01. The volume of harvested acres on groundnut sector was sustainably raised up between the periods of 2006-07 and 2007-08.In the year 1992-93 the volume of harvested acres descend shortly and then again the ascending trend in the volume of harvested acres of agriculture sector is visible in fiscal year 2003-04.Maximum harvested acres were 2555 thousand acres in the year 2017-18.Minimum harvest acres were 1102 thousand acres in the year 1997-98. The result obtained for harvested acre of groundnut during the study period by fitting all the models were presented in Table (4.3). And also the model summary statistics is described in Table (4.4).

Table (4.3)

Linear and Non-linear Models of Groundnut Harvested Acre in Myanmar

Model	Parameters				Criteria			
	β_0	β_1	β_2	β_3	R^2	MAPE	MSE	RMSE
Linear	889.61	51.80			0.89	0.09	26486.78	162.75
Quadratic	457.73	1.07	1.6		0.94	0.06	13431.54	115.9
Cubic	1452.68	-103.67	9.95	0.18	0.98	0.03	4248.73	65.18

Source: Statistical Year Book

The value of the bold number explained that the cubic model is better than the other models with respect to that criterion.

Forecast Cubic model is $\hat{Y}_{harvested}$= 1452.68– 103.67 t +9.95t2 - 0.18t^3

Table (4.4)

Model Summary and Parameter Estimates of Groundnut Harvested Acre

Model	Parameter			
	Constant	β_1	β_2	β_3
Linear	889.61 (0.00)***	51.80 (0.00)***		
Quadratic	1160.15 (0.00)***	1.07 (0.916)	1.6 (0.00)***	
Cubic	1452.66 (0.00)***	-103.67 (0.00)***	9.95 (0.00)***	0.18 (0.00)***

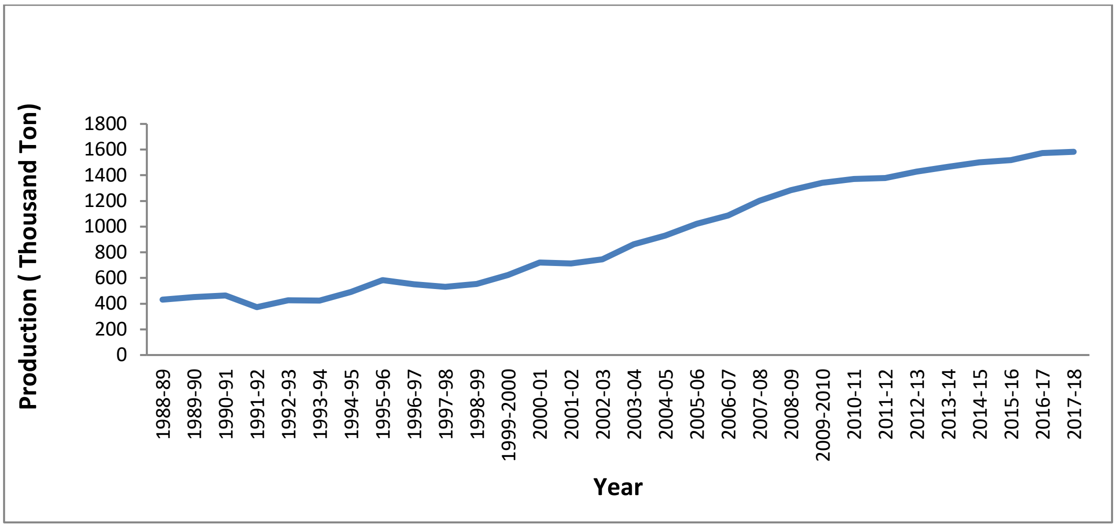
Source: SPSS Output

*** Statistically significant at 1 percent level

The presented in Table (4.3), the coefficients of the linear and cubic models were significant at 1% level. The coefficient of quadratic model is not significant for harvested acre of groundnut revealed that the maximum R^2 of 98% was observed in cubic model. The cubic model showed comparatively lower values of MAPE (0.03), RMSE (4248.73) and MSE (65.18). Hence, the cubic model was chosen as the best fitted model for sown acres during 1988-89 to 2017-18 in Myanmar.

4.1.3 Production of Groundnut

The production of groundnut in Myanmar during 1988-89 to 2017-18 is as shown Appendix-A, Table (1) and Figure (4.3).



Source: Statistical Year Books

Figure (4.3) Observed Production of Groundnut in Myanmar

From the Figure (4.3),it was recorded that the average production acres for the entire period 1988-89 to 2017-18 was 441 thousand tons. The volume groundnut production slightly increases from fiscal year 1999-2000 to 2015-16 and the total production of groundnut crop for the entire period from 1987-88 to 2017-18 was 27631thousand tons. Maximum production was 1483 thousand tons in 2017-2018 and minimum production was 373 thousand tons in 1991-1992.

The result obtained for production of groundnut during the study period by fitting all the models were presented in Table (4.5) and also the model summary statistics is described in Table (4.6).

Table (4.5)

Linear and Non-linear Models of Groundnut Production in Myanmar

Model	Parameters				Criteria			
	β_0	β_1	β_2	β_3	R^2	MAPE	MSE	RMSE
Linear	184.13	47.54			.95	0.11	9547.16	97.71
Quadratic	316.13	22.79	-0.79		.98	0.43	499251.2	700.58
Cubic	523.54	-51.48	6.69	12	.99	0.05	3230.47	56.84

Source: Statistical Year Book

The value of the bold number shows that the model is better than the other models with respect to that criterion.

Forecast Cubic model is $\hat{Y}_{production} = 523.54 – 51.48t + 6.69t^2 – 0.12t^3$

Table (4.6)

Model Summary and Parameter Estimates of Groundnut Production

Model	Parameter			
	Constant	β_1	β_2	β_3
Linear	184.13 (0.00)***	47.54 (0.00)***		
Quadratic	316.13 (0.00)***	22.79 (0.00)***	-0.79 (0.00)***	
Cubic	523.54 (0.00)***	-51.48 (0.00)***	6.69 (0.00)***	-0.13 (0.00)***

Source: SPSS Output

*** Statistically significant at 1 percent level

All the estimated parameters in cubic model was significant at 1% level. The described in Table (4.5) and (4.6), among them cubic model was found to have highest R^2(0.99), and low values of MAPE (0.05), MSE (3230.47) and RMSE (56.84).As the results of sown acre, harvest acre and production in Myanmar, the cubic model is occurred to be the best for describing the growth pattern and making forecast with minimum forecasting error.

4.2 Forecasting of Sown Acre, Harvested Acre and Production of Groundnut in Myanmar

In this section, to compute the forecasted values for groundnut sown acre, harvested acre and production were presented from 2018-19 to 2020-2021 year based upon the best fitted model of each data series. The forecasts values from 2018-19 to 2020-21 were described the following.

4.2.1 Sown Acre of Groundnut

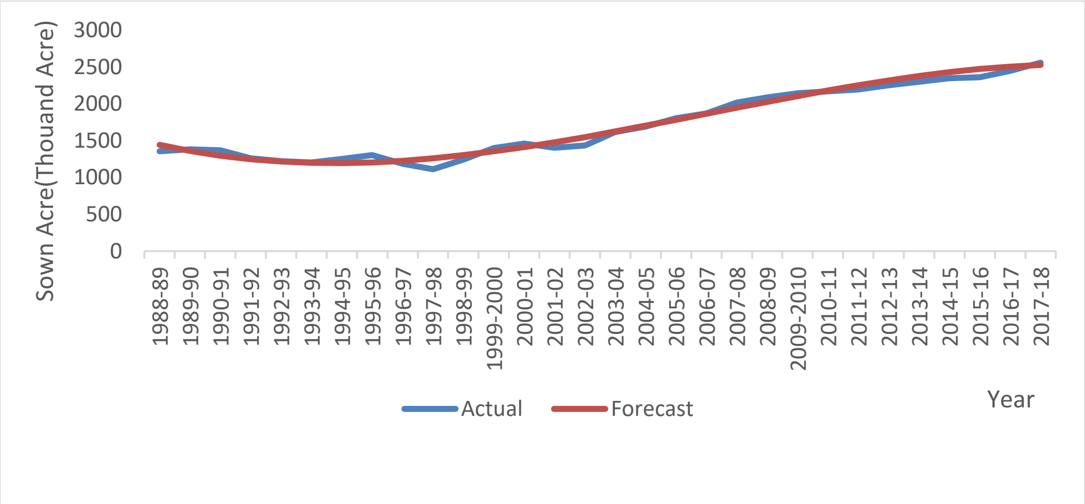
In Table (4.7), described the best fitted model for sown acre in Myanmar is used to make forecasts. The forecasting period extends from 2018-19 to 2020-2021.

Table (4.7)

Forecasted Values of Groundnut Sown Acre by Cubic Model

Year	Forecast Value(Thousand Acre)
2018-2019	2536.70
2019-2020	2534.38
2020-2021	2518.04

The observed values and the forecast values from 1988-89 to 2019-2020 is as shown in Figure (4.4).



Source: Statistical Year Books

Figure (4.4) Observed and Forecast Trends of Groundnut Sown Acre in Myanmar

From Table (4.7) and Figure (4.4), it was resulted that predicted sown acre would be slightly decrease between the years 2018-19 to 2020-2021 as compare to observed data of 2017-18.

The actual value and the forecast value of groundnut sown acre were present in the following Table (4.8).

Table (4.8)

Actual and Forecast Values of Groundnut Sown Acre

Year	Forecast Sown Acre ('000 acre)	Actual ('000 acre)
2018-2019	2536.70	2613.45
2019-2020	2534.38	2740.89
2020-2021	2518.04	2818.78

Source: Statistical Year Book

The actual value of groundnut sown acre in fiscal year from 2018-19 to 2019-2020 are 2613.45 thousand acres, 2740.89 thousand acres and 2818.78 thousand acres. The forecast value of groundnut sown acre based upon the fitted model is 2536.70 thousand acres in 2018-2019, 2534.38 thousand acres in 2019-2020 and 2518.04 thousand acres. The forecast value would be slightly decreased between the year 2018-19 and 2019-2020 as compare to the actual value.

4.2.2 Harvested Acre of Groundnut

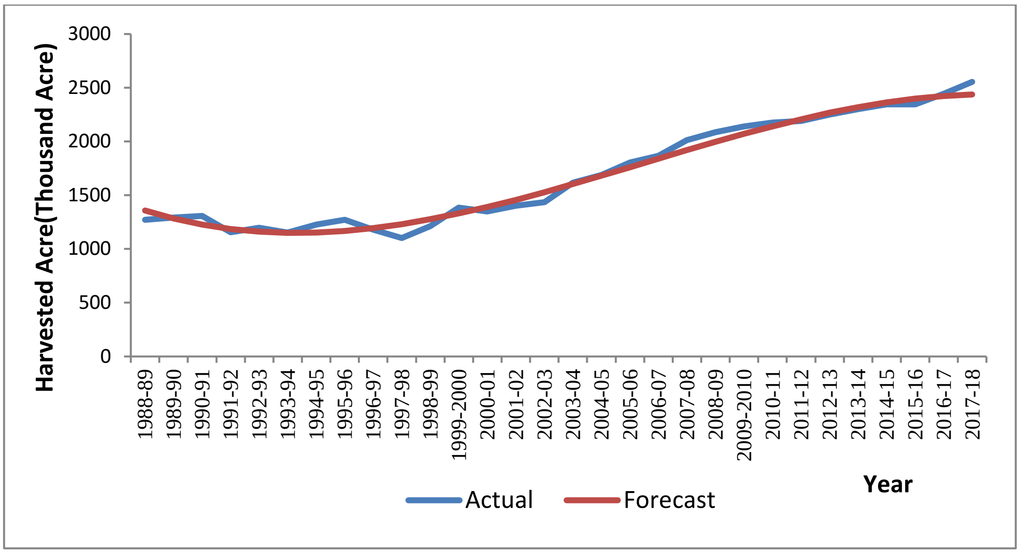
The groundnut harvested acre was forecasted by cubic model. The forecast values for three year periods from 2018-19 to 2020-2021 are shown in Table (4.9).

Table (4.9)

Forecasted Values of Groundnut Harvested Acre by Cubic Model

Year	Forecast Value (Thousand Acre)
2018-2019	2438.46
2019-2020	2425.78
2020-2021	2398.44

The observed values and the forecast values from 1988-89 to 2020-2021 is as described in Figure (4.5).



Source: Statistical Year Books

Figure (4.5) Observed and Forecast Trends of Groundnut Harvested Acre in Myanmar

From Table (4.9) and Figure (4.5) shows that predicted harvested acre would be slightly decrease between the years from 2018-19 to 2020-2021 as compare to observed data of 2017-18.

The actual value and forecast value of groundnut harvested acre were shown in Table (4.10).

Table(4.10)

Actual and Forecast Values of Groundnut Harvested Acre

Year	Forecast Harvested Acre ('000 acre)	Actual ('000 acre)
2018-2019	2438.46	2613.45
2019-2020	2425.78	2739.57
2020-2021	2398.44	2795.58

Source: Central Statistical Organization

The actual value of groundnut harvested acre in fiscal year from 2018-19 to 2020-2021 are 2613.45 thousand acres, 2739.57 thousand acres and 2795.58 thousand acres. The forecast value of groundnut harvested based upon the fitted model is 2438.46 thousand acres in 2018-2019, 2425.78 thousand acres in 2019-2020 and

2398.44 thousand acres in 2020-2021. The forest value would be decreased between the year 2018-19 and 2019-20 as compare to the actual value

4.2.3 Production of Groundnut

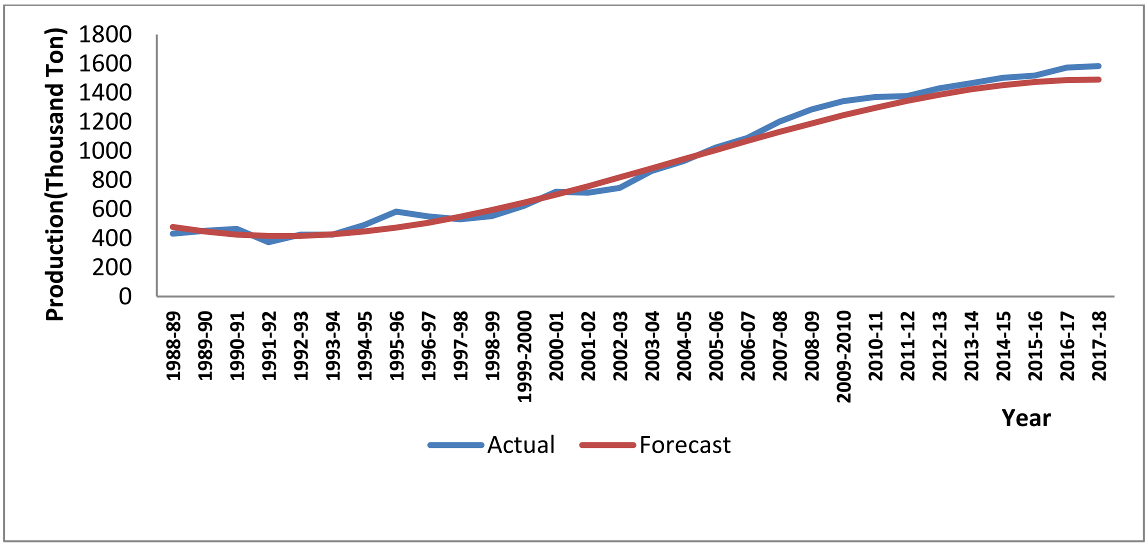
The best fitted cubic models for groundnut production is used to make forecasts for three year periods from 2018-19 to 2020-2021 are expressed in Table (4.11).

Table (4.11)

Forecasted Values of Groundnut Production by Cubic Model

Year	Forecast Value(Thousand Tons)
2018-2019	1483.92
2019-2020	1466.90
2020-2021	1438.30

The observed values and the forecast values from 1988-89 to 2019-2020 is as express in Figure (4.6).



Source: Statistical Year Books

Figure (4.6) Observed and Forecast Trends of Groundnut Production in Myanmar

From Table (4.11) and Figure (4.6) described the predicted groundnut production would be slightly decrease between the years 2018-19 to 2019-20 as compare to observed data of 2017-18.

The actual value and the forecast value of groundnut production in 2018-19 and 2020-21 were present in the following Table (4.12).

Table (4.12)

Actual and Forecast Values of Groundnut Production

Year	Forecast Production (‘000 ton)	Actual (‘000 ton)
2018-2019	1483.92	1562.43
2019-2020	1466.90	1615.72
2020-2021	1438.30	1595.82

Source: Central Statistical Organization

The actual value of groundnut production in fiscal year from 2018-19 to 2020-2021 are 1562.43 thousand tons, 1615.72 thousand tons and 1595.82 thousand tons. The forecast value of groundnut production based upon the fitted model in 2018-19 year is 1483.92 thousand tons, 1466.90 thousand tons in 2019-2020 and 1438.30 thousand tons in 2020-2021. Comparing the forecast value and actual value; the forecast value would be slightly decreased between 2018-19 and 2020-21.

4.3 Multiple Linear Regression Model for Groundnut Production

The multiple linear regression model for groundnut production was constructed using the three independent variables (sown, yield, irrigation). Different models: multiple linear regressions, semi-log models (log-lin and lin-log) multiple linear regressions, and log-log model was chosen for the analysis based on statistical criteria. The model of nonlinear relationship is converted into linear by using log-log multiple linear regressions. The computations of the remaining models are shown in appendix.

The general log-log multiple linear regression model for groundnut production is as follows;

$$Ln\ (Production) = \beta_0 + \beta_1 Ln(Sown) + \beta_2\ Ln(Yield) + \beta_3\ Ln(\ Irrigation) + ei$$

where; Ln (Sown) = Log of Sown (thousand Acre)

Ln (Yield) = Log of Yields per harvest Acre (thousand Acre)

Ln (Irrigation) = Log of Irrigation(Acre)

The following Table (4.13) represents the log-log multiple linear regression model for groundnut production and other related input variables (sown, yield and irrigation).

Table (4.13)

Parameter Estimates and Summary Statistics for Log-log Models

Variable	**Coefficient**	**Std. Error**	**t**	**P-value**
Constant	-2.13***	0.06	-35.88	0.000
Ln (Sown)	0.84***	0.02	37.74	0.000
Ln(Yield)	1.18***	0.04	29.10	0.000
Ln(Irrigation)	0.30**	0.03	3.37	0.002
F-ratio	9728.02			
R^2	0.99			
Adjusted R^2	0.99			
Durbin-Watson	2.5			
n	30			

Source: SPSS output

*** Statistically significant at 1 percent level

** Statistically significant at 5 percent level

According to the result, the overall model is statistically significant at 1 percent level. It indicates that all coefficients in the model are different from zero and it explains the goodness fit of the model. Sown, yield and irrigation are statistically significant at 1 percent level. The log-log multiple linear regression model for groundnut production and other related input variables can be expressed as follow:

Ln (Production) = -2.132 + 0.84Ln(Sown) + 1.18Ln(Yield) + 0.30Ln(Irrigation)

Se = (0.06) (0.84) (0.04) (0.03)

t- statistics (-35.88) (37.74) (29.10) (3.37)

$R^2 = 0.99$; F = 9728.02

From the above equation, sown, yield and irrigation have positive effects on production. It sown acre increases by 1%, production will increase by 0.840% when yield and irrigation are constant. Therefore, it can be concluded that if sown acre increase, production will be increased. Moreover, if yield increase by 1%, production will increase by 1.18% when sown and irrigation stay constant. Thus, it can be concluded that if yield increases, production will be increased. Similarly, if irrigation increase by 1%, production will goes up 0.30% when sown and yield remain constant. Hence, it can be concluded that if irrigation increases, production will be increased. According to the study of log-log linear regression model, groundnut production will increase when the input variables such as sown acre, yield of harvested acre, and irrigation increase.

4.4 Testing of Normality for Groundnut Production

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

4.4.1 Detecting Multicollinearity

The problem can be deleted from the value of Tolerance and VIF (Variance Inflation Factor). If the correlation among the independent variables is weak association and the value of Tolerance is not less than 0.1 and the value of 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 (4.14).

Table (4.14)

Tolerance and VIF of Independent Variable

No.	Independent Variable	Tolerance	VIF
1	Ln (Sown)	0.235	4.25
2	Ln(Yield)	0.103	9.68
3	Ln(Irrigation)	0.151	6.62

Source: SPSS output

According to the Table (4.14), among the independent variables, it is found that the collinearity statistics of the value of the Tolerance is not 0.1. The values of the VIF are 4.25, 9.68 and 6.62 respectively. Since the single of VIF is at least 10, it can be concluded that there is no multicollinearity problem in the study.

4.4.2 Testing for Normality of Disturbances

One of the basic assumptions is that disturbances are normally disturbance will zero mean and constant variance. To check whether the disturbances are normally distributed, histograms and Normal Probability Plot of the standardized residuals used in the analysis for the groundnut productions.

The histogram for standardized residuals for the groundnut production is shown in Figure (4.7).

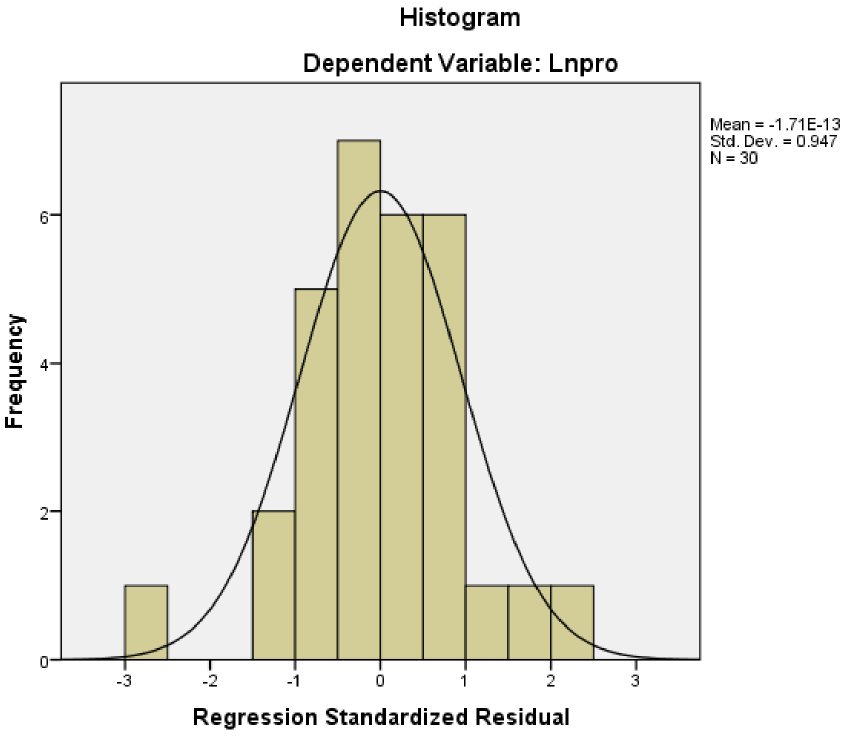


Figure (4.7) Histogram of Residuals of Groundnut Production

The normal plot of standardized residuals for the groundnut production is as shown in Figure (4.8).

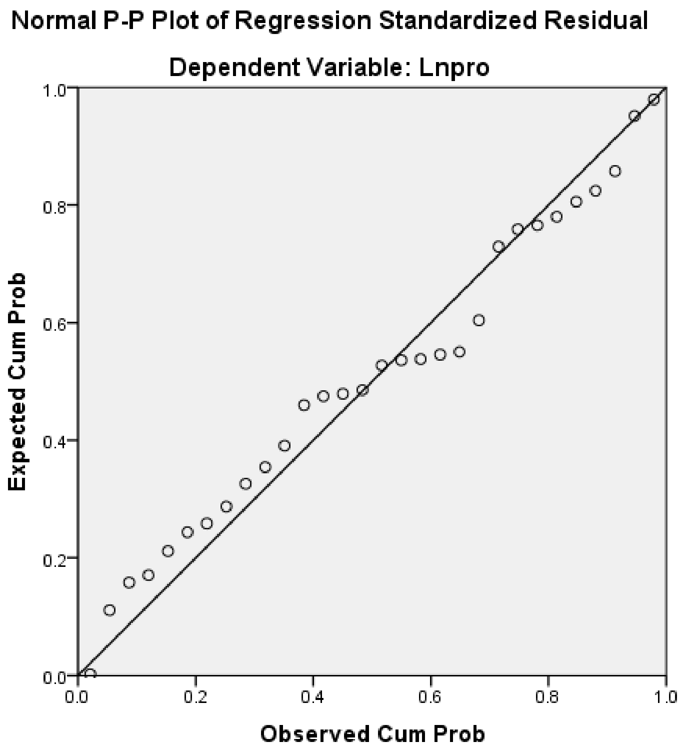


Figure (4.8) Normal Probability Plot of Residuals of Groundnut Production

According to Figure (4.7) and Figure (4.8), it can be concluded that the normality assumption appears to be generally reasonable.

4.4.3 Testing for Same 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 value against the disturbances. Figure (4.9) presents the predicted groundnut production on X-axis and the disturbance for groundnut production on Y-axis.

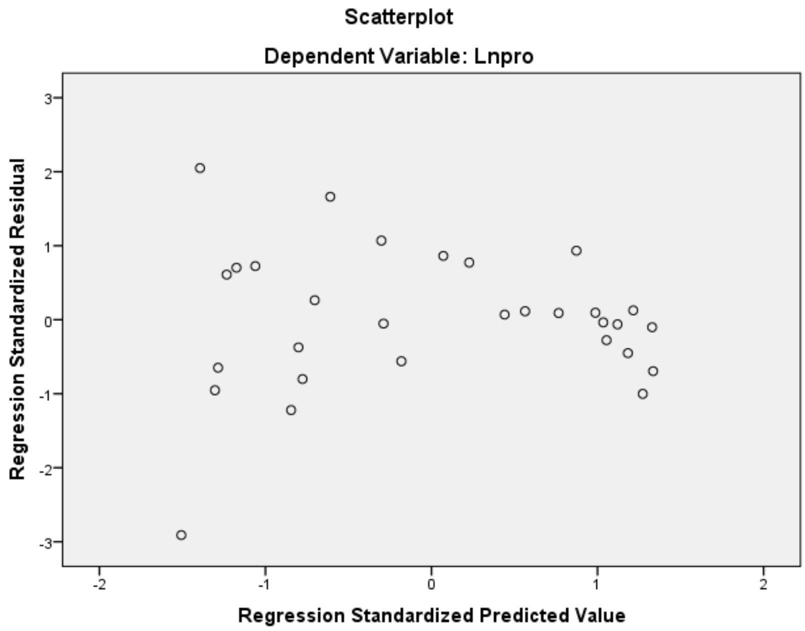


Figure (4.9) Detection of Autocorrelation of Groundnut Production

4.4.4 Testing for Durbin-Watson Statistics

Reject H_0 : Positive autocorrelation	Inconclusive	Do not reject H_0: Evidence of no autocorrelation	Inconclusive	Reject H_0 : Negative autocorrelation

0 d_l (1.006) d_u (1.421) 2.5 4-d_u (2.579) 4-d_l (2.994) 4

Figure (4.10) Durbin-Watson Statistic of Groundnut Production

The Durbin-Watson statistic test is used to determine whether the residuals were auto correlated or not. The Durbin-Watson statistic is used to test hypothesis of no autocorrelation. For α = 0.01 or 1% level of significance, critical values for the Durbin-Watson statistics are d_L=1.006 and d_U=1.421. Since the calculated value of D.W = 2.5, the null hypothesis is not rejected and it is concluded that there is no evidence of autocorrelation. Therefore, D.W statistic support that there is no positive and negative correlation among disturbances.

CHAPTER V
CONCLUSION

The main of this thesis is to find out the fitted trend for sown acre, the harvested acre, and production of groundnut and to choose the best fitted model for agricultural production in Myanmar from 1988-89 to 2017-18. The best fitted model was chosen based on model selection criteria like R^2, MAPE, MSE and RMSE. Moreover, the multiple regression models are used to estimate and to test the relationship between dependent variable (production)and their related three variables (Sown, Yields and Irrigation).

In the case of groundnut sown acre, all the model fitted well showing significant R^2 value. In comparison with other models, cubic model was high R^2, MAPE, RMSE and MSE are smallest. Hence the cubic model was chosen for future forecast the groundnut sown acre. According to the p-value, linear and cubic models are significant at 1% level and quadratic model is not significant.

For the groundnut harvest acre, it was found that all linear and nonlinear model fitted well showing significant R^2value. In comparison with other models, cubic model was high R^2, MAPE, RMSE and MSE are smallest. Among these models, cubic model identified as the best fitted model. According to the p-value, linear and cubic models are significant at 1% level and quadratic model is not significant.

In groundnut production, the analysis show that cubic model was high R^2,least MAPE, RMSE and MSE are smallest. Hence the cubic model was chosen for future forecast the groundnut production. According to the p-value, linear, quadratic and cubic models are significant at 1% level.

In multiple regression log-log model, the overall model is statistically significant at 1 percent level. It indicates that all coefficients in the model are different from zero and it explains the goodness fit of the model. Sown, yield and irrigation are statistically significant at 1 percent level. In the estimated log-log model, sown, yield and irrigation have positive effects on production. It sown acre increases by 1%, production will increase by 0.840% when yield and irrigation are constant. Therefore, it can be concluded that if sown acre increase, production will be increased. Moreover, if yield increase by 1%, production will increase by 1.18% when sown and irrigation stay constant. Thus, it can be concluded that if yield increases, production will be increased. Similarly, if irrigation increase by 1%, production will goes up 0.30% when sown and yield remain constant. Hence, it can be concluded that if irrigation increases, production will be increased.

Agriculture is an important component in the developing countries in social and economic aspects. As food insecurity remains an important issue in each country, the increase in production provides more food security for farmers plus an additional source of income. Most of the farmer lack of knowledge. And hence, Government should make the farmers who training about agriculture.

Also, Government should give many training classes with skilled and qualified agriculturalists. The farmers should use the pesticides efficiently and usefully, to check the quality of seeds, soil situation, temperature, weather and to manage the financial situations. Advised methods are especially meant for the smallholder farmer and the development of Myanmar specific framework for ongoing agricultural development. The agricultural areas of groundnut also guide to increase production for both domestic intake and export. Therefore, it is suggested that the expansion of groundnut land, the more advancing for agriculture labor, the agriculture loan and adoption of proper agricultural technology should be conducted. As for policy suggestion, awareness programs of agricultural education should be conducted for Myanmar farmers.

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Appendix

Appendix – A

Table (1)

Observed Values of Groundnut in Myanmar

Year	Sown Acre (Thousand Acre)	Harvested Acre (Thousand Acre)	Production (Thousand ton)
1988-89	1355	1272	431
1989-90	1380	1294	451
1990-91	1369	1308	465
1991-92	1261	1157	373
1992-93	1220	1198	426
1993-94	1204	1152	425
1994-95	1252	1227	492
1995-96	1303	1272	583
1996-97	1184	1181	550
1997-98	1111	1102	531
1998-99	1241	1212	553
1999-2000	1400	1384	624
2000-01	1458	1348	720
2001-02	1405	1402	712
2002-03	1435	1434	745
2003-04	1617	1617	863
2004-05	1690	1689	931
2005-06	1805	1804	1023
2006-07	1867	1867	1088
2007-08	2014	2014	1202
2008-09	2086	2086	1284
2009-10	2141	2141	1341
2010-11	2168	2177	1370
2011-12	2192	2192	1378
2012-13	2252	2252	1429
2013-14	2300	2300	1465
2014-15	2346	2346	1502
2015-16	2359	2347	1518
2016-17	2445	2444	1573
2017-18	2557	2555	1583

Source: Statistical Year Book

Table (2)

Observed Values and Forecasted Values for Sown Acre of Groundnut in Myanmar Using Cubic Model

Year	Sown Acre (Thousand Acre)	Forecast value (Thousand Acre)
1988-89	1355	1443.80
1989-90	1380	1359.88
1990-91	1369	1294.34
1991-92	1261	1246.10
1992-93	1220	1214.08
1993-94	1204	1197.20
1994-95	1252	1194.38
1995-96	1303	1204.54
1996-97	1184	1226.60
1997-98	1111	1259.48
1998-99	1241	1302.10
1999-2000	1400	1353.38
2000-01	1458	1412.24
2001-02	1405	1477.60
2002-03	1435	1548.38
2003-04	1617	1623.50
2004-05	1690	1701.88
2005-06	1805	1782.44
2006-07	1867	1864.10
2007-08	2014	1945.78
2008-09	2086	2026.40
2009-10	2141	2104.88
2010-11	2168	2180.14
2011-12	2192	2251.10
2012-13	2252	2316.68
2013-14	2300	2375.80
2014-15	2346	2427.38
2015-16	2359	2470.34
2016-17	2445	2503.60
2017-18	2557	2526.08

Source: Statistical Year Book

Table (3)

Observed Values and Forecasted Values for Harvested Acre of Groundnut in Myanmar Using Cubic Model

Year	Harvested Acre (Thousand Acre)	Forecast Value (Thousand Acre)
1988-89	1272	652.98
1989-90	1294	617.99
1990-91	1308	593.25
1991-92	1157	578.07
1992-93	1198	571.71
1993-94	1152	573.46
1994-95	1227	582.62
1995-96	1272	598.47
1996-97	1181	620.29
1997-98	1102	647.37
1998-99	1212	679.00
1999-2000	1384	714.46
2000-01	1348	753.03
2001-02	1402	794.02
2002-03	1434	836.69
2003-04	1617	880.33
2004-05	1689	924.24
2005-06	1804	967.70
2006-07	1867	1009.99
2007-08	2014	1050.40
2008-09	2086	1088.22
2009-10	2141	1122.73
2010-11	2177	1153.21
2011-12	2192	1178.97
2012-13	2252	1199.27
2013-14	2300	1213.40
2014-15	2346	1220.66
2015-16	2347	1220.33
2016-17	2444	1211.69
2017-18	2555	1194.03

Source: Statistical Year Book

Table (4)

Observed Values and Forecasted Values for Groundnut Production in Myanmar Using Cubic Model

Year	Production (Thousand Acre)	Forecast value (Thousand Acre)
1988-89	431	478.62
1989-90	451	446.30
1990-91	465	425.80
1991-92	373	416.34
1992-93	426	417.14
1993-94	425	427.42
1994-95	492	446.40
1995-96	583	473.30
1996-97	550	507.34
1997-98	531	547.74
1998-99	553	593.72
1999-2000	624	644.50
2000-01	720	699.30
2001-02	712	757.34
2002-03	745	817.84
2003-04	863	880.02
2004-05	931	943.10
2005-06	1023	1006.30
2006-07	1088	1068.84
2007-08	1202	1129.94
2008-09	1284	1188.82
2009-10	1341	1244.70
2010-11	1370	1296.80
2011-12	1378	1344.34
2012-13	1429	1386.54
2013-14	1465	1422.62
2014-15	1502	1451.80
2015-16	1518	1473.30
2016-17	1573	1486.34
2017-18	1583	1490.14

Source: Statistical Year Book

Table (5)

Groundnut Crops under Irrigation and Average Yield

Year	Irrigated Area (Thousand Acres)	Yields (Basket)
1988-89	20.68	61
1989-90	8.20	63
1990-91	7.95	65
1991-92	7.70	70
1992-93	9.87	64
1993-94	10.42	67
1994-95	11.42	72
1995-96	13.40	81
1996-97	15.02	83
1997-98	26.94	84
1998-99	42.12	79
1999-2000	37.00	78
2000-01	41.41	86
2001-02	58.62	88
2002-03	51.34	91
2003-04	49.60	93
2004-05	54.48	96
2005-06	58.04	100
2006-07	53.79	103
2007-08	58.67	106
2008-09	61.44	108
2009-10	66.57	111
2010-11	72.06	112
2011-12	72.86	112
2012-13	72.53	113
2013-14	79.79	114
2014-15	77.98	114
2015-16	86.45	116
2016-17	88.58	116
2017-18	90.85	112

Source: Statistical Year Book

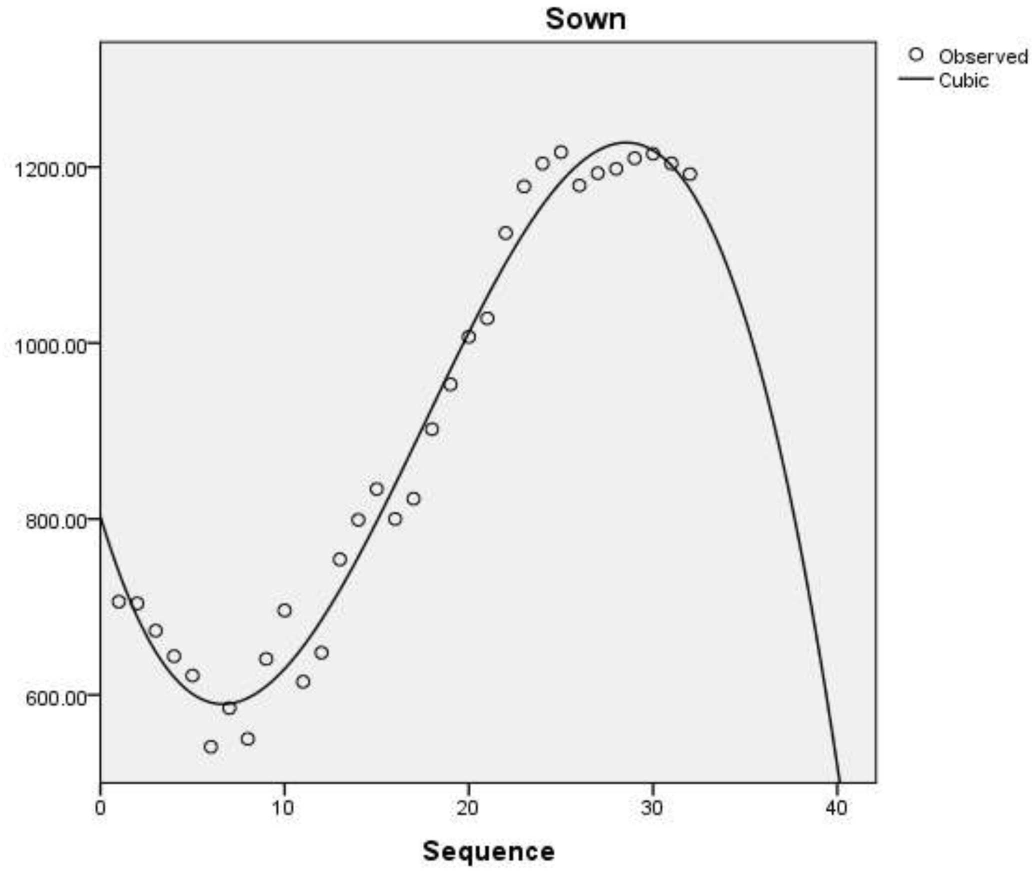
Appendix B - 1

Model Summary and Parameter Estimates

Dependent Variable: Sown Acre

	Model Summary					Parameter Estimate			
Equation	R^2	F	df_1	df_2	Sig	Constant	β_1	β_2	β_1
Linear	0.870	201.589	1	28	0.000	951.73	49.17		
Quadratic	0.94	112.887	2	27	0.000	1250.31	-6.8	1.8	
Cubic	**0.98**	**471.836**	**3**	**26**	**0.000**	**1548.18**	**-113.47**	**10.27**	**-0.18**

Source: SPSS Output



Source: SPSS Output

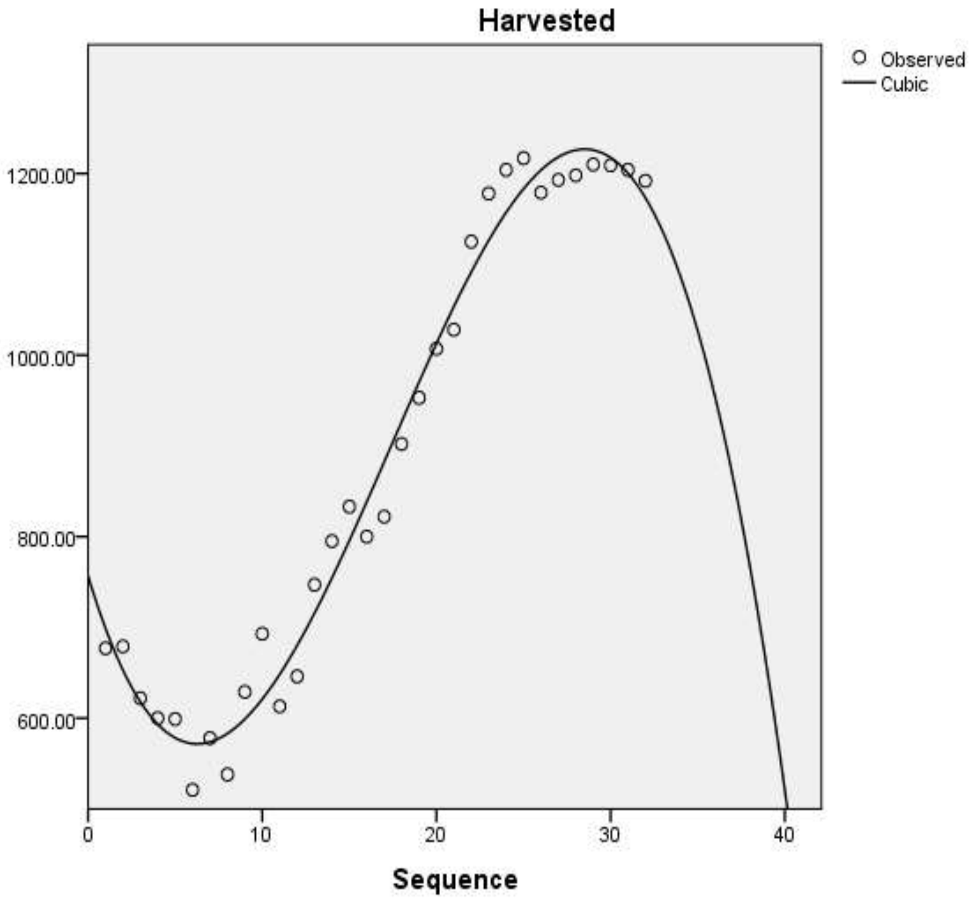
APPENDIX B - 2

Model Summary and Parameter Estimates

Dependent Variable: Harvested Acre

	Model Summary					Parameter Estimate			
Model	R^2	F	df_1	df_2	Sig	Constant	β_1	β_2	β_1
Linear	0.89	239.054	1	28	0.000	889.61	51.80		
Quadratic	0.94	127.115	1	27	0.000	1160.15	1.07	1.6	
Cubic	**0.98**	**524.204**	**1**	**26**	**0.000**	**1452.68**	**-103.67**	**9.95**	**-0.18**

Source: SPSS Output



Source: SPSS Output

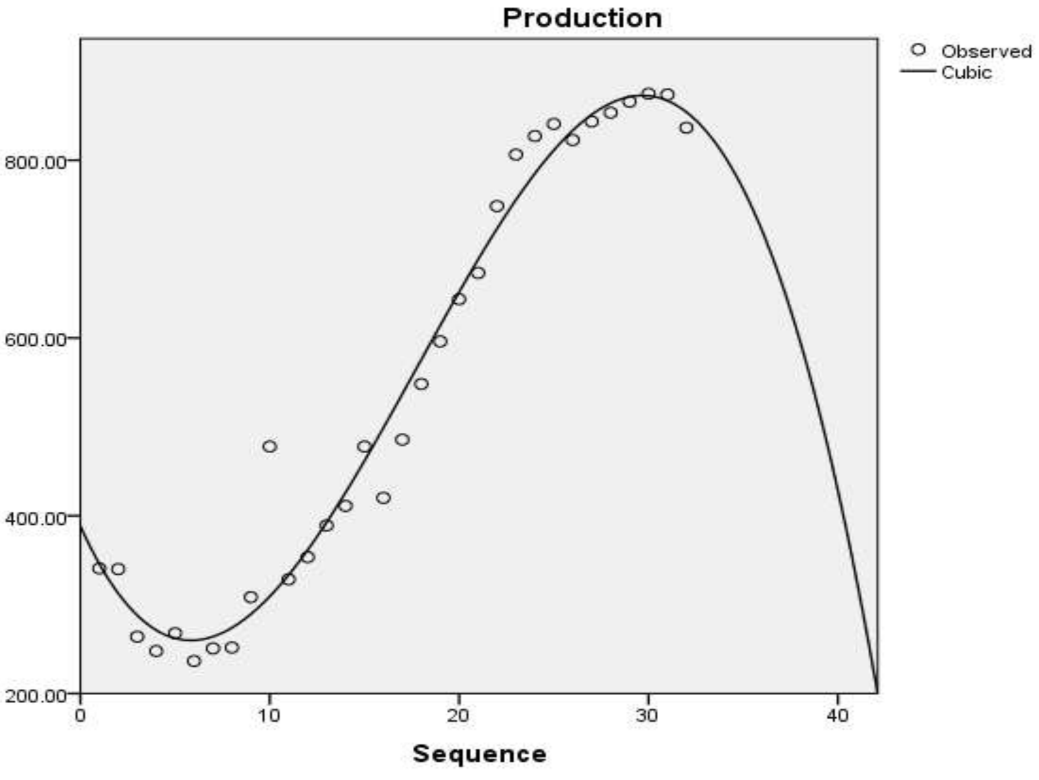
APPENDIX B – 3

Model Summary and Parameter Estimates

Dependent Variable: Production

	Model Summary					Parameter Estimate			
Model	R^2	F	df_1	df_2	Sig	Constant	β_1	β_2	β_1
Linear	0.95	283.311	1	28	0.000	15.4	47.54		
Quadratic	0.916	158.872	1	24	0.000	316.13	22.79	-0.79	
Cubic	**0.980**	**328.000**	**1**	**26**	**0.000**	**523.54**	**-47.111**	**4.827**	**-0.091**

Source: SPSS Output



Source: SPSS Output

Model Summary Log-Lin Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.997[a]	.994	.993	.01744	1.135

a. Predictors: (Constant), arri, sown, yield

b. Dependent Variable: Lnpro

ANOVA[a]

odel		Sum of Squares	df	Mean Square	gF	Sig.
1	Regression	5291973.667	3	1763991.222	1004.038	.000b
	Residual	45679.299	26	1756.896		
	Total	5337652.967	29			

a. Dependent Variable: pro

b. Predictors: (Constant), Lnirr, Lnsown, Lnyield

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-10423.851	367.878		-28.335	.000		
	Lnsown	2461.136	137.856	.668	17.853	.000	.235	4.249
	Lnyield	1803.062	250.378	.406	7.201	.000	.103	9.678
	Lnirr	-62.000	54.710	-.053	-1.133	.267	.151	6.626

a. Dependent Variable: pro

CollinearityDiagnosticsa

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	Lnsown	Lnyield	Lnirr
1	1	3.968	1.000	.00	.00	.00	.00
	2	.032	11.165	.00	.00	.00	.18
	3	.000	125.143	.96	.40	.08	.51
	4	.000	153.218	.04	.60	.92	.31

Model Summary of Log-Log Model

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	1.000a	.999	.999	.00677	2.569

a. Predictors: (Constant), LnIrri, LNSown, Lnyield

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.337	3	.446	9728.018	.000b
	Residual	.001	26	.000		
	Total	1.338	29			

a. Dependent Variable: LnProduction

b. Predictors: (Constant), LnIrri, LNSown, Lnyield

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-2.132	.059		-35.886	.000		
	LNSown	.840	.022	.455	37.735	.000	.235	4.249
	Lnyield	1.177	.040	.530	29.105	.000	.103	9.678
	LnIrri	.030	.009	.051	3.374	.002	.151	6.626

Dependent Variable: Lnpro

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	Lnsown	Lnyield	Lnirr
1	1	3.968	1.000	.00	.00	.00	.00
	2	.032	11.165	.00	.00	.00	.18
	3	.000	125.143	.96	.40	.08	.51
	4	.000	153.218	.04	.60	.92	.31

a. Dependent Variable: Lnpro