EFFECT OF AGROCHEMICAL FOR PADDY YIELD IN KALUTARA DISTRICT: A REGRESSION APPROACH

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Declaration

This research project report is submitted to the Department of Mathematics Faculty of Engineering of University of Moratuwa as a partial fulfillment of MSc- Operational Research. It has been composed by myself and has not been submitted for any Degree.

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B.L.N. Perera Date

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Abstract

Paddy is a major crop in Sri Lanka. Many farmers use Agro-Chemicals for their crops. Farmers believe that Agro-chemical increases the paddy yield. The objectives of the research were to: identify the effect of the fertilizer consumption to the paddy yield in Kalutara district; identify the effect of the pesticide usage to the paddy yield in Kalutara district, identify the relationship between paddy yield and fertilizer consumption, pesticide usage. Simple random sampling technique was used to select the sample of farmers. Regression analysis used as the analyzing technique for this specific study. The average fertilizer and pesticide usage around 622.5 kilograms per acre and 248.4-millilitres per acre respectively. The regression equation as follows: Log Paddy yield = 5.95 + 0.001458 Fertilizer consumption (KG per acre). The coefficient value for fertilizer consumption of the regression equation around 0.001458, With increment of one KG of fertilizer 0.001458 KG of paddy yield per acre can be expected to increase. According to the regression analysis fertilizer consumption positivity impact for the paddy yield while pesticide consumption negatively effects for the paddy yield. But to increase the paddy, yield the farmers use an acceptable level of fertilizer level and the pesticide level.

Key words: - Paddy yield, Fertilizer consumption, Kalutara district, Agro-chemicals

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CHAPTER 01

1.Introduction to Research

In addition to production, agricultural goods, most of which have non-market values, are multifaceted. The word 'multifunctionality' refers to farming that, apart from food and fiber production, may have several outputs and thus contribute to many goals at a time. Agriculture broad functions include food protection, preserving and ensuring rural community sustainability and protecting the environment, such as land conservation, sustainable natural resources management, biodiversity conservation and landscape preservation(Matsuno et al., 2006). Most numbers of Asian countries are depending on agricultural goods. The major crop of Asian counties is paddy. Rice is cultivated for cultivation in flooded soil environments and constitutes over 80% of the intakes of fresh water in most countries of Asia, with some countries accounting for more than 95%(Wu et al., 2010).

For human survival and social growth, agriculture is important. The general purpose of agricultural sustainability is for agriculture to remain sufficient for land, food security to be guaranteed, current standards of living to be enhanced, future generation grows to be secured and harmonious agricultural and growth frameworks to ensure a stable rural society. The main role of agriculture is to supply human life with food, thus ensuring adequate food for present and future generations are the primary goal of sustainable agricultural development. Rice is one of Asia's leading grain crops. Paddy Rice Fields cover over 90 per cent of the global rice-growing region in Asia, and over half of the world's population is made up of the larger rice-producing countries in Asia(Wu, 2013).

Sri Lanka cultivates paddy as a major crop. About 1.8 million farm families rely on rice. Further, rice is the largest crop that accounts for almost 28% of Sri Lanka's total agricultural land and 25 % of total jobs. Rice in the agricultural sector contributes 17,5% to the Gross Domestic Product (GDP). The average annual rice consumption per capita was about 92 KG, according to the Sri Lankan Homeland Ministry(Wickramasekara, 1980). Though rice is Sri Lanka's staple food, the rice must be imported from other

countries to meet domestic requirements. The current annual paddy production in Sri Lanka amounts to approximately 2.8 million tons. Also, the projected national average yield for national consumption was shown to rise to 4.1 metric tons per hectare in 2025(Bandara and Weerahewa, 2003). Paddy is grown under irrigation and rain-fed conditions in all the provinces of Sri Lanka with various agro-ecological environments. Kalutara having a special agro-ecological environment which suitable for cultivating paddy(Mendis and Udomsade, 2005).

Due to high yield varieties cultivation, irrigated crop area growth and increased use of vegetation nutrients, paddy production in Sri Lanka has grown considerably over the past three decades. Successive governments have funded paddy generation through guaranteed pricing schemes, major irrigation schemes and fertilizer subsidy schemes. High yield varieties were the main contributing factors in the country's increase in paddy production. Since high yield varieties are highly sensitive to fertilizer, adequate application of fertilizers is important to achieve the required yield levels(Ashraf Esfahani et al., 2019). The government started its involvement in the fertilizer markets with the establishment of a program of fertilizer subsidy because of the value of fertilizers in growing agricultural production. The main objective of the aid scheme was to provide fertilizers as cheaply as possible, thus promoting greater use of them to increase productivity in agriculture. For over four decades, the fertilizer subsidy has been available, while farmers plan to continue with many amendments in the future. While it is extremely difficult for the government to face the rising expenditure on the subsidy for fertilizer mainly recently due to its fiscal consequences. Due to governmental programs, most farmers use fertilizers for their lands. With the fertilizers, the farmers can obtain a higher yield per unit area. Most of the districts cultivate paddy. Kalutara is also a district that cultivates paddy as its major crop(Ekanayake, 2009).

It is understood that insecticides and herbicides played a key role in improving worldwide crop production(Khan et al., 2010). Insect pests in this part of the world are a major source of crop damage and a decrease in yield. Most of the time Asian countries use synthetic

pesticides to pesticides to reduce pest damage(Lin, 1991). Pesticides control pests. But pesticides did not target harmful pests. They target all the pests. There is an argument that due to the reduction of other insects the yield can be decreased. On the other hand, synthetic pesticides causing different health effects for farmers(Bhattacharjee and Ray, 2010).

1.1 Research gap

Many researches were done based on fertilizer consumption and the pesticide consumption of Sri Lanka and also in worldwide. But there is a research gap that needs to address which is whether the agro-chemicals actually affect the paddy yield of Sri Lanka. In this research, this study try to address this issue which is agrochemicals actually affect the paddy yield or not. To investigate it the researcher have selected Kalutara district as our population. Data were collected from farmers on the paddy yield, fertilizer consumption and pesticide usage.

1.2Research objectives

1.2.1 Main objective

The main objective of this study is to investigate the effectiveness of agrochemicals for paddy yield in Kalutara district.

1.2.2 Specific objectives

To identify the effectiveness of fertilizer consumption to paddy yield

To identify the effectiveness of pesticide consumption to paddy yield

Chapter 02

2.1Literature survey

In this study, the main objective is to get an understanding of the findings of the other researches related to this study. This study mainly focuses on the effect of the fertilizers and the pesticides on the paddy yield in Kalutara district.

2.2Paddy cultivation in the Asian region

It is said to be at least 7000 years ago that the paddy rice system in Asia started. It feeds over two billion people at present. It is also one of the world's leading food processing systems. This paddy rice system is distinguished in relation to the upland food production systems by high productivity and high sustainability(Masumoto, 2005). These features are derived from its highly efficient nutrient replenishment mechanisms and its inherent soil erosion resistance, which today are essential in the face of the global soil productivity crisis because of soil degradation. In addition, soil and weed problems are substantially less susceptible to paddy rice than upland systems. The paddy rice system needs to be stepped up in the production of infrastructure and application of chemical inputs to meet the demand of an increasingly growing population(Kawaguchi et al., 1977).

2.3 Soil nutrient level and the paddy cultivation

The covering in the lowlands on which paddy rice is produced is an alluvial layer eroded from the highlands of the catchment by the mountains. The lowland soil, which obtains eroded top soils from the catchments, is naturally better prepared with plant nutrient than upland soil since the topsoil in the catchment maintains much of the soil nutrient reserves. However, these rich lowland soils only can be used by those crops which tolerate waterlogging or submerging. Paddy's rice is a well-adjusted cereal crop(Kim et al., 2012). The very typical sequence of chemical transformation of materials follows complex biological changes in submerged soils. Since molecular oxygen nitrate has vanished as a base for denitrifies, manganese oxides are solubilized due to a decrease to Mn ions and orange and reddish coloured iron oxides decelerate soil into soluble ferrous ions. Many fermentation reactions based on different organic substrates continue to produce carbon dioxide, ammonia nitrogen, lower molecular organic acids and so on, along with these mineral transformations(Kyuma et al., 1995).The first month after the submergence, all of these biochemical changes are vigorous when organic matter readily decomposes as the source of microorganisms' energy is available abundantly. Before this phase of energetic biochemical change, there is a phase in which diffusion oxygen supplies exceed their consumption at the soil / water interfaces, albeit extremely slowly. Since the interface traps all oxygen, like ferrous and Mn ions, from the substantially decreased, blue-grey ploughing layer, a thinly oxidized orange coloured coating(Yang et al., 2009).Due to human activities, the soil microorganisms and soil structure has been changed. Nutrient level especially nitrogen and phosphorus level of the soil rapidly decline. For paddy cultivation, farmers use fertilizers to increase the nutrient level of the soil(Zhang and Gong, 2003).

The supply of nitrogen and Phosphorus is important for high crop yields, but down-stream and downwind losses of nitrogen and phosphorus from these same nutrients diminish the environmental quality and human goods(Kögel-Knabner et al., 2010). In many developed countries, agricultural nutrient balance differs considerably from intakes that are

insufficient to sustain soil productivity to unnecessarily damaging surpluses in many emerging economies to high-speed and fast-growing economies .Harvested crops extract nitrogen and phosphorus from agricultural soils, and the maintenance of agricultural production needs replacement by biological processes, such as the fixation of nitrogen, or by adding to the field animal wastes or mineral fertilizers(Ansari and Ismail, 2008). The key mechanism of introducing nutrients is fertilizer globally. The amount of new nitrogen and phosphorus that enter the terrestrial biosphere has more than doubled. These contributions help to keep the production of world crops ahead of human population growth and can boost economic development in rural areas(Vitousek et al., 2009).

The soils are degraded directly by erosion and salinization and indirectly by nutrient removal during harvest, and their impacts on yields can only be visible after decades and hundreds. Initial site characteristics, especially sensitiveness to disturbance and unique management practices, depending on the speed and trajectory of changes in soil fertility. The relation of prehistoric practices to soil property modifications is difficult because comprehensive records are rarely kept and both farming practices and changes in soil fertility are rarely quantified when available(Hartshorn et al., 2006).Soil nutrient depletion is significant because land use intensifications for agricultural production have not yet been adequately exploited, and directly linked to food insecurity in developing and least developed countries(Chase et al., 2014). The continued failure to provide nutrients with degraded soils as well as losses of nutrients from wind and water erosion not only aggravates the soil depletion but also threatens agricultural sustainability in the regions. This is evident in the decline of crop yields in many sections in Africa, Asia and Latin America in terms of low-input and unequal fertilization. Negative effect on soil fertility and production of human-induced nutrient depletion. Around 135 ha of soil worldwide reportedly have been vulnerable to the nutrient depletion, with over-cultivation and insufficient nutrient application affecting 97% of soil in developing and less developed countries; while 71 ha of soil have been impacted by tropical deforestation in many countries. Human nutrient depletion can intensify soil erosion as soil organic matter losses and structural soil stability declines continuously(Tan et al., 2005).

2.4Nitrogen for paddy cultivation

Paddy areas with a production of 1.5-2 Mg. ha-1 are estimated at approximately 20 KG of nitrogen to collect 1 Mg of paddy. There is no fertilizer but the rice was grown for a century by year without any fertilizer. It is then difficult, without the use of nitrogen, to justify such a long-lasting rice harvest. In soil organic matter, much of the nitrogen is present in paddy soils. Ammonia N (NHt-N) is gradually released by microbial decomposition from the organic matter. Since NHt-N is stable in anaerobic environments, the soil mineral and organic particles are held as a caption until they are taken up by rice roots. However, NHt-N becomes unstable under one condition. As previously noted, a small oxidized layer on the soil surface is distinct from a reduced ploughing layer after one month or so from the start of waterlogging. NHt-N is quickly converted into nitrate by nitrifying bacteria as it enters this oxidized sheet. As an anion, the NO}-N is not retained by soil particles and quickly washed into the plough layer by percolating water, where N is denitrified and the atmosphere is lost. A deep placement system for ammonium fertilizers has been developed to mitigate such a loss of nitrogen. The soil is not the only usable source of rice nitrogen. There are plenty of microbes in paddy fields that can fasten atmospheric nitrogen, which is a significant source of rice nitrogen(Uphoff and sustainability, 1999).

2.5Phosphorous for paddy

K and N of the three main macros have been shown to have a secured supply mechanism, if not adequate, in paddy soils. Phosphorus is the 11th highest in the Earth's crust and omnipresent in the soil at a fair amount. It's usually not its absolute quantity that matters, therefore. In acidic soils, P is found predominantly in the form of iron (Fe-P), and aluminum phosphates (AI-P) in the humid climate regions, which are difficult to overcome and control the abundance of P in the soil. Naturally, in the process of organic matter decomposition, organic forms of P may be released. However, in comparison to

nitrogen, compared with the mineral phosphorous type the quantity of such organic P compounds is usually very limited. With the changes of the paddy farmers use fertilizers to increase their paddy yield. Mineral nutrients are more effective than natural nutrients.

2.6Paddy cultivation and fertilizer consumption

A tropical plant, Paddy is well planted in a warm and humid climate. It is cultivated primarily as a rain fed crop in heavily precipitated areas. This is why the rainy season is basically 91 per cent of the total cultivated area. It is not only important for consumers, but also for farmers, since it is one of the country's leading crops. In order to sustain farmers involved in its production, this crop must be profitable. Even at high input costs, some farmers strive to increase yield. The wide-ranging crop cultivation has placed a heavy demand on agricultural inputs, especially seed, fertilizer and human labour (Kumari et al., 2018).

Many studies have focused on the demand for fertilizer as a key contribution to agriculture. Early research by Griliches (1958, 1959), Heady, Yeh, Carman, Gunjal, Roberts, and Heady, etc. In general, the emphasis has been on the estimates of total fertilizer or applications of nutrients for all crops, at the national or regional level. The aggregated demand for fertilizer usage for all crops in the United States was calculated by Griliches (1958). He showed that for the period 1911–1956, increases in both fertilizer and crop prices could explain much of the increase in the use of fertilizer.

And by the usage of the previous time. Griliches (1959) calculated regional demand functions over the years 1931 to 1956 using the same model for total fertilizer consumption. While the model clarified a considerable amount of the variability in regional fertilizer use, the estimated demand price elasticity ranged from elastic to inelastic, in different regions. Heady and Yeh (1959) estimated the demand for fertilizers for all plants in the United States and their total fertilizer function and individual nutrients. The consumption variables included fertilizer prices, crop pricing, total crop cash, total crop acres, acres of some crops, wage rates as well as the wholesale price index, and time.

Moreover, they calculated relationships in ten distinct geographical regions of the United States for overall fertilizer use. Their research made it possible to equate aggregate fertilizer with individual demand elastics(Solaiman et al., 1995).

Most numbers of modern researches were proved that world demand for fertilizer increase day by day. The question is, actually the fertilizers increase the crop yield.

2.7Pesticide consumption for paddy cultivation

Pesticides have been used in the last two decades to help avoid pre-harvest and post-harvest losses in an effort to provide the increasing population of the world with enough nutrients. The use in agriculture of synthetic pesticides has evolved rapidly and shadowed the conventional methods for protecting crop damage from insects, rodents, sicknesses and weeds. While the use of pesticides has made a major contribution to food security by reducing the production of crops and losses after harvest. Rising cropping productivity in Indians has been improved by pesticides alongside fertilizer and high-yield varieties(Shende and Bagde, 2013).

Almost 12% of the overall cultivable losses is generally attributed to the world's weeds alone. The resemblance of some paddy herbs, including Echinochloa spp. It is very difficult for farmers to discern them at early stages of growth when weaving the hands. Due to its similar growth activity, rooting and nutrient requirements, graminoid weeds compete more with cereals. Weeds are more effective than crops to extract nutrients. The weeds of C4 are mainly affected by the exploitation of sunlight by decreased photo syntheses and adversely affect plant productivity. Not all weeds are harmful in crop fields. Weeds do not impact yields at low density and some weeds can even improve crop growth (Manandhar et al., 2007). So, the greatest number of farmers use synthetic chemicals to control weeds.

Rising global productivity, reducing insect-borne, infectious diseases and protecting/restoring forests, forests, harvested goods, homes and fibers have consistently demonstrated their importance in chemical pesticides. At present, pesticides are not more

valued than in developing countries, and particularly in tropical regions that are trying to join the global economy by supplying countries in temperate climes with fresh fruit and vegetables over the off-season. Those developing countries will become important "breadbaskets" for the world and will be able to grow 2 or even 3 crops annually. These objectives cannot be reached, however, without increased use in the agricultural practice of pesticides, primarily insecticides, herbicides and fungicides. Most developing countries are underway with the movement of skilled workers from agriculture into urban areas in pursuance of increased economic growth, from an agrarian culture to the modern industrialized society. While multi-national manufacturers sell a variety of 'improved' pesticide chemicals throughout the world, import costs are exorbitant in view of the restricted access by developing countries to foreign currency. Household malaria spraying costs at least nine times as much with DDT, using parathyroid esters. Sometimes, developing countries abandon or restrict these monitoring systems without globally funded programs. In agriculture, 'new' and non-patented agents are starting to be generated in the country, less costly, more hazardous and eco-persistent.

The key advantages are the benefits of the pesticides – the predicted direct profits. For example, the impact of killing the feeding of caterpillars on the crop brings the key advantage of increased production and improved cold quality. The three major consequences result in 26 major advantages from the safety of spas to saved lives. The secondary advantages arising from the primary benefits are less immediate or less apparent. You can be subtle, less intuitive or longer-lasting. Therefore, it is harder to assess cause and effect for secondary benefits.

The higher colt yield, for example, may contribute to a healthier, more educated population and to additional income that can be put into children's education or medical care. Several secondary benefits, from fitter to preserved biodiversity, are established. The use of pesticides in forestry, public health and the national domain, and, of course, farming, on which the Indian economy is heavily dependent, has brought tremendous benefit. The production of food grain, of only 50 million tons, increased by 1948–49 from

an estimated 169 million ha of permanently grown ground, almost four to 198 million tons by the end of 1996–97. This was done through the application of high-yield crops, advanced irrigation methods and farm chemical products. In most countries, including in the United Kingdom wheat yields and, in the USA, output and production have increased dramatically. Productivity improvements were attributable to many factors, including fertilizer usage, improved varieties and machinery usage. The reduction in losses from weeds diseases und insect pests, which are able to significantly reduce the number of harvestable products was an essential part of the operation. In medium soil, even under essential puddle conditions, rice provided an efficient and economical method of weed control to prevent a reduction in rice yields from weeds of 28 to 48 percent based on comparisons of control plots. In the long term, severe weed infestation, particularly at the early stage of cultivation, leads to a 40% decrease in yields. Both economic and labour benefits have been provided by herbicides. The killing of vectors is the best approach to vector-borne diseases. Insecticides are often the only practical way to control insects that spread deadly diseases like malaria and are estimated to kill 5000 people every day. In 2004, Bhatia wrote that malaria in the developing world is a major cause of morbidity and death and is a major public health issue in India. Strategies for disease control are also crucial for livestock. In First World countries, a diet containing fresh fruit and vegetables has been observed that there is far higher than the potential hazards of eating low pesticide residues in plants. Increasing evidence indicates that eating the fruits and vegetables reduces the risk of cancer, high blood pressure, cardiovascular conditions, diabetes, stroke and other chronic conditions regularly(Akhtar et al., 2009).Rice quality assessment includes the consistency, scale, colour, shape and characteristics of the milling, food and eating. The size and shape of the grain are determined by the genetic makeup of a certain species, but the frying consistency, appearance and cooking and eating characteristics may be affected greatly by the basic oil treatment(Paranagama et al., 2003).

2.8Effects of fungus for paddy yield

The *Magnaporthe grisea* filamentous fungus is the most damaging disease of rice, which is the rice blast. Despite the development of resistant plants genotypes, epidemics of the disease continue to occur in many developed countries around the world and threaten the supply of food in several emerging nations. In mature plants, the fungus attacks the developing panicle and causes all rice seeds to be totally lost. Since rice remains the biggest food crop of over a third of the world's population, better methods are needed to control this disease. M. In the standard foliar pathogen, grisea infects the rice crop. Split into the humid air, asexually spores, known as conidia, are closely bound to the leaf surface. A conidium creates a germ tube with a drop of water that grows and distinguishes a specialized infection structure called appressorium which adheres closely to the surface of the plant. This specialized cell produces huge turgorpressure, which penetrates the surface of the plant. Hyphae from bubbling, lobed infection develops in and within plant cells once inside the plant. Later on, a lesion grows mycelia that sports and releases more conidia to restart the cycle of infection under conditions of high humidity. One the fungus spread to the plant cell it will reduce the photosynthesis. So eventually the yield has taken out the form an area decrease(Xu et al., 1996). Pathogenic treats have developed different methods for overcoming the various challenges during their hosts' infection. The Magnaporthe grisea rice blast triggers one of cultivated rice's most damaging diseases and has emerged as a model of foliar pathogenicity science. This fungus is subjected to a series of clearly established leaf infection developmental phases, including the creation of complex penetration structures. During the invasion of their hosts, pathogens have evolved various strategies to solve different challenges. The Magnaporthe grisea rice blast is a model for foliar pathogenicity research, which causes one of the most damaging diseases in cultivated rice. The fungus is subject to a sequence of clearly defined developmental phases of leaf infection and the development of complex structures of penetration. So, most of the time farmers use synthetic fungicides to reduce the fungal effect which leads to reduce the paddy yield taken out from per unit area.

2.9Paddy cultivation in Sri Lanka

Paddy, coconut and other local consumption field crops, and tea, rubber, cocoon and export minor crops are the prevalent crops grown in Sri Lanka. Around 800,000 farmers and families directly rely on paddy grown in 30% of the land area. In 2002 the total area of paddy grown in the dry (March – September) and wet (October – February) seasons of the crop (maha) was above 852,000 ha. Around 70% of produced rice comes from small paddy farms below 1.0 ha. Nearly 50% of these farmers cultivate paddy of holdings smaller than 0.4 ha. 314,000 farmers are farmers(De Silva et al., 2007).

2.10Fertilizer consumption in Sri Lanka

The economy of fertilizer use was checked in Sri Lanka's major cropping sectors in 1988. Some economic aspects of fertilizer use in Sri Lankan tea, rubber, coconut and paddy industries have been studied. The projected Regression Models for use of fertilizer have suggested that the relative fertilizer and production prices have a major impact on the use of fertilizer, suggesting that the abolition of the fertilize subsidy would further exacerbate the fertilizer use situation in these industries(Ekanayake, 2009). The modes provide an increasing trend. This means the fertilizer use for crop cultivation increase day by day. Paddy cultivation also the same. Farmers did not use the actual amount of fertilizers for their paddy lands. Due to that fertilizer consumption increases.

2.11Paddy cultivation in Kalutara district

Kalutara district is a major district that grows paddy as their major captive crop. Kalutara district provides a considerable amount of rice yield for full fill rice demand in Sri Lanka. Most numbers of farmers use pesticides and fertilizers for increasing the paddy cultivation

Kalutara district is the second administrative division of Sri Lanka's 25 districts. A district secretariat headed by a district secretary appointed by the central government of Sri Lanka is responsible for that district. The city of Kalutara is the capital of the district. Kalutara distributes an area of 1,598 square kilometers in the southwest of Sri Lanka. The district is bounded by North Colombo, East Ratnapura, South Galle and Western Indian Ocean. The district of Kalutara is divided into 14 Secretaries, each headed by a Secretary. Kalutara District's population was 1,217,260 in 2012.

Chapter 03

3.1 Research design and methodology

3.1.1Introduction

The main purpose of this chapter is to provide an adequate basis for the analysis of this study. The conceptual framework of how the data were collected, the data requirements, the samples and the duration of the data, the data sources and the analytical techniques for the analysis are included in this section. All the achievements associated with the analysis are completed in this section.

3.2 Conceptual framework of the model

Paddy yield depends on various factors. Pest diseases and nutrient level of the soil highly impact paddy yield in worldwide. Soil erosion coursing for reduction of soil nutrient. Erosion leads to slower-growing of plants and reduces the yield taken from per unit area. Fungal infections reduce photosynthesis. Fungal for thallus like body. Most of the time they form their chemicals between the plant cells. The thallus reduces the solar radiation came into the photosynthetic cells. So, the yield reduces. Pests effects for the plant leaves and plant parts. Sometimes they effect for harvested crops. Therefore, pests and different infections effect for the paddy yield.

Graphical illustration of the model

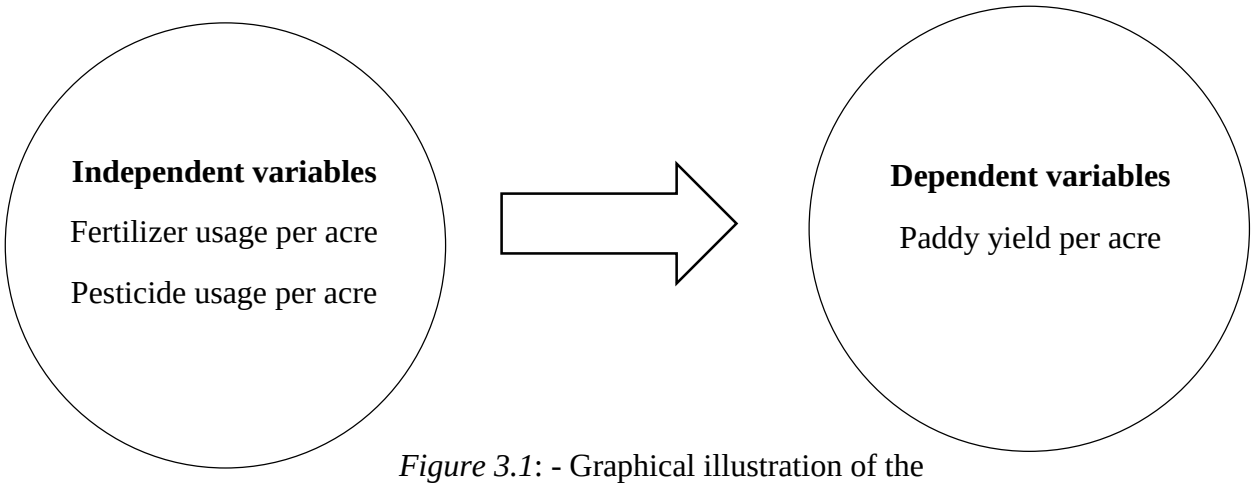

Figure 3.1: - Graphical illustration of the

3.3Hypotheses Development

This research tested the either accept or reject hypothesis statement. There was only one hypothesis statement which was divided into the null and alternative hypothesis. The alternative hypothesis (H1) was as follows.

H0: Agrochemicals not effects for paddy yield

H1: Agrochemicals effects for paddy yield

3.4Study area

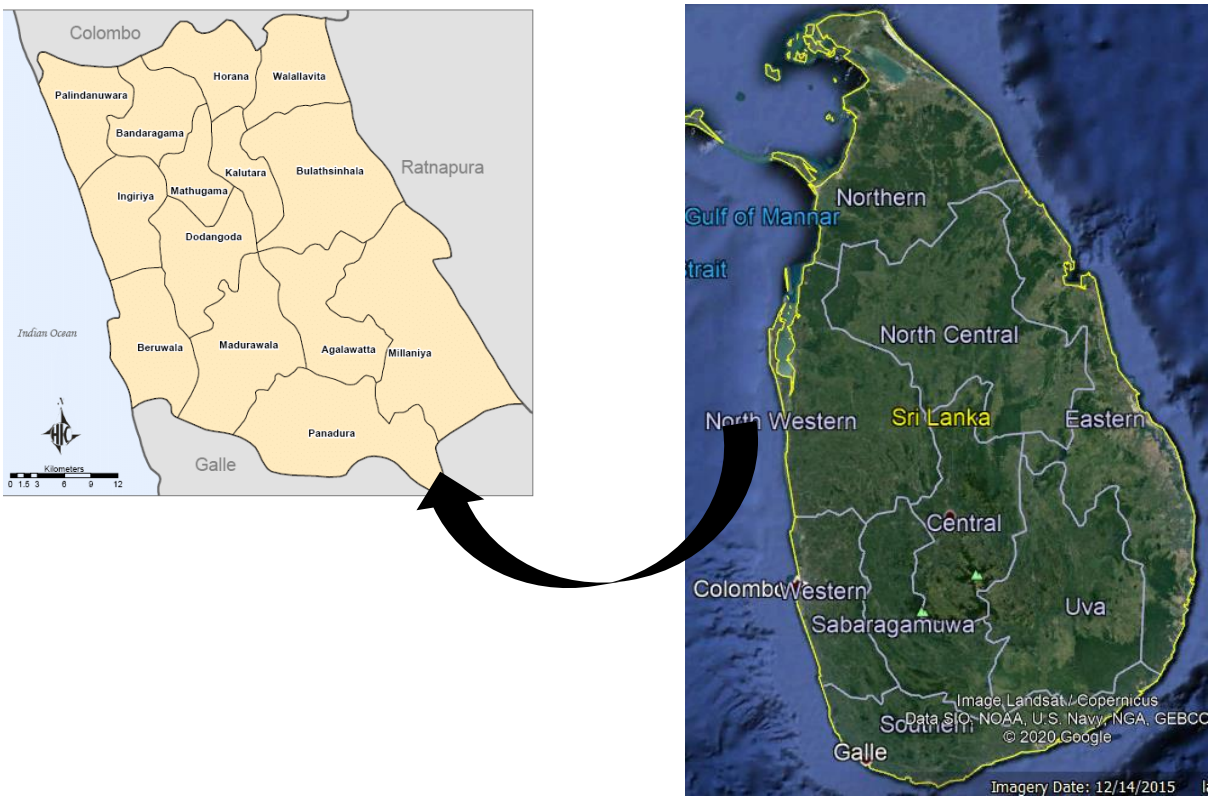

Figure 3.2: - Study area

3.5Data collection

In this study, data collected using a questioner survey. The questionnaire survey was conducted covering all Divisional secretariat divisions (DSD) of Kalutara district. To get the data, the researcher visited farmers and ask relevant questions and noted down their response. Face to face survey done to collect the data. An interviewee is present physically in a face-to-face survey to ask the survey questions and help the respondent respond to them.

stratified random sampling method was used as the sampling method. the DSD divisions are used as strata. the data has been collected covering all the DSD divisions in the Kalutara district.

3.6Paddy yield

Paddy yield was collected as seasons. Then calculate the paddy yield for the year. Most of the time farmers did not use the metric unit. By using suitable transformations calculate the paddy yield as in kilograms.

3.7Pesticides consumption

Pesticides consumption was taken as milliliters per acre The data can be directly collected from the farmers. Farmers mixed the fertilizer as a milliliter of pesticide with water.

3.8Fertilizers

The data was directly collected form the famers and calculated the fertilizer consumption per unit area (KG per acre)

Variables

Depending on variable	**Independent variables**
Paddy yield	Fertilizer consumption Pesticides consumption

Description of variables

Variable	Description	Measuring unit
Paddy yield	Paddy yield is taken as yearly	Kilograms per acre
Pesticides consumption	Pesticide consumption is taken as per yearly	Milliliters per acre
Fertilizer consumption	Fertilizer consumption is taken as per yearly	Kilograms per acre

3.9Methods

Regression equation

Regression analysis is a strong statistical tool for analyzing the relationship between two or more interest variables. Regression analysis is a reliable way to decide which variables affect a subject of interest. The regression method enables you to decide with certainty which factors matter, which factors can be ignored and how each other affects these factors. Regression analysis is a set of statistics used to estimate relationships between a dependent variable and one or more independent variables. Reference analysis The strength of the relationship between variables can be measured and the potential relationship between them modelled.

Paddy yield = $\alpha + \beta 1$Pesticides consumption + $\beta 2$ fertilizer consumption + e

α: - intercept

β: - coefficients

e: - error

The constant term in the regression analysis is the value that crosses the y-axis on the regression line. The y-intercept is also called the y-intercept. In this model α denote the intercept. Regression coefficients provide estimates of unknown population parameters and the relationship of a variable predictor to the response. Coefficients are the values multiplying the predictor values of linear regression. The coefficients denote as β. The normal regression error, also known as the standard estimation error, represents the average distance from the regression line that the observed values fall. Comfortably, the regression model uses the units of the response variable on average to say how wrong is. Smaller values are stronger since the observations are similar to the relevant rows. The standard error denotes as "e". Use Minitab 19 version for data analysis.

3.10Basic assumption testing

3.10.1Normality of the data

Normality is one of the most important assumptions of the overall statistical models. All the variables that are selected for the model are normally distributed. At least the dependent variable should be normally distributed.

3.10.2Shapiro-Wilk W Test

Shapiro-Wilk W Test In most cases, this test for normality is the most effective. It is the combination of two values depending on a random sample of n observations for the variance of a normal distribution. The number is commensurate with the square of the best linear deviation estimator. The denominator is the complete square of the sample mean observations. The test statistic W can be written in the form of the Pearson coefficient of correlation between the ordered observations and a set of weights used to measure the numerator. As these weights asymptotically are commensurate with the relevant predicted normal order statistics, W is approximately a measure of the straightness of the usual quintile map. The closer W is to one, the more the sample becomes natural.

3.10.3Kolmogorov-Smirnov Test

This normality test is based on the maximum difference between the cumulative-normal distribution observed and predicted. The Lilliefors adjustment is used since it uses the average and standard sample deviation to measure the predicted normal distribution. The lower the overall difference, the higher the probability of normal distribution

3.10.4Multiclonality

Multicollinearity is a condition of exceptionally high relations or interrelationships between the independent variables. This is also a form of data disruption, and if the statistical assumptions drawn about the data are valid, they might not be accurate. In a multiple regression model, Multi-collinearity is the phenomenon of strong interrelations between independent variants. Mular linearities can lead to distorted or misleading results when a scientist or analyst tries to decide the best way to predict or to interpret the dependent variable in the statistical model for any independent variable. Multi-columnarity will typically lead to longer trust intervals and less stable probability values for the independent variables. In other words, the statistical conclusions from a multi-coordinate model cannot be accurate.

3.10.5VIF (Variation Inflation Factor)

In regression, multicollinearity is observed by the variance inflation factor (VIF). If there is a link between the model's predictors, the regression results may be adversely influenced by the involvement. VIF factor uses to evaluate the multicollinearity of the independent variables and the VIF coefficients provide an idea of the interlinkage between independent variables.

3.10.6Heteroscedasticity

Heteroscedasticity occurs with statistic when standard defects of the predicted variable are non-constant and are monitored over a number of separate variable values or in relation to preceding time periods. When the residual errors are examined visually, the telltale for heteroscedasticity is that they appear to fan over time. Two types of heteroscedasticity also occur: conditional and unconditional. Conditional heteroscedasticity describes volatility correlated with volatility of the previous time. The data set should be Heteroscedastic.

Chapter 04

4.1Data analysis

Descriptive statistics

Table 4.1: - Descriptive statistics of the variables

Statistics

Variable	N	Mean	SE Mean	StDev	Minimum	Maximum
fertilizer consumption	40	622.5	47.5	300.1	160.0	1300.0
pestiside usage	40	248.4	15.8	100.2	35.0	500.0
Log paddy	40	6.7874	0.0810	0.5123	5.7683	7.9374

Figure 4.1describe about the descriptive statistics of the selected variables for regression analysis. Figure 4.1describe the mean and other essential parameters which use to describe the variables. Mean values of the fertilizer consumption and pesticide usage around 622.5 kilograms per acre and 248.4 milliliter per acre.

4.2Normality test

The normal distribution in statistics is a very significant distribution. And there's a great deal to be found when the data can be interpreted by a regular distribution. The z values can be used to decide which percentage of the data is below, above or between two values.

The normal probability plot is a graphical technique to determine whether a data set is distributed normally. Differences in normality signify deviations from this straight line. A special case of the probability plot is the probability plot.

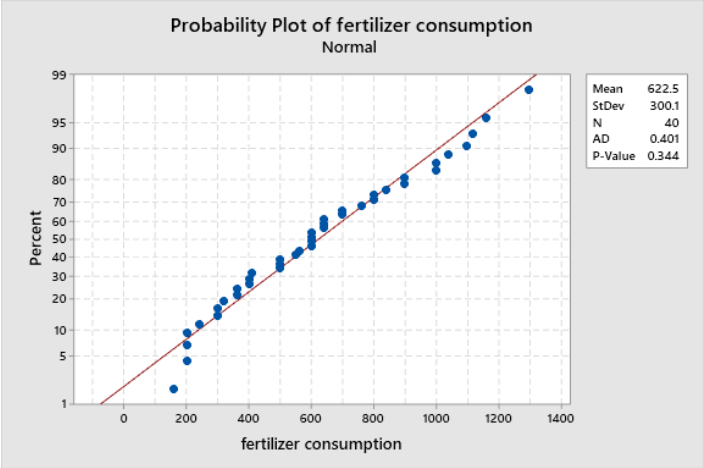

Figure 4.1: - Probability plot of fertilizer consumption

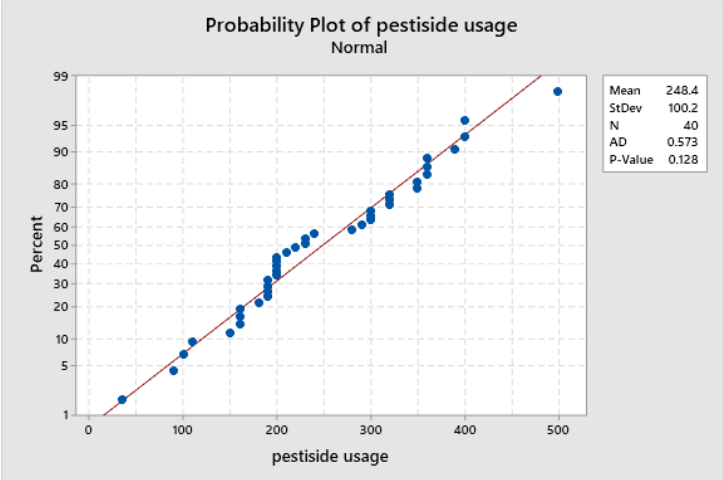

Figure 4.2: - Probability plot of pesticide usage

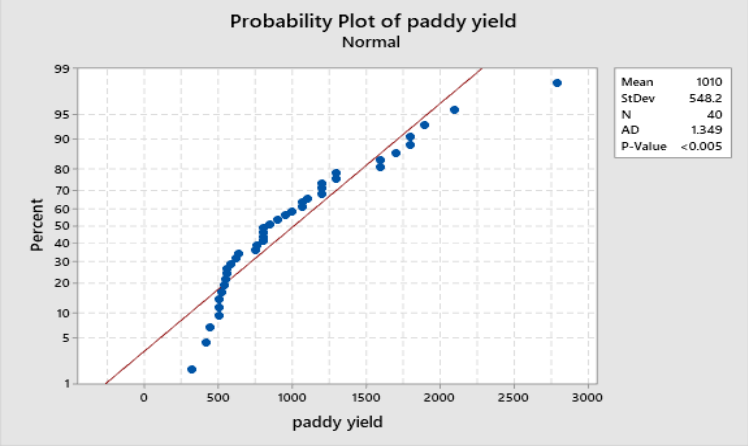

Figure 4.3: - Probability plot of paddy yield

Normality test hypothesis,

H_0^1:- The data set normally distributed

H_1^1:- The data set not normally distributed

Pesticide consumption and fertilizer consumptions p-value for normality test is higher than 0.05.

According to the p values of figure 4.2 and 4.3, we do not have evidence to reject the null hypothesis. The p values of figure 4.2 and 4.3 were higher than 0.05. Therefore, those two variables are normally distributed. But the paddy yield is not normally distributed according to figure 4.4. The multiple regression model developed base on several assumptions. Normality is one of the key assumptions. Dependent variable paddy yield, violate the assumption. with that, the model cannot apply to this data set. there are many ways to transform the data into a normal distribution. converting data into a natural logarithm is a method that commonly uses for transformed data. The paddy yield transformed into a logarithm and form a new variable called Log paddy. When a data set is not normal there are several transformations can be used to convert the data. The normality depends on the range that the data set distributed. Transformations reduce the range and reduce the variability of the data.

The new regression equation will be,

Log Paddy = $\alpha + \beta 1$Pesticides consumption + $\beta 2$ fertilizer consumption + e

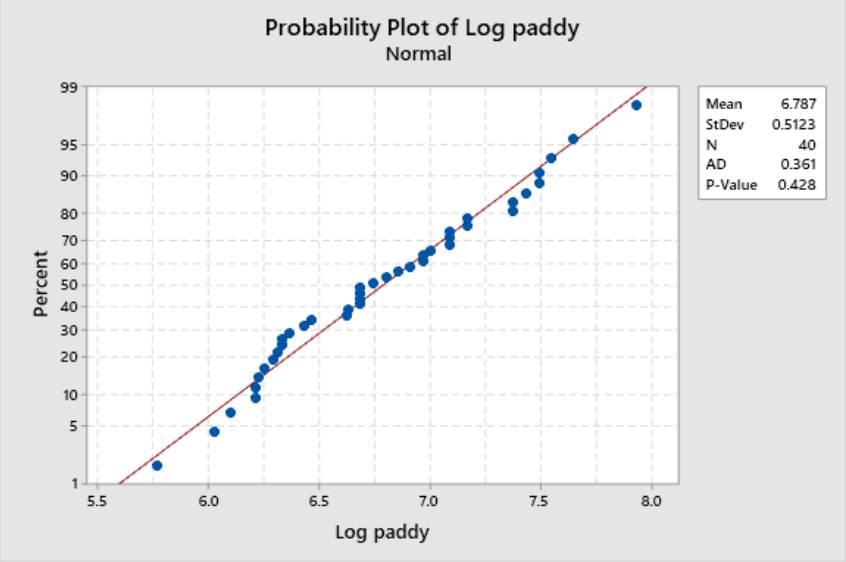

Figure 4.4: - Probability plot of Log paddy

4.3Results of Regression Analysis

Regression analysis consists of a model summary and the results of the regression coefficients.

Table 4.2: - Regression coefficients

Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	5.950	0.164	36.31	0.000
fertilizer consumption	0.001458	0.000144	10.13	0.000
pestiside usage	-0.000282	0.000431	-0.65	0.517

The regression model and the fertilizer consumption, significantly affect the paddy yield. according to Table 4.2 the p-value of the model less than 0.05. The overall model is significant. Therefore, this model can be used for predicting future results. the correlation test results have shown that there is a slightly negative relationship between paddy yield and pesticide usage. this maybe leads to an insignificance effect with paddy yield.

Regression equation as follows

Regression Equation

Log paddy = 5.950 + 0.001458 fertilizer consumption - 0.000282 pestiside usage

S	R-sq	R-sq(adj)	R-sq(pred)
0.257451	76.04%	74.74%	71.90%

Figure 4.5: - Regression coefficients

Figure 4.5 shows that the R square value near 75 percent. This model predicts 75 presents of the actual value. But the pesticide consumption is not significant. Therefore, the regression model is

Log paddy = 5.950 + 0.001458 fertilizer consumption

4.4. Test of Heteroscedasticity

One big principle of linear regression is that the residuals should not be heteroscedastic. In simpler terms, this means that there is no improvement in the residual variance with the required reaction variable values. Heteroscedasticity is a concern because the normal

regression of fewer quadrants assumes all residues are from a continuously variable population (homoscedasticity). The residuals should always be different in order to follow the regression criteria and be able to trust the findings.

One of the key assumptions of classical linear regression is that the disturbance is constant across the observation. This is called the assumption of homoscedasticity. If the disturbance does not have a constant variance, it is heteroscedasticity. To test this assumption, the researcher, use residual plots. A residual plot is a graph displaying residuals on the horizontal axis and the horizontal component. A linear regression model is suitable for data when the points in a residual compartment are randomly distributed along the horizontal axis.

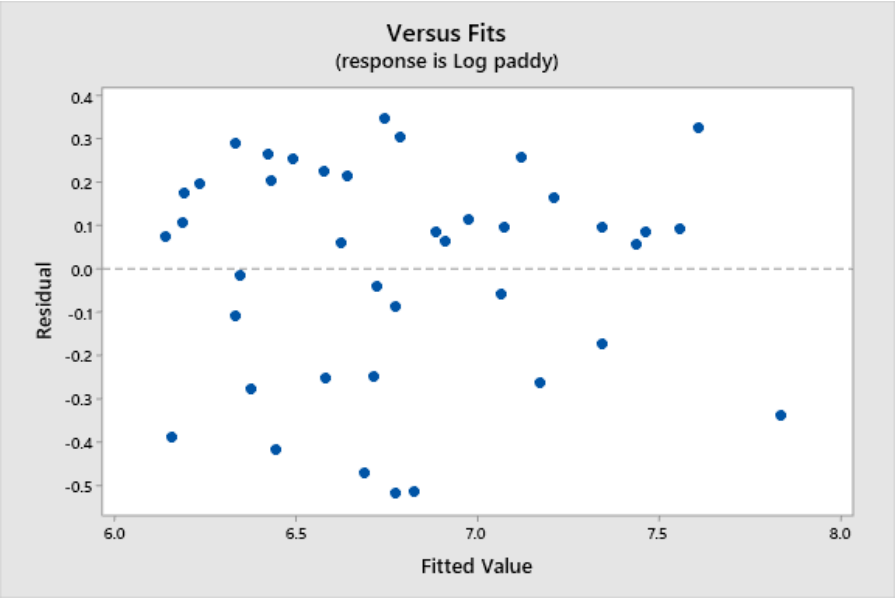

Figure 4.6: - Residuals plot

Figure 4.6 describe the variations of the residuals. The variation of the residuals is minimum there for the homoscedasticity is present.

4.5 Variance Inflation Factor (VIF)

Variance Inflation Factor (VIF) values that exceed 10 are generally viewed as evidence of the existence of problematic multicollinearity. The VIF is mathematically the same as the ratio of the overall model variance to the variance of a model which includes only this

single independent variable for regression model variables. For each independent variable, this ratio is determined. A high VIF implies

that the independent variable associated with the model is very similar to other variables. Most articles use 10 or 6 as the reference value. If the VIF value exceeding those limits means the model contains multicollinearity.

Table 4.3:- VIF table

Coefficients

Term	VIF
Constant	
fertilizer consumption	1.10
pestiside usage	1.10

According to Table 4.3, the vif values are not exceeded the reference values, therefor multicollinearity is minimum.

4.6 Correlation test results

Correlation indicates the frequency of an association between two variables, and the correlation coefficient is expressed numerically. The values range from -1.0 to 1.0 of the correlation coefficients. A positive correlation is a relationship between the two variables, which is the association of the two variables in the same direction. This is when one of the factors increases and the other increases.

Table 4.4:- Correlation coefficients

Correlations

	Log paddy	pestiside usage
pestiside usage	-0.309	
fertilizer consumption	0.870	-0.298

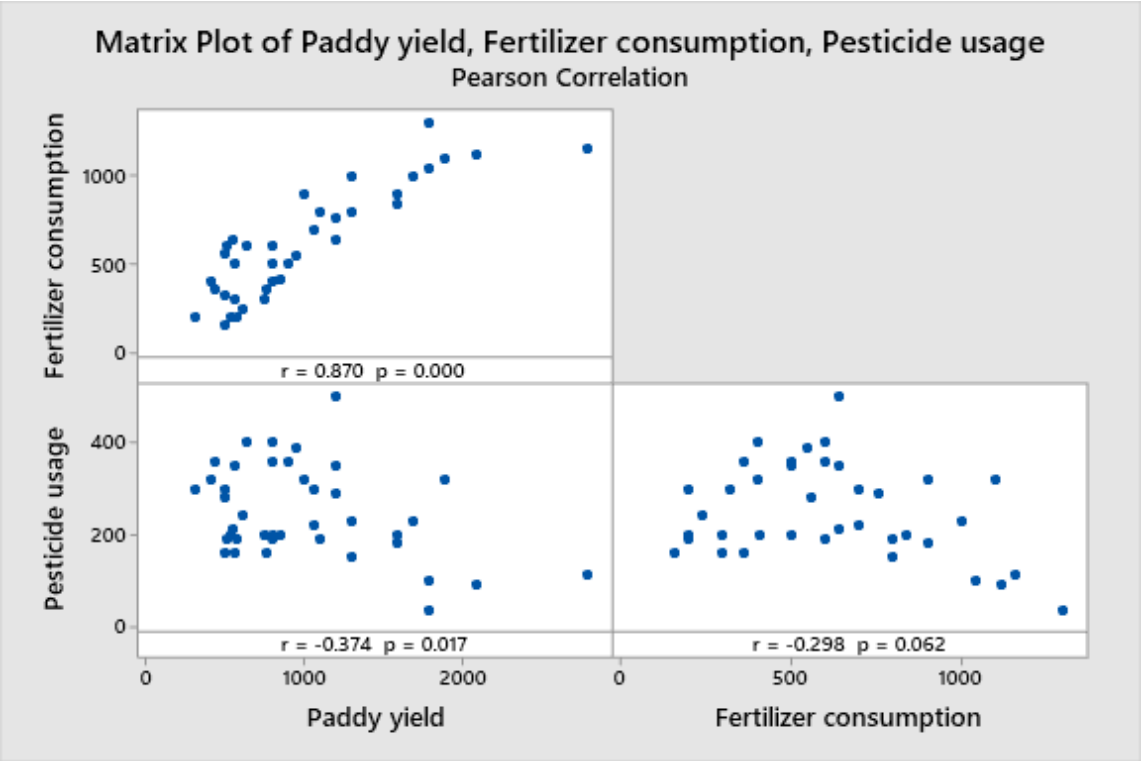

Figure 4.6: - Correlation matrix

4.7 Pesticide usage

Table 4.4 describe the correlation coefficients. According to Table 4.4, Pesticide usage is negatively correlated with the paddy yield. It is not a strong correlation. The correlation weekly and negatively correlated with pesticide consumption. So the paddy yields not very much effect on the pesticide consumption of farmers. But According to Figure 4.6, those two variables are significant with the dependent variable paddy yield.

4.8 Fertilizer consumption

Fertilizer consumption strongly and positively correlated with Paddy yield. This means that fertilizer consumption directly impacts paddy yield. The fertilizer consumption increases the paddy yield of Kalutara district.

Chapter 05

5.1. Conclusion

Sri Lanka is an agricultural country. this specific study enables us to identify the effect of the Agrochemicals on the paddy yield. Farmers cultivated tea rubber coconut and paddy as their major crops. Empirical results of this study show that the average consumption of fertilizer and pesticides of this district around 622.5 kilograms per acre and 248.4 millilitres per acre. This study was conducted to identify the effect of the Agrochemicals on the paddy yield. The regression analysis was used to identify the relationship between selected parameters. The regression results also indicate that fertilizer and pesticides increase the paddy yield of the selected area. The correlation coefficient of the fertilizer consumption around 0.873. therefore, the fertilizer consumption highly correlated with the paddy yield. with the usage of the fertilizer, the farmers can increase their paddy yield. But the farmers should aware of the acceptable level of fertilizer that can be used for the crop. The regression model was highly significant. These findings are similar to those of other economic and biophysical studies. The regression equation as follows: Log Paddy yield (KG per acre) = 5.95 + 0.001458 Fertilizer consumption (KG per acre) – 0.000282 Pesticide usage (milliliter per acre). The regression analysis and correlation test were used to interpret the results. According to the regression analysis, fertilizer consumption positivity impact the paddy yield while pesticide consumption negatively affects the paddy yield. According to the results the pesticide consumption is insignificant to

regression analysis. Therefore the new regression equation for the study, Log Paddy yield (KG per acre) = 5.95 + 0.001458 Fertilizer consumption (KG per acre) but the agro-chemical effect for the paddy yield of the Kalutara District.

5.2 Recommendations

This study enables us to investigate to evaluate the effect of the Agrochemicals on the paddy yield. Kalutara district selected for this study. This study can be done for several crops including rubber and coconut. And this type of research further develops and can be conducted for all the island to identify the effect of Agrochemicals.

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Appendix

Paddy yield (KG per arc)	Fertilizer consumption (KG per arc)	Pesticide usage (ml per arc)
1700	1000	230
520	600	190
560	300	160
1300	800	150
2100	1120	90
1800	1040	100
2800	1160	110
580	200	190
1600	900	180
1600	840	200
1066.666667	700	220
1200	760	290
1066.666667	700	300
550	640	210
760	360	160
800	600	190
1200	640	350
752.9411765	300	200
620	240	240

540	200	200
500	160	160
800	600	360
444.4444444	360	360
320	200	300
412.9032258	400	320
560	500	350
505.2631579	320	300
500	560	280
640	600	400
1200	640	500
800	400	400
850	410	200
900	500	360
950	550	390
1100	800	190
1300	1000	230
1000	900	320
800	500	200
1900	1100	320
1800	1300	35