The Impact of Fertilizer Subsidy on Average Paddy Yield in Sri Lanka

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Abstract

Concerning Paddy cultivation, it is one of the major sectors of livelihood in Sri Lanka, employing more than 1.8 million people. The Fertilizer subsidy scheme was initiated in 1962 with the invention of High Yielding Varieties parallel to the Green Revolution. There were three main components given under the subsidy program Urea, Triple Super Phosphate (TSP), and Potassium Chloride (MOP). As in other developing countries, fertilizer subsidy has become a politically sensitive issue in Sri Lanka, since paddy farmers are the majority of voters in the country. Mostly, it has favorably affected paddy yield, self-sufficiency, effectiveness, and food security while there are many bad effects such as overuse of chemical fertilizer, ignoring organic fertilizer, dependency on imported fertilizers, a huge burden on the government budget, etc. Therefore, the objective of the study is to evaluate the impact of fertilizer subsidy on average paddy yield in Sri Lanka. Secondary data was gathered in order to find the impact of fertilizer subsidy on average paddy yield. Multiple regression analysis was used to analyze the impact of providing Urea and all fertilizers with the changes in fertilizer scheme from time to time and other data were represented using relevant graphs and tables. Can be seen a gradual increase in the import of fertilizer subsidy in Sri Lanka. In this study, it was found that fertilizer subsidy has a positive significant relationship with average paddy yield in Sri Lanka. So, it can be concluded that, the need for the existence of fertilizer subsidies in Sri Lanka with the moderation the of fertilizer subsidy scheme in order to reduce the huge government burden on fertilizer subsidy in Sri Lanka.

Keywords: Average Paddy, yield Fertilizer Subsidy.

INTRODUCTION

Many successive governments in the world, pushed toward providing subsidies, especially for the agricultural sector (Mint & Benson, 2009). Among them, input subsidies for fertilizer were one of the major interventions by the government in order to achieve food security and self-sufficiency (Ahmed 1987, Bayes, Parton & Piggott 1985, Renfro 1992). As in many other countries, fertilizer subsidy plays a significant role in agricultural policy in Sri Lanka. Since rice is the staple food in Sri Lanka, it is important to explore the impact of fertilizer subsidy on Total Government Expenditure, Import, and total paddy production in Sri Lanka with the changes in fertilizer subsidy schemes from time to time. Paddy cultivation in Sri Lanka is accounted for 36% of the total cultivated area (Department of Agriculture, 2018). It is cultivated during the Yala and Maha seasons and a higher yield is received during the Maha Season (Central Bank of Sri Lanka, 2018).

Fertilizer subsidy has been provided for more than five decades in Sri Lanka with modifications and policy changes from time to time. Despite concerning huge budgetary burden, it has mainly focused on ease for farmers. According to the Department of Agriculture, the subsidy was given to the farmers who owned 5 acres (2 hectares) of paddy cultivated lands. The Fertilizer subsidy scheme was initiated in 1962 with the invention of High Yielding Varieties parallel to the Green Revolution. There were three main components given under the subsidy program Urea, Triple Super Phosphate (TSP), and Potassium Chloride (MOP). With the different views and modifications, we can identify five major phases of changes in fertilizer subsidy from its beginning in 1962 (Ekanayake 2005, Weerahewa et al. 2010, Central Bank of Sri Lanka, 2007– 2012, cited by Bhavan & Maheshwarathan, 2012).

Period 1: 1962-1989 -Subsidy provided for three main fertilizers (Urea, TSP & MOP)

Period 2: 1990-1994 -Subsidy removal

Period 3: 1995-1996 - Reintroduced and Subsidy provided for three main fertilizers (Urea, TSP & MOP)

Period 3: 1997-2005 -Subsidy provided only for Urea

Period 4: 2005 onwards- Subsidy provided for all three fertilizers (Urea, TSP & MOP)

During the period of 1962-1989, the subsidy was given for all fertilizers targeting primarily paddy farmers. As a result of fluctuations in world market prices of fertilizers, a fixed price was implemented during the period of 1983-1987. In 1990, the government totally removed the fertilizer subsidy until 1994 causing world oil prices to increase and depreciation the of the exchange rate. Later, the government again introduced the subsidy scheme for all fertilizers with the changes.

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In 1997, the government restricted the subsidy providing only for Urea. This policy was conducted until 2005 and again, the policy was modified as giving subsidies for all fertilizers at a fixed price of Rs. 350 for a 50kg fertilizer bag regardless of international market price changes.

The impact of the fertilizer subsidy policy on government expenditure has gradually increased over the past three decades (Central Bank of Sri Lanka, 2018). As well as the impact of this policy on paddy yield is also a very important factor (Bhavan & Maheswaranathan, 2012, Perera et al.2014) in the Sri Lankan context. Many successive governments over the past recent decades have provided fertilizer subsidies aiming at increasing the paddy yield (Gamawelagedara, Wickramasinghe & Dissanayake 2011, Rajapaksa & Karunagoda,2009). Concerning past research, fertilizer subsidy has significantly contributed to increase paddy production in Sri Lanka achieving self-sufficiency and price stabilization (Ekanayake 2005, Weerahewa, Kodithuwakku & Ariyawardhane 2010). The introduction of chemical fertilizer has created many problems in past years, hence it has become a very important topic of discussion from various points of view (Weerahewa et al.2014**).**

Considering fertilizer subsidy on paddy cultivation, there are a number of consequences of this scheme both favorable and adverse aspects. Mostly, it has favorably affected paddy yield, self-sufficiency, effectiveness, and food security while there are many bad effects such as reducing soil fertility, overuse of chemical fertilizer, ignoring organic fertilizer, water pollution, dependency on imported fertilizers, a huge burden on the government budget, etc. (Weerahewa et al.2014, Rajapaksa and Karunagoda 2009, Weerahewa et al. 2010, Ministry of Finance & Planning 2013). However, not much evidence to prove whether the subsidy caused to increase in the average paddy yield in Sri Lanka. The paddy fertilizer subsidy scheme was continuing over the past decades with different modifications from time to time and it marks considerable issues in the economy. Despite much past evidence from researchers, that favorable and unfavorable economic consequences are led do occur problems in paddy cultivation in Sri Lanka. Concerning the research problem regarding fertilizer subsidy, the question is raised "should the fertilizer subsidy be removed?" or "why it should be continued within the Sri Lankan context?" As ascertained problems and favorable facts of previous studies, the question is raised how the fertilizer subsidy could affect to evaluate of the average yield of the paddy cultivation in order to achieve the relevant objectives of implementing the fertilizer subsidy by the government. Especially, Rice is the staple food in Sri Lanka hence, the subsidy on paddy cultivation could affect more than 1.8 million employees in the country. Therefore, resolving the question of "should the fertilizer subsidy be removed or continued?" is a timely and important fact regarding fertilizer subsidy.

The main objective of the study is to explore the impact of Fertilizer Subsidy on average paddy yield in order to make appropriate policy recommendations. For that, there are two main specific objectives such as, to identify the impact of fertilizer subsidy on Government Expenditure, Import and to explore the impact of fertilizer subsidy on Average Paddy Yield in Sri Lanka.

This paper is organized as follows: first, it makes an introduction to the fertilizer subsidy scheme and then it reviews the literature on the macroeconomic impact of fertilizer subsidy in paddy cultivation. Based on the literature review, a hypothesis is formulated. Then the study describes the materials and methods and results are presented and discussed in the next section. Finally, it concludes the paper by reviewing its contributions and policy implication.

LITERATURE REVIEW

As noted in the previous chapter, a subsidy helps to achieve lots of economic and social goals in various ways in a country. Supporting agriculture sectors, poverty alleviation, research and development, and supporting domestic industries can be seen as major goals which are to be fulfilled by the subsidy (Abboushi, 2007). In order to achieve these goals, it can involve income distribution or reducing the cost of production. Specially, agricultural subsidies are evolved with many targets such as food sufficiency, improving the living standard of farmers, enhancing production efficiency, food safety, quality of foods, protecting the environment, etc. Most importantly, developing countries target on poverty alleviation, development of the agriculture sector, and improving rural development by providing subsidies (Moor & Calamai, 1997). However, it could be seen that it has both positive and negative outcomes which have occurred due to subsidies.

There are lots of studies that have evaluated the impact of fertilizer subsidy with special reference to paddy production for mainly used three fertilizers (Nitrogen, Phosphorous and Potassium) in both developed countries and developing countries. Fertilizer demand and usage are differed from one country to another due to some major facts such as climate, technology, soil fertility and sociological factors. Here it is reviewed that different perspectives regarding fertilizer subsidy. Fertilizer subsidy as the main variable in the agriculture sector has been discussed by many researchers over the past years. When considering the global context, Griliches (1958) and Heady and Yeh (1959) evaluated the aggregate demand for fertilizers in the United States with the changes in their prices during the period 1911 to 1956. Boyle (1982) used the fertilizer usage estimating cost function approach to evaluate the usage of three main fertilizers in the USA.

Wanninayake and Semasinghe (2012) used the average yield of paddy as their dependent variable and fertilizer subsidy was taken as two dummy variables as independent variables in order to find the impact of providing subsidy on average paddy yield. For the estimation of efficiency of agricultural inputs, the above researchers have used average yield as a dependent variable (Y), harvested extent land (X1), and quantity of fertilizer (X2) as explanatory variables using the most appropriate theoretical explanation; Cobb-Douglas production function. Kukuchi and Aluwihare (1990) have estimated a fertilizer response function using average yield as the dependent variable, and the use of Nitrogen fertilizer as their explanatory variable in order to evaluate the long-term macro impact of fertilizer subsidy since independence. Chandrasiri and Karunagoda (2008) evaluated the paddy production function using land, machinery, agrochemicals, and fertilizer inputs in different regions in Sri Lanka in order to make the relationship between them. Karunaratne & Herath (1989) estimated the efficiency of rice production function in Sri Lanka with some variables. Farm size, agrochemical cost, labour, and fertilizer usage for Maha and Yala seasons were taken as explanatory variables while paddy production was taken as the dependent variable. Kanthilanka & Weerahewa (2019) estimated the production function using paddy yield as the dependent variable and trend, irrigation, season, machinery, fertilizer usage, and labor as explanatory variables in their study. Rajakaruna in 2016 examined the descriptive statistics of that context similar to the above variables in order to find out the impact of fertilizer usage on paddy production. Land, labor, fertilizer, and pesticides were considered explanatory variables while the yield of paddy was considered as the dependent variable by Bhavan & Maheshwarathan in 2012.

According to past theoretical literature, using fertilizer subsidy as independent variables and average paddy yield as the dependent variable and using a simple regression model, is more appropriate to examine the relationship between yield of paddy and fertilizer subsidy (Bhavan & Maheshwarathan 2012, Rajakaruna 2016, Chandrasiri and Karunagoda 2008, Idiong 2007, Perera, Rathnayake & Fernando 2016, Wanninayake and Semasinghe 2012,). This was adopted globally as well as within Sri Lankan context with respect to fertilizer subsidy in paddy cultivation. In this study, it examines the impact of fertilizer subsidy on average paddy yield at the macroeconomic level using fertilizer subsidy as dummy variables for explanatory variables and average paddy yield for the dependent variable (Wanninayake and Semasinghe 2012).

Reviewing past literature, it can be stated that most researchers have found that there is a positive relationship between fertilizer usage and average paddy yield (Ekanayake 2006). Findings by Ekanayake in 2006 were again confirmed by the World Bank (2007) and the Department of Census and Statistics, Sri Lanka (2011) concluding that average paddy yield is positively related to fertilizer usage. Chandrapala & Silva (1988) examined the impact of fertilizer usage in main crop fields in Sri Lanka. The results indicated that removing of fertilizer subsidy will worsen paddy production in Sri Lanka implying that there is a significant positive relationship between the yield of paddy and fertilizer usage.

A study conducted by Ekanayake (2006) focused on the impact of fertilizer subsidies on paddy production in Sri Lanka. Evaluating three separate demand functions for three major fertilizers, he indicated that prices of fertilizer do not have a significant impact on fertilizer usage pointing out that fertilizer subsidy is not a significant variable in determining paddy production in Sri Lanka. Further, the results indicated that the correlation between paddy prices and fertilizer usage is higher than the correlation between fertilizer prices and fertilizer subsidy. Therefore it suggested that fertilizer subsidy could be removed gradually in long term.

According to Nurul (2012) in Malaysian context, the researcher has found that, fertilizer subsidy has significantly affected on the total paddy production in Malaysia. It has positively contributed to increase the paddy yield. As noted in their study, the removal of paddy production will badly affect the self-sufficiency level in Malaysia. Therefore, the availability or providing subsidy is very essential to maintain because farmers are not in a position to buy fertilizer on their own. According to Mulyadiana, Marwanti, and Rahaya (2018), the results indicated that land, use of fertilizer usage, and effectiveness of fertilizer subsidy have a significant positive relationship with the yield of paddy while, labor and use of seed have no significant impact on paddy production in the Malaysian context. This implied that having a fertilizer subsidy is more important to increase rice production in Malaysia.

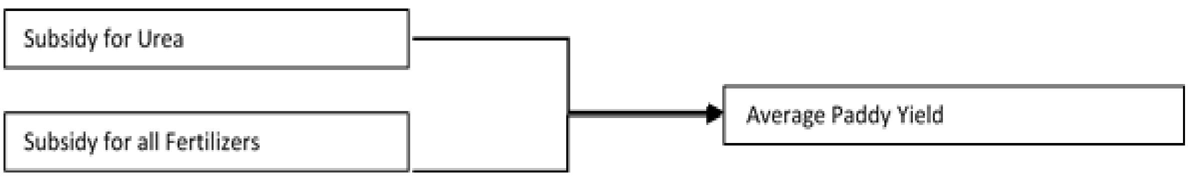
Wanninayake and Semasinghe (2012) conducted a study with the objective to examine the effectiveness of fertilizer subsidies on paddy production. They have revealed that the relationship between the average yield of paddy and fertilizer subsidy is statistically positive and significant. The marginal analysis of evaluating the efficiency of the fertilizer usage, revealed that private benefit is higher than the private cost implying an inefficiency of fertilizer usage or underutilization of fertilizer usage. Since fertilizer usage is highly encouraged by the fertilizer subsidy, there should be mechanisms to reconsider the subsidy instead of removing that process.

Considering past studies, they explored many facts and information about the fertilizer subsidy scheme with some consequences and inefficiencies. Also, there is a criticism that, though the fertilizer subsidy is more politically and socially acceptable, not much evidence to prove that it is economically efficient. This brief empirical literature examined that there are various experiences of fertilizer subsidy on agricultural products, especially in the paddy farming sector not only in a global context but also within the Sri Lankan context. However, it can be concluded that fertilizer subsidy has become a more significant and popular research area regarding agricultural perspectives. Therefore, reviewing past literature, the following hypothesis was formulated,

H1: Fertilizer subsidy has a positive relationship with average paddy yield

METHODOLOGY

The main objective of the study is to explore the impact of Fertilizer Subsidy on average paddy yield in the Sri Lankan context. The impact on government expenditure and import will be stated by graphs and explanation while the impact on average paddy yield will be evaluated based on the reviewed literature as hypothesized above literature part. Considering past literature, the study uses following variables as follows.



Organization of variables

For graph explanation,

Annual Total Usage of Fertilizer in Sri Lanka

Fertilizer Subsidy as a Government Expenditure

Impact of fertilizer as a share of Import

For regression analysis,

Impact of Fertilizer subsidy according to the subsidy provided time period,

Independent variables-Providing Subsidy only for Urea (1) Otherwise (0)

Providing Subsidy for Three Fertilizers (1) Otherwise (0)

Dependent variable- Average Paddy Yield

This study mainly focuses on the macroeconomic impact of fertilizer subsidies. Therefore, the study deals with secondary data cross-sectional and time series data. Secondary data were collected from the Department of Census and Statistics (DCS), Department of Agriculture, The Ministry of Finance, The Mahaweli Development Authority, Department of Agrarian Services, and the Central Bank of Sri Lanka related to paddy cultivation. In order to find out the relationship between fertilizer subsidy and average paddy yield, data were collected from 1990 to 2018.

METHOD OF ANALYZING

Considering past researchers, have used different econometric models and methods to analyze data based on their views. Wanninayake & Semasinghe (2012) analyzed their research estimating the effectiveness of fertilizer subsidy, using the Multiple Regression Model on average paddy yield. Fertilizer subsidy has been taken as the dummy variable while the usage of fertilizer on paddy production has been estimated through the marginal analysis. This study has adopted a quantitative approach where multiple regression model is used to examine the impact of fertilizer subsidy on average paddy yield. Time series data were collected from 1990 to 2018 and fertilizer subsidy has been taken as the dummy variables in this model (Bhavan & Maheshwarathan, 2012).

Descriptive statistics will be used to evaluate the impact of fertilizer subsidy on government expenditure and imports using secondary data. Multiple regression analysis was used to examine the impact of fertilizer subsidy on average paddy yield under 0.05 level of significance using the following model (Bhavan & Maheshwarathan, 2012).

Initially, it considered the impact of fertilizer subsidy on government expenditure, imports, and the annual total fertilizer usage in Sri Lanka using relevant graphs and explanations. Then it evaluates the impact of providing fertilizer subsidies in different time periods by conducting the following method.

$Y = \beta 0 + \beta 1P1 + \beta 2P2 + ui$

Where,

Y = Average Paddy Yield (Kg)

P1= 1- If subsidy was given only for Urea, 0-Otherwise

P2= 1- If subsidy was given for all fertilizers, 0-Otherwise

Benchmark: Period in which the Subsidy was not given (1990-1994)

Here, Y represents the Dependent variable while P1 and P2 represent the explanatory variables in the model ((Bhavan & Maheshwarathan, 2012). In this model, the absence of fertilizer subsidy is the benchmark while β0 represents the average yield of paddy when the subsidy is not given. After measuring the regression model, the significance for each independent variable is tested and the estimation of each coefficient is interpreted with the other results considering the impact on independent variables for the dependent variable. Significance was tested under a 5 percent level of significance using the following hypotheses. Based on regression results, the study investigates whether the subsidy policy is significantly affected paddy production. Reviewing the past researches (Wanninayake 2012, Perera et al.2016, (Ekanayaka, 2005, Rajapaksa & Karunagoda, 2009, Weerahewa et al. 2010) the hypothesis of Average paddy yield is increased with the subsidy scheme is tested.

Several econometric tools are applied to estimate the regression function in order to analyze the impact of the fertilizer subsidy scheme.

Unit Root Test

Before evaluating the model, it needs to be considered whether the analyzed series data are stationary or not as well as to check whether there is a long-run relationship between the data. Stationary means the variance and auto covariance are independent of time. To check the variables are stationary level (I), it is used the unit root test and to test the first different stationary (I(I)), the Augmented Dickey-Fuller (ADF) test is used.

Regression Test

In order to test the regression analysis, the natural logarithm values of variables are used to estimate the paddy production function by using a multiple linear regression model.

Normality Test

In order to test whether the residuals of the model are normally distributed or not, Jarque- Bera test with histogram and Zero mean value of residuals were applied.

Multicollinearity

As a basic assumption of the method of least square, the absence of perfect multicollinearity is very essential to test. In this study, the Variance Inflation Factor and Tolerance value test were used to justify the presence or absence of multicollinearity.

Homoscedasticity

According to the OLS assumptions, it is assumed that there is no heteroscedasticity in the model. Due to the presence of heteroscedasticity, we may face the problem of incorrect estimations. Breush-Pagan-Godfrey Heteroscedasticity Test was applied to test the relevant assumption.

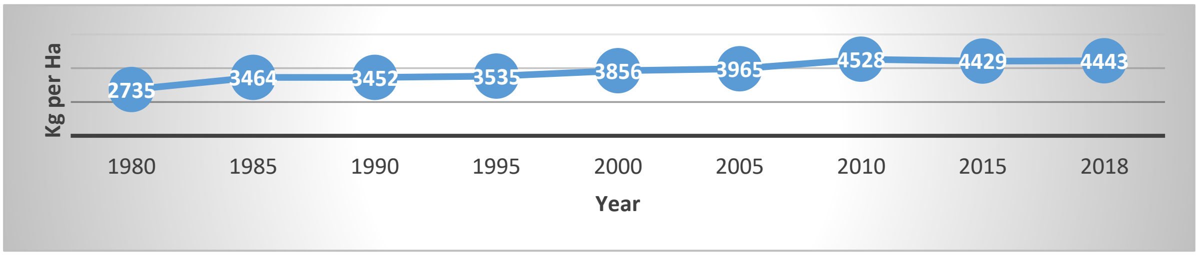
DATA ANALYSIS

This chapter is designed to represent how the main objective of the study is achieved by representing secondary data. The study, it has used both descriptive and inferential statistics to present the findings including charts, graphs, tables, and outputs of statistical packages. The ordinary Least Square (OLS) technique was adopted for the study to evaluate regression results.

Average Paddy Yield

Considering the paddy production and average paddy yield per hectare in Sri Lanka, there could be seen a gradual increase in the average paddy yield over the past few decades. In the 1950s it accounted that 1230 kg per hectare and it increased to 2735 kg per hectare by 1980. In 2018 it accounted for 4443 kg per hectare compared to 4297 kg per hectare in 2017. This improvement can be caused by several factors such as usage of fertilizer, the impact of the fertilizer subsidy program, agrochemicals, availability of water resources and other services.

Figure 4.1. Average Paddy Yield (1980-2018)



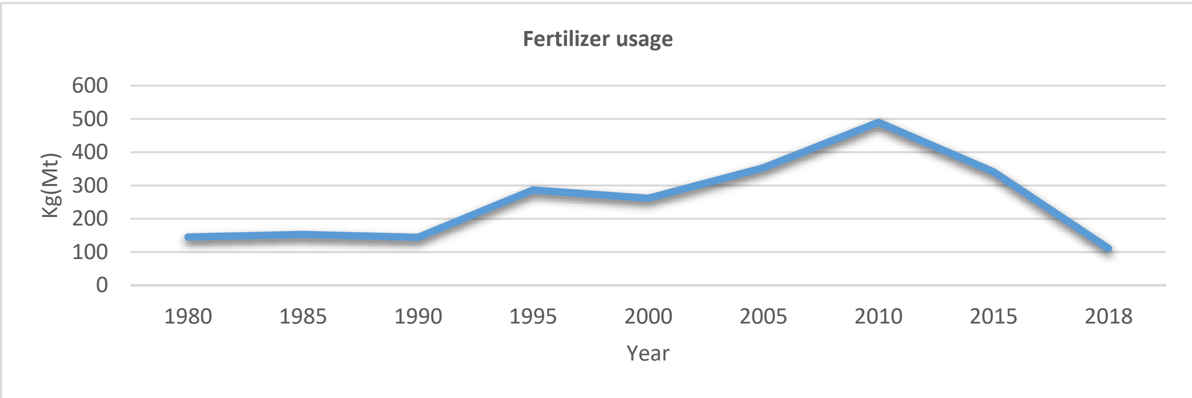
Source: Department of Census and Statistics

Usage of Fertilizer on Paddy Cultivation

In 1961, the usage of fertilizer in the paddy sector, was about 10 % while it increased to 53 % by 1996. The average use of Urea in the 1960s was recorded as 4.3 kg per hectare and it accounted as 284 kg per hectare in 2005 (Wickramasinghe et al 2009). The fertilizer usage during the period in which subsidy was not given is 225 kg per hectare. Again, after the reintroducing the of the fertilizer subsidy scheme, the usage of fertilizer usage was recorded as 457 kg per hectare from 2006 to 2017. This data provides the implication that the fertilizer subsidy scheme is significantly affected to the average use of fertilizer over the years.

Considering the total usage of fertilizer in 1980, it accounted for 145 Mt and it increased gradually within the past years.

Figure4.2: Fertilizer Usage (1980-2018)



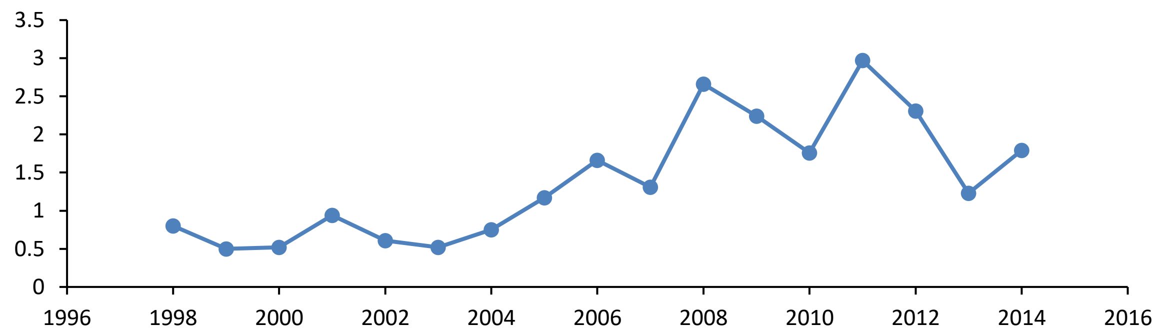
Source: Central Bank of Sri Lanka (Annual Reports)

According to the above graph, the usage of fertilizer increased from 1980 to 2010. After that, there could be seen a huge decrease in fertilizer usage regarding paddy cultivation. However, it can be concluded that fertilizer usage has been impacted by successive governments' policy recommendations in time to time.

Accordingly, it can be stated that there is a significant relationship between fertilizer usage and average paddy yield over the past five decades. Therefore, it needs to ascertain the macro level impact of fertilizer usage on average paddy yield in order to make further modifications to the fertilizer subsidy policy.

Fertilizer Subsidy as a Total Government Expenditure

Figure4.3: Fertilizer Subsidy as a total Gov. Expenditure



Source: Central Bank of Sri Lanka (1995-2015)

After initiating the subsidy program in 2006, the expenditure on fertilizer was recorded as 73.4% compared to the previous year (Central Bank of Sri Lanka 2007). With the fluctuations in world market prices of fertilizer, the burden has again raised hence the government has allocated 15 billion for the subsidy program (Central Bank of Sri Lanka 2009).

Providing fertilizer subsidy is a huge intermediary cost to the government as well as it is somewhat a complex process rather than providing a cash subsidy (Ministry of Finance & Planning 2016). The burden on the government budget has gradually increased with the fertilizer subsidy (Weerahewa et al 2010). Therefore, it need to study the impact on government budget in order to make efficient subsidy program

Data Analysis on Impact of Fertilizer Subsidy on Average Paddy Yield

In this section, the study mainly focused to identify the impact of providing subsidies on average paddy yield by taking fertilizer subsidy as a dummy variable. The multiple Regression technique was used to determine the association and contribution of fertilizer subsidy to the average paddy yield in Sri Lanka. Here the study used the Unit root test, Normality test, Multicollinearity test, and Heteroskedasticity test, for analysis of the impact of independent variables on the dependent variable.

Defining Variables

L (AVE_YIELD_PER_ACRE) –Average Yield per Acre (kg)

SUB__FOR_UREA – If Subsidy only for Urea (1) Otherwise (0)

SUB_FOR_ALL – If Subsidy for all fertilizer (1) Otherwise (0)

L- Natural Log values of data

Unit Root Test

If the p-value of the test, is less than 5%, it states that the particular variable is stationary. Therefore, in this study, the consistency of stationary variables is tested using the first difference of the series on the series lagged once. As shown in Table 4.1 stationary test indicated that all the variables get stationary after the first differences. (Appendix-A).

Table 4. 1. ADF Unit root test

Variable	Level/ First Difference	Probability		
		Intercept	Trend & Intercept	None
L(AVE_YIELD_PER_ACRE)	Level	0.8970	0.0046	0.9990
	First difference	0.0000		
SUB__FOR_UREA	Level	0.5006	0.6849	0.1792
	First difference	0.0003		
SUB_FOR_ALL	Level	0.3728	0.2753	0.3617
	First difference	0.0003		

Source: Secondary data (1990-2019)

Multicollinearity

After getting the stationary of the variables it should be found whether the absence of multicollinearity. Considering the test of multicollinearity, if the pairwise correlation (zero-order correlation) coefficient is higher than 0.8, then the problem of multicollinearity is serious. Given table 4.2, the pair-wise correlation of two explanatory variables is less than 0.8 indicating that there is no problem of multicollinearity in the study (Appendix-B).

Table 4.2 Pair-wise Correlation among variables

Correlation Probability	SUB__FOR_UREA	SUB_FOR_ALL
SUB__FOR_UREA	1.000000	
SUB_FOR_ALL	-0.699854	1.000000
	0.0000	

Source: Secondary data (1990-2019)

If the probability value (p) is less than 5% or, if t statistics is greater than 2 then, there is a significant association between the two variables. Accordingly, in the study, there is a negative significant association between subsidies providing for Urea and subsidies providing for all fertilizer.

The tolerance and Variance Inflation Factor is also used to detect multicollinearity among variables. In this study, the value of VIF of two variables is less than 10 and, the TOL value is greater than 0.2 (Table 4.3). Therefore, the study is free from multicollinearity issues proving the basic assumption of the OLS. (Appendix C)

Table 4. 3 VIF and TOL values of variables

Variable	VIF	TOL (1/VIF)
SUB__FOR_UREA	1.966667	0.5084
SUB_FOR_ALL	1.966667	0.5084

Source: Secondary data (1990-2019)

Residual Analysis

Zero mean value of Disturbance Ui

E (ui|xi) = 0

By calculating positive and negative ui values, it is canceled out the summation of positive values into negative values. It can be proven as follows. (Appendix D)

Table 4. 4: Zero mean value of Disturbance Ui

Sum of Positive Residuals	+ 1.60825
Sum of Negative Residuals	-1.60825
Change	0

Source: Secondary data (1990-2019)

Normal distribution of error term

If the residual is normally distributed then the histogram should be bell shaped. According to JB test, if the value of JB statistic is close to zero and the probability value is greater than 5% then, it can be stated that residuals are normally distributed. In the study, the probability value is 0.839926 which is higher than 5%. JB statistic is 0.3488 means that the value close to zero. Hence, it can be concluded that the residuals are normally distributed. The residual distribution in Figure 1.1 also approximates a normal curve by completing the Ordinary Least Square assumption. Therefore, the model represents the best linear unbiased estimators (B.L.U.E).

Homoscedasticity

In this study, the Breusch-Pagan-Godfrey Heteroskedasticity test was used to identify heteroscedasticity. The result indicated that the probability value of chi-square is 0.2021 means that, it is not significant because the p-value is higher than 5%. Hence, it implies that, the absence of heteroskedasticity in the model. (Appendix E)

Model Specification

In order to identify the impact of Fertilizer Subsidy on Average Paddy Yield, the Ordinary Least Squares (OLS) technique was adopted using the following equations. (Appendix-F)

Equation,

AVE_YIELD = 3430.4+394.82*SUB_UREA + 815.66*SUB_ALL

According to the above equation,

β0= 3430.4 means, that when no subsidy is given either for Urea or all fertilizers, the average yield is 3430.4kg. Simply, in the period of subsidy removal (1990-1994) the average paddy yield is 3430.4kg per hectare.

β1=394.82 means, that considering subsidy is given only for urea rather than removal of subsidy, it increases the average yield by 394.82 units, holding subsidy providing for all fertilizers constant. Hence, there is a positive relationship between the two variables. As estimates reveal, there is a statistically significant difference in average paddy yield with the provision of fertilizer subsidy for Urea. According to the estimates, by providing Urea as a subsidy, the average yield is increased up to 3825.22kg per hectare. It is the summation of average paddy yield with no subsidy and the increase of paddy yield when the subsidy is given only for Urea (3430.4 kg+394.82 kg). So, the results indicate that the expenditure on providing Urea by 1kg will cause to increase the paddy yield by 394.82 kg per hectare. It reveals the importance of providing fertilizer subsidies for paddy cultivation.

β2=815.66 means, considering subsidy given for all fertilizers rather than removal of subsidy, it increases the average paddy yield by 815.66 units keeping subsidy provided only for Urea constant. Hence, there is a positive relationship between the two variables. As estimates reveal, there is a statistically significant difference in average paddy yield with providing all fertilizers for paddy cultivation. According to the estimates, by providing all fertilizers as a subsidy, the average yield is increased up to 4246.06kg per hectare. It is the summation of average paddy yield with no subsidy and the increase of paddy yield when the subsidy is given for all fertilizers. (3430.4 kg+815.66 kg). So, the results indicate that the expenditure on providing all fertilizers by 1kg, will cause to increase in the paddy yield by 815.66 kg per hectare. It reveals the importance of providing fertilizer subsidies for paddy cultivation.

This result indicates that providing all fertilizers as a subsidy, has a higher influence on average paddy yield rather than providing it only for Urea. It is higher by about 420.84 kg per hectare (815.66 kg-394.82 kg) which means providing fertilizer subsidy for all fertilizers will cause to increase in the average paddy yield of more than twice the amount than subsidy is given only for Urea. Therefore, it causes to gain more favors by providing all fertilizers than spending only on providing Urea. Therefore, necessary action should be taken to moderate the fertilizer subsidy in order to have a better yield for the expenditure.

Furthermore, the probability values the of coefficient of variables are less than 0.05. This indicates a significant association between explanatory variables and dependent variables. The probability value of a variable of providing Urea as a subsidy is 0.0126 and the probability value of providing all fertilizers as a subsidy is 0.0000. According to these estimates providing all fertilizers as a subsidy is more significant than providing it only for Urea.

The R squared value, 0.60145 shows that 60% of total variations in average paddy yield are explained by the explanatory variables. Providing subsidy for all fertilizers will largely affect on average paddy yield indicating the most important explanatory variable in the regression model. The calculated F value is 20.3698 and the table value of F is 3.37 (2'26). According to that, it can be concluded that the overall model is jointly or simultaneously significant. Here, the calculated F value is higher than the F table value. This evidence proves that fertilizer subsidy contributes to produce relatively a higher average yield in paddy cultivation. In terms of economic viewpoint, this finding justifies the fertilizer subsidy for paddy cultivation in Sri Lanka. Then, the hypothesis formulated in the study as fertilizer subsidy has a positive relationship with average paddy yield can be accepted by reviewing the results of the study.

A similar result can be found in research by Wanninayake and Semasinghe (2012). According to their model, they also found a positive relationship between average paddy yield and fertilizer subsidy. As stated in that study, the Average yield in the years of fertilizer subsidy does not exist, was 3430.6 per hectare. If subsidy was only provided for Urea, the average yield is increased by 421.15 kg per hectare. As well as with the subsidy provided for Urea, average yield is increased up to 3851.75 kg per hectare (= 3430.6+421.15). It is 4074.90 (= 3430.6+644.3) per/ha in the period in which subsidy was given for all three types of fertilizers. The results indicated a positive relationship between these variables as well as, the significance of providing fertilizer subsidy for all fertilizers rather than spending only on Urea. Providing subsidies for all fertilizers will cause to increase in the paddy yield than it provides only for Urea. Reviewing the current study and past studies, it states the importance of the existence of a well-organized fertilizer subsidy scheme for paddy cultivation in the Sri Lankan context. Therefore, it is a requirement to decrease the unnecessary expenditure on inefficient fertilizer subsidy schemes in time to time with the changes of political views appointed in Sri Lanka.

CONCLUSION AND RECOMMENDATION

With the analysis of the results, it can be concluded that the fertilizer subsidy plays a major role in the Sri Lankan economy regarding determining the average level of paddy yield. Especially, rice is the staple food in Sri Lanka, and the involvement the paddy cultivation is highly affected by the fertilizer subsidy. Providing subsidies is a major requirement for the paddy sector in order to increase the production of paddy. Not only that, it can be concluded that, due to the fertilizer subsidy, the average paddy yield has been largely influenced by the fertilizer subsidy.

As a developing nation, the agriculture sector could be seen as an important aspect that yields a higher contribution to the GPP. In the world, most countries have achieved their structural change from the agriculture sector to the industrial sector, only after achieving the success of the agriculture sector. Therefore, in the Sri Lankan context, it should be encouraged the paddy sector by providing various types of fertilizer subsidy schemes for the sake of agricultural sustainability. Rapid economic development of the county could be achieved with the improvement of the agriculture sector, thereby achieving the higher living standard of the country. Moderation of fertilizer subsidy is essential for the macro aspect in order to overcome the issues regarding the higher burden on import and government expenditure.

In order to increase the paddy yield in Sri Lanka, some of the policy implications which could be adopted in the paddy sector are, moderation of the fertilizer subsidy scheme to adjust the higher burden on government expenditure, policy implementation towards the organic fertilizer subsidy scheme rather than chemical fertilizer subsidy, restriction on import of fertilizer and funding for the local farmers to produce organic fertilizer, reviewing progress committee for the paddy sector at micro level paddy farming activities.

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APPENDICES

Macroeconomic Impact

VAR Lag Order Selection Criteria
Endogenous variables: AVE_YIELD SUB_ALL SUB_UREA
Exogenous variables: C
Date: 10/30/20 Time: 14:10
Sample: 1990 2019
Included observations: 28

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-219.8940	NA	1648.235	15.92100	16.06374	15.96464
1	-170.9904	83.83484	95.87177	13.07074	13.64168*	13.24528
2	-157.7504	19.85990*	72.72846*	12.76789*	13.76704	13.07334*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix A

Unit Root Test

AVE.YIELD

Null Hypothesis: D(AVE_YIELD) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.263272	0.0000
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AVE_YIELD,2)
Method: Least Squares
Date: 09/29/20 Time: 19:11
Sample (adjusted): 1993 2019
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AVE_YIELD(-1))	-2.415627	0.332581	-7.263272	0.0000
D(AVE_YIELD(-1),2)	0.584079	0.189239	3.086455	0.0050
C	101.0931	31.90119	3.168946	0.0041

R-squared	0.808314	Mean dependent var	11.92593
Adjusted R-squared	0.792340	S.D. dependent var	338.6004
S.E. of regression	154.2993	Akaike info criterion	13.02010
Sum squared resid	571398.7	Schwarz criterion	13.16409
Log likelihood	-172.7714	Hannan-Quinn criter.	13.06292
F-statistic	50.60230	Durbin-Watson stat	1.668390
Prob(F-statistic)	0.000000		

SUB.UREA

Null Hypothesis: D(SUB_ALL) has a unit root

Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.160828	0.0003
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SUB_ALL,2)
Method: Least Squares
Date: 09/29/20 Time: 19:22
Sample (adjusted): 1992 2019
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SUB_ALL(-1))	-1.012048	0.196102	-5.160828	0.0000
C	0.036145	0.064189	0.563093	0.5782

R-squared	0.506024	Mean dependent var	0.000000
Adjusted R-squared	0.487025	S.D. dependent var	0.471405
S.E. of regression	0.337631	Akaike info criterion	0.735021
Sum squared resid	2.963855	Schwarz criterion	0.830178
Log likelihood	-8.290289	Hannan-Quinn criter.	0.764111
F-statistic	26.63415	Durbin-Watson stat	2.008424
Prob(F-statistic)	0.000022		

SUB.ALL

Null Hypothesis: D(SUB_UREA) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.099020	0.0003
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SUB_UREA,2)
Method: Least Squares
Date: 09/29/20 Time: 19:23
Sample (adjusted): 1992 2019
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SUB_UREA(-1))	-1.000000	0.196116	-5.099020	0.0000
C	0.000000	0.052414	0.000000	1.0000

R-squared	0.500000	Mean dependent var	0.000000
Adjusted R-squared	0.480769	S.D. dependent var	0.384900
S.E. of regression	0.277350	Akaike info criterion	0.341677
Sum squared resid	2.000000	Schwarz criterion	0.436834
Log likelihood	-2.783476	Hannan-Quinn criter.	0.370767
F-statistic	26.00000	Durbin-Watson stat	2.000000

Prob(F-statistic)	0.000026

Appendix B

Test for Multicollinearity

Pair wise Correlation

Covariance Analysis: Ordinary
Date: 10/30/20 Time: 18:37
Sample: 1990 2019
Included observations: 30

Correlation t-Statistic Probability	SUB_ALL	SUB_UREA
SUB_ALL	1.000000 ----- -----	
SUB_UREA	-0.699854 -5.184593 0.0000	1.000000 ----- -----

Appendix C

VIF Results

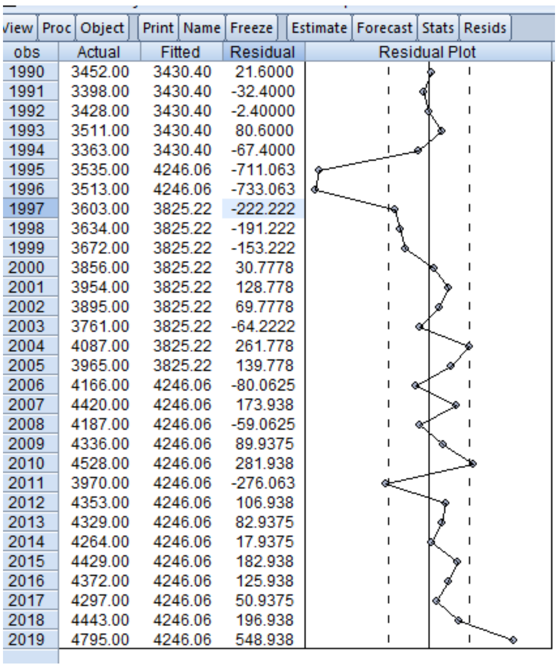
Variance Inflation Factors
Date: 10/30/20 Time: 18:33
Sample: 1990 2019
Included observations: 30

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
SUB_ALL	18415.66	4.200000	1.960000
SUB_UREA	21825.96	2.800000	1.960000
C	14030.98	6.000000	NA

Appendix D

Normality Tests

Zero mean value of disturbance Ui



obs	Actual	Fitted	Residual
1990	3452.00	3430.40	21.6000
1991	3398.00	3430.40	-32.4000
1992	3428.00	3430.40	-2.40000
1993	3511.00	3430.40	80.6000
1994	3363.00	3430.40	-67.4000
1995	3535.00	4246.06	-711.063
1996	3513.00	4246.06	-733.063
1997	3603.00	3825.22	-222.222
1998	3634.00	3825.22	-191.222
1999	3672.00	3825.22	-153.222
2000	3856.00	3825.22	30.7778
2001	3954.00	3825.22	128.778
2002	3895.00	3825.22	69.7778
2003	3761.00	3825.22	-64.2222
2004	4087.00	3825.22	261.778
2005	3965.00	3825.22	139.778
2006	4166.00	4246.06	-80.0625
2007	4420.00	4246.06	173.938
2008	4187.00	4246.06	-59.0625
2009	4336.00	4246.06	89.9375
2010	4528.00	4246.06	281.938
2011	3970.00	4246.06	-276.063
2012	4353.00	4246.06	106.938
2013	4329.00	4246.06	82.9375
2014	4264.00	4246.06	17.9375
2015	4429.00	4246.06	182.938
2016	4372.00	4246.06	125.938
2017	4297.00	4246.06	50.9375
2018	4443.00	4246.06	196.938
2019	4795.00	4246.06	548.938

Appendix E

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.610832	Prob. F(2,27)	0.2183
Obs*R-squared	3.198035	Prob. Chi-Square(2)	0.2021
Scaled explained SS	5.865683	Prob. Chi-Square(2)	0.0532

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 10/30/20 Time: 18:44
Sample: 1990 2019
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2512.240	59869.69	0.041962	0.9668
SUB_ALL	101088.1	68589.35	1.473816	0.1521
SUB_UREA	22378.38	74670.63	0.299695	0.7667

R-squared	0.106601	Mean dependent var	63139.39
Adjusted R-squared	0.040423	S.D. dependent var	136663.4
S.E. of regression	133872.7	Akaike info criterion	26.54181
Sum squared resid	4.84E+11	Schwarz criterion	26.68193
Log likelihood	-395.1271	Hannan-Quinn criter.	26.58663
F-statistic	1.610832	Durbin-Watson stat	0.882976
Prob(F-statistic)	0.218330		

Appendix F

Dependent Variable: AVE_YIELD
Method: Least Squares
Date: 10/30/20 Time: 18:50
Sample: 1990 2019
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SUB_ALL	815.6625	135.7043	6.010587	0.0000
SUB_UREA	394.8222	147.7361	2.672483	0.0126
C	3430.400	118.4524	28.96015	0.0000

R-squared	0.601415	Mean dependent var	3983.867
Adjusted R-squared	0.571890	S.D. dependent var	404.8102
S.E. of regression	264.8677	Akaike info criterion	14.09098
Sum squared resid	1894182.	Schwarz criterion	14.23110
Log likelihood	-208.3647	Hannan-Quinn criter.	14.13580
F-statistic	20.36983	Durbin-Watson stat	0.932955
Prob(F-statistic)	0.000004		