An Economic Evaluation of Fertilizer Subsidy on Paddy Production in Sri Lanka

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Abstract

Fertilizer subsidy is one of the largest subsidy programs implemented in Sri Lanka. In 2018, approximately Rs.40 billion was allocated from the national budget for providing fertilizer subsidies for cultivating paddy in the country. The primary objective of this paper is to estimate the costs and benefits of fertilizer subsidy scheme which is implemented over the last 14 years in Sri Lanka. The secondary data covering the period between 2005 and 2018 on value of total fertilizer subsidy, total paddy production and the extent of land used for cultivating paddy was used for the analysis. The result of the study shows a significant variation in the total paddy production and the costs of total fertilizer subsidies which vary from 9 % to 36 % of the value of total rice production (benefits) during the study period. Furthermore, econometric model estimation confirms that total fertilizer subsidies, cultivated land area and regional variation have significant impacts on total paddy production in the country. The results of the study will help the government to understand the effectiveness of the existing subsidy program and design a more appropriate target system in the future.

Keywords: Fertilizer subsidy, Paddy Production, Relative Advantage, Sri Lanka

Introduction

The cultivation of paddy plays an important role in the domestic agricultural sector of Sri Lanka. During the period 2000-2019, annual average contribution of the paddy cultivation to the agricultural GDP of the country was 20 per cent (Central Bank of Sri Lanka, 2019). Out of the total employment, the contribution of the agriculture sector was 28 per cent in the year 2018 while the contribution of the agriculture sector for the national income accounted for 8 per cent (Central Bank of Sri Lanka, 2019). Besides, approximately 13 per cent out of the total extent of agricultural lands has been reserved for the paddy cultivation. The rate of self-sufficiency was recorded as 130 % by 2015. Rice consumption provides about 40 per cent of per capita calories and 30 per cent of per capita protein to an average Sri Lankan's diet, and accounts for nearly 15 per cent of average per capita consumption expenditure. Therefore, it is believed that cultivation of rice is the principal contributor to the rural economy in the country as the majority of rural households engage not only in the production, but also selling rice as their main or additional source of livelihood (DCS, 2019).

The paddy cultivation in Sri Lanka had been facing unprecedented challenges such as stagnation of yield, diminishing income due to escalation of costs of production, and abandonment of rice lands since the early 1980s, (Thiruchelwam, 2005; Athukorala et al. 2012). These issues were mainly due to low productivity. Successive governments at the end of the 1960s and the beginning of the 1970s identified the need to increase productivity in the paddy farming sector. Meanwhile, the Sri Lankan government identified large-scale subsidy projects as an appropriate tool to increase productivity in the rice-farming sector in the long-term. As a result, there has been a steady increase in rice production in Sri Lanka from 1975 to 2019, leading to self-sufficiency in feeding the population of 20 million (approximately) in the country. Apart from the objective of ensuring food security, the agriculture policy of the government places high priority on transforming traditional subsistence agriculture to one which maximizes productivity (SLCARP, 2018). Increasing in productivity may bring benefits to farmers in improving their livelihood (Mergos and Stoforos, 1997; Morris et al. 2007; Esther et al. 2011). In any country, an incentive such as agriculture subsidies should have the capacity to maintain and improve the standards of living of farmers enhancing the agricultural production (Ahmed, 1987; Arriyagada et al. 2010). The efficiency and innovation in this sector will contribute to adequate and reliable sources of food in the country while protecting food safety, quality and the environment. In the developing world, agricultural subsidies target poverty alleviation, rural development and increasing of income of poor farmers. Therefore, it is obvious that agricultural subsidies are playing a major role in any economy in the world (Ghosh, 2004).

The evidence from the past studies clearly shows a gradual decline of the number of paddy cultivating families in the country and its impact on the rural economy. This is because of the high cost of inputs and low level of the returns, resulting the falling of income generation ability of the farming community. This has resulted farmers to move out of paddy cultivation looking for alternative sources of income. Therefore, government intervention in developing infrastructure facilities including irrigation systems and formulating policies at national level are rationalised by policy makers. The government is expected to minimize the cultivation cost by introducing a subsidy scheme for the fertilizer which is being used as a main application in the field of paddy cultivation (Weerahewa, 2004). The increase of paddy harvest, expansion of the lands under the paddy cultivation, minimization of rice importation and improvement of the living standards of the farming community is expected from the fertilizer subsidy programme implemented by the government in the country. At present, paddy cultivation in Sri Lanka is largely dependent on subsidies which are not highlighted in policy discussions. Supply of free water, extension of services free of charge, concessionary loans are among benefits given by the government to rice farmers in the country. The fertilizer subsidy is the most controversial input subsidy program provided for paddy farming sector. It was initiated in 1962 with the introduction of High Yielding Varieties (HYVs) as an effect of the Green Revolution. At present, fertilizer subsidies on paddy farmers accounts approximately 50% of the overall use of chemical fertilizer in the country and it is approximately Rs. 40 billion in value (Central Bank of Sri Lanka 2019).

The Government of Sri Lanka has been subsidizing fertilizer for more than seven decades. In 1962, the government introduced a price subsidy for fertilizer. The main objective of this subsidy scheme was to make fertilizer available at an affordable price in order to encourage its use (Weerahewa et al 2010). Initially, the Government of Sri Lanka paid subsidies directly to fertilizer importers and informed them to distribute required fertilizer among the farmers. However, this practice has been changed with time under different policies implemented by different regimes. For example, when a new government came into power in 2015, they changed the fertilizer subsidy policy from material subsidies into direct cash transfer. Although there are several studies such as Ekanayake (2005); Rajapakshe and Karunagoda (2009); Rashmika and Edirisinghe (2016) in Sri Lanka which examined the factors that determine the demand for fertilizer in paddy cultivation, these studies have failed to consider recent data that capture the real benefits of spending money for fertilizer subsidy in the country. Given this background, this study estimates the costs of fertilizers subsidies and evaluates it as a ratio of the gains in spending money on fertilizer in Sri Lanka over the last 14 year period in the country. Accordingly, the main objective of the study is to estimate the benefits in terms of increasing yields of paddy due to the fertilizer subsidy scheme in Sri Lanka. It will also identify the cost and benefit of giving fertilizer subsidy for paddy farmers in the country. Further, the relationship between fertilizer subsidies and paddy yield will be estimated using an econometric model.

Literature review

The fertilizer subsidy for rice sector in Sri Lanka has been the subject of a number of economic studies and analyses (Kikuchi & Aluwihare, 1990; Rajapakshe and Karunagoda, 2009; Weerahewa et al. 2010). However, the findings of these studies have not been consistent. While some studies (Ekanayake, 2005) find that the fertilizer subsidies have an important determinant in stimulating rice production in Sri Lanka, some other studies provide contradictory results. Meanwhile, several studies (Salunkhe and Deshmush, 2012) done in developing countries show the benefits of deregulation of fertilizer supply interns of ensuring better quality and availability of the input through enforcing market competition. When the production and distribution of fertilizer is highly regulated, it may contribute to the limited capacity utilization while limiting competition among fertilizer producers and distributors (Ahmed, 1987; Arriyagada et al. 2010). Eventually, this will contribute to fertilizer shortages if no proper monitoring mechanism is implemented (Yamaguchi and Sanker, 2007).

Griliches (1958) has estimated the aggregate demand function for the usage of fertilizer on all crops in United States. The model explained, the large portion of the variation in the regional fertilizer use. Russel and Williams (1977) examine changes of fertilizer consumption in two villages of Bangladesh during the period from 1977 to 1978 using primary data. Findings of this study show that fertilizer consumption for an acre of crops has increased together over the period even though the fertilizer price ratio had increased. Burrell (1982) estimates the demand for fertilizer in the United Kingdom. The researcher used three different modelling approaches with two different data sets (nitrogen and all fertilizers). The estimated elasticity in this analysis with respect to crop price is between -0.4 to -0.5 for nitrogen and between -0.1 to -0.3 for fertilizer. The demand for nitrogen fertilizer is more sensitive to its own price than Phosphate and Potash fertilizer. Bogahawatte (1982) studies, the factor determining the aggregate production and consumption decisions of rice during the period from 1955 to 1979 and Thusiman et al. (1987) assessed the fertilizer subsidy scheme that was in operation in the early 1980s.

Sing and Sidhu (1985) analysed the price supports vs. fertilizer subsidy in Ghana. The study provided a decision criterion for the policy makers to choose between the price supporter and fertilizer subsidy under different situations depending on objectives of the policies. Yohanes et al. (1990) attempt to study the use of fertilizers by farmers in Ethiopia. Accordingly, a high level of subsidy may carry the potential of serious distortions relative to smaller levels of subsidy for at least some farmers. Narayan & Gupta (1991), Shahsibzada and Gaffar (1995) analysed the impacts of withdrawal input subsidies on crop yields. Singh (2004) examines the issues of inter crop, inter regional and inter class equity in fertilizer subsidy distribution in India. The results of the study show that paddy and wheat cultivation are the major beneficiaries of fertilizer subsidy. The study reveals a fair degree of inter class equity in distribution of fertilizer subsidy both at country level and state level. Ekanayaka (2005) assessed the impact of fertilizer prices on fertilizer demand for the period from 1962 to 2005. The result showed an inelastic fertilizer demand response to fertilizer price.

Several studies (Rajapaksa & Karunagoda, 2009; Rajapakshe and Karunagoda, 2009; Herath et al. 2013) that attempted to examine the factors determining the demand for fertilizer in paddy cultivation in Sri Lanka. Ekanayake (2005) investigated the impact of fertilizer prices on fertilizer demand for the period from 1962 to 2005 and the results showed an inelastic fertilizer demand response to fertilizer price. Similar results are shown by Thusiman et al. (1987) and Weerahewa (2004). According to Rajapaksa and Karunagoda (2009) the price control can be more effective than fertilizer subsidization in promoting fertilizer use and rice productivity, even when the responses were inelastic to rice price. However, according to Wickramasinghe et al. (2009) the current fertilizer subsidy program has been effective and efficient in terms of achieving national objectives in economy, food security, and rural welfare policies. Wijetunga et al. (2008), Rajapaksa and Karunagoda (2009) and Wickramasinghe et al. (2009) have recommended a gradual scaling down of the subsidy for rice farmers in the country. According to their findings, the rice supply and fertilizer demand in non-commercial farming areas were more responsive to fertilizer price than in the commercial farming areas.

Several recent studies (Gulati and Bajaree, 2015; Salunkhe and Deshmush, 2012) in this area have shown that, input subsidies such as fertilizer help to maintain the productivity of the paddy farm. Preveen et al. (2017) examines the benefits of fertilizer subsidies from farmer's point of view and observe that the benefit of subsidies reaches to all farmers in India. Accordingly, small and marginal farmers receive about 53 percent of the total subsidies allocated to all crops. Abeygunwardhana, (2014) studied reasons for continuing fertilizer subsidies in Sri Lanka. The key findings of this study suggest that the persistence of the rice fertilizer subsidy in Sri Lanka is best explained by a model of shared food preference. Gulati and Bajaree (2015) raised three key issues such as fiscal sustainability, price distortion and distributional impacts with regard to fertilizer subsidy in India. Furthermore, Usman (2016); Salunkhe and Deshmush (2018) have shown the importance of providing fertilizer subsidies to increase the yields of agricultural crops in different countries. Meanwhile, studies done by Yamaguchi & Sanker (2007), Weerahewa et al. (2010) and Semasinghe (2012) discuss the costs and benefits of fertilizer subsidies in Sri Lanka.

Accordingly, the evidence given by the above-mentioned studies show that the impacts of fertilizer subsidies on rice output can vary from country to country. In Sri Lanka, many farming communities experience the adverse climatic changes such as drought, rainfall, flood and threats from wild animals. The fluctuation of the price levels for commodities is a common and crucial issue yet to be addressed by the policy makers. Sri Lankan farmers are struggling in getting advantages from the subsidy scheme due to various reasons such as unavailability of collateral due to contract farming, unpredictability of the volume of the harvest and lack of financial discipline. Therefore, it is paramount to identify the real benefits of spending money on fertilizer subsidies in any country. This study will partly fill this void of the literature.

Methodology and Data

The Linear, Cobb-Douglas (CD) or Constant Elasticity of Substitution (CES) production functions are the best-known functional forms economics that are used to express the technological correlation between inputs and outputs. The inputs here are often capital, labour, raw materials or any other factors which is believed to be correlated with the output (Mergos and Stoforos, 1997). However, CD or CES production functions are employed under the strong presumption of an elasticity of substitution with respect to relevant factors of production (Esther et al. 2011). Therefore, this study employed simple linear functional forms to identify the relationship between the rice output and relevant aggregate level variables. Theoretically, paddy output can be a function of the land, capital, labour, fertilizer and any other relevant variable (Chembezi, 1990). In this study, we used land, fertilizer[1] and several dummy variables in the production function. The variables; capital and labour are not used as there is no district-wise data related to those two variables. The general form of the model can be written as Equation 1.

$$Y = f(L, F, Z) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where Y is the total output of paddy, L is the cultivated land area, F is the expenditure on fertilizer subsidies and Z represents the dummy variables which captures the different climatic zones and seasonal variation in Sri Lanka. The study uses panel data analysis techniques as it has the advantage of containing the information necessary to deal with both the inter temporal dynamics and the individuality of the entities being investigated (Renfro, 1992). There are basically three types of panel data models namely, a pooled ordinary least square (OLS) regression, panel model with random effects and panel model with fixed effects (Greene, 2000). The general specification of the pooled OLS model is given by Equation 2:

$$Y_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 L_{it} + \beta_3 D_1 + \beta_4 D_2 + \beta_5 D_3 + \mu_{it} \ldots\ldots\ldots\ldots (2)$$

i = 1, 2, ….,25 (districts)

t = 2005, ...2019 (season)

L = cultivated land area

F = Expenditure on fertilizer subsidies

D1 = dummy variable (1 if Yala season, 0 otherwise)

[1] We used fertilizer expenditure as a proxy variable to represent the fertilizer quantity in the model.

D2 = dummy variable (1 if Dry zone, 0 otherwise)

D3 = dummy variable (1 if Intermediary zone, 0 otherwise)

where i and t denote district and years, such that Y is the dependent variable which is the average production by each district in year t, β_0 is the constant Y intercept across all district. In Equation 2 μ_{it} are the residuals and are approximately normally distributed with a mean of zero [$\mu_{it} .. N(0, \sigma^2)$]. In this case the error term can vary over both districts and time. When using a pooled OLS regression, districts' unobservable individual effects are not controlled and the heterogeneity of the districts under consideration for the analysis can influence measurements of the estimated parameters (Greene, 2008). Further, using a panel data model incorporating individual effects allows us to account for individual heterogeneity. If this heterogeneity is not considered, it will be inevitably bias in the results (Baltagi, 2008). Therefore, by incorporating districts' unobservable individual effects in Equation (2) the model to be estimated is as follows:

$$Y_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 L_{it} + \beta_3 D_1 + \beta_4 D_2 + \beta_5 D_3 + w_{it} \text{............}(3)$$

where, $w_{it} = e_i + \mu_{it}$ with e_i being households' unobservable individual effects. The difference between a polled OLS regression and a model considering unobservable districts effects lies precisely in e_i . When we consider the random effect model, Equation 3 will be the same although e_i is presumed to be having the property of a zero-mean independent of the district observation error term μ_{it} which has constant variances and is independent on the explanatory variables. In this study, we first ran the pooled OLS fixed effects and then the random effects model incorporating all variables. Based on the various tests including the Hausman test, the latter model was selected and estimated after controlling various variables.

This study is used in secondary data on paddy production and fertilizer subsidy in Sri Lanka. Annual data between 2005 and 2018 covering 25 districts in the country is used in the analysis. Data is gathered from the

Department of Census and Statistics of Sri Lanka, Central Bank Reports and the Ministry of Finance and Planning. The main variables used in this analysis are total paddy production (MT), fertilizer subsidy expenditure (Rs / billion), value of total paddy production (Rs / billion) and cultivated land area (hectares). In order to investigate a relative advantage of the fertilizer subsidy scheme among the different districts in Sri Lanka as well as to identify the cost and benefits of fertilizer subsidy for paddy production, the value of the total fertilizer costs are expressed in terms of the total value of the paddy productions in different years.

Results and Discussion

The rice sector in Sri Lanka had been facing many challenges over the last few decades, such as stagnation of yield, diminishing income, increasing costs of production and abandonment of rice lands (Athukorala et al. 2012). These issues were mainly due to low productivity. The successive governments at the end of the 1980s have identified the need to increase productivity in the rice farming sector (Abeygunwardhana, 2014). This has resulted in increasing the total area under paddy cultivation significantly. Overall, productivity has also increased from 3.56 MT per hectare in 2000 to 4.25 MT per hectare in 2018. At present, approximately more than two thirds of the total rice cultivation area is assured irrigation. Rice is cultivated during two seasons, *Maha* and *Yala*. *Maha* (October to March) usually accounts for about 65 per cent of the annual production and the rest, 35 per cent being produced from the *Yala* crop (April to September). This study uses annual district- wise data between 2005 and 2018. Table 1 gives statistical details on the variables used in the analysis.

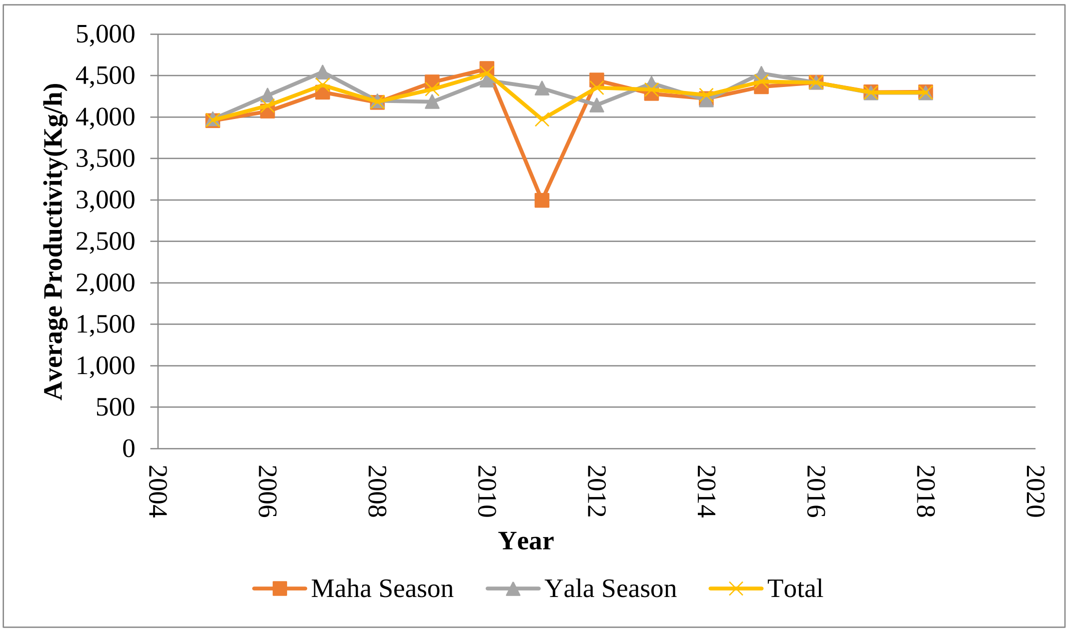
Table 1: Average figures with different seasons and climatic zones

Variable	*Yala* Season	*Maha* Season	Dry Zone	Wet Zone	Intermediate Zone
Paddy Yield (Kg/per hectare)	3,983	3,871	4,173	3418	4,402
Cultivated Land Area (Hectares)	26,271	14,875	27,566	8337	29,043
Fertilizer Expenditure (Rs/ Million)	934	512	982	284	1,007

Note: All the information related to paddy yield and cultivated land area are taken from the website of Department of Census and Statistics in Sri Lanka (Paddy Statistics 2019).

The paddy cultivation in the country is highly dependent on the climatic factors. The climatic factors determine vulnerability of paddy production as well as its productivity. We estimated the average yield of paddy per hectare which is an indicator of the productivity and found that there is not much difference between the two main seasons namely *Yala and Maha*. Although we are expecting the lowest average paddy yield in wet zone, the results show that the average yield of paddy in wet zone has reached the same level as others. According to the average cultivated land area, extent of the agricultural lands is slightly larger in intermediate and dry zones than the other regions, but the data show that extent of the lands has no effect on the paddy productivity. On average, a minimum cultivated area is reported from wet zone, but the paddy harvest is considerable when compared to other zones. The minimum average fertilizer expenditure is from wet zone while the values of other regions remain high. We investigated the average productivity of the two seasons as well as country during the study period. Figure 1 reports the average productivity changes from 2005 to 2018 both in *Yala* and *Maha* season.

Figure 1: Average productivity changes during the study period (Kg/ per hectare)



The measurement of productivity and identifying the trend helps in knowing the regions or time period that performs with a lower or higher efficiency in comparison with the other areas or time period (Usman, 2016). From time to time, considerable efforts have been made by governments to increase the productivity level of paddy in the country in addition to providing fertilizer subsidies to farmers. However, in Sri Lanka, the relatively higher growth rate of the agricultural sector in the past has been achieved mainly through the introduction of Green Revolution (GR) varieties and the expansion of cultivated areas (Athukorala et al. 2012). This was due to large-scale government expenditure on irrigation development and resettlement programs in the dry zone within the country. This pattern of growth can no longer continue since Sri Lanka had run out of its new agricultural land around a decade ago (De Silva, 1999). Therefore, it is necessary to increase average productivity of the cultivated land. The average productivity of paddy (per hectare) during 2005 to 2010 in *Maha* Season has taken a relatively higher value. However, in 2011 there is a huge drop in paddy productivity, which is less than half of the value compared to others. And then again, it is getting back to normal from 2012 to 2018. The changes of the average productivity of the two main cultivation zones in the country are given in Figure 2.

Figure 2: Average productivity changes between dry zone and wet zone (Kg/ per hectare)

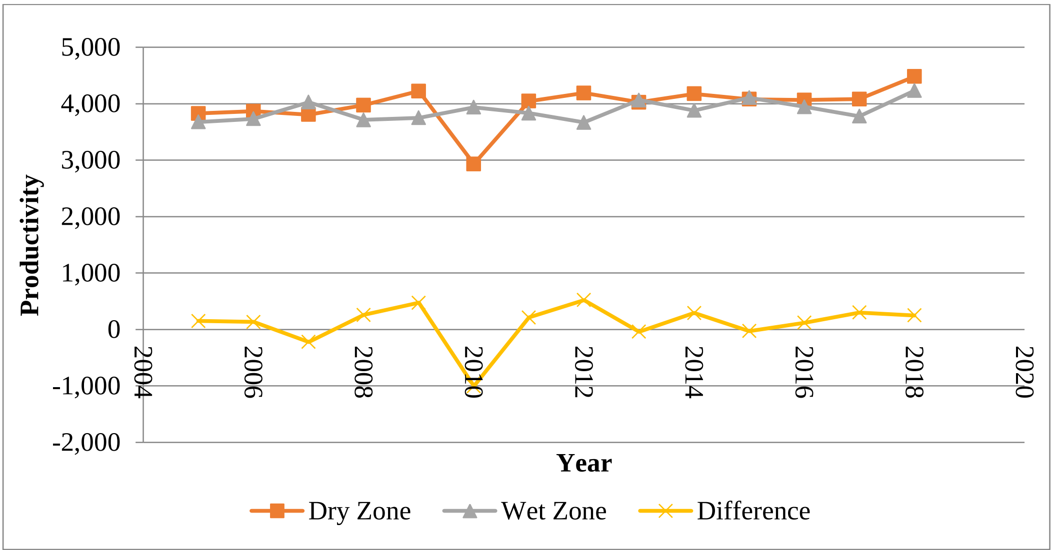


Figure 2 shows, the average productivity changes between wet zone and dry zone. This productivity difference was estimated by subtracting the productivity of wet zone from dry zone. It is evident that there are positive and negative differences in this period. According to the graph in 2007, 2010, 2013 and 2015 there is a negative difference which implies the average productivity which is higher in wet zone than in the dry zone. As usual, in other years the productivity of dry zone had been high, but not in a significant difference. We estimated the correlation between productivity difference and the changes of the fertilizer expenditure during this period and found that the correlation coefficient is 0.28 implying a positive, a significant value. In general, application of fertilizer may differ from region to region within the country, due to cultural practices, climate, soil type, crops that were grown and the farm structure. However, most of these factors do not change with the time.

Furthermore, productivity can be mainly determined by the availability of water depending on the rainfall pattern in the country which can be changed during the study period.

The National Fertilizer Secretariat (NFS) is the authoritative body responsible for coordinating all activities relating to importation and distribution of subsidized fertilizers in the country. The NFS estimates the fertilizer requirements each year in advance and prepare a fertilizer requirement plan for the next year. However, activities such as importing, wholesale marketing and delivery of fertilizers to the village distribution centres are done by the Ceylon Fertilizer Cooperation and the Colombo Commercial Fertilizer Company (Abeygunawardane, 2014). The current fertilizer subsidy scheme for rice started in 2005 and subsidy mainly includes nitrogen, phosphorous, and potassium fertilizers[2]. Since 2005, several changes were undertaken with regard to the fertilizer subsidy policy. A significant change happened during 2016 with the introduction of cash grant (fertilizer allowance) programme as an alternative for the fertilizer subsidy. However, this has changed again in 2019 to the material grants with the political changes in the country.

Table 2: Total paddy output and expenditure on fertilizer subsidies

Year	Total Paddy Production (MT/1000)	Total Value of Paddy Production (Rs/million)	Fertilizer Subsidy Expenditure (Rs/million)	Subsidy as a % of total value of the paddy output
2005	3,369	134,760	29,000	21.52
2006	3,179	127,160	30,000	23.59
2007	3,283	131,320	30,000	22.84
2008	4,134	169,494	30,000	17.70
2009	4,336	195,120	30,000	15.38
2010	4,528	203,760	30,000	14.72

[2] Both owner and tenant farmers were eligible to receive the subsidy upon producing documentary evidence of the right to cultivate.

2011	3,970	178,650	30,000	16.79
2012	4,353	195,885	36,456	18.61
2013	4,620	207,900	19,706	9.48
2014	3,381	152,145	31,802	20.90
2015	4,819	216,855	35,000	16.14
2016	4,420	198,900	37,500	18.85
2017	2,383	107,235	38,750	36.14
2018	3,930	176,850	40,000	22.62

Note: Value of the total paddy output is estimated using average price of paddy in Sri Lanka

Table 2 shows total paddy production and fertilizer subsidy expenditure from 2005 to 2018 in Sri Lanka. It is evident that the total paddy production has been fluctuating during this period but it has shown an increase in the past 14 years. According to the Table 2, total government expenditure on subsidy as a percentage of total value of the paddy output varies between 9 % to 36 % over the study period. The total value of paddy production has fluctuated due to changes in the cultivated area, productivity as well as market prices. Over the years, subsidy scheme has been changed according to changes in government. In addition to that, the cultivated land area can have some impacts on determining the government expenditure on fertilizer subsidies on an aggregate level. Due to changes of these factors, the amount of allocation for fertilizer from the annual budget has fluctuated during the study period. We estimated the cost of fertilizer subsidies after expressing it as a percentage of total value of the paddy output during the study period. Last column in Table 2 shows these estimates. For example, in 2005 total cost of fertilizer subsidy as a percentage of total value of paddy output was 21.52. This has increased to 36 % in 2017 which is the highest percentage during the study period and the lowest percentage is reported as 9.48 % in 2013. Similar estimation was done for *Yala* and *Maha* seasons separately and average of the entire period was estimated. Those estimations are given in Table 3.

Table 3: Estimation for different seasons (subsidy as a % of total value of the paddy output)

Year	Subsidy as a % of total value of the paddy output			
	Yala	*Average*	*Maha*	*Average*
2005	22.15		21.94	
2006	21.13		21.43	
2007	22.46		25.57	
2008	17.52		17.33	
2009	19.77		18.03	
2010	16.60		23.45	
2011	14.49		14.49	
2012	24.19		22.60	
2013	10.32	22.6	12.08	24.12
2014	20.60		20.29	
2015	15.70		16.56	
2016	41.09		58.99	
2017	36.04		36.72	
2018	29.60		28.82	

Note: Average for the entire period is given in the second column in season

We also expressed the government expenditure on fertilizer subsidies as a % of total paddy output value for different seasons and estimated the average value of each season. It becomes clear that these averages are 22.6 and 24.1 for *Yala* and *Maha* seasons respectively. Next, we estimated the tolerable level of output for each year. The purpose of this calculation is to identify the effectiveness of providing fertilizer subsidy for paddy production in Sri Lanka. Accordingly, in 2005 fertilizer subsidy expenditure is similar to 22 % of the total paddy production in

Yala Season which implies that the tolerable level of paddy output in that year is 78 %. This implies that in 2018, gains of cultivating paddy is similar to 78 % if we subtract the cost of fertilizer from the total value of the output. In other words, 28 % of total paddy production has satisfied the requirement of covering total fertilizer expenditure in this year. We also estimated the cost of fertilizer subsidy to produce one kilogram of rice using aggregate data. The cost for *Yala*, *Maha* and total to the country is given in Table 4.

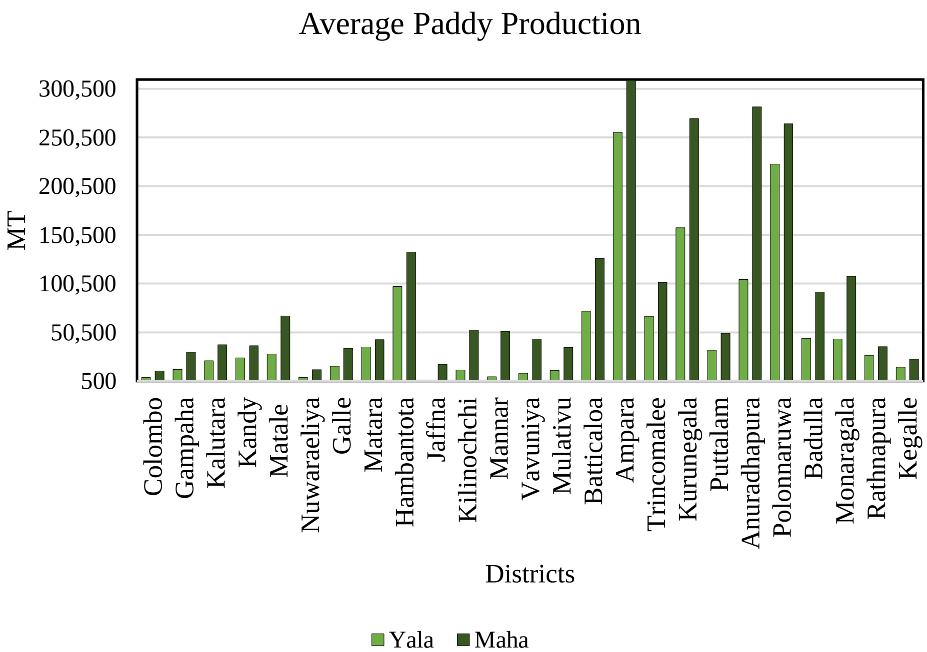
Table 4: Cost of fertilizer subsidy to produce one kilogram of rice

Year	*Yala* (Rs./Kg)	*Maha* (Rs. /Kg)	Both seasons (Rs ./Kg)
2005	8.86	8.78	8.82
2006	8.87	9.00	8.94
2007	9.44	10.30	9.87
2008	7.89	7.80	7.85
2009	8.58	7.76	8.17
2010	7.30	10.32	8.81
2011	6.52	6.52	6.52
2012	10.89	10.17	10.53
2013	4.13	4.83	4.48
2014	9.27	9.13	9.20
2015	7.07	7.46	7.26
2016	18.50	26.55	22.53
2017	16.22	16.53	16.37
2018	11.84	11.53	11.69

Note: Costs are estimated using secondary data

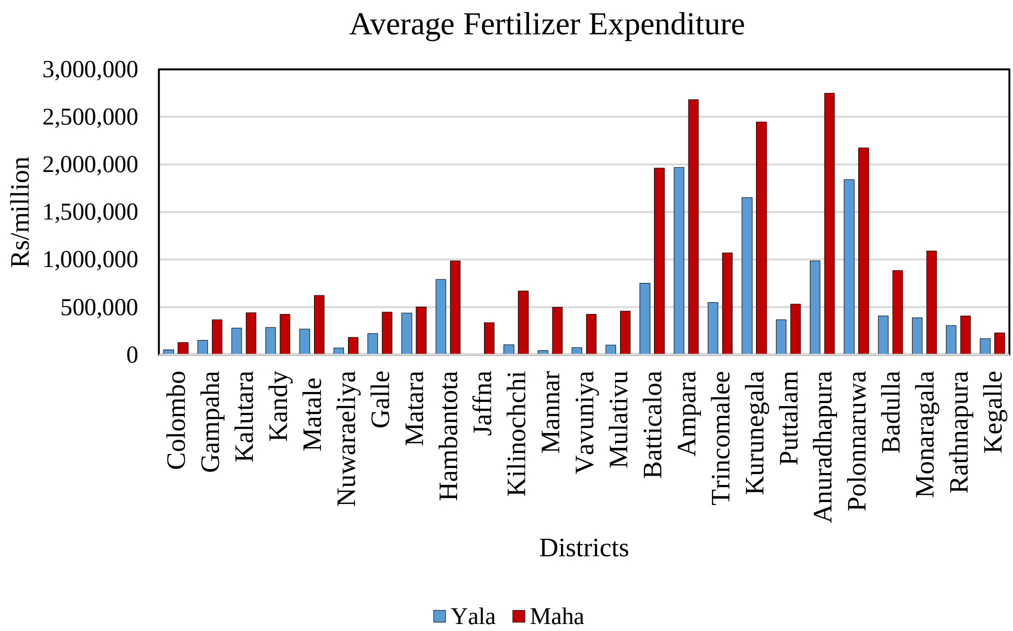
A considerable fluctuation of per unit cost of fertilizer subsidies was noted during the study period. The per unit cost has been significantly different through the years due to changes in the subsidy amount granted and total paddy yield in the country. Furthermore, spatial analysis of agricultural production or productivity can be very important as it can highlight the problems of production relations on the basis of suggestions by the policy makers. Spatial productivity is generally determined by the productivity of land and productivity of infrastructure related to agriculture. These two factors are interrelated and an attempt has been made to examine the spatial differences using the analysis of the district wise output differences in the country. Therefore, as the next step of our analysis, we obtained the details of average district paddy production and fertilizer subsidy expenditure for 25 districts in Sri Lanka. The calculated district averages for *Yala* and *Maha* seasons are given in Figure 3 and Figure 4. Comparatively, a higher average of paddy production and fertilizer expenditure can be seen in *Maha* Season than *Yala* Season. In both seasons, most of the districts in dry zone have recorded a relatively higher level of contribution to the economy through higher productivity. According to data, a lower average is reported from Mannar, Nuwaraeliya, Vavuniya, Kilinochchi, Gampaha and Kegalle in *Yala* season. According to Figure 3, there were 4 districts with very high productivity category. The major reason for the very high productivity of these areas is the higher average yield values.

Figure 3: District averages of paddy production in *Yala* and *Maha* seasons



According to Figure 4, it is evident that the average fertilizer expenditure is comparatively higher in Ampara, Anuradhapura, Polonnaruwa and Kurunegala in both seasons which also showed the highest production of paddy during the study period. However, the lowest fertilizer expenditure is reported from Mannar, Vavuniya and Nuwaraeliya which is consistent with the lowest paddy yields. Figure 4 clearly shows the spatial variation of fertilizer expenditure among different districts in the country as well as between two seasons. This is due to the variations in the cultivated land and the climate of the districts. Accordingly, relatively higher fertilizer expenditure could be observed in districts of dry zone where around 65 % of the total paddy output is produced in the country.

Figure 4: Average fertilizer expenditure for *Yala* and *Maha* seasons



As the next step of the analysis, we ran pooled OLS (application OLS to panel data without considering the panel identity), fixed effect model and random effect models without controlling the variables. In order to decide the functional form, different models with different functional forms such as linear, log linear and mixed of some log variables with normal variables were tested. It is found that the log model provides a better result in terms of model fit and number of statistically significant variables. Consequently, the log model was used to estimate the parameters of the models. According to the Hausman test, we found that a panel data model of random effects was the most appropriate way to carry out analysis of the relationship between the production and its determinants. Therefore, we used the panel data random effect model as the most appropriate model for analysing the data. Table 5 reports the results of the pool OLS model after controlling different variables.

Table 5: The result of the OLS model

Variables	M1	M2	M3
Fertilizer subsidies (F)	1.001***	0.245***	0.187***
	(0.015)	(0.024)	(0.0210
Cultivated land area (L)		0.823***	0.833***
		(0.025)	(0.021)
D1 = dummy variable			0.005
(1 if *Yala* season, 0 otherwise)			(0008)
D2 = dummy variable			0.134***
(1 if Dry zone, 0 otherwise)			(0.009)
D3 = dummy variable			0.161***
(1 if Intermediary zone, 0 otherwise)			(0.012)
Constant	-4.028***	-0.863***	-0.495
	(0.131)	(0.126)	(0.114)
Observations	672	672	672
R-squared	0.866	0.948	0.962
Adj. R-squared	0.865	0.948	0.962

Note: Standard errors in parentheses***, **, and * denote 1%, 5% and 10% levels of significance respectively.

The results of the random effect model are reported in Table 5. We also estimated the different versions of the models by controlling different variables. Accordingly, M1 includes only the fertilizer subsidy variable and M2 includes the cultivated land area related variables in addition to the fertilizer variable. Next, we include all the dummy variables given by M3. When comparing the results of different models, it is clear that most parameter estimates of all the models are statistically significant, indicating their importance in production of rice farming in Sri Lanka.

Expenditure on fertilizer subsidies variable is significant in all three models at 1 % level of significance. However, when the number of variables is increasing gradually, magnitude of the coefficient value is decreasing. As the final step of the analysis, we estimated random effect model and the results are reported in Table 6.

Table 6: The result of the Random Effect model

Variables	M4	M5	M6
Fertilizer subsidies (F)	0.888***	0.177***	0.170***
	(0.021)	(0.200)	(0.019)
Cultivated land area (L)		0.807***	0.807**
		(0.019)	(0.019)
D1 = dummy variable			-0.010
(1 if *Yala* season, 0 otherwise)			(0.018)
D2 = dummy variable			0.141***
(1 if Dry zone, 0 otherwise)			(0.018)
D3 = dummy variable			0.179***
(1 if Intermediary zone, 0 otherwise)			(0.026)
Constant	-3.060***	-0.214*	-0.238*
	(0.126)	(0.129)	(0.125)
Observations	677	677	677
R-squared within	0.393	0.823	0.823
Between	0.974	0.971	0.986
Overall	0.866	0.948	0.962

Note: Standard errors in parentheses***, **, and * denote 1%, 5 % and 10 % levels of significance respectively.

The results reported in Table 6 provide interesting information about the impacts of government subsidies on paddy production in Sri Lanka. The fertilizer subsidy variable is significant in all specifications of the models and takes the expected sign. However, as expected, that the role fertilizer subsidies are gradually decreasing when more variables are introduced into the model. The coefficient value of this variable becomes gradually lower while at the same time it becomes more significant. We also investigated the correlation between rainfall and the total paddy production in the country during the study period[3]. It was found that there is a strong positive relationship between the rainfall and *Maha* season's production, the correlation p value 0.012 is less than significant level of 0.05. It was also found, a positive relationship between rainfall and *Yala* season's production, the correlation p value 0.082 is greater than the significant level of 10 %. This shows the importance of planning the season according to the weather forecast. It will contribute significantly to increase the paddy production in both seasons in the country.

Table 7: Estimated benefits cost ratio based on MP of fertilizer expenditure

Year	Benefits (Rs. / Million)	Cost (Rs. / Million)	Benefit/ Cost (Ratio)
2005	11,858.88	29,000	0.409
2006	11,190.08	30,000	0.373
2007	11,556.16	30,000	0.385
2008	14,915.47	30,000	0.497
2009	17,170.56	30,000	0.572
2010	17,930.88	30,000	0.598
2011	15,721.2	30,000	0.524

[3] As district wise rainfall data is not available in the country, that variable was not included into the econometric model.

2012	17,237.88	36,456	0.473
2013	18,295.2	19,706	0.928
2014	13,388.76	31,802	0.421
2015	19,083.24	35,000	0.545
2016	17,503.2	37,500	0.467
2017	9,436.68	38,750	0.244
2018	15,562.8	40,000	0.389

Note: Benefits were estimated using yearly average price of paddy

As the final steps of the analysis, we estimated the total benefits (aggregate changes of the production) of providing fertilizer subsidies to farmers using the estimates derived from the Random Effects model. The coefficient of the fertilizer subsidy variable (that shows Marginal Product-MP of fertilizer expenditure) and average price of paddy (per Mt) in each year were used for this purpose. We first estimated the value of MP of fertilizer expenditure and then the value of total production of the paddy which was generated due to the fertilizer subsidies in the country is estimated. This value of total production of paddy which generated due to the fertilizer subsidies gives us the total benefits generated by the fertilizer subsidies given by the government. As we have the costs information related to the subsidies, cost can be compared with the benefits which show in Table 7. It becomes clear that benefit cost ratio is less than one implying benefits of providing fertilizer subsidies is always less than the costs when considering the marginal contribution of government expenditure on fertilizer subsidies during this period. The highest benefit cost ration reported in 2013 is (0.92) while the lowest is reported in 2017 which is similar to 0.38 as aggregate level.

Conclusion and Policy recommendations

The study evaluates the Sri Lankan paddy sector performance under the fertilizer subsidy expenditure from year 2005 to 2018. According to the analysis, it is evident that the performance of paddy sector in the past 14 years has been fluctuating over the years as well as among the districts. A similar fluctuation is found for the fertilizer subsidy expenditure as well. On average government expenditure on fertilizer subsidies as a percentage of total value of the paddy output is 22 % during the study period. It was found that these averages were slightly different between seasons and districts. According to the analysis, it is evident that the amount of fertilizer subsidy expenditure has contributed to increase the paddy output in the country by 17 % on average. Given the budgetary constraint from unrecoverable expenditure on the subsidies, that has forced the government to reduce its future allocation for agricultural development has not generated sufficient benefits to rationalise the subsidy program in the future. Therefore, while changing the focus of the fertilizer subsidies in Sri Lanka, it is required to take necessary steps in order to increase the productivity of paddy farming.

The district-wise analysis of the paddy yield helps us to understand relative competitiveness of paddy production among different districts. Accordingly, it is clear that Anuradhapura, Polonnaruwa, Ampara, Kurunegala and Hambantota are relatively better performing districts in terms of total production and productivity. Further, the calculation done in order to estimate the benefits and costs of fertilizer subsidies to identify the effectiveness of providing fertilizer subsidy for paddy shows that benefits of it are always less than the costs of it. Finally, the results of random effects model show the importance of land, fertilizer subsidies and other factors in modelling paddy output in Sri Lanka. It is clear that fertilizer is an essential input in paddy farming hence, fertilizer related competitive policies are essential for any national effort aimed improving agriculture productivity in the country. Poor planning, shortage of fertilizer and weak incentives could result in failure to achieve the objectives of the subsidy scheme. Therefore, the results of this study can be used to improve the efficiency and effectiveness of fertilizer subsidy program in increasing the productivity and promoting paddy output in Sri

Lanka in the long run. In general, Sri Lanka has also experienced market imperfections due to imperfect or incomplete markets and government interventions in the paddy sector for many years. The long-term costs of such market imperfections can be substantially large. Therefore, it is required, to rethink the existing policies for planning a sustainable and competitive paddy farming sector in the future. Moreover, the government can provide necessary incentives to increase the organic paddy farming in the country which will contribute to reduce the negative environmental impact of agriculture. In this context, small scale individual farming practices in organic farming is needed to be improved and an integrated management system has to be implemented as an important strategy to make it success in the country. Reducing usage of chemical fertilizers will reduce chemical induced diseases such as CKDU and save valuable foreign exchange used in importing chemical fertilizers while reducing government expenditure on subsidies given to farmers at present.

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