The economic impact of fertilizer subsidy policy on paddy productivity with special reference to Mahaweli System H in Sri Lanka

M. S. S. Perera*, R. M. A. K. Rathnayake and P.J.S. Fernando
Department of Business Economics, Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, Sri Lanka
**Corresponding author: sumudu@sjp.ac.lk*

Introduction

It is clear that paddy cultivation is the single most important crop occupying a 34 percent of the cultivated area (Department of Agriculture, 2014) in Sri Lanka. Paddy is cultivated during two seasons; *Yala* and *Maha*, in which *Maha* season yields a higher annual average harvest every year (Central Bank of Sri Lanka, 2014). Fertilizer subsidies represent a significant segment of the agricultural policy of most developing countries and for Sri Lanka too fertilizer subsidy has become the lime light of the discussion under the agricultural policy. Figure 1 shows that the expenditure on fertilizer subsidy as a percentage of total government expenditures has gradually increased over the period of 1996 to 2011 and thereafter the subsidy has dropped drastically. The common practice of the governments elected up to 2015 was to give the fertilizer subsidy as a material subsidy. The new government elected in 2015 implemented a new policy to give direct cash transfer instead of the material subsidy. This policy aims to encourage farmers to shift from chemical fertilizer to alternatives and to ensure that farmers receive good quality fertilizer (Department of Government Information, 2016). The government is in the process of reducing the fiscal burden of this fertilizer subsidy by way of giving it as a cash transfer. Hence, it is worthwhile to undertake an analysis on the economic impact of this policy change.

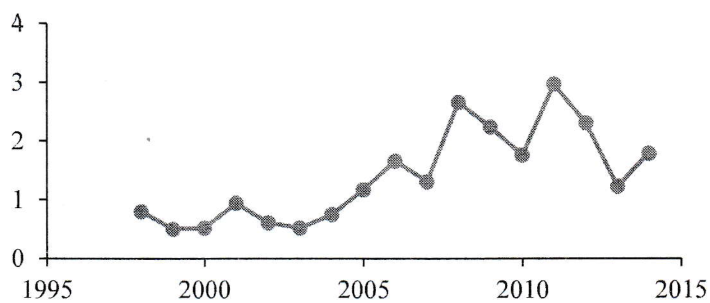

Figure 1 Government expenditure on the fertilizer subsidy (% of total government expenditure)
Source: Central Bank of Sri Lanka (2014) and Weerahewa, (2010)

A study conducted for Philippines had considered the production factors as land, fertilizers, seeds, labor costs, herbicides, and pesticides. Its results indicate that land area, planting season, fuel cost, fertilizer cost, and land rent have positive significant relationship with the value of rice production in Philippines (Koirala et al., 2013). Battese and Coelli, 1992 have conducted a study for India found that land area, cost of labour and ratio of irrigated land to total land were significant factors for rice production and they were positively related. A study undertaken in Senegal River Valley has established that the production function is affected positively by land, seed, fertilizer and services and negatively by labor costs. Further, it is revealed that fertilizer, herbicides, bird chasing efforts, use of post-harvest also has an effect on paddy production (Diagne et al., 2013).

Many farmers, agricultural officers, fertilizer producing companies and many more related stakeholders are kept in doubt, with respect to the real outcome of the cash transfer programme. There are contradictory arguments being posed from different parties (Warunasuriya, 2015). Henceforth, there is a need to analyze the economic impacts of the policy change and this is estimated in terms of impact on the land productivity of paddy in the selected area. Further, on micro-level, a farmer might change the amount of fertilizer applied in paddy cultivation under the new policy. The farmer's spending decision and the purpose of the use if the cash received from the subsidy programme is another questionable area. Therefore, the aims of this study are to assess the impact of fertilizer usage on paddy productivity and to analyze the economic impact of the policy change on the farmers.

Methodology

The study used quantitative approach to achieve the objectives where OLS regression analysis and LSDV regression were employed as main tools. Mahaweli system H was selected as the geographical area by considering two factors. According to the recent statistics in 2015 and 2016, system H was one of the largest paddy cultivating areas among the Mahaweli Special Areas[6] in terms of total paddy production (annual) and net extent harvested. Also, the system H has reported the second highest average paddy productivity in both 2015 and 2016, which was lower only to Udawalawe area.

Consequently, the System H has accounted for the highest paddy production in the Year 2015 and the second highest paddy output in the year 2016. Similarly, in terms of the net extent harvested, the system H is the second highest in year 2015 and third highest in the year 2016.

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[6] The Mahaweli system consists of six special areas namely Udawalawa, System B, C, G, H and System L.

The major part of the system H falls within the Anuradhapura district where small areas falling within the Matale and Kurunegala districts. The system H consists of seven (7) blocks namely Galkiriyagama, Meegalewa, Mahailuppallama, Nochchiyagama, Tambuttegama, Talawa and Eppawala. The sample was selected using the cluster sampling technique and the characteristics of seven Mahaweli blocks were assumed to be homogeneous. The second stage of clustering was done at the village level and Meegalewa Grama Niladhari Division was chosen assuming the homogeneity of farming related dimensions in all the villages situated in the block. When considering the homogeneity assumption, it is to be noted that these villages display common characteristics in agricultural aspects such as impact of the Mahawelli Authority, land size, climate, irrigated or rain-fed cultivation. In addition, there is no significant diversity in demographic factors such as average income, size of a family, living standards etc. In Meegalewa Grama Niladhari Division, almost all the households who engage in farming (213 households) were taken into the sample of this study. A structured questionnaire was used to gather micro data for the analysis. A pilot study was conducted to test the questionnaire before the master survey, which was conducted in June 2016.

Yield per hectare (total yield per season/cultivated land area in the season) was considered as the indicator of paddy productivity. As suggested by the existing literature, labour input, machine input, farmer's education, training received by the farmer, age of the farmer and season were selected as independent variables other than fertilizer and square of fertilizer. Land was not explicitly included as an independent variable but its impact was captured by modifying the dependent variable by land variable (yield = harvest divided by land). A dummy variable was employed to capture the seasonal variations in *Yala* and *Maha* seasons.

Three separate regression models for (1) *Yala* season, (2) *Maha* season, and (3) for both seasons were estimated as follows:

Model 1: for Yala season;

$$Yieldy_i = \beta_0 + \beta_1\, labour_i + \beta_2\, machine_i + \beta_3\, fertilizer_i + \beta_4\, fertilizer^2_i + \beta_5\, primary_i + \beta_6\, olevel_i + \beta_7\, alevel_i + \beta_9\, trained_i + \beta_{10}\, age_i + u_i$$

Model 2: for Maha season;

$$Yieldm_i = \beta_0 + \beta_1\, labour_i + \beta_2\, machine_i + \beta_3\, fertilizer_i + \beta_4\, fertilizer^2_i + \beta_5\, primary_i + \beta_6\, olevel_i + \beta_7\, alevel_i + \beta_9\, trained_i + \beta_{10}\, age_i + u_i$$

Model 3: for both seasons;

$$Yield_{it} = \beta_0 + \beta_1\, labour_{it} + \beta_2\, machine_{it} + \beta_3\, fertilizer_{it} + \beta_4\, fertilizer^2_{it} + \beta_5\, primary_{it} + \beta_6\, olevel_{it} + \beta_7\, alevel_{it} + \beta_8\, season_{it} + \beta_9\, trained_{it} + \beta_{10}\, age_{it} + u_i$$

Where, β_0's are the constant terms/intercepts and the β parameters represent coefficients of respective independent variables. 'u_i' is the disturbance term of models. 'i' stands for the position of each observation and 't' specifies the season.

Table 1 Variables and their descriptions

Variable	Description	Measurement
Dependent Variable		
Yield	Paddy yield: paddy harvest in kg per hectare	kg/ha
Independent Variables		
labour	Labour input: aggregate of hired and family labour	Hours
machine	Machine input	Hours
fertilizer	Fertilizer input: aggregate of MOP, TSP and Urea	Kg
$fertilizer^2$	Squared value of fertilizer input	kg^2
primary	Whether the farmer's highest qualification is primary education or not	0 = no, 1 = yes
olevel	Whether the farmer's highest qualification is G.C.E. Ordinary Level	0 = no, 1 = yes
alevel	Whether the farmer's highest qualification is G.C.E. Advanced Level	0 = no, 1 = yes
season (used only in Model 3)	Season of paddy cultivation	0 = Yala, 1 = Maha
trained	Whether the farmer has received agriculture related training or not	0 = no, 1 = yes
age	Age of the farmer	Years

We employed OLS regression to estimate Model 1 and Model 2, whereas Model 3 was estimated using LSDV regression, which is capable to control the timing effects of the two seasons (0 = *Yala* and 1 = *Maha*).

Table 1 shows the descriptions and measurements of variables used in the analysis.

Table 2 Results of regression analysis with fertilizer and square of fertilizer

Variables	(1) Yala Season (2016) Cash Transfer Programme	(2) Maha Season (2015) Fertilizer Subsidy Programme	(3) Both Seasons
Constant	2,095***	2,988***	2,502***
	(202.5)	(243.5)	(155.9)
fertilizer	7.037***	4.049***	5.007***
	(1.057)	(0.746)	(0.574)
$fertilizer^2$	-0.00481***	-0.00170***	-0.00229***
	(0.000936)	(0.000438)	(0.000384)
Observations	213	213	426
R-squared	0.183	0.134	0.169

*Notes: Standard errors in parentheses and *** $p<0.01$, ** $p<0.05$, * $p<0.1$*

Results and discussion

Table 2 presents the results of regression models which were aimed to examine the relationship between paddy yield and fertilizer. Both fertilizer variables were significant at 0.01 significant level in all three models.

Table 3 shows the results of regression models estimated to examine the impact of fertilizer on paddy productivity after controlling for other variables. The models were free of multicollinearity problem as the Correlation Matrix (Table A in Appendices) does not show correlation coefficients above 70 percent other than the non-linearly related fertilizer and its square term.

Table 3 Regression analysis Model 1, Model 2 and Model 3

Variables	(1) OLS Yala Season	(2) OLS Maha Season	(3) LSDV Both Seasons
Constant	1,600*	4,223***	2,746***
	(956.5)	(942.9)	(679.1)
Labour	0.726	0.803	0.826**
	(0.596)	(0.546)	(0.404)
Machine	19.41***	7.543**	10.76***
	(5.408)	(3.225)	(2.777)
Fertilizer	6.319***	4.036***	4.392***
	(1.085)	(0.764)	(0.592)
fertilizer^2	-0.00429***	-0.00173***	-0.00210***
	(0.000950)	(0.000444)	(0.000384)
Primary	-328.5	-946.3	-603.8
	(614.2)	(610.4)	(434.7)
Olevel	-13.78	-856.0*	-354.0
	(513.8)	(496.6)	(357.9)
Alevel	108.5	-992.5	-352.2
	(630.9)	(622.2)	(443.0)
Trained	57.29	9.153	-21.48
	(338.0)	(334.9)	(237.2)
Age	5.302	-13.90	-5.740
	(14.93)	(14.99)	(10.64)
Season			530.5**
			(209.2)
Observations	207	209	416
R-squared	0.247	0.199	0.233

*Notes: Standard errors in parentheses and *** $p<0.01$, ** $p<0.05$, * $p<0.1$*

Source: Compiled by the authors

Fertilizer and square of fertilizer were significant in all three models at 1 percent significant level. Additionally, machine input has become significant in all three models at 1 percent significant level while labour input was significant only in

Model 3. There is a significant different in paddy productivity in two seasons as indicated by positive and highly significant coefficient of the *Session* variable.
The explanatory powers of three models have not increased considerably even after adding other control variables. This phenomenon proves the significant impact of fertilizer on paddy productivity. The positive and highly significant coefficient of *fertilizer* variable and highly significant negative coefficient of the *fertilizer2* variable suggest that there is an optimum level of fertilizer that affects the paddy productivity. The optimal points were calculated (using the first set of models) as 732.49 kg, 1190.88 kg and 1093.23 kg for *Yala* season, *Maha* season and for both seasons, respectively. These calculated results suggest that there are farmers who use fertilizer more than the optimal level. The negative coefficients of fertilizer 2 variable advocates that when a farmer applies fertilizer exceeding the optimal use, it leads yield to fall.
The optimum fertilizer usage recorded under the cash transfer programme in Yala 2016 is significantly lower than the optimum fertilizer usage recorded under the material subsidy programme in Maha 2015. In addition, the productivity of fertilizer on average (yield per fertilizer kilogram) is 14.5 kilogram per one kilogram of fertilizer under the cash transfer programme whereas the number is 12.7 per kilogram under the material subsidy programme. This further indicates that paddy productivity has increased under the cash transfer programme.

Conclusion and policy recommendations

According to the regression analysis, it is evident that the farmers tend to apply whatever the amount of fertilizer given by the government under the material subsidy scheme. Therefore, the findings vote for the introduction of cash subsidy under which the farmer decides the amount of fertilizer to be applied. Accordingly, the study suggests that the prevailing cash subsidy system will become a solution for over utilization of fertilizer. However, this would be successful only if the government takes actions to specify the fertilizer recommendations for each farmer or for each area after doing continuous and reliable soil tests as fertilizer requirements depend on the soil conditions.

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Appendix

Table A Correlation matrix

	Yield	labour	machine	feritilizer	fertilizer2	primary	olevel	alevel	season	trained	age
ield	1										
abour	0.1958	1									
nachine	0.2367	0.1747	1								
eritilizer	0.3132	0.2002	0.0741	1							
ertilizer2	0.1347	0.1397	0.017	0.8654	1						
rimary	-0.0214	0.0064	-0.0391	0.0725	0.0377	1					
level	0.0177	0.0716	0.0281	-0.0466	-0.0733	-0.528	1				
level	-0.016	-0.059	0.0531	0.0337	0.0924	-0.146	-0.5167	1			
eason	0.2175	0.0574	0.0526	0.2546	0.1737	-0.0019	-0.0015	-0.0018	1		
rained	0.008	0.0585	0.1161	-0.0159	-0.0068	0.0459	0.0417	-0.0465	-0.0027	1	
ge	-0.0105	-0.0581	-0.0102	-0.0495	-0.11	0.1482	-0.1204	-0.1003	0.0022	0.045	1