*Advances in Management & Applied Economics, vol. 7, no. 1, 2017, 31-51*
*ISSN: 1792-7544 (print version), 1792-7552(online)*
*Scienpress Ltd, 2017*

# Evaluating the Fertilizer Subsidy Reforms in the Rice Production Sector in Sri Lanka: A Simulation Analysis

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**Abstract**

This paper analyses the change in fertilizer subsidy policy in Sri Lanka with a view to understand its impact on national rice production, demand/supply of inputs, farm profit and government budget. In addition, cost effectiveness of the fertilizer subsidy is evaluated in terms of transfer inefficiency. Demand supply equilibrium model along with input markets is employed to obtain the results. The results indicate, complete fertilizer subsidy reduction would reduce rice production by around 4%, while a 36% decline in the fertilizer demand for paddy cultivation. Although, the subsidy cut reduces the enormous government burden, farmers are unfavorably affected by 40% reduction of farm profit. Moreover, fertilizer subsidy would cause government to spend Sri Lankan Rupees (SLRs.) 1.38-1.91 to increase farm profit by one rupee. Meanwhile, a 3% decline of paddy production and a 14.5% increase in the rice price is expected with the proposed cash transfer policy.

**JEL classification numbers**: Q11, Q13
**Keywords**: fertilizer subsidy, transfer inefficiency, two-stage technology.

## 1 Introduction

Fertilizer subsidy has been politically more litigious agricultural policy in Sri Lanka for more than five decades. It is considered to be predominantly imperative to induce farmers to adopt high yielding varieties with a view to increase rice self

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Article Info: *Received*: October 23, 2016. *Revised:* November 25, 2016.
*Published online*: January 5, 2017

sufficiency in the country as well as to ease the burden on farmers' budget. In the meantime, eliminating/reducing or switching it to a direct transfer payment system is the most widespread adjustment method being considered by many governments in the world. This is largely driven by the logic that generalized subsidies can be ineffective, costly and inequitable, while replacing them with targeted transfers can remove market distortions and more cost effectively support vulnerable groups (Coady *et al*., 2010). On the other hand, adequate subsidies and the distribution of productive inputs can bolster local production, and their removal should be carefully assessed given the negative impacts (Khor, 2008).

Fertilizer subsidy policy in Sri Lanka was introduced in 1962 and this has been continued up to now with several changes, while populist governments have used the subsidy to appeal to the politically important farming community (Bandara and Jayasuriya, 2009). Over the years, subsidy has significantly contributed to increase paddy production and help the country for attaining self-sufficiency in rice. However, there are numerous concerns over the effectiveness and financial sustainability of program as well as anxiety over soil and water pollution, health and food safety in the country in the more recent years. Meantime, the government is under increasing financial pressure due to low income and increasing external debt. Inefficient resource allocation is another concern. These problems raise a question about continuing fertilizer subsidy policy in rice sector in Sri Lanka. Therefore, this mounting burden of fertilizer subsidy compelled the newly elected government in end of the 2015 to suggest some modifications to the fertilizer subsidy policy. Accordingly, the government would convert the subsidy to a cash allowance of Sri Lankan Rupees (SLRs.) 25,000 per year for 1 hectare (payment quota up to 2 hectares) for paddy farmers from 2016 *Yala* season[2]. To defend their proposition the government argues that its intention is encouraging farmers to move away from using chemical fertilizers and to ensure that farmers are given good quality fertilizer, instead of the unsafe that is often given on the subsidy. However, the All Ceylon Farmers' Federation and opposition parties have not taken this proposal as a benevolent offer by the government. Recently, the market price of a 50 kg bag of the fertilizers urea, TSP and MOP has risen to SLRs. 2,641, 2,829 and 3,014 respectively. This means that farmers now have to pay more than 6.5 times a high price for fertilizer compared to previously paid price of SLRs. 350 per 50kg. Hence, farmers complained that they cannot afford to buy standard fertilizer and there is a fertilizer shortage as a result of stockpiling by traders and, lead farmers face difficulties in purchasing fertilizer stocks. As a result, the government made a decision to fix the price of a 50 kg bag of fertilizer at SLRs. 2,500. However, since there is no obligation for paddy farmers to obtain

[2] Paddy is cultivated during two seasons in Sri Lanka referred *Maha* (Wet season, October to March) which accounts for about 65 per cent of the annual production and *Yala* (dry season, April to September) which usually accounts 35 per cent.

such direct cash transfer as a replacement for previously given subsidy, its effectiveness is questionable.

With such background, we find that modifications to fertilizer subsidy policy in the country are currently a concern. Although few indirect studies have been carried out to assess the impact of elimination of fertilizer subsidy in the country, until now, no attempt have been made to use two-stage technology which specifies Bio chemical (BC) and Machinery (M) technology processes in Sri Lanka. One-stage Constant Elasticity of Substitution (CES) technology assumed in most synthetic models is too restrictive; hence we assume BC and M technology which are closer to the reality than one-stage CES. It is important to evaluate the changing relative prices of inputs and thus cause the substitution effect among the factors of production as a result of subsidy cut which is possible using our model. Moreover, I believe that this is the first attempt to evaluate the effects of currently proposed direct transfer payment system in Sri Lanka.

Therefore, the main objective of this paper is to evaluate the various adjustment techniques (reduction/complete removal of subsidy and direct transfer) to the fertilizer subsidy policy in Sri Lanka using simulation under different subsidy rates, with a view to understand its impact on the paddy production, input demand and their prices. Moreover, this paper evaluates the effect of subsidy adjustments including proposed direct transfer payment on government budget, farm income and cost effectiveness in terms of transfer inefficiency.

The remaining sections of the paper are organized as follows. The section 1.1 summarizes the rice sector in Sri Lanka and focuses on the evolution of the fertilizer subsidy policy and their issues in the country. The section 1.2 briefly examines the implications of various fertilizer subsidy policies implement in other countries. While, section 2 describes the data and methodology used, section 3 discusses the results. The final section concludes the paper.

## 1.1 Sri Lanka's Rice Sector and Fertilizer Subsidy Policy

### Rice sector in Sri Lanka

Agriculture is continuing to play a key role in the country despite its persistent decline to contribution of GDP to the entire economy. Food crops accounts for the lion's share-nearly 80 percent of the total agricultural budget on an average (Wijetunga and Abeysekera, 2010) and, from that rice accounts for about 50 percent of the food crop budget. Rice is the staple food of the Sri Lankans and the per capita consumption of rice fluctuates around 100 kg per year which provides 42% of total calorie and 34% total protein requirement of an average individual. In the meantime, average consumer spends 14% of total food expenditure on rice (Department of Census and Statistics, 2012). In the year 2015, it contributed 11% to the agricultural GDP and 0.9% to the total GDP (Central Bank of Sri Lanka, 2015). In addition, rice occupies the largest land area (25%) (Henegedara, 2002) under agriculture and provides livelihood for nearly 1.8 million farmers in Sri

Lanka. It is grown under both irrigated and rain-fed conditions in the dry, intermediate and wet zones of Sri Lanka during two cropping seasons: *maha* and *yala*. Out of 0.77 million ha of rice lands in the country, around 90% are cultivated in the *maha* season and 55% in the *yala* season. Meanwhile, more than 30% of the total labor force directly or indirectly depends on paddy farming (Weerahewa *et al*., 2010). However, the majority of paddy farmers (more than 75%) are small holders with a land area of less than one hectare and only around 3% of farmers cultivate larger than two hectare of paddy lands (Department of Census and Statistics, 2002). Given such a significant role of the paddy sector, every successive government since independence has taken several measures to enhance paddy production in the country. Among them fertilizer subsidy has played a key role in boosting rice production and safeguarding self sufficiency in Sri Lanka during the last five decades.

**Fertilizer Subsidy Policy Changes**

The provision of fertilizer has been subsidized for more than five decades in Sri Lanka since 1960s'. It has become customary to provide subsidy continuously to farmers in spite of tremendous pressure on government budget, because deviation from it is politically most sensitive. According to the government policy all paddy farmers including tenant farmers who cultivate less than 5 acres of paddy land (2 hectares) are eligible for the fertilizer subsidy and the subsidy is given according to the recommendations of the Department of Agriculture.

We can identify five major phases in the provision of fertilizer subsidy in the country since its inception in 1962 to before substitute it with direct transfer system in 2016.

Phase 1(1962-89) - Subsidy provided for three main fertilizers of Urea, TSP and MOP

Phase 2 (1990-94)- Period of subsidy removal

Phase 3 (1995-96) – Re-introduce the fertilizer subsidy for three main fertilizers of Urea, TSP and MOP

Phase 4 (1997-2005) - Subsidy provided only for Urea

Phase 5 (2005-15) - Subsidy provided for all three main fertilizers at a fixed price (Rs. 350 per kg bag)

During the period 1962-89, the subsidy was provided for all three main types of fertilizers; nitrogen (N), phosphorus (P), and potassium (K) in the forms of urea, Sulphate of Ammonia, Muriate of Potash (MOP) and Triple Super Phosphate (TSP) were subsidized at different rates (Ekanayake, 2006) targeting primarily at paddy. This subsidy rate amounted to 40-50% of the cost of fertilizer at the beginning. However, in 1979, subsidy rate was increased to 85% for urea and 75% for other fertilizers respectively. As a result of increased world market fertilizer prices in 1981, the government allowed retail prices of fertilizer to increase by reducing the subsidy rates to 65% for urea and MOP, and 40% for TSP. Regardless of the world market price fluctuations, a fixed fertilizer price had been maintained during 1983-87. Later in 1990, the government completely removed the fertilizer subsidy for all types of fertilizers until October 1994, in line with increasing fertilizer prices in the international market with rising oil prices and depreciation of exchange rate. It caused a sharp escalation of fertilizer prices from the beginning of 1990s, leading to a sharp decline of total fertilizer use by farmers. However, fertilizer subsidy was reintroduced in 1994 and continued with several changes[3)] until 1997. Nevertheless, in 1997 the government decided to restrict the subsidy only to urea and it was continued until 2005 under different fixed price levels[4)]. The previous subsidy policy[5)] evolved in the end of 2005 to provide subsidy to three main fertilizers (urea, TSP and MOP) at fixed selling price of SLRs. 350 per 50kg bag, regardless of world market price (allowing the subsidy component to vary depending on the import price) for paddy farmers. This scheme was extended to several other plantation crops in 2007 and finally covered all other crops in 2011 to subsidized 50kg bag of fertilizer at SLRs. 1,200.

As illustrated in Figure 1, the government expenditure on fertilizer subsidy cost increased from 6.9 billion SLRs in 2005 to 36.4 billion SLRs in 2012 (National Fertilizer Secretariat, various years). This accounts 4.4% of agriculture GDP and 2% of the total government expenditure as averaged (Central Bank of Sri Lanka, 2014). Moreover, the subsidy as a percentage of market price exceeds 90%[6)] in all three major fertilizers in 2012. In addition, fertilizer subsidy continues to drive up recurrent expenses, particularly in the wake of higher global oil prices which pushes up the market price of fertilizer. During the period 2005-2014, the total government expenditure on the fertilizer subsidy was increased to Rs. 238.3 billion (Central Bank of Sri Lanka, 2014).

[3)] Price level for a 50 kg bag for urea was set at SLRs. 350 in 1994, and SLRs. 600 in 1996.
[4)] SLRs. 350 in 1997-2002, SLRs. 800 in 2003, SLRs. 600 in 2004 and SLRs. 550 in 2005 (Weerahewa *et al*., 2010).
[5)] Here consider the fertilizer policy between 2005- 2015.
[6)] Market prices were SLRs. 68.95/kg (Urea), SLRs. 72.13/kg (MOP) and SLRs. 72.35/kg (TSP) in 2012 (Fertilizer Secretariat) while farm gate price is SLRs. 7/kg of all the fertilizers.

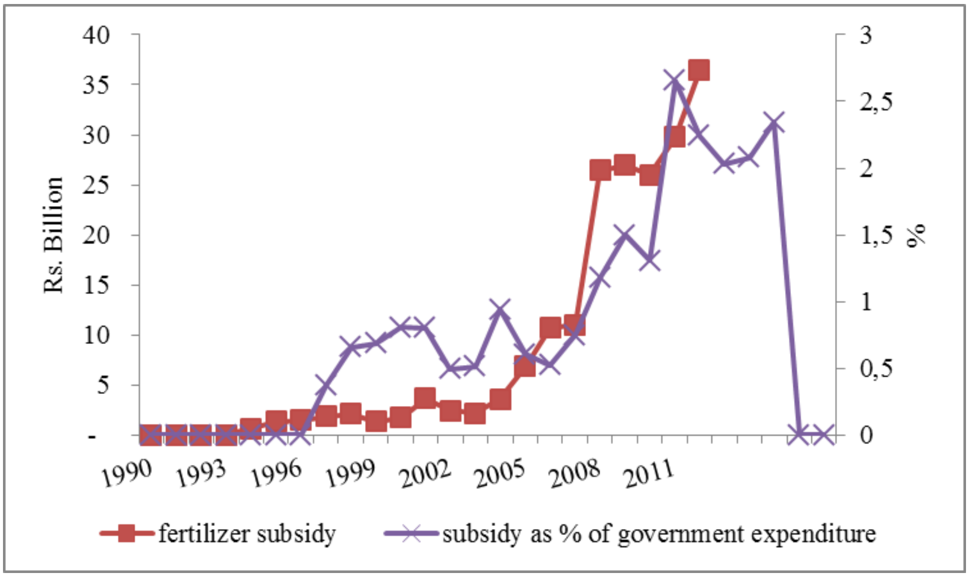


Figure 1: Government Expenditure on Fertilizer Subsidy; 1990-2012
Source: Department of Census and Statistics

**Concerns of the Fertilizer Subsidy Policy**

According to many researchers, there are several shortcomings of the fertilizer subsidy program implemented during the recent period. As example, subsidy is given out without any targeting mechanism and a large proportion of the benefits are captured by relatively wealthy farmers (Tibbotuwawa, 2010). This study further noted a large proportion of farmers do not receive the fertilizer at the subsidized price and a substantial amount is sold on the black market as a result of the weaknesses in targeting, combined with rent seeking at various stages in the distribution chain. On the other hand, existence of two methods of subsidies as SLRs 350/50 kg for paddy and SLRs. 1200/50kg for other crops resulted in paddy farmers selling fertilizer at a higher price which leads to lower utilization of fertilizer in paddy sector than purchased amount under the subsidy price (Central Bank, 2014). In addition, researchers further noted that there are some misallocations in the current subsidy as the total amount of fertilizer issued is much higher than the total area of 5 acres of paddy lands (Wijetunga, 2013). Meantime, the current program seems highly cost ineffective due to government spends between 1.4 and 2.4 SLRs per acre to increase farm income by only one rupee per acre (World Bank, 2013). Thiruchelvum (2005) also pointed out that Sri Lanka maintains high level of self sufficiency in rice at a cost to the economy.

The Agrarian Service Centers (ASC) plays a major role in distribution of fertilizer with the assistance of Agricultural Production and Research Assistants

(ARPA) and Divisional Officers (DO). However, in many cases ASCs do not receive their requirements hence; farmers could not obtain their requirements at the beginning of the season. In addition, some corruptions and misallocations of subsidy in the distribution program were reported. The quality of fertilizer imported was also questioned in the recent years while some research findings reveal that low quality of chemical fertilizer is the reason behind the increasing number of kidney diseases in areas where paddy is cultivated (Jayasumana *et al.*, 2014). In addition, Chandrajith *et al.* (2010) has reported trace element content in different fertilizers applied to paddy soils in different areas in North Central Province in Sri Lanka where majority of paddy farmers live. The data reveals that a considerable amount of Cadmium and Lead are accumulated in agricultural soil due to application of fertilizer in the long run. World Bank (2015) also reported that the intensive use of low quality fertilizer leads to environmental and potential human health hazards. Thus it negatively affects the bottom 40 percent of people who are directly or indirectly engaged in agriculture. Further this report reveals that subsidies would distort market decisions by encouraging cultivation of certain crops especially paddy, while hindering the movement to value added crops. In addition, there are several other shortcomings of the fertilizer subsidy policy in the country such as leakages and concerns due to low quality fertilizers as well as administration and efficiency problems (Central Bank of Sri Lanka, 2014; Tibbotuwawa, 2010, Wijetunga, 2013; Jayasumana *et al.*, 2014; and World Bank, 2013).

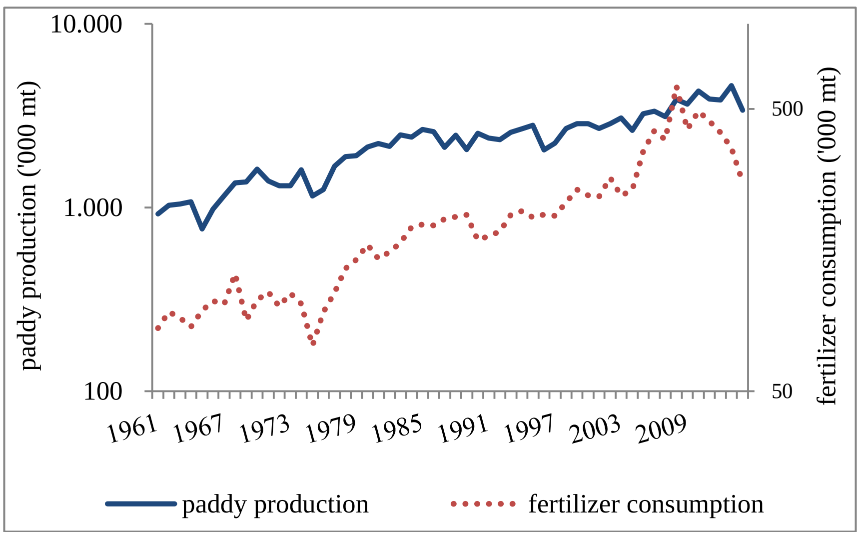


Figure 2. Paddy Production and Fertilizer Consumption
Source: FAO and IRRI

Despite some negative issues of the fertilizer subsidy program, it is one of the main factors that contributed to the recent progress of the paddy sector in terms of production and the country is nearly self-sufficient in rice even though cost of production is continuously escalating. According to research carried by Wickramasinghe *et al.* (2009), urea use at the national level increased from 4.36 kg/ha in 1965 to 284 kg/ha in 2005. Meanwhile, the average fertilizer usage for paddy has increased from 140 kg/ha in 1961 to 386 kg/ha in 2012 (Figure 2) which contributes to the improvement in paddy yield. The main factor for the rapid diffusion of fertilizer among farmers appears to be its relative low price. As a result, the subsidy leads to a significant drop of the paddy farmers' share of fertilizer price which accounts to 3% of the total cost. However, due to an additional charge of SLRs. 150 for insurance since 2014, the farmers were compelled to pay sum of SLRs. 500 per 50 kg for the fertilizer despite the said price of SLRs. 350. This scheme was subjected to criticism as allegations were made regarding the low quality of the fertilizer. It is said that there are around 50,000 kidney patients in the country, who are mostly farmers and agricultural workers and around 20,000 people have died of kidney failure in the country according to government reports.

### 1.2 Fertilizer subsidy policies in other countries and there implications: A literature review

Fertilizer subsidy is provided in different forms in other countries such as state supply of fertilizer inputs, cash payment, voucher/coupon system, reduced market price or transport subsidy etc. Subsidization of inputs regarded as an unsatisfactory way of fostering agricultural growth (Timmer *et al,* 1983). In a world of perfectly competitive markets, conventional economic analysis demonstrates that subsidies are not desirable as they inevitably result in economic inefficiencies and welfare losses (Crawford *et al*, 2006). Moreover, models for OECD countries indicate that subsidies are the least efficient way of transferring income to agricultural households (Filipski and Taylor, 2012). In South Asia, fertilizer subsidies are crowding out investments in essential public goods. For example, World Bank (2010) estimated that investment in Bangladesh has fallen from 5.2 percent over less than a decade, mainly because of increased spending on the fertilizer subsidy (World Bank, 2010). Also the government control of the fertilizer market in Bangladesh resulted in misallocation of resources and inefficient production distribution (World Bank, 1997). In the case of high income countries, OECD analysis suggests that less than half the value of an input subsidy translates into higher net incomes for farm households, with the majority of the transfer leaking to input suppliers or incurred as efficiency losses (OECD, 2001).

Conversely, some authors argued that input subsidies may be useful in stimulating the adoption of new technologies of production (Dalrymple, 1983; World Bank, 1986). Analysis by Chand and Pandey (2008) show that in India, if subsidy on fertilizer is removed completely, the price of fertilizer will increase by 69% and this would cause a 9% reduction in food grain production. Minot *et al.*

(2009) conclude that fertilizer subsidies are a cost effective way of assisting the rural poor, if they can be justified on the grounds of equity.

Numerous studies in Malawi, Holden and Lunduka (2013) conclude that most vulnerable households are not sufficiently included the subsidy program, and the targeting system is not particularly effective. Moreover, they found that vouchers tend to be sold by smaller farms and purchased by large farms. Although targeting poor and female-headed households is a program objective in Malawi, female headed households were less likely to be target in practice (Dorward *et al.*, 2008; Chibwana *et al.*, 2010) and the wealthiest households acquired more subsidized fertilizer. Evidence from empirical studies on the cost effectiveness of the subsidy programs overwhelmingly suggest that the high costs associated with them exceeded their benefits (Morris *et al.*, 2007). Meantime, Kherallah *et al.* (2002) present a broader discussion of the impact of fertilizer market reform on fertilizer prices and argue that eliminating subsidies can cause the fertilizer price to rise less than proportionately. However, Sharma and Thaker (2010) found that small and marginal farmers have a large share in cultivated area in India, thus reduction in fertilizer subsidy is likely to have an adverse impact on farm production and income of small and marginal farmers and un-irrigated areas.

In addition, there are some positive and negative factors in India's direct cash transfer program. As mentioned by Kapur *et al.* (2008), the poor people tend to misspend some of the money they receive. However, it would relieve financial constraints faced by the poor, many of whom turn either to usurious money lenders or to micro credit institutions. The administrative costs of cash transfer program will be much less because it has high initial fixed costs but modest subsequent annual costs. Further, cash transfer would help to remove the inherent inequality in subsidies. As highlighted by Kapur (2011), cash transfers could be seen as basic income support for the poor, allowing them to make their own choices more effectively if over the long term, as market infrastructure improves and production stabilizes. Conversely, some researchers justify the fertilizer subsidies and question the rationale for direct transfer. As per the Sharma and Thaker (2010), the direct transfer of subsidy to farmers is not a right policy decision in India because it would be difficult to ensure that direct transfer of subsidy to farmers is actually used by farmers only for buying fertilizer and there are no leakages in the transfer of subsidy. Hence, it might adversely affect agricultural production in the country, if the subsidy is not used for fertilizer. In Nicargua, Maluccio (2010) finds that nearly all the transfer from Red de Proteccion Social is used on consumption and education with little spending linked to agricultural or non agricultural activities.

In addition to the cash transfer, some countries use a voucher system to supply fertilizer to farmers. Malawi's voucher program is the largest success story in smart subsidies. After eliminating the universal subsidy in mid 1990s, it reintroduced limited subsidies in 1998 and in 2005 the program was redesigned as the Agricultural Input Subsidy Program (AISP), a voucher based universal subsidy program has resulted in substantially increased maize production leading to food security increases and exporting some maize (Dorward and Chirwa, 2011). The input vouchers are preferable to direct state distribution of fertilizer because the use of input vouchers promises to stimulate the development of a private sector input supply chain (Minot and Benson, 2009). However the experience of Malawi reveals that voucher based subsidies do not necessarily promote the development of private distributors. They further noted that vouchers appears to be a poor choice for attaining social safety net and poverty reduction objectives, even in rural farming communities. In addition, Banful (2011) who studied the new subsidy program introduce 2008 in Ghana finds that more vouchers were targeted to districts that the ruling party has lost in the previous presidential election and more so in districts that had been lost by a higher percentage margin and hence there is significant threat to the efficiency of fertilizer subsidies remains.

Therefore the examination of various fertilizer subsidy policies in different countries show mixed results and each system has merits and demerits. Such implication of the selected subsidy policy may vary with different group of farmers or geographic area and the monitoring of the program. Therefore, when a country wants to apply any form of fertilizer subsidy policy to motivate farmers to use it or to increase the production, it should be selected with careful consideration of implications to deliver maximum benefits to the society.

## 2 Data and Methodology

**Data**

The analysis is based on 2009/10 *Maha* season and 2010 *Yala* season whole island cost of cultivation data published by the Department of Agriculture in Sri Lanka. Benchmark year of 2010 is selected for the analysis due to normal domestic production as well as normal world market fertilizer prices prevailed in this year. Average production cost per acre of *Yala* and *Maha* season, in both irrigated and rain-fed areas were averaged using 2010 production extent data obtained from the Department of Census and Statistics. As the land cost is not shown in the cost of cultivation books, residual is assumed as land rent.

According to the benchmark data, total paddy production was 4.8 million tons and total production cost of paddy was SLRs. 126.4 billion. Among the inputs, labor is the predominant cost component which represents 29% share of the total cost. The machinery cost is the second highest cost component corresponding to 19% of the share. Agrochemical and seed cost used for analysis are 6.7% and 5.6% respectively. However, fertilizer cost share is only 2.3% to the total cost because of the low fertilizer price set by the government. Land rent represents 37% of the total cost. Producer price of paddy was SLRs. 26.2 per kg and the total extent cultivated was 937 thousand ha.

**Model**

Demand supply equilibrium model with input markets is employed for the analysis.

The production technology is assumed to be a two-stage with BC process (seed, agrochemicals, fertilizer, land) and M process (labor and machine). It is an extension of Egaitsu and Shigeno (1983) and Kaneda (1982) type technology specifications. We specify cost function as dual to the technology. In the two-stage CES technology, the first stage CES is for BC and M technology (elasticity of substitution is assumed to be low, 0.05[7)]) and second stage CES is for BC process (elasticity of substitution is assumed to be 0.2[8)]) and M process (elasticity of substitution is assumed to be 0.6[9)]).

Input supply and rice demand functions are assumed to be constant elasticity form. However, for Sri Lanka, price elasticities of factor supply are relatively hard to find from literature. In previous study, OECD (2001) suggests smaller price elasticity values for farm owned inputs and higher values for purchased inputs. Therefore, we follow the OECD (2001) and elasticity of supply for labor, purchased inputs (agrochemicals and machinery) and seed are assumed to be 1, 1.5 and 0.5 respectively. Since Sri Lanka has a small open economy in fertilizer import, we assume that the fertilizer market supply is horizontal at benchmark market price. In addition, paddy land is treated as specific factor of production (supply is fixed at the benchmark level). The price elasticity of rice demand is assumed as -0.9[10)].

Farmers wish to sell their product to private intermediaries as soon as they obtain the harvest to cover their loan requirements even at lower prices. Though there is Paddy Marketing Board (PMB) which is supposed to intervene in paddy marketing in order to maintain farm income, the quantity of purchase is very

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[7)] Binswanger (1974) found that the elasticity of substitution between machinery and fertilizer were insignificantly different from zero. Therefore we guess the elasticity is very small. Sensitivity analysis is conducted with different elasticity values ranging from 0.05 to 0.2, and we found that the results are not changed significantly.

[8)] We did simulation for various values of elasticity of substitution ranging from 0.2-0.9 and calculate output. The result is relatively consistent with that of Kikuchi and Aluwihare (1990) when elasticity of substitution is 0.2.

[9)] Kondo (1991) specified BC process and M process of Egaitsu-Shigeno production structure as translog functions and results of elasticities of substitution between machine and labor are from 0.5 to 0.9.

[10)] Obtained from Table 12, Weerahewa, 2004.

small[11] and farm gate paddy price remains low. Therefore, mainly intermediaries purchase paddy at low prices and sell to consumers at high prices. This leads to a big gap between consumer price and producer price of rice. Even if it is interesting to understand how this gap is endogenously determined, we assume it (marketing margin) is exogenous in this study and set at the five year average margin.

The farm gate fertilizer price is a policy variable, which is exogenously determined by the government. It is set at 0.1 (SLRs. 7/kg) at the benchmark.

Therefore, we can define the cost function by;

$$\mathrm{C}(P_{Seed}, P_{Che}, P_{Fert}, P_T, P_L, P_M, Q) = C\big(C_{BC}(P_{Seed}, P_{Che}, P_{Fert}, P_T), C_M(P_L, P_M)\big)Q \qquad (1)$$

where $P_{Seed}, P_{Che}, P_{Fert}, P_T, P_L, P_M, Q$ denote seed, agrochemical, fertilizer, land price, wage, machinery cost and output level, respectively.

$C_{BC}$ and $C_M$ describe sub-cost function for BC and M technology, respectively. Using the above cost function, the structure of the model employed in this study is as follows:

$$\frac{\partial \mathrm{C}}{\partial P_j}(P_{Seed}, P_{Che}, P_{Fert}, P_T, P_L, P_M, Q) = S_j\big(P_j\big) \qquad (2)$$

$$\text{for } j = Seed, Che, T, L, M$$

$$\frac{\partial \mathrm{C}}{\partial P_{Fert}}(P_{Seed}, P_{Che}, \bar{P}_{Fert}, P_T, P_L, P_M, Q) = S_{Fert}(P_{Fert}) \qquad (3)$$

$$\bar{P}_{Fert}\text{: Exogenous}$$

$$P_{Fert}\text{: Exogenous}$$

$$P_{rice} = \mathrm{D}(P_{rice}) \qquad (4)$$

$$P_{rice} = C\big(C_{BC}(P_{Seed}, P_{Che}, \bar{P}_{Fert}, P_T), C_M(P_L, P_M)\big) + \text{ marketing margin} \qquad (5)$$

$\bar{P}_{Fert}$ is the farmers fertilizer price set by the government, $P_{Fert}$ is the domestic market price of fertilizer. Since Sri Lanka has small open economy in the fertilizer trade, domestic market price of fertilizer is assumed to be constant as unity (bench mark domestic market price of fertilizer).

For comparison, one-stage CES technology (elasticity of substitution is assumed to be 0.4[12]) is also employed. The benchmark year market price indices are set as one. As benchmark data are available, we can simply calculate the real values. Simulations are based on assumed farm gate fertilizer price index of 0.3, 0.5 and 1 set by the government. Because there is no obligation to receive the

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[11] In 2012, less than 5% of the total paddy production of the country is purchased by PMB (Department of Census and Statistics, 2015). Therefore, we do not consider their impact.

[12] This value is average of two elasticity of substitution in two stage CES technology. We did sensitivity analysis with different elasticity values ranges from 0.2-0.9. There are no big differences in results.

direct transfer payments, it does not have any impact on the model. Therefore, we have to consider only the change in farm gate price of fertilizer. According to the recent policy change the government announced the maximum price as LKRs. 2,500 per 50 kg of fertilizer bag. Since there is some government intervention in fertilizer market up to now, the weighted farm gate price index value is estimated using the market price of Urea (LKRs. 2,641), TSP (LKRs. 2,829) and MOP (LKRs. 3,014). Accordingly, the farm gate fertilizer price index of 0.8 is used to specify the direct transfer payment proposed by the government.

Sensitivity analyses is conducted assuming different values for the elasticity of substitution for two-stage CES of BC-M technology (values ranging from 0.05 to 0.2), two- stage CES of BC process (values ranging from 0.2 to 0.9) and M process (0.5 to 0.9) to check the robustness of the results (Appendix Table 1).

# 3 Simulation Results and Discussion

The results of simulation analysis explained above are summarized in Table 1.

The figures from the two-stage CES show that paddy production is declined by 3.8% compared to the base year production level, if the subsidy is completely withdrawn. However, when one-stage CES technology is used, production goes down only by 3.2% if the fertilizer subsidy is totally removed. The analysis further shows that fertilizer supply and demand trim down by 19%, 27%, and 36% if the government increases the issue price of one kilogram of fertilizer to farmers by 0.3 (21 SLRs), 0.5 (35 SLRs) and 1 (70 SLRs, which is equal to the market price) respectively with two-stage CES technology. In addition, the results reveal that the demand/supply of machinery and labor decrease by 3.2% and 2.8% respectively if the fertilizer subsidy is totally removed. Contrast to that demand/supply for agro chemical and seed rise by 1.4% and 1.2% respectively. Meanwhile, results show that the value of rice production decreases by 3.1% under the proposed direct transfer payment method. However, the fertilizer demand under this system declines by 33% in the short run and machinery and labor demand also decrease by 2.6% and 2.3% respectively. In addition, reduction in seed and agro chemical demand is nearly 1%.

As observed in two-stage CES, rice price increase is around 9% and 18% if the issue price of fertilizer to farmers is increased to 0.5 and 1 respectively. However, it is around 8% with the one-stage CES if 50% subsidy (0.5) is applied. It is estimated that rice price will increase by 14.5%, if the farm gate price of fertilizer is increased to 0.8 under the direct transfer method. Compared to output price increases, price of input such as seed and agro chemical also increases while market prices of machinery and labor are decreased with the two-stage CES technology.

Table 1: Simulation Results

| | Bench mark value | Simulation results (%) | | | | |
|---|---|---|---|---|---|---|
| | | 2SCES | | | | 1SCES |
| Issue Price of fertilizer to farmers (Index) | 0.1 | 0.3 | 0.5 | 0.8 | 1.0 | 0.5 |
| Production Value (bil. SLRs) | 126.4 | -1.1 | -2.0 | -3.1 | -3.8 | -1.8 |
| Factor Demand and Supply | | | | | | |
| seed (bil. SLRs) | 7.0 | 0.4 | 0.7 | 1.0 | 1.2 | 0.7 |
| fertilizer (bil. SLRs) | 28.9 | -19.2 | -26.8 | -33.1 | -35.9 | -46.8 |
| chemical (bil. SLRs) | 8.4 | 0.5 | 0.9 | 1.3 | 1.4 | 1.0 |
| machinery (bil. SLRs) | 24.2 | -0.9 | -1.6 | -2.6 | -3.2 | 1.0 |
| labor (bil. SLRs) | 36.7 | -0.8 | -1.4 | -2.3 | -2.8 | 0.9 |
| Market Prices | | | | | | |
| rice (Index) | 1.0 | 4.9 | 9.0 | 14.5 | 17.8 | 8.1 |
| seed (Index) | 1.0 | 0.9 | 1.4 | 2.0 | 2.3 | 1.5 |
| chemical (Index) | 1.0 | 0.4 | 0.6 | 0.8 | 1.0 | 0.7 |
| machinery (Index) | 1.0 | -0.6 | -1.1 | -1.7 | -2.1 | 0.7 |
| wage (Index) | 1.0 | -0.8 | -1.4 | -2.3 | -2.8 | 0.9 |
| Shadow rental (Index) | 1.0 | 3.0 | 5.1 | 7.3 | 8.4 | 3.3 |
| Farm Profit (bil. SLRs) | 46.9 | -10.8 | -20.0 | -32.6 | -40.3 | -16.6 |
| Fertilizer subsidy expenditure (bil. SLRs.) | 26.0 | -37.2 | -59.3 | -85.1 | -100.0 | -70.4 |
| Transfer inefficiency 1 (decrease subsidy expenditure/ decrease farm profit) | | 1.91 | 1.64 | 1.45 | 1.38 | 2.35 |
| Farm Income (bil. SLRs.) production value-fertilizer cost | 123.5 | -4.4 | -8.3 | -13.4 | -16.6 | -5.7 |
| Transfer inefficiency 2 (decrease subsidy expenditure/decrease farm income) | | 1.76 | 1.51 | 1.34 | 1.27 | 2.59 |

Source: Authors' estimation

Note: Definition of farm income is based on World Bank, (2013)

The major difference in results obtained from one-stage and two- stage CES technologies is the changes in demand/supply as well as the market prices of labor and machinery. According to the results, when two-stage CES technology is employed, demand/supply and prices of the labor and machinery declined. However, values increased with one-stage CES. This means that the specification in production technology is important for evaluating factor market intervention.

Moreover, the study result reveals that if the government increases the issue price of fertilizer to farmers by 50% of the market price, public expenditure decreases by 59 % (SLRs 15.3 billion) compared to the base year subsidy expenditure of SLRs. 26 billion. Meanwhile, the farm profit decreases by 20% (SLRs 9.4 billion). However, if the fertilizer subsidy is removed completely, farm profit decreases by 40% (SLRs. 18.9 billion) where as market price of rice increases by 18% with two-stage CES technology. In addition, the proposed cash transfer method will reduce the farm profit by 33%.

The simulation reveals that the government spends SLRs. 1.38-1.91 to increase farm profit by one rupee (Transfer inefficiency 1 in Table 1). World Bank (2013) estimated the transfer inefficiency in fertilizer subsidy program from the viewpoint of farm income increase. Since this study defines the farm income as farm gate production value minus fertilizer cost, we follow the same definition and estimate the transfer inefficiency. These values are shown as transfer inefficiency 2 in Table 1. Judging from the figures, our results are consistent with the results obtained by World Bank (2013)[13)].

Results of our analysis are also in line with findings of some previous studies which use different approaches to calculate the impacts of fertilizer subsidy in Sri Lanka. Kikuchi and Aluwihare (1990) estimated that removing the fertilizer subsidy would reduce paddy yield by only 1-2% in the long run, since nitrogen demand was relatively inelastic with respect to price. Moreover, Ekanayake (2006) supported this conclusion and found low elasticity of fertilizer policies on consumption of the three main fertilizers. Gunawardena and Flinn, (1987) estimated short run production elasticities by using micro level data and concluded that there is relatively small incentive to increase paddy production in response to reduction in the price of fertilizer (-0.01). According to these results, complete subsidy cut reduces output by 0.9% which is smaller than our estimated result. However, our results seems to underestimate, compared to the recent findings of the World Bank (2013) which estimated the rice yield reduction by around 8% with the removal of the subsidy.

In contrast to the negative impact on paddy production and farm profit, fertilizer subsidy (before 2016) leads to unnecessarily usage of fertilizer more than the optimal level and other adverse environmental and health effects, also reported. Further, the subsidy itself is considered as a huge burden on the government budget. On the other hand, there are evidences that fertilizer usage is

[13)] Subsidy program is highly cost ineffective as government spends between SLRs. 1.4 to SLRs. 2.4 per acre to increase farm income by one rupee (World Bank, 2013).

encouraged by the fertilizer subsidy which directly increases the paddy production (yield). In addition, the elimination of subsidy is likely to create substantial political concern especially among rural groups in the society which we observed shortly after the new government proposed a system of substituting it with direct cash transfer. Moreover, we cannot expect that the farmers apply more organic manure to their fields as substitute for chemical fertilizer because there is no requirement to use organic fertilizer to receive the cash payments. Further, if the government intention is to convert farmers to apply organic fertilizer, there should be some planned and regular mechanism to produce organic fertilizer in large scale. Otherwise it is not realistic to use organic fertilizer substituting chemical fertilizer to obtain the same yield. In addition, effectiveness of the proposed direct cash payment is doubtful since without obligation rural farmers might use this money for some other purposes or to drink alcohol. Therefore, it is worth to consider all the impacts prior to introduce such a policy change by the government and need to introduce less distortive and effective policies for the development of the rice sector.

# 4 Conclusion

Fertilizer subsidy reforms are politically more sensitive and extremely difficult input policy because once adapted to huge subsidy it is not easy to get rid of them. Therefore, it is useful to consider various policy options and assess them for the effectiveness in addressing different purposes. We developed a tool which is able to examine the effects of various fertilizer subsidy changes with a more realistic functional form (BC-M specification), and the effects of changes to the fertilizer subsidy on national rice production, demand and supply of inputs, farm profit, government budget and the transfer inefficiency are examined.

The results suggest that, complete removal of fertilizer subsidy reduces the fertilizer demand/supply and farm profit significantly while paddy production declines by around 4%. In addition consumer rice prices also increase drastically with the reduction of fertilizer subsidy. However, this will ease the massive burden on the government budget. Moreover, the proposed cash transfer will reduce the paddy production by 3% and rice price will increase by 14.5% in the short run. In addition, input demand of fertilizer, labor and machinery will decrease with two-stage CES technology while demand for seed and agro chemical will increase. Meanwhile, adjustment to the fertilizer subsidy will reduce the farm profit by 11 to 40%. In addition, results reveal that the government spends SLRs. 1.38-1.91 to increase farm profit by one rupee. Therefore, the fertilizer subsidy program applied before 2016 in the country is less cost effective. Furthermore, it is hard to expect that the farmers apply more organic manure as substitute for chemical fertilizer because there is no requirement to use organic fertilizer to receive the cash payments. Even though the fertilizer subsidy program in the country seems to be less efficient in economical terms, it is not easy to make many alterations because of political sensitiveness of the subsidy program.

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## Appendix 1: Sensitivity Analysis

Sensitivity analysis is conducted assuming different values for elasticities of substitution for two-stage BC_M, BC and M process from those determined arbitrarily in the text. Using the results as given in the Appendix Table 1, we can conclude that our simulation results are relatively robust under different parameter settings. Therefore, the analysis is meaningful.

Appendix Table 1: Results of Sensitivity Analysis

| | | | BC_M=0.2 | BC=0.9 | M=0.9 |
|---|---|---|---|---|---|
| | **Benchmark** | **Count Fact** | **% Change** | **% Change** | **% Change** |
| Production | 126,382 | 125,312 | -0.8 | -2.0 | -1.1 |
| **Factor demand** | | | | | |
| seed | 7,034 | 7,029 | -0.1 | 4.8 | 0.4 |
| fertilizer | 28,902 | 23,177 | -19.8 | -57.6 | -19.2 |
| chemical | 8,473 | 8,465 | -0.1 | 8.5 | 0.5 |
| machine | 24,266 | 24,243 | -0.1 | -1.6 | -0.9 |
| labor | 36,783 | 36,752 | -0.1 | -1.4 | -0.8 |
| land | 46,935 | 46,935 | 0.0 | 0.0 | 0.0 |
| **Prices** | | | | | |
| Rice | 1.000 | 1.038 | 3.8 | 9.0 | 4.9 |
| seed | 1.000 | 0.999 | -0.1 | 9.7 | 0.9 |
| fertilizer | 1.000 | 1.000 | 0.0 | 0.0 | 0.0 |
| chemical | 1.000 | 0.999 | -0.1 | 5.6 | 0.4 |
| machine | 1.000 | 0.999 | -0.1 | -1.1 | -0.6 |
| labor | 1.000 | 0.999 | -0.1 | -1.4 | -0.8 |
| land | 1.000 | 0.995 | -0.5 | 15.5 | 3.0 |

Source: Authors' estimation