

usage of paddy sector was only about 10 percent. It has increased to 53 percent by 1996. Average use of urea at the national level in 1965 was about 4.36 kg/ha. By 2005, it increased to 284 kg/ha (Wickramasinghe, Samarasingha, and Epasinghe (2009). During the period 1990-94 that the fertilizer subsidy was not available average usage of fertilizer was about 225 kg/ha. After re-introducing the subsidy, the usage has increased to 457 kg/ha during 2006-2012. This implies that the average use of fertilizer has increased significantly at the subsidized fertilizer prices.

6. Impact of fertilizer subsidy on average yield

Average yield of domestic paddy farming has increased remarkably during the past decades. During the 1950s it was about 1230 kg/ha. By 1980s it has increased to 2735 kg/ha. At present average yield is about 4500 kg/ha (CBSL, 1998; 2012). This improvement is caused by a number of factors including use of inorganic fertilizer, HIVs, agrochemicals, extension services and more crucially on the availability of water for paddy farming.

ANOVA regression model can be used in order to evaluate the impact of fertilizer subsidy on average yield of paddy cultivation. Data of 23 years from 1990 to 2012 was used in the analysis. Fertilizer subsidy was taken into account by a dummy variable in the model. As explained above, during the first five years since 1990 no subsidy was given to the paddy cultivation. In between 1998 and 2005 subsidy was given only for the Urea. Between 1995 and 1997 and again since 2005 to 2012 subsidy was given for all three fertilizers. The impact of these three modes of fertilizer subsidy can be taken into account by two dummy variables. In addition to that, Average yield (Y_t) was used as dependent variable. It is a scale variable. The general form of the model is as follows:

$$Y_t = \beta_0 + \beta_1 D_1 + \beta_2 D_2 + u_t$$

Where, Y = average yield

$$D_1 = \begin{cases} 1, & \text{if subsidy was available only for Urea} \\ 0 & \text{Otherwise} \end{cases}$$

$$D_2 = \begin{cases} 1 & \text{if subsidy was available for all fertilizers} \\ 0 & \text{Otherwise} \end{cases}$$

In the model 'absence of the subsidy' is the benchmark. Average yield of the years when fertilizer subsidy was not existed is given by parameter β_0 . OLS estimates of the parameters are given in Table 1.

As estimates reveal, there are statistically significance differences of the average yields between different level of fertilizer subsidy. Average yield in the years of fertilizer subsidy is not existed was 3430.6 per/ha. Average yield is 3851.75 (= 3430.6+421.15) per/ha in the years of which subsidy was given only for Urea. It is 4074.90 (= 3430.6+644.3) per/ha in the period of which subsidy was given for all three types of fertilizers. What these evidences prove that fertilizer subsidy contributes to produce relatively a higher average yield in the paddy cultivation. In terms of economic viewpoint, this finding justifies the fertilizer subsidy of paddy cultivation in Sri Lanka. However, this

finding is not much sensible because it just says that average yield is higher when the fertilizer subsidy is available. It does not provide any other information related to fertilizer subsidy and average yield. Thus this finding is less supportive for the decision makers.

7. Efficiency of the usage of fertilizer

Effectiveness of fertilizer subsidy in terms of economic viewpoint can be assessed by evaluating the efficiency of the usage of fertilizer in paddy cultivation. This is because one of the prime objectives of the fertilizer subsidy is to encourage farmers to use fertilizer sufficiently. Marginal analysis provides appropriate tools to evaluate the efficiency of the use of inputs in a process of production. According to the marginal analysis efficient point of the utilization of a given input is the point that the value of the marginal product (MVP) of the input equals to its marginal cost (MC). Symbolically this condition can be expressed as $MVP_i = MC_i$. Since the difference between these two components is the marginal benefit (MB), at the equality point marginal benefit of the input become zero. Any input utilization point that deviates from this condition, i. e. if $MVP > MC$ or $MVP < MC$, indicates the inefficient utilization of the given input. At the optimum input utilization point marginal benefit of the particular input must be equal to zero ($MB = 0$).

For the evaluation of the efficiency of input utilization based on the above analysis, production function technique can be tested. Among the various types of standard production functions, Cobb-Douglas production function is appropriate for this analysis because in addition to its theoretical relevance, it provides the necessary tools for the above analysis. In this analysis yield of each year (Y) is taken as the explained variable while extent of harvested land (X_1) and quantity of fertilizer used (X_2) in each year are taken as explanatory variables. The effects of other factors on the variation of yield are to be taking into account by the error term.

The general form of the production function is

$$Y_t = \beta_0 X_{1t}^{\beta_1} X_{2t}^{\beta_2} e^{u_t}$$

The log-linear form of this function is

$$\ln Y_t = \ln \alpha + \beta_1 \ln X_{1t} + \beta_2 \ln X_{2t} + u_t$$

If ' $\ln \alpha$ ' of the model is defined as β_0 , we can re-write the above model as

$$\ln Y_t = \beta_0 + \beta_1 \ln X_{1t} + \beta_2 \ln X_{2t} + u_t$$

Where,

$\ln Y_t$ = log value of yield in t^{th} year

$\ln X_{1t}$ = log value of land extent in t^{th} year

$\ln X_{2t}$ = log value of fertilizer used in t^{th} year

β_0 , β_1 and β_2 are parameters.

Data pertain to the years between 1995 and 2012 were used to estimate the function and OLS estimates are given in Table 2.

The value of coefficient of determination is 0.858 and p-value of ANOVA is 0.000 implying that the overall model is statistically significant. Further p-values of slop coefficients

are less than 0.05 imply that those are also statistically significant at 5 percent significance level. Positive slope coefficients indicate that there is a positive relationship of yield with two inputs i.e. land and fertilizer. D-W statistic is 1.65; implies that though there is a positive autocorrelation it is not strong so as to harmful to the parameter estimates.

The estimates reveal that production elasticity of land (X_1) and fertilizer (X_2) inputs are 0.606 and 0.451, respectively. These imply that 1 percent increase of the extent of land and fertilizer lead to an increase in the yield by 0.606 percent and 0.451 percent respectively. The sum of the production elasticity of two inputs shows the constant returns to scale. This means that yield increases proportionately to the increase of both inputs. However, it should be noted that there are some other factors which are not included implicitly in the model which explain 14 percent of the total variation of the yield.

In order to evaluate the efficiency of input usage based on the above framework, value of marginal products and marginal cost of each input should be computed². Computed values of marginal product, marginal cost and marginal benefit of each input are given in Table 3.

Marginal benefits of land and fertilizer have deviated from zero implying. This implies that the utilization of both inputs is economically inefficient. Negative marginal benefit of land implies that the average land size of paddy farming is larger than the optimum size. For the efficiency of land utilization, average land size should become smaller than the existing size. In practice, it is accepted that larger the land size input utilization is more efficient; hence produce higher yield. Thus, this result is contradicted with the practical situation. However, on the other hand, one can argue that a small plot produce higher yield because when land size is small farmers make their every efforts to get maximum yield and they can utilize inputs more economically hence producing higher yield.

Positive marginal benefit of fertilizer indicates that the fertilizer is used less than the optimum level. Thus, for more benefits, usage of fertilizer must be increased. However, it should be noted that the quantity of fertilizer used in paddy farming does not depend on the subsidy because the quantity of fertilizer obtained by each farmer is determined exogenously by government officials on the recommendation of the Department of Agriculture³. Hence, it is needed to reconsider these recommendations.

² MPP of i^{th} input can be estimated by using the formula $MP_i = \hat{\beta}_i \frac{\bar{Y}}{\bar{X}_i}$. MVP of each input can be computed

multiplying MPP of each input by the price of output. The price of a metric ton of paddy was used as the price of output. Value of the rent of a hectare of paddy land was taken as the marginal cost of the land input while subsidy price of a metric ton of fertilizer was considered as the marginal cost of fertilizer input.

³ The Department of Agriculture developed its latest fertilizer recommendations for paddy in 2001. These recommendations are based on productivity levels (7, 6, 5,

Overall, the analysis reveals that the usage of fertilizer in paddy farming is economically inefficient. Fertilizer is used less than the optimum level. However, there is no evidence to suggest that it is linked directly with the fertilizer subsidy.

8. Social costs and benefits of fertilizer usage

The above analysis was based purely on the private cost and benefits of paddy farming and did not taken into account the social cost and social benefits. For the realistic evaluation, social cost and benefits must be compared rather than merely private cost and benefits. Private cost of production consists only of the cost encountered directly by the producer. But, efficiency of the production process is determined not only based on the private cost and benefits but on the entire cost and benefits experienced/enjoyed by the society as a whole. So-called 'social cost' includes the entire cost encountered by the society including private cost and external cost of the production. Similarly, social benefits include the entire benefits of the production process including private benefits and external benefits enjoyed by the producer and society.

Quantifying social costs and benefits is not an easy task. Thus, in this evaluation, an attempt was made to examine the social cost and benefits based on the experiences and published facts and information instead of quantifying them.

9. Fertilizer subsidy and private benefits

As explained earlier, usage of fertilizer significantly contributes to increases the average yield of paddy farming. Increase of average yield increases the paddy production directly and the farmers' income indirectly. On the other hand, while increasing farmers' income, direct cost of paddy farming is reduced significantly by the fertilizer subsidy. This in turn leads to make paddy cultivation a profitable economic activity. The increase of paddy production contributes to food security of paddy farming families. These are the private benefits of fertilizer subsidy.

10. Contribution of fertilizer usage to food security and social benefits

Self-sufficiency of essential food item and food security are the crucial factors that affect the stability of key aspects including social, economic, cultural and political of any country. If the supply of essential food items depends on imports, it will be adversely affected on the stability of these aspects. Because of this, every country make efforts not only to achieve self-sufficiency in essential food items but also to sustain food security. Only then a country can face the unexpected disasters and challenges effectively.

As a result of the efforts made by the successive governments for over past five, six decades since

and 4 metric tons per ha), agro climatic zones (low country dry and intermediate zones, low-country wet zone, and up-country and mid-country wet and intermediate zones), and the age of the plant (3, 3½, 4, and 4½ months) (Weerahewa et al. (2010).

independence, Sri Lanka has almost achieved self-sufficiency in rice at present. In 1950, we have imported 0.482 million metric tons of rice. The domestic rice production was only about 0.185 metric tons. By 2012, rice import has declined to about 0.36 million metric tons. It is undoubted that the usage of fertilizer is one of the key contributors to this success. Applying fertilizer together with High Yielding Varieties involve in increasing average yield of paddy cultivation as such total paddy production of the country. This progress is hard to achieve without the use of inorganic fertilizer. This is one of the benefits experienced by the entire society as a result of the usage of fertilizer. Moreover, increase of paddy production of the country as a result of the usage of fertilizer contributes to increase the Gross Domestic Product (GDP) of the country. This is another external benefit enjoyed by the society due to the fertilizer subsidy.

It is, now, clear that fertilizer subsidy generates benefits to the paddy farmers directly and to the entire nation, indirectly. These are the arguments in favor of the fertilizer subsidy.

11. Social cost of Fertilizer Subsidy

Though fertilizer subsidy produces benefits significantly to the nation, as evidences prove, it generates a huge cost, too. As explained above, considerable amount of government income is devoted for fertilizer subsidy, annually. Opportunity cost of the subsidies in the countries like Sri Lanka, which has a very low government income base, is immense because they restrict public expenditure on other productive investments. Accordingly, expenditure on fertilizer subsidy constrains the public investments in other productive sectors making adverse impacts for the long term sustainability of the economy. This is one of the indirect costs of fertilizer subsidy encountered by the society. Apart from this, the most critical social cost generated by the usage of fertilizer is the damage made by it to the environment and human lives. It is believed that unusual chronic kidney disease reported among paddy farmers in the dry zone is a consequence of huge usage of inorganic fertilizer and agrochemicals. Although the debate over the effects of fertilizer on the human health is not over and experiments are continuing, the reports based on several experiments have suggested that the root cause of unusual spreading of kidney disease in agricultural areas in dry zone is the use of inorganic fertilizer (Jayasuman *et al.*, <http://www.biomedcentral.com/1471-2369/15/124>). With the increases of the number of kidney patients, on the one hand, the government has to bear a huge cost for the treatments because the cost of dialysis and transplantation is very high. On the other hand, the families with kidney patients also have to spend much of their little income for the treatments. Moreover, informal inquiries revealed that some of the families have lost their income base since the patient is head of the household or the main income earner of the family. Therefore, they have become poorer. Meanwhile, some argue that the improper and excessive application of inorganic fertilizer may cause pollution of waterways by heavy metals such as cadmium, which they believe has resulted in increased occurrence of chronic renal failure. Deposition of nitrates and phosphates in water

bodies causes excessive algae growth resulting in oxygen depletion, water contamination and fish mortality (Bandara, 2009; Tibbotuwawa, 2010). With the pollution of waterways, providing quality drinking water has become a big issue. The government has to bear an additional cost to provide drinking water.

It is clear that the usage of fertilizer has produced a huge cost for the individual families as well as for the society. Although fertilizer subsidy produces substantial social benefits too, the problem is much critical since the social cost is not only in terms of physical resources but in terms of human lives. Thus, the usage of inorganic fertilizer must be reconsidered seriously. However, it does not mean that fertilizer subsidy should be completely removed. In fact, removing fertilizer subsidy is not an easy task because on the one hand, fertilizer subsidy is a highly politically sensitive phenomenon and on the other hand, removing fertilizer subsidy will decrease profitability of paddy farming since it is the only relief that farmers get within gradual increase of other costs of paddy farming. Moreover, it will adversely affect the self-sufficiency of rice. Thus, instead of removing fertilizer subsidy policymakers should reconsider the fertilizer recommendation for paddy farming and substitute for inorganic fertilizer.

12. Conclusions and Policy Discussions

As theoretically expected, there is a significant positive relationship between fertilizer subsidy and average yield of paddy farming. Fertilizer subsidy has contributed largely to increase the average yield. As a result, at present, paddy production has increased largely and the country has achieved self-sufficiency in rice.

In purely economic point of view fertilizer usage is inefficient; it is less than the optimum level. For the efficiency, fertilizer usage must be increased. When take into account the social costs, fertilizer usage is inefficient, too. In this point of view, fertilizer usage is higher than the optimum level. This implies that social cost can be decreased by decreasing fertilizer usage. Hence, policymakers should handle this dilemma very sensibly. Undeniably, fertilizer subsidy has encouraged farmers to use fertilizer increasingly. Hence, making appropriate revisions to fertilizer subsidy such as introducing targeting mechanism, incorporate it into the market mechanism are some policy options that can be applied in order to decrease fertilizer usage. Reconsideration of fertilizer standard for paddy farming is another policy option. Furthermore, in the long run, concentration on the alternatives for and the quality of inorganic fertilizer is some other policy options. However, undoubtedly there may be a trade-off between self-sufficiency of rice and human health and environmental safety.

Table 1: Coefficients of the ANOVA model

| Variables | Coefficient | Std. Error | t | Sig. |
|----------------|-------------|------------|--------|-------|
| Constant | 3430.600 | 126.820 | 27.051 | 0.000 |
| D ₁ | 421.150 | 161.664 | 2.605 | 0.017 |
| D ₂ | 644.300 | 155.322 | 4.148 | 0.000 |

Table 2: Coefficients of the production function

| Model | B | Std. Error | t | Sig. |
|----------------|-------|------------|-------|------|
| Constant | 1.334 | .962 | 1.386 | .186 |
| X ₁ | .606 | .181 | 3.356 | .004 |
| X ₂ | .451 | .094 | 4.785 | .000 |

Table 3: Marginal values of Land and Fertilizer inputs

| Input | Marginal product (Mt'000) | Value of marginal product (SLRS) | Marginal cost (SLRS) | Marginal benefit (SLRS) |
|------------|---------------------------|----------------------------------|----------------------|-------------------------|
| Land | 0.726 | 21780 | 29820 | -8040 |
| Fertilizer | 0.619 | 18570 | 7000 | 11570 |

References

- [1] Bandara, J. M. R. S. (2009). Agriculture development towards nutritional security. Sunday Observer, October 11.
- [2] Chandrasiri, W. A. C. K., and K. S. Karunagoda. (2008). Technical efficiency of paddy production in the North and North Western Provinces of Sri Lanka. Paper presented at the 2nd Annual Research Forum of the Sri Lanka Agricultural Economics Association, October 3.
- [3] Chirwa Ephraim and Andrew Dorward. (2013). Agricultural Input Subsidies: The Recent Malawi Experience, Oxford University Press.
- [4] Dorward Andrew, Shenggen Fan, Jonathan Kydd, Hans Lofgren, Jamie Morrison, Colin Poulton, Neetha Rao, Laurence Smith, Hardwick Tchale, Sukhadeo Thorat, Ian Urey & Peter Wobst. (2004). Institutions and Policies for Pro-poor Agricultural Growth. Development Policy Review, 22 (6): 611–622.
- [5] Ellis, F. (1992). Agricultural policies in developing countries. Cambridge, Cambridge University Press.
- [6] Ekanayake, H. K. J. (2006). The Impact of Fertilizer Subsidy on Paddy Cultivation in Sri Lanka. Staff Studies, CBSL, Volume 36, Nos. 1 & 2.
- [7] Gulati, A., and A. Sharma. (1995). Subsidy syndrome in Indian agriculture. Economic and Political Weekly 30 (39): 93–102, [Online] Available: <http://www.jstor.org/pss/4403271>
- [8] Weerahewa Jeevika., Sarath S. Kodithuwakku, and Anoma Ariyawardana. (2010). The Fertilizer Subsidy Program in Sri Lanka. Case Study 7- 1 1: Food Policy for Developing Countries: The role of Government in the Global Food System', Cornell University, Ithaca, New York.
- [9] Kodithuwakku, S. S., and P. Rosa. (2002). The entrepreneurial process and economic success in a constrained environment. Journal of Business Venturing, 17 (5): 431–65.
- [10] Nurul Nadia Ramli, Mad Nasir Shamsudin, Zainalabidin Mohamed, and Alias Radam. (2012). The Impact of Fertilizer Subsidy on Malaysia Paddy/Rice Industry Using a System Dynamics Approach. International Journal of Social Science and Humanity, Vol. 2, No. 3, May 2012
- [11] Rajapaksa, R. D. D. P., and K. S. Karunagoda. (2008). Fertilizer demand for paddy cultivation in Sri Lanka: A profit function approach. Paper presented at the Second Annual Research Forum of the Sri Lanka Agricultural Economics Association. October 3.
- [12] Smith, L.E.D., & I. Urey. 2002. Agricultural Growth and Poverty Reduction: A Review of Lessons From the Post-Independence and Green Revolution Experience in India. Report written as part of a research project on Institutions and Economic Policies for Pro-poor Agricultural Growth, funded by the Department for International Development of the United Kingdom (ESCOR Project R7989). Wye, Kent: Department of Agricultural Sciences, Imperial College at Wye.
- [13] Steve Wiggins and Jonathan Brooks (2010). The Use of Input Subsidies in Developing Countries. Global Forum on Agriculture 29-30 November 2010 Policies for Agricultural Development, Poverty Reduction and Food Security OECD Headquarters, Paris
- [14] Vijay Paul Sharma and Hrima Thaker, (2009). Fertilizer Subsidy in India: Who are the Beneficiaries? W.P. No. 2009-07-01, Indian Institute of Management, Ahamadabad-380 015. India. 2009 July.
- [15] Wickramasinghe, W., Samarasinha, G. and Epasinghe, S. (2009). Fertilizer policy on paddy farming: Evaluation of subsidy program 2005. Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo, Unpublished report.
- [16] Wijetunga, W. M. L. K., Thiruchelvam, S. and Balamurali, N. (2008). Impact of "KETHATA ARUNA" fertilizer subsidy on paddy production in Minipe Scheme. Paper presented at the Second Annual Research Forum of the Sri Lanka Agricultural Economics Association, October 3.
- [17] Sri Lanka Poverty Review - Department of Census and ... (n.d.). [Online] Available: http://www.statistics.gov.lk/poverty/SriLankaPovertyReview%20_English.pdf
- [18] Tibbotuwawa, Manoj. (2010). Better Targeting of Transfers: The Fertilizer Subsidy. Talking economics blog, Monday, August 16, 2010: [Online] Available: <http://ipslk.blogspot.com/2010/08/better-targeting-of-transfers.html>.