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## **FACTOR DEMAND FOR PADDY CULTIVATION IN SRI LANKA WITH SPECIAL REFERENCE TO FERTILIZER SUBSIDY PROGRAMME**

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### **Abstract**

*The Government of Sri Lanka has been providing incentives for paddy production through various policy measures. The major input policy namely, fertilizer subsidy, has become a heavy financial burden on the Government budget with the escalation of fertilizer prices. No empirical evidence is available to ratify the Government's policy on fertilizer subsidy and therefore, this study attempts to analyze the impact of fertilizer subsidy on paddy supply and fertilizer demand. The factor demand for paddy cultivation was derived using trans-log profit function and thereby input demand and supply response elasticities were estimated for four different districts representing various agro climatic regions. According to the estimated elasticity values, it can be concluded that the fertilizer demand as well as paddy production in the country depend more on paddy price than fertilizer prices. Moreover, the results indicate that the paddy supply and fertilizer demand in non-commercial farming area are more responsive to the fertilizer price than in the commercial farming area. These findings suggest that consistent output price policies are more important than the fertilizer subsidy to enhance the national paddy production.*

**Key words:** *Elasticities, Factor Demand, Fertilizer Subsidy, Profit Function*

### **Introduction**

The higher production and average yield of paddy in Sri Lanka is mainly attributed the support provided by successive governments, by way of introducing a series of policy measures during last few decades. The fertilizer subsidy scheme was introduced in 1960s, to influence the farmers to use more inorganic fertilizer with the introduction of high yielding varieties (Office of the Advisor on Sustainable Development, 2003). The main objective of the introduction of fertilizer subsidy scheme was to make fertilizer available at cheap price. The

subsidy scheme has undergone several revisions and all varieties of fertilizer were made available at Rs.7.00 per kg since the end of 2005 (Central Bank of Sri Lanka, 2006) and it is continuing up to date. This policy has become popular within the prevailing political environment in spite of its short term and long term impacts on the economy and the environment. As a result, the Government expenditure on fertilizer subsidy was Rs 11,000 million in 2007. Hence, the fertilizer subsidy has become a heavy financial burden on the Government budget.

According to the National Fertilizer Secretariat (NFS) (2007), 79%, 87% and 48% of Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MOP) are used for paddy cultivation respectively and these three fertilizers accounts 80% of total fertilizer use in the country. Therefore, analysis of fertilizer demand for paddy cultivation is an important factor for policy recommendation. The removal of fertilizer subsidy is a relief for the government budget, whereas any reduction of inorganic fertilizer usage, without any suitable substitute would adversely affect agricultural productivity, national food security and household income. It will also adversely affect the government objective of increasing food production through "Lets cultivate and lift up the nation" programme. However, no empirical evidence is available to justify the Government's policy on fertilizer subsidy. Within this background the overall objective of this study is to analyze the factors affecting paddy supply and more specifically, to investigate the impact of fertilizer subsidy scheme for paddy supply and fertilizer demand in the country.

Various econometric techniques are employed for the estimation of output supply and factor demand parameters such as, production function approach, cost function approach, profit function approach etc. Binswanger (1974) in his paper has applied cost function concept to study factor demand for agriculture. In this paper the advantages of using cost function in the case of estimating factor demand, rather than use of production function are emphasized. Further, the paper identifies the trans-log cost function approach in particular as an extremely useful method for estimation of production parameters. The same functional form has also been used for estimating derived demand for composite wood products by Marcin (1991). The dual cost function is employed to derive the system of input demand equations for Canadian agriculture (Lopez, 1980). The purpose of the paper is to analyze the structure of the Canadian agricultural production sector and its derived demand for inputs. Hence the aggregate demand equations for labor, capital, land and intermediate inputs are estimated using time series data. The Generalized Leontief (GL) functional form is employed to estimate the aggregate cost function and price elasticities for the Canadian agriculture.

Many authors have used profit function in empirical estimation of factor demand and output supply parameters (Fulginiti and Perrin, 1990, Ball, 1988, Bapna *et al.*, 1984, Yotopoulos *et al.*, 1976, Altermeier and Bottema, 1991, Sidhu and Baanahte,

1979 and 1981). Intervention of the Government of Argentina on agriculture price related policies have been studied using multiple inputs and multiple output framework using trans-log profit function (Fulginiti and Perrin, 1990). The same kind of approach has been used by Ball (1988) in the estimation of supply responses for five food categories. The paper stressed that the production parameter should be determined jointly for several crops rather than estimating individual production functions.

However, data limitation would restrict the multiple outputs and multiple input analyses. Therefore, formulation of normalized restricted profit function for a single crop has been used by Lau and Yotopoulos (1972) for Indian agriculture. The analysis jointly estimated profit function and the labor demand for Indian agriculture. Later the same methodology has been used for estimation of demand for labor, fertilizer and fixed inputs for Taiwan agriculture and it has been concluded that the normalized profit and factor demand function approach gives the reasonable estimation for the parameters of the production function than direct production function estimation (Yotopoulos *et al.*, 1976). Sidhu and Baanante (1979) have used the same formulation to analyze the fertilizer demand for Mexican wheat variety in India.

Further, Sidhu and Baanante (1981) extended their analysis and have estimated input demand and output supply equations for single crop, for India using farm level data for Mexican wheat variety and it has implied that the application of the trans-log profit function allowed a more disaggregated analysis of the production structure, compared to the Cobb-Douglas formulation. Also the flexibility of trans-log formulation permitted measurements of different impacts of various exogenous variables. The findings of Sidhu and Baanante (1981) provides strong support for the approach of normalized profit functions in empirical applications of economic theory for deriving factor demand and output supply parameters.

Fertilizer, labor, seed, animal power etc. are commonly used as variable inputs in the derivation of profit function in agriculture, whereas, land, machinery, capital etc are commonly used as fixed factors. In addition to the above factors, some studies have also considered socio economic (educational level, age) and environmental factors (soil type, slope, and rainfall) (Sidhu and Baanante, 1981). Due to lack of specific data, proxy estimates are commonly used as fixed factors. As an example, expenditure on repairs, maintenance, machinery hire, electricity, interest etc or sometime aggregate of several categories have been used as proxy for machinery as a fixed factor (Fulginiti and Perrin, 1990).

As a main input in agriculture, demand for fertilizer has been considered for many studies over the years. Sidhu and Baanante (1979) have estimated basically aggregate chemical fertilizer demand for wheat cultivation in India. According to

the findings fertilizer demand depends more on output price than fertilizer price and output supply too depend on output price. More disaggregated study for crop wise fertilizer demand was conducted by Gunjal *et al.*, (1980) using time series data. Bapna *et al.*, (1984) have derived systems of output supply and factor demand equations from a profit function for semiarid tropical area in India. Another comprehensive study done for food crop sector in Indonesia has used trans-log form of profit function to derive factor demand using time series data, where fertilizer has been considered as a major input (Alterneier and Bottema, 1991).

According to the literature discussed, simultaneous equation model that jointly estimates output supply and factor demand parameter for several crops is the best approach rather than the use of single equation model. Further, the profit function approach has many advantages than the production function approach. Many past studies have discussed the properties of trans-log functional form. However the difficulties of collecting data restrict the multiple output and multiple input analysis and simultaneous equation model can even be estimated for a single crop.

### Methodology

In this study, four models were estimated for Polonnaruwa, Hambantota, Kurunegala and Kalutara representing dry, intermediate and wet zone of paddy growing in Sri Lanka. Polonnaruwa and Hambantota districts contribute around 14% and 6% to the national rice production annually (Department of Census and Statistics, 2007). These two districts belong to the dry zone and paddy is cultivated mainly under major irrigation schemes whereas, Kalutara district represents the wet zone and the paddy cultivation exists mainly under rain-fed condition. On the other hand, the commercial level paddy cultivation exists in Polonnaruwa, Hambantota and Kurunagala districts while paddy cultivation in Kalutara is mainly for home consumption. Kurunegala district belongs to intermediate zone where both rain-fed and irrigated paddy cultivation exists.

The demand for a production input, such as fertilizer, is a derived demand based on the demand for final product. Farmers are assumed to behave rationally and the general profit function can be expressed as,

$$\pi = PQ - wx \dots\dots\dots (01)$$

$$\text{And the production function is given by } Q = f(x,z) \dots\dots\dots (02)$$

Where  $\pi$  is profit,  $P$  and  $w$  are prices of input and output respectively,  $Q$  is the output quantities,  $x$  is the vector of variable input quantities and  $z$  is the vector of fixed factors. The profit function can be solved for maximization situation.

$$\text{Max } PQ - wx \quad \text{subject to } Q = f(x,z)$$

The solution of this problem is a set of input demand and output supply functions which are given below.

$$X = x(P, w, z) \dots\dots\dots (03)$$

$$Q = q(P, w, z) \dots\dots\dots (04)$$

Substituting equation (03) and (04) in equation (01) gives the profit function which include profit maximization level of input and output.

$$\Pi = P'q(P, w, z) - w'x(P, w, z) \dots\dots\dots (05)$$

Differentiating profit function with respect to the input price  $w$  and output price  $P$ , inverse input demand function and output supply functions can be obtained.

$$X_i^* = -\frac{\partial \pi}{w_i} = X^*(P, w, z) \quad \text{and} \quad Q^* = \frac{\partial \pi}{p} = Q^*(P, w, z)$$

In this study restricted normalized trans-log functional form was used due to its flexibility and desirable mathematical properties (Sadoulet and Janvry, 1995, Binswanger, 1974, Sidhu and Baanante, 1981). The functional form can be written as,

$$\ln \pi = a_0 + \sum_i a_i \ln p_i + \sum_m b_m \ln z_m + \frac{1}{2} \sum_{i,j} b_{ij} \ln p_i \ln p_j + \frac{1}{2} \sum_{m,n} c_{mn} \ln z_m \ln z_n + \sum_{i,m} d_{im} \ln p_i \ln z_m$$

with  $b_{ij} = b_{ji}$  and  $c_{mn} = c_{nm}$

Where,  $\pi$  is the restricted profit which is total revenue minus total cost of variable inputs,  $p_i$  is price of  $i^{\text{th}}$  variable input and  $z_m$  is  $m^{\text{th}}$  fixed factor. All the prices were normalized by dividing by  $p$ , output price.  $a_0$ ,  $a_i$ ,  $b_m$ ,  $b_{ij}$ ,  $c_{mn}$  and  $d_{im}$  are the parameters and  $\ln$  indicate the natural logarithm. The derived factor demand and output supply functions are;

$$q_i = -\frac{\pi}{p_i} \left[ a_i + \sum_j b_{ij} \ln p_j + \sum_m d_{im} \ln z_m \right]$$

The output supply equation can be ignored and the variable input demand functions and the trans-log profit function are needed. And thereby the important parameters for policy analysis, input demand, yield response and cross elasticities were estimated.

Labor, seed and fertilizer were included as factors of production of paddy. The real expenditure on machinery was included as a proxy for fixed capital equipment. In order to capture the technological differences over time, a time variable was included. Major fertilizers needed in paddy farming, Urea, MOP and TSP were aggregated and average unit price was considered for the analysis. The profit function analysis was based on data gathered from Cost of Cultivation Survey conducted by Socio Economics and Planning Center and the Department of Agriculture, biannually for the period of 1990 to 2006 (Socio Economics and Planning Centre 1990 to 2006).

Prior to perform the econometric analysis, all time series variables were tested for the presence of stationarity. If a series is stationary, its variance and autocovariance are independent of time. In order to test for unit root at its level or

first difference stationary, all variables were subjected to Augmented Dicky-Fuller (ADF) unit root test (Enders, 1995).

The profit function and factor demand functions were simultaneously estimated using seemingly unrelated regression technique. The cross equation restrictions were imposed in the analysis and profit function and factor demand equations were estimated while output supply equation was restricted. The STATA 8.2 statistical soft ware was used in the estimation.

## Results and Discussion

The Augmented Dicky-Fuller (ADF) unit root test was performed for all variables of all districts to check their stationary levels. All variables were stationary and significant at least at 10% levels and hence, all variables can be used for econometric analysis.

The trans-log profit function consists of output price, factor prices, fixed factor and their interactions. Four different profit functional systems estimated for each districts are presented in Table 01 where "*pmd*", "*pseed*", "*pferti*" are wage rate, seed price and fertilizer price normalized by the output price "*ppaddy*" and *l* indicate the natural logarithm of variables. The variable "*lotherc*" indicates the proxy for fixed factor, machinery.

Except some variables in Kurunegala district, all other districts show expected sign for variables. The coefficients of factor prices should be negative in the profit function. In this study three major variable factors were considered and out of them wage rate and its interaction terms are significant for all four districts where labor demand functions can be estimated for all districts. Coefficients of seed price show significant negative relationship for Polonnaruwa and Hambantota districts whereas, for Kalutara it is not significant although it shows correct signs. Coefficients of fertilizer and its interaction terms in profit function are significant for Hambantota and Kalutara districts.

**Table 01: Estimated Normalized Trans-log Profit Function for Paddy**

| Variable        | Polonnaruwa             | Hambantota               | Kurunegala               | Kalutara               |
|-----------------|-------------------------|--------------------------|--------------------------|------------------------|
| lpmd            | -3.46748*<br>(0.896472) | -3.99678*<br>(0.516837)  | 1.035292*<br>(0.439321)  | -4.4958*<br>(0.39507)  |
| lpseed          | -0.14764*<br>(0.062569) | -0.58679*<br>(0.165696)  | 0.104002**<br>(0.062466) | -0.0449<br>(0.03472)   |
| lpferti         | 0.041419<br>(0.188361)  | -0.26728**<br>(0.161667) | 0.203551<br>(0.148381)   | -0.5175*<br>(0.16018)  |
| lotherc         | 0.633958*<br>(0.288599) | 0.935038*<br>(0.192274)  | -0.95923*<br>(0.515284)  | 0.27855*<br>(0.10928)  |
| Lppaddy_lpmd    | 0.53756*<br>(0.119872)  | 0.471938*<br>(0.087481)  | -0.0689<br>(0.045146)    | 0.64141*<br>(0.07589)  |
| Lppaddy_lpseed  | 0.020996*<br>(0.008535) | 0.08259*<br>(0.02541)    | -0.00708<br>(0.006796)   | 0.00392<br>(0.00518)   |
| Lppaddy_lpferti | -0.01605<br>(0.024995)  | 0.032801<br>(0.022593)   | -0.02829<br>(0.018876)   | 0.09364*<br>(0.0262)   |
| Lpmd_lpseed     | -0.00613<br>(0.003874)  | -0.06514*<br>(0.014556)  | -0.01369*<br>(0.00385)   | -0.007<br>(0.00662)    |
| Lpmd_lpferti    | 0.065236<br>(0.053129)  | -0.06701<br>(0.05151)    | 0.145605*<br>(0.048524)  | -0.0762<br>(0.0856)    |
| Lpseed_lpferti  | 0.002002<br>(0.002258)  | 0.022148*<br>(0.009706)  | 0.007006<br>(0.005835)   | -0.0034<br>(0.00337)   |
| Lotherc_lpmd    | 0.24968*<br>(0.103191)  | 0.389606*<br>(0.065077)  | -0.15863*<br>(0.060962)  | 0.37018*<br>(0.05241)  |
| Lotherc_lpseed  | 0.01454*<br>(0.006174)  | 0.078031*<br>(0.016691)  | -0.02543*<br>(0.007695)  | 0.00426**<br>(0.00224) |
| Lotherc_lpferti | 0.019871<br>(0.020354)  | 0.055114*<br>(0.014251)  | -0.01981<br>(0.023028)   | -0.0187<br>(0.0161)    |
| ttrend          | 0.060664*<br>(0.014877) | 0.053826<br>(0.007789)   | -0.04945*<br>(0.01425)   | 0.04748*<br>(0.00621)  |
| _cons           | 0.720841<br>(1.095382)  | -0.42511<br>(0.710668)   | 6.908387*<br>(1.503418)  | 0.50254<br>(0.38064)   |
| R-square        | 0.45                    | 0.6441                   | 0.2387                   | 0.4796                 |

Note: Standard errors are in parenthesis, \* Significant at 5%, \*\*Significant at 10%

### Factor Demand Functions

Estimated factors; labor, seed and fertilizer demand functions are shown in Tables 02a, 02b 02c respectively. According to the Table 02(a), coefficients of labor demand functions are significant for all equations and have higher R-square value. All the coefficients of seed demand function in Hambantota district are significant. The major objective of this study is to investigate the impact of fertilizer price which was significant only for Hambantota and Kalutara districts and it has fairly high R-square. The estimated fertilizer demand functions are shown in Table 02(c).

**Table 02(a): Estimated Labour Demand Equations**

|                   | Polonnaruwa | Hambantota | Kurunegala | Kalutara  |
|-------------------|-------------|------------|------------|-----------|
| profit_pmd        | 3.467478*   | 3.996781*  | -1.03529*  | 4.49584*  |
|                   | (0.896472)  | (0.516837) | (0.439321) | (0.39507) |
| profit_pmd_ppaddy | -0.53756*   | -0.47194*  | 0.068905   | -0.6414*  |
|                   | (0.119872)  | (0.087481) | (0.045146) | (0.07589) |
| profit_pmd_pseed  | 0.00613     | 0.065144*  | 0.013692*  | 0.00701   |
|                   | (0.003874)  | (0.014556) | (0.00385)  | (0.00662) |
| profit_pmd_pferti | -0.06524    | 0.067008   | -0.1456*   | 0.07622   |
|                   | (0.053129)  | (0.05151)  | (0.048524) | (0.0856)  |
| profit_pmd_otherc | -0.24968*   | -0.38961*  | 0.158633*  | -0.3702*  |
|                   | (0.103191)  | (0.065077) | (0.060962) | (0.05241) |
| _cons             | 32.11817*   | 30.24489*  | 37.698*    | 36.6415*  |
|                   | (2.392589)  | (1.762202) | (1.063572) | (1.67517) |
| R-square          | 0.5497      | 0.6506     | 0.5888     | 0.8057    |

Note: Standard errors are in parenthesis, \* Significant at 5%, \*\*Significant at 10%

**Table 02(b): Estimated Seed Demand Equations**

|                     | Polonnaruwa | Hambantota | Kurunegala | Kalutara   |
|---------------------|-------------|------------|------------|------------|
| profit_pseed        | 0.14764*    | 0.586786*  | -0.104**   | -0.14824   |
|                     | (0.062569)  | (0.165696) | (0.062466) | (0.126144) |
| profit_pseed_ppaddy | -0.021*     | -0.08259*  | 0.007082   | 0.028679   |
|                     | (0.008535)  | (0.02541)  | (0.006796) | (0.020029) |
| profit_pseed_pmd    | 0.00613     | 0.065144*  | 0.013692*  | -0.03063   |
|                     | (0.003874)  | (0.014556) | (0.00385)  | (0.025108) |
| profit_pseed_pferti | -0.002      | -0.02215*  | -0.00701   | 0.003898   |
|                     | (0.002258)  | (0.009706) | (0.005835) | (0.01309)  |
| profit_pseed_otherc | -0.01454*   | -0.07803*  | 0.025432*  | -0.00434   |
|                     | (0.006174)  | (0.016691) | (0.007695) | (0.010121) |
| _cons               | 44.69448*   | 71.42616*  | 42.24229*  | 43.03394*  |
|                     | (1.85689)   | (5.697897) | (1.27726)  | (0.686484) |
| R-square            | 0.1815      | 0.6079     | 0.4641     | 0.0449     |

Note: Standard errors are in parenthesis, \* Significant at 5%, \*\*Significant at 10%

**Table 02(c): Estimated Fertilizer Demand Equations**

|                      | Polonnaruwa             | Hambantota               | Kurunagala              | Kalutara              |
|----------------------|-------------------------|--------------------------|-------------------------|-----------------------|
| profit_pferti        | -0.04142<br>(0.188361)  | 0.267279**<br>(0.161667) | -0.20355<br>(0.148381)  | 0.51749*<br>(0.16018) |
| profit_pferti_ppaddy | 0.016046<br>(0.024995)  | -0.0328<br>(0.022593)    | 0.028295<br>(0.018876)  | -0.0936*<br>(0.0262)  |
| profit_pferti_pmd    | 0.00613<br>(0.003874)   | 0.065144*<br>(0.014556)  | 0.013692*<br>(0.00385)  | 0.00701<br>(0.00662)  |
| profit_pferti_pseed  | -0.002<br>(0.002258)    | -0.02215*<br>(0.009706)  | -0.00701<br>(0.005835)  | 0.00339<br>(0.00337)  |
| profit_pferti_otherc | -0.01987<br>(0.020354)  | -0.05511*<br>(0.014251)  | 0.019811<br>(0.023028)  | 0.01866<br>(0.0161)   |
| _cons                | 178.9487*<br>(6.540468) | 164.4247*<br>(8.424969)  | 165.3148*<br>(7.357165) | 120.062*<br>(6.98901) |
| R-square             | 0.4672                  | 0.4269                   | 0.1941                  | 0.2309                |

Note: Standard errors are in parenthesis, \* Significant at 5% \*\*Significant at 10%

### Output Supply and Factor Demand Elasticities

**Table 03(a): Elasticity Values - Hambantota District**

|              | Price of paddy | Fertilizer price | Wage rate | Seed price | Machinery cost |
|--------------|----------------|------------------|-----------|------------|----------------|
| Paddy supply | 0.95387        | -0.2272          | -0.6154   | -0.1113    | -1.2582        |
| Fertilizer   | 2.84571        | -1.0269          | -1.1693   | -0.6495    | 0.84964        |
| Labor        | 1.62304        | -0.323           | -1.0713   | -0.2287    | 1.10767        |
| Seed         | 0.88325        | -0.1889          | -0.3202   | -0.3742    | 1.23622        |

**Table 03(b): Elasticity Values - Polonnaruwa District**

|              | Price of paddy | Fertilizer price | Wage rate | Seed price | Machinery cost |
|--------------|----------------|------------------|-----------|------------|----------------|
| Paddy supply | 0.85029        | -0.2625          | -0.5065   | -0.0813    | 0.59294        |
| Fertilizer   | 2.94526        | -1.333           | -0.8265   | -0.7858    | 0.59857        |
| Labor        | 1.29289        | -0.1603          | -1.0344   | -0.0982    | 0.85272        |
| Seed         | 1.33897        | -0.2498          | -0.2614   | -0.8278    | 0.68035        |

**Table 03(c): Elasticity Values - Kurunegala District**

|              | Price of paddy | Fertilizer price | Wage rate | Seed price | Machinery cost |
|--------------|----------------|------------------|-----------|------------|----------------|
| Paddy supply | 2.26511        | -0.4659          | -1.6142   | -0.1851    | -1.3869        |
| Fertilizer   | 4.86896        | -1.5619          | -1.694    | -1.6131    | -0.8666        |
| Labor        | 3.19494        | -0.2753          | -2.7237   | -0.1959    | -0.9809        |
| Seed         | 2.16014        | -0.4428          | -0.4678   | -1.2495    | -1.0412        |

**Table 03(d): Elasticity Values - Kalutara District**

|              | Price of paddy | Fertilizer price | Wage rate | Seed price | Machinery cost |
|--------------|----------------|------------------|-----------|------------|----------------|
| Paddy supply | 2.36847        | -0.3832          | -1.787    | -0.1983    | 0.81824        |
| Fertilizer   | 5.04924        | -1.0915          | -1.985    | -1.9727    | 0.21897        |
| Labor        | 3.2146         | -0.4573          | -2.5566   | -0.2007    | 0.51575        |
| Seed         | 1.99785        | -0.4114          | -0.4137   | -1.1728    | 0.30775        |

For all four districts paddy (rice) price has a positive effects on paddy supply while variable factor prices have negative effects as expected. This study mainly focused on fertilizer and fertilizer demand functions are significant for Hambantota and Kalutara districts. The estimated elasticity of paddy supply with respect to the output price is quite high and it ranges from 0.95 (Hambantota) to 2.36 (Kalutara) as shown in the Tables 03a, 03b, 03c and 03d. The elasticity values for Polonnaruwa and Hambantota districts are more or less same while other two districts show relatively higher value. The former districts primarily cultivate paddy and majority of people depend on it and therefore, price elasticity is relatively low. Farmers in Kurunegala district depend on both rain-fed and irrigated conditions and hence rain-fed areas can be shifted to cultivate other crops whenever expected price for paddy is low. Majority of farmers in Kalutara district engage in paddy cultivation as part time farmers. Therefore, farmers in both Kurunegala and Kalutara districts show relatively higher price elasticity.

The elasticity of paddy supply with respect to the fertilizer price is -0.22, -0.26, -0.46 and -0.38 for Hambantota, Polonnaruwa, Kurunegala and Kalutara respectively. All figures show the expected sign that the paddy supply will decrease with increase of fertilizer price. The values of elasticities for all districts are less than 0.5. Hence the paddy supply with respect to the fertilizer price is inelastic. The results indicate that the fertilizer subsidy has only a small effect on paddy supply and expected paddy price has greater effects on supply.

The elasticity of fertilizer demand with respect to the paddy price ranges from 2.8 (Hambantota) and 5.0 (Kalutara). It indicates that farmers use more inputs when expected price of paddy (rice) is high. Therefore, the higher output price would help to increase national production. The price elasticities of fertilizer are -1.02, -1.33, -1.5, and -1.09 for Hambantota, Polonnaruwa, Kurunegala and Kalutara respectively. Farmer's response to fertilizer price is more or less similar in all districts. Moreover, the low fertilizer price is a better incentive for use of more chemical fertilizer for paddy.

The results imply that the fertilizer demand for paddy cultivation is more responsive to paddy price than fertilizer price. Estimating fertilizer demand functions by using simple regression model, Ekanayake (2006) has found that the correlation between fertilizer demand and paddy price is higher than correlation between fertilizer usage and fertilizer price. Therefore, any increase of fertilizer price would not reduce the fertilizer application if farmers can get higher price for paddy price. Moreover, the results indicate that the paddy supply in non-commercial farming area (Kalutara) is more responsive to the fertilizer price than the commercial farming area (Hambantota). Majority of farmers in major paddy growing areas depend on paddy cultivation for their livelihood. Therefore, their decision may not drastically change with expected price of paddy (rice) or input prices such as fertilizer. But farmers in non-commercial districts have a choice since they are engaged in agriculture as a part time job. Also the returns for increased use of fertilizer are low since the average yield is low when compared to commercial areas. With the higher input price, the profit margin would decrease drastically compared to high potential areas. Therefore, supply of paddy from non-commercial areas is more responsive to fertilizer price than commercial areas.

### **Conclusions and Recommendations**

In this paper, normalized restricted profit function and factor demand functions for variable inputs for paddy were jointly estimated. Empirical application of simultaneous equation model, particularly profit function approach, provides better estimation for input demand and output supply parameters.

According to the results, fertilizer price as well as paddy price has significant effect on paddy supply in the country. But the effect of paddy price is higher than fertilizer price on paddy supply. Therefore, it can be concluded that the output price policy is a more powerful tool than the input price policy to enhance the paddy supply.

The other controversial issue is that how the higher price of fertilizer would affect fertilizer usage. Although fertilizer demands depend on both fertilizer and paddy (rice) prices, paddy (rice) price has a higher effect than fertilizer price. Gunawardana and Oczkowski (1992) estimating the agricultural supply response for Sri Lanka, have concluded that pricing policy is an incentive for increasing paddy production. According to Bogahawatta (1982), guaranteed price scheme in Sri Lanka has an effect on increase of paddy production. These results are also in line with the findings of empirical studies in other countries. Estimating fertilizer demand for Maxican wheat varieties, Sidhu and Baanante (1979) have concluded that output price policy as a powerful policy measure to influence fertilizer use. Therefore, it can be concluded that fertilizer usage for paddy cultivation influence on more output price than input price. Moreover, elasticity of fertilizer demand with respect to the paddy price is comparatively higher in non-commercial areas compare to commercial areas. Therefore, the output price policy would be more helpful for an increase of cultivated area in the country.

The magnitudes of elasticity values are higher in non-commercial areas than the commercial areas which imply that farmers in commercial areas are less responsive to policy changes in comparison to farmers in non-commercial areas. The paddy supply in non-commercial farming area (Kalutara) is more responsive to the fertilizer price than the commercial farming area (Hambantota). The behavior of fertilizer demand with respect to the fertilizer price is more or less similar for all districts. Therefore, it can be concluded that the fertilizer price influences less on farmers in commercial areas than non-commercial areas.

It can be concluded that the fertilizer demand as well as paddy production in the country depend more on paddy price than fertilizer prices. The fertilizer price has less effect on commercial areas than non-commercial paddy growing areas. Therefore, the consistent output price policies are more important than the fertilizer price policy to enhance the national paddy production. These findings suggest that the fertilizer subsidy can be gradually withdrawn for paddy production with the introduction of strong output price policy. Further, development of appropriate infrastructure facilities and institutional support such as store facilities, paddy marketing etc. are useful measures to support output price.

Further this study can be improved including organic fertilizer as a variable input in order to investigate the substitutability. The data limitation restricted the multiple output and input analysis.

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