

Resource-use Pattern in Paddy Cultivation in Sri Lanka: a Production Function Approach

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Introduction

Rice has been the staple food of Sri Lankans for centuries. Paddy cultivation is part and parcel of the Sri Lankan culture, and the role of the rice sub-sector in achieving food security, both at the national and household level, has been duly recognised by successive Governments. Paddy production, rice processing, marketing and distribution and rice imports have been regulated in varying degrees over time by successive Governments to enhance domestic rice production by ensuring a fair price for producers and/or to protect consumers from adverse effects of increasing prices of rice.

Most paddy farmers in Sri Lanka cultivate small parcels of land. A large majority of small-holder paddy farmers are concentrated in irrigation settlements in the dry zone and pockets of the wet zone. Large paddy fields are predominant in the Eastern Province of the country where paddy cultivation is done on a commercial scale. According to previous studies, Sri Lanka has comparative advantage in growing paddy in irrigated areas (Tibbatuwawa and Weerahewa, 2004, Rafeek and Samarathunga, 2000). Small-holders cultivate paddy using family labour mainly for consumption purposes and the surplus is marketed.

The resource use pattern in paddy production has been subjected to investigation by a number of authors. Abeysekara (1972) revealed that paddy production in 1971 *Maha* was highly responsive to land, labour and fertiliser, whereas paddy production was negatively affected by other agro-chemical application. Furthermore, coefficient estimates revealed that paddy production technology was characterised by increasing returns to scale. Karunarathna and Herath (1989) found that there are significant differences between yields in *Maha* and *Yala*. *Yala* cultivation is significantly affected by land, fertiliser application, agrochemical and family labour while the extent of land and fertiliser use affect paddy production in *Yala*. In both seasons hired labour does not have a significant effect on production. Udayanganie *et al* (2006) revealed that the extent of cultivation, fertiliser usage and pesticide usage significantly influenced paddy production during the 2003/4 *Maha* season.

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According to Kemah and Thiruchelvam (2008) there are significant differences in resource use for paddy in Anuradhapura across major, medium and minor irrigation regimes. Under major irrigation schemes seed, fertiliser, labour and power have significant effects on paddy productivity with elasticity values of 0.129, 0.2198, -0.313 and 0.864 respectively. Under medium irrigation conditions labour was found not to be significant. While, minor irrigation cultivation responded only to fertiliser and power. Bandara *et al.* (2012) revealed that Trincomalee paddy production under minor irrigation was more responsive to land, labour, hired labour, fertiliser, chemical, machinery and off-farm income. Bhavan and Maheswaranathan (2012) revealed that in Batticaloa paddy production is significantly affected by land, fertiliser application and pesticide application with 0.0001, 0.492 and 0.359 elasticity values.

It is review that data used for the analysis were from smaller geographical areas during the given years or a season and hence the results cannot be generalised for the country. The policy agenda towards agriculture of the country is gradually changing and a direct impact on input market is observed. For example fertiliser subsidy has converted to cash transfer system and imports of pesticide (Eg: Glyphosate) has been banned. Further, huge labour migration out of agriculture is also evident since other industrial development is given priority in development activity in Sri Lanka. Against this backdrop, the investigation of resource supply and usage in agriculture, especially in paddy production, at national level is a timely and valuable area of research. The objective of this study is to examine the resource-use pattern in paddy production in Sri Lanka for 2005-2015. It uses data from major paddy growing areas of the country covering both *Yala* and *Maha* seasons, as well as areas both rain fed and irrigated.

Methodology

A multiplicative function was specified in the following form to depict the technical relationship between input and output.

$$Y = \alpha MC^{\beta_1} SD^{\beta_2} LB^{\beta_3} UR^{\beta_4} TSP^{\beta_5} MOP^{\beta_6} EXP^T \beta_7 EXP^S \beta_8 EXP^I \beta_9$$

Where,

Y: Average yield (kg/acre)

T: Trend (2005=1, ..., 2015=11)

S: Season (0=*Maha*, 1=*Yala*)

I: Irrigation schema (0=Rain Fed, 1=Irrigated)

MC: Real Machinery Cost (Rs./acre)

SD: Seed Rate (Kg/acre)

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LB: Labour (Man days/acre)

UR: Urea (Kg/acre)

TSP: Triple Super Phosphate (Kg/acre)

MOP: Murat of Potash (Kg/acre)

The above data for the period from 2005 to 2015 was gathered from the Cost of Cultivation (COC) reports from the Department of Agriculture. The reports are issued twice a year for *Maha* and *Yala* separately. Both cost and quantity of various resources used in paddy cultivation are included. Three-stage sampling procedure is adapted in selecting farmers, where, at the first stage representative districts are selected based on distribution of cultivated extent under different irrigation regimes (irrigated and rain fed), secondly Agrarian Service Centers (ASC) which cover at least 51% of total cultivated extent within districts are selected. Finally specified numbers of farmers (50 farmers up to year 2008 and from 2009, 30 farmers) are randomly selected from identified Agrarian Service Centers (ASC) for the gathering of data and then district average values of inputs and outputs of paddy production are included in the COC reports. The reports contain both dry zone and wet zone paddy-producing districts, covering specific agr-ecological zones (AEZ) in Sri Lanka. The different districts included in the reports are namely Ampara (East and West), Anuradhapura, Hambantota, Kurunagala (Irrigated and RF), Mannar, Polonnaruwa, Mahaweli (B, C, H), Trincomalee, Gampaha, Kalurata, and Kandy. The unit of observation is the District and number of observation units was 243. The function was estimated using a robust estimation to correct for heteroskedasticity treating the dataset as an unbalanced panel.

Results and discussion

Descriptive statistics

According to descriptive statistics, average productivity of paddy cultivation was found as 1897.14 kg per acre (CV=0.23). Machinery usage for the cultivation is given as expenditure on machinery and average machinery cost was Rs 5097.61 per acre with a coefficient of variation of 0.23, indicating huge variation in the investments on machinery in paddy production in Sri Lanka. Seed is the most basic input in production and seed paddy rate has been found to vary among observations with an average seed rate of 49.8kg per acre (CV=0.26). Labour in paddy cultivation is recognised as a combination of family and hired labour. On average a paddy producer employs 25 man days (CV=0.30) during a given season.

Fertiliser application is essential for the supply of nutrients and the proper growth of paddy in order to ensure maximum potential productivity. Urea, TSP and MOP are identified as major fertiliser groups applied in paddy cultivation as supplements of

N, P and K nutrients respectively. Among others, the quantity of urea application is primary with average application level of 92.5 kg per acre (CV=0.25). On the other hand, TSP application is on average 31.86kg per acre (CV=0.23) while MOP application is 32.76kg per acre (CV=0.22) by an average farmer cultivating paddy in Sri Lanka.

Estimates of production function analysis

The results of the estimation of the production function indicate that the model specified explains 77.56 percent of the variability as per the R-square value. The season of cultivation, method of irrigation, seed rate applied and urea application have a statistically significant and positive effect on paddy productivity. The coefficients of the multiplicative function are the input-use elasticities. Among all inputs employed in paddy production, urea application is elastic with value of 0.228. Next to this, the seed rate is shown as the second most elastic factor in paddy production. TSP application and labour are inelastic. The elasticity values for all the inputs are presented in Table 1. They imply that returns to scale or the sum of factor elasticities in paddy production was 0.423, suggesting that when all inputs are increased by one per cent, the resulting paddy production would change by less than one percent.

Table 01: Estimates of Production Function

Variable name	Mean	SD	Coefficient	Robust S.E	t value
Machinery Cost	5097.6	1166.49	0.032	0.083	0.38
Seed	49.81	12.93	0.215**	0.050	4.26
Labour	25.0	7.5	-0.006	0.074	-0.09
Urea	92.48	23.11	0.229**	0.053	4.34
MOP	32.72	7.2	0.030	0.050	0.60
TSP	31.86	7.2	-0.075	0.054	-1.39
Trend			0.007	0.004	1.65
Season			0.027*	0.016	1.66
Irrigation			0.335**	0.037	9.03
Constant			5.261*	1.045	5.03

*: Significant at 10%, **: Significant at 5%

Conclusions

Over time, resource use has differed, and it is recognised that only machinery cost is increasing, while labour shows a decreasing trend similar to all fertiliser categories

(urea, TSP and MOP). Seed rate fluctuation is minimum and follows constant levels in paddy production.

The results of the estimation reveal that resource use pattern in paddy cultivation is characterised by decreasing returns to scale, and seed rate and urea application have positive and significant effects on paddy productivity: suggesting that further application of urea and seeds would result in higher yields. When controlled for other inputs, paddy productivity is higher in *Yala* than that *Maha*, and irrigated areas are more productive than rain-fed: areas suggesting that expansion of cultivation in irrigated areas in *Yala* would result in better yields.

Key words: Paddy production, Production function, Elasticity, Sri Lanka

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