Supply Response Analysis of Low Country Vegetable Production in Sri Lanka

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ABSTRACT

As a solution to the problem of low productivity in vegetable cultivation hybrid technology was introduced. In this study an attempt was made to identify the major factors that determine the supply of vegetables and their supply elasticities, to compare the cost of cultivation of local varieties and hybrids and to analyze the pattern of input usage. In order to identify the factors those determine the supply of selected vegetables, a Nerlove type supply response model was applied to aggregate data. The partial budgeting technique was applied to compare cost and benefits of hybrids and local varieties. Fisher's Ideal index was used to construct the input indices.

Results showed that farmers responded positively to the past prices of vegetables and technological improvement. The comparison of local and hybrid varieties showed that positive economic incentives have provided by hybrids.

KEYWORDS: Hybrid, Supply Response Analysis, Trend Analysis, Partial Budgeting, Problems.

INTRODUCTION

Vegetables being an essential component in the daily meal of the people in Sri Lanka and it occupies a significant place in the domestic food production and consumption. On an average about 7.5 percent of the monthly household food expenditure is on vegetables (DCS, 2002). The Medical Research Institute of Sri Lanka recommends consumption of at least 200 g of vegetables per day per person. However, an average Sri Lankan consumes about 92g of vegetables per day. It is evident that a considerable gap, 108g/per capita/ day, has to be fulfilled.

In Sri Lanka vegetables are generally classified into two major groups; Up - country vegetables (Beans, Tomato, Carrot, Leeks, Capsicum, Cabbage, Beetroot, Radish, Knol - khol and Cauliflower) and Low - country vegetables (Brinjal, Okra, Bitter gourd, Snake gourd, Luffa, Red pumpkin, Cucumber, Ash plantain, Leafy vegetables, Mushroom and Mea). It is estimated that the annual production of vegetables in Sri Lanka amounts roughly to about 525,157 mt. On an average, about 69,546 ha of land are annually devoted to vegetable cultivation in this country (HARTI, 2004).

Vegetable production in Sri Lanka follows a seasonal production pattern because of the bi-modal rainfall pattern that prevails in the country. Production is high during the months of February to March and September to October and supply is low during June to July and November to December mainly due to seasonality of production. This seasonality in production is the major cause for the price fluctuations in vegetables. The problem of unstable prices is important because it causes income losses to farmers when prices are low and high expenditure to consumers when it is high. A possible solution for the problem of production and price fluctuation is to break this seasonality. This involves investment in new research and extension efforts on off season vegetable cultivation (Samarathunga *et al.*, 1996).

The production trend of Up-country vegetables during the past decade shows an upward trend while production of Low-country vegetables shows a downward trend. There is a need for continuous production of high quality vegetables throughout the year for local and export markets. The seeds of some of the locally produced vegetables are of poor standard and not preferred by the farmers, the use of these substandard materials leads to lower yields (Gunasena, 2004). In order to increase the food production expanding land area under agriculture no longer possible. Since additional land available for vegetable cultivation is limited, more emphasis has to be given on increase of productivity. As seed is the basic input to agriculture, its role as a catalyst in ensuring optimum utilization of other agri-production and protection inputs and cost of effectiveness is crucially recognized. The role of hybrids and seed of improved varieties in enhancing productivity is now widely acknowledged. Hybrid technology fits well for the second green revolution in food grain production which is necessary to meet the challenges of rapidly growing population in Asia and the Pacific (Chopra, 1998).

Although it has been claimed many advantages of hybrids, Sri Lankan farmers have encountered many problems under local conditions. Hybrid seeds are expensive. They need intensive management practices and consume relatively high levels of fertilizer and chemicals. All hybrids available in Sri Lanka are exotic types. They are not well adapted to the local climatic and soil conditions. Thus, incidence of pest and diseases is relatively high. Further, hybrids do not always perform better than that of open pollinated varieties.

With the liberalization of seed imports, the cultivation of hybrid vegetables has been increasing in

Sri Lanka. However, no detail studies have been carried out to assess the economic benefit of cultivation of hybrids *vis á vis* local varieties. Thus, this study aims to evaluate the benefit of hybrid vegetable production in Sri Lanka. An attempt is made to evaluate the capacity of hybrid technology to break existing seasonality of vegetable production and to improve productivity. The other objectives of this study are to estimate the supply response of vegetables to selected economic variables, to analyze the pattern of input usage and to compare the cost of cultivation of local varieties and hybrids.

METHODS

1. Supply Response Analysis of Low Country Vegetables

In order to identify the factors those determine the supply of selected vegetables, a Nerlove type supply response model was applied to aggregate data. The supply response of individual crop was also estimated using the relationship between output and inputs. The following supply response model was applied using and annual time series data from 1992 to 2002.

$$A_t=\alpha+\beta_1 I_t+\beta_2 W_t+\beta_3 P_{t-1}+\beta_4 T+\varepsilon \ldots\ldots (1)$$

$$A_t=\alpha+\beta_1 P_{t-1}+\beta_2 T+\varepsilon \ldots\ldots (2)$$

Where:

A_t = Area planted to vegetables in season t (Ac)
I_t = Price index of inputs in season t (seed and fertilizer)
W_t = Average wage rate in season t (Rs per man day)
P_{t-1} = Price index in season t-1 for aggregate function/Price of vegetables in season t-1(Rs/kg)
T = Time trend
ε = Error term
α = Intercept
β_i = Unknown elasticity coefficients to be estimated

Quantity supplied was considered as the dependent variable and price of inputs, labour wage rate, price of vegetable and changes in technology were considered as influential variables on quantity supplied.

Total vegetable production is determined by the extent and yield. Yield is not under strong control of producers as it is very dependent on various factors such as weather, incidence of pest and disease etc. Producers usually have more control over the extents they cultivate than on the production level. In addition, measurement of extents is easier and subject to less error than the measurement of output (Samarathunga *et al.*, 1996). Therefore in this analysis area cultivated was used as a proxy for quantity supplied.

The Fisher' s Ideal quantity and price indices were used to aggregate quantity supplied and input price of seed and fertilizer respectively. Since continuous time series data on input prices and usage is only available for Pole bean production, input index was constructed using input prices and quantities used in Pole bean cultivation during the period of 1992 to 2003 considering 2003 as the base year.

The average wage rate data of Pole bean cultivation were used assuming it represents the average wage rate of low country vegetables.

Production and all island producers' prices were used to construct the price index considering 2002 as the base year. Although the production data were available for 18 years, i.e., from 1985 to 2002, the price data were available only for 12 years, *i.e.*, from 1991 to 2002. Therefore the analysis had to be limited for the period 1992 to 2002.

Assuming that the producers base their production decisions on expected price and considering the most recent producers' price is important determinant of expected price, lagged price of previous year was used (Gunawardena *et al.*, 1980).

Changes in technology are an important factor in explaining changes in total production or output. In view of the unavailability of a direct measure of changes in technology, time trend is often used as a proxy assuming a smooth change in technology of equal amounts each time period (Gunawardena *et al.*, 1980).

2. Trend Analysis of Inputs

Seed, fertilizer and labour were considered as main inputs in vegetable production. Fisher's Ideal index [1] was used to construct the input indices considering 2003 as the base year and an aggregate measure of input prices of seed and fertilizer was constructed using input prices and quantities used in Pole bean cultivation during the period of 1984 to 2003. It was assumed that the change in this index represents the change in input prices of the vegetable sector.

Average wage rate data of Pole bean cultivation during the period of 1984 to 2003 were used to analyze the trend in labour.

All the price values (price of seed, fertilizer and wage rate) were deflated by Colombo Consumers' Price Index (CCPI) number to remove the inflation effect considering 1952 as the base year and changes of input indices with nominal and real prices were graphically analyzed.

3. Cost of Production: Conventional and Hybrid Vegetables

Matale district, one of the main vegetable growing districts of Sri Lanka was selected and a field survey was conducted in Yatawaththa, Naula, Sadagama, Dambulla, Kalogahaala areas in Matale district during the period of May to August 2005.

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[1]

$$F=\frac{\sqrt{(\sum p_n q_o)}\sqrt{(\sum p_n q_n)}}{\sqrt{(\sum p_o q_o)}\sqrt{(\sum p_o q_n)}}$$

p_n = Commodity price during given period
p_o = Commodity price during base period
q_n = Corresponding quantity produced during given period
q_o = Corresponding quantity produced during base period

Primary data were collected using a pre-tested open ended questionnaire from 30 vegetable farmers. Both conventional and hybrid seed users were selected. Data on production, quantities and prices were collected from Department of Agriculture (DOA), Department of Census and Statistics (DCS) and Central Bank of Sri Lanka (CBSL). In a study of this nature, it is not possible to deal with all the vegetable varieties grown in Sri Lanka. Therefore, only three main vegetable types were selected for the analysis. Bitter gourd, Luffa and Cucumber were selected as they are the major vegetables grown in the selected area. Partial budgeting technique was used to compare the cost of cultivation between hybrid and local varieties. The preliminary investigation showed that among various cultural practices of hybrid cultivation, the costs of seeds, seeding/nursery preparation, fertilizer, pesticides and disease control and harvesting and drawing were significantly different from that of local varieties. These cost components were compared with respect to conventional and hybrid for each vegetable and the percentages of cost differences were calculated. Further, the percentages of yield and gross income differences were estimated for local and hybrids.

$$\% \text{ change} = \frac{(\text{Hybrid} - \text{Conventional})}{\text{Conventional}} * 100$$

RESULTS AND DISCUSSION

1. Supply Response Analysis of Low Country Vegetables

The double log form of model described above was used to identify the factors affecting vegetable supply. The stability of the models was judged based on coefficient of determination (R^2), sign of the parameter estimates consistent to the theoretical expectations and by the significance of variables. The model with aggregated variables did not yield meaningful result and this may be due to limited coverage of vegetables in this study. Hence, the model was applied to the individual crop.

According to the Table 1 the impact of price index on supply level was significant in aggregate Vegetables. The supply response of Bitter gourd has significantly affected by own price and technological improvement. The supply levels of Snake gourd and Ladies-fingers were significantly determined by own price and average wage rate. The price of seed, fertilizer and average wage rate showed significant positive relationships in Cucumber and this is in contrary to the expectation and thus, need further investigation.

The own price elasticity of selected vegetables was found to be 0.00406 and it explains that for increase in vegetable price, 1% the supply was increased by 0.00406%.The degree of change in the supply in response to the own price change did not have a remarkable impact.

The own price responsiveness was 0.00374 in Bitter gourd which means, by 1% increase in own price, the supply was increased by 0.00374% which was not a remarkable amount and time responsiveness was 0.00407.

The own price responsiveness were 0.00341 and 0.00458 in Snake gourd and Ladies-fingers respectively which mean, by 1% increase in own price, the supply was increased by 0.00341% in Snake gourd and 0.00458% in Ladies-fingers, which were not remarkable amounts. Average wage rate responsiveness indicated 0.0024 and 0.00251 implying that for a 1% increase in the wage rate, the supply of vegetable were increased by 0.0024% and 0.00251% respectively.

The input price elasticity of Cucumber was found to be 0.00035 and it explains that for increase in input price 1% the supply was increased by 0.00035% and wage rate responsiveness was 0.0021, which were not notable amounts.

Economic theory suggests that when the price of inputs (seed, fertilizer and wage rate) is increasing the supply of vegetables reduces. However model (1) showed significant positive relationships. Therefore model (2) was selected as the best model for the supply of vegetables.

According to the Table 2 the impact on price index on supply level was significant in aggregate vegetables. The supply response of Bitter gourd, Snake gourd, Ladies-fingers and Cucumber have significantly affected by own price. The technological improvement showed significant positive relationship in Bitter gourd and Snake gourd.

The own price elasticities were 0.0068, 0.00577, 0.00684, 0.00955 and 0.0079 in aggregate vegetables, Bitter gourd, Snake gourd, Ladies-fingers and Cucumber respectively. The time responsiveness were 0.0057 and 0.00575 in Bitter gourd and Snake gourd respectively, which were not remarkable amounts.

Table 1.Factors Influencing Supply Levels of vegetables

Vegetable	Intercept	Input index	Price index for aggregate function or lag veg. Price	Avg. wage rate	Time trend	Adj. R^2
Aggregate	7.54153*	ns	0.00406**	ns	ns	0.96
Bitter gourd	7.54327*	ns	0.00374*	ns	0.00407**	0.98
Snake gourd	7.54713*	ns	0.00341**	0.0024**	ns	0.97
Ladies-fingers	7.52708*	ns	0.00458**	0.00251**	ns	0.96
Cucumber	7.57185*	0.00035086**	ns	0.0021**	ns	0.97

** Significant at 5% ** Significant at 10% ns = Not significant*

Table 2.Factors Influencing Supply Levels of vegetables

Vegetable	Intercept	Price index for aggregate function or lag veg. Price	Time trend	Adj. R^2
Aggregate	7.55*	0.0068*	ns	0.93
Bitter gourd	7.53*	0.00577*	0.0057**	0.95
Snake gourd	7.53*	0.00684*	0.00575**	0.94
Ladies-fingers	7.57*	0.00955*	ns	0.89
Cucumber	7.63*	0.0079*	ns	0.92

** Significant at 5% ** Significant at 10% ns = Not significant*

2. Trend Analysis of Inputs

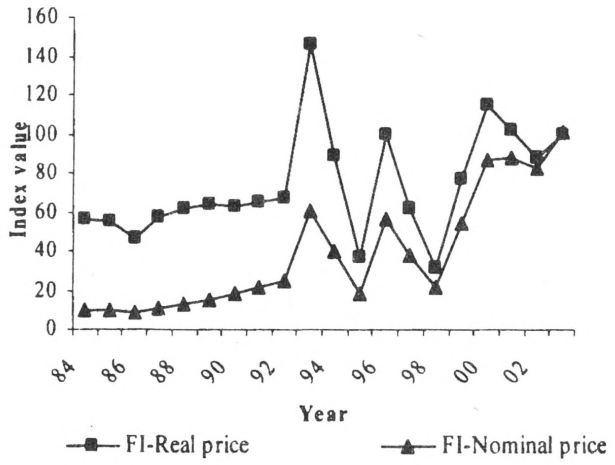

Figure 1.Fisher's Ideal indices of inputs (seed and fertilizer) in Maha season

Figure 2.Fisher's Ideal indices of average wage rate in Maha season

The coverage of the index was limited by the availability of data. Figure 1 and 2 showed the changes in input prices during the period of 1984 to 2002. Seed, fertilizer and wage rates showed an increasing trend. Seed and fertilizer prices showed a decline in 1996 and 1999 but a sharp increase could be observed after 2002.

3. Cost Comparison of Conventional and Hybrid Vegetable Cultivation

Since the survey was one shot survey the information collected were subjected to memory lapses, because the data gathered were in respect of cultivation activities of the previous season. Therefore, farmers tend to overestimate costs and underestimate yields and incomes.

According to the Table 3 seed cost of vegetables: Bitter gourd, Luffa and Cucumber have changed by 69, 114, and 783 per cent respectively while other cost components have changed differently in selected crops. Therefore, the cost of seed has substantially increased with the shift from conventional to hybrid. The cost of fertilizer has increased in cucumber showing that it is not related with the changes in yield.

Figure 3, 4 and 5 compare the different cost components of hybrids and local vegetable production. Seeding (SD) and fertilizer application (FA) costs are generally higher with hybrid types. The cost of pest and diseases control (PD) in Bitter gourd has decreased with hybrid cultivation while higher pest and disease control cost is associated with the hybrid cultivation of Luffa and cucumber.

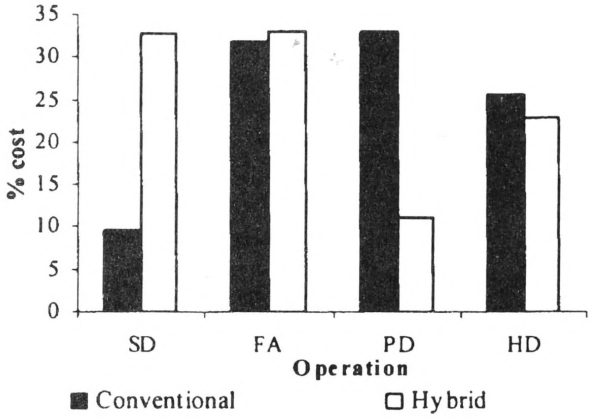

Figure 3 .Cost of Production (Rs/Kg): Bitter gourd

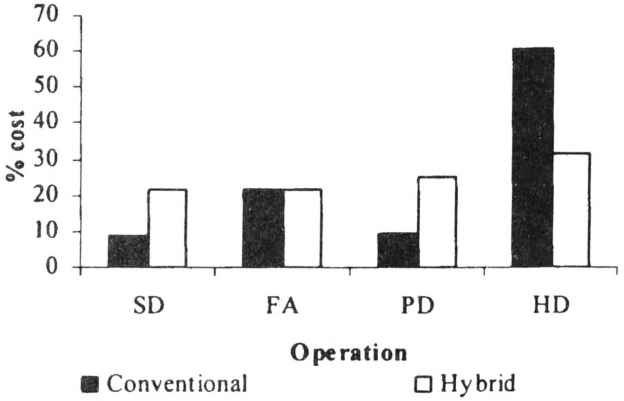

Figure 4. Cost of Production (Rs/Kg): Luffa

Table 3. Cost of Production: Bitter gourd, Luffa, Cucumber (Rs/Kg)

Type of operation	Type of vegetable								
	Bitter gourd			Luffa			Cucumber		
	Con.	H.	%ch.	Con.	H.	%ch.	Con.	H.	%ch.
Seeding	0.632	1.07	69.3	0.42	0.9	114.28	0.06	0.53	783.33
Fertilizer application	2.1	1.08	-48.57	1.08	0.9	-16.66	0.76	1.09	43.42
Pest & disease control	2.18	0.36	-83.48	0.45	1.03	128.88	0.685	1.15	67.88
Harvesting & drawing	1.7	0.75	-55.88	3	1.31	-56.33	2.88	2.63	-8.68

Note: Con. = Conventional, H. = Hybrid, % ch. = % change

Table 4. Comparison of yield and gross income.

	Yield(kg/Ac)			Gross income(Rs/Kg)		
	Conventional	Hybrid	% change	Conventional	Hybrid	% change
Bitter gourd	10000	16000	60	29.207444	40	36.95139
Luffa	16000	32000	100	20	26.80234	34.0117
Cucumber	40000	24000	-40	6	13.74537	129.0895

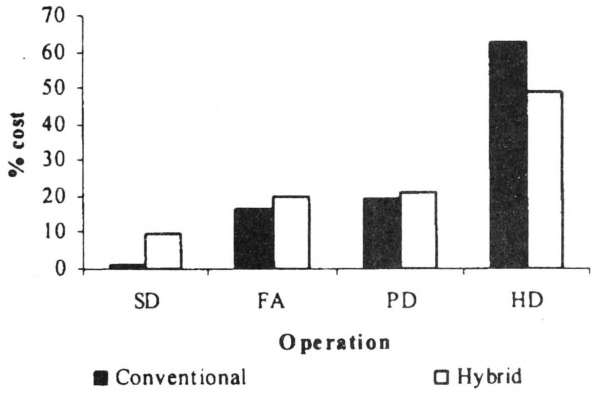

Figure 5. Cost of Production (Rs/Kg): Cucumber

This indicates that hybrids of Luffa and cucumber are more vulnerable to local pest and diseases than those of local varieties. The lower pest and disease control cost for hybrids of Bitter gourd indicates that hybrids of Bitter gourd resist more to local pest and diseases than that of local varieties. Bitter gourd and Luffa give higher yield than local types (Table 4). In case of Cucumber, local varieties seem to perform better than hybrids (Table 4). The higher yield has contributed to reduce the unit cost of harvesting and drawing (HD). Hybrid vegetables give higher yields and as a result, unit cost of production has decreased.

Farmers in Matale district have being cultivating vegetables for ages using conventional seeds. The new seed policy, which was formulated in 1997, has enhanced the private sector participation in vegetable seed production, import and distribution. Aggressive promotion schemes of private sector through free distribution of seeds, chemicals, and fertilizer and extension services caused farmers shifting from conventional seeds to hybrid seeds.

After using hybrid seeds for several seasons farmers have encountered many problems.

Results showed most of farmers reported about high prices of seeds and high pest and disease problems (Table 5). But 55% of farmers and 45% of farmers reported about high market price and preference and high yield respectively (Table 6).

Table 5. Problems Associated with Hybrid Seeds

Problems	Farmers reporting % as 'yes'
High prices of seeds	50
High pest and disease problems	40
High usage of fertilizer and chemicals	20
Lack of seed availability	10
Lack of agriculture extension service	15
Low yield	10
Low taste	20

Table 6. Advantages of Hybrid Seeds

Advantages	Farmers reporting % as 'yes'
High market price and preference	55
High yield	45
Low pest and disease problems	15
Low usage of fertilizer and chemicals	5

CONCLUSIONS

The supply response analysis showed that farmers responded positively to the past prices of vegetables and technological improvement.

The comparison of local and hybrid varieties showed that positive economic incentives have provided by hybrids. Despite the high cost of seeds and high pest and disease incidents farmers prefer to cultivate hybrid seeds because of high market price, preference and higher yield. In order to decrease pest and disease incidents there is a need of formal extension service to provide new technology and knowledge. Further, the shift indicates the changes in the socio economic environment of vegetable production and consumption. These changes have to be understood and also have to incorporate in the future local crop development programs.

The study further revealed that the indiscriminate imports of hybrids have resulted in the loss of local varieties. Therefore, extra care has to be taken to preserve local varieties and farmers should encourage producing local seeds which have already been identified by new seed policy. The new seed policy expects to reduce seed imports by enforcing a cess between 1-5% and crediting them to the "Development fund for seed security" which will be diverted to fund research.

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