GROWTH PERFORMANCE OF RICE SECTOR: THE PRESENT SCENARIO IN SRI LANKA

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ABSTRACT

The Sri Lanka government is promoting the development of agriculture sector with the slogan of "Let us grow more to uplift the nation". Therefore, this study was carried out to analyse the growth performance of rice sector, and to identify the appropriate model to predict the future trend of the sector in Sri Lanka. The study was mainly done based upon the secondary data. The growth performance was analyzed by considering mainly four variables such as sown extent, harvested extent, total production and productivity. Then, behaviour of different variables was tested by using scatted plot diagram with time. Based on the behaviour of the variable, different time series (TS) models were tested. Sown extent and harvested extent have not shown a strong relationship with time. Over the years average sown extent and harvested extent were 858.28 and 813.37 ha thousand, respectively. But total production (thousand Mt) and productivity (kg per ha) have increased significantly with time. Therefore, the responsible factor to increase the total rice production was increasing the productivity. Cubic model was the most suitable to predict the total production and productivity which were $Y = 1557.82 + 173.52t - 11.17t^2 + 0.24t^3$ ($r^2 = 89.51$) and $Y = 2227.67 + 210.13 t - 11.19t^2 + 0.22t^3$ ($r^2 = 95.20$) respectively. In this context, it is possible to meet future demand for rice through increasing the land productivity by adopting the best field practices.

INTRODUCTION

Agriculture has been the backbone of Sri Lankan economy with one-third of the rural population dependent on agriculture. It contributes about 12.1 % of the country's GDP and 32.7 % of the total employment (Central Bank 2008). Therefore, the Government is promoting the development of agriculture sector with the slogan of "Let us grow more food to uplift the nation". Rice is the principle contributor of the rural economy as the majority (72%) of rural households is engaged in production of rice as their main and supplementary source of livelihood (Henegedara 2002). Rice is the main crop cultivated by the majority of farmers in rural areas and it is the staple food of the 18.6 million inhabitants of Sri Lanka. Further, it is the livelihood of more than 1.8 million farmers. Rice contributes 1.8 % of country's GDP (Central Bank 2008). Rice is cultivated in almost all parts of the country, except at very high altitudes, as a wetland crop (Henegedara 2002).

The annual per capita consumption of rice was around 92 kg in 1998 and it was dependent on the paddy production in the country and the price of imported wheat flour. By 2008 it increased to 96 kg and total production was 3.88 million tons of rough rice (paddy), which is about 97.8 % of the national requirement. With the present population growth rate of 1.2 %, slightly increasing per capita consumption, requirements for seed, and for wastage in handling, Sri Lanka needs more than 4 million tons of paddy by the year 2010. Hence, it is projected that the national average yield should increase to 4.4 t/ha to feed the population of Sri Lanka in 2010. However, the gross extent sown and production in year 2008 were 1.05 million hectares and 3.85 million tons. Paddy production in 2008 year was increased by 23.8 %, (Central Bank 2008). Therefore, this study was carried out to analyze the growth performance of rice sector in Sri Lanka, and to identify the appropriate model to predict the future trend on sown extent, harvested extent, total production and productivity of the rice sector.

METHODOLOGY

Published secondary data were used for this analysis. The data were collected from the Central Bank reports from 1977 to 2008. The growth performance was analyzed by considering mainly four variables such as sown extent (thousand ha), harvested extent (thousand ha), total production (thousand t) and productivity (kg per ha). Data were first tabulated. Then, behaviour of different

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variables was tested using scattered plot diagram against time factor (Ljung GM and Box GEP 1978). Based on the behaviour of the variable, different time series (TS) models *viz;* linear model, polynomial such as Quadratic and Cubic models with the time factor were tested (Madridakis *et al*. 1983). The different models have been shown by the following formulae.

Linear model $(Y = a + bX)$,
Quadratic model $(Y = a + b_1X + b_2X^2)$
Cubic model $(Y = a + b_1X + b_2X^2 + b_3X^3)$

Where as, Y = production, X = time period, a = intercept and b, b_1, b_2, b_3 = regression coefficients

The goodness of fit of models was tested by using coefficients of determination (R^2) (Majumdar 2002). Coefficient of determination was measured by applying formula (i).

$$R^2 = \Sigma(y'- \ddot{y})^2 / \Sigma(y-\ddot{y})^2 \ldots\ldots\ldots\ldots(i)$$

Whereas, Y = production, y' = predicted production and ÿ= mean production

Based on the selected best TS model, appropriate forecasting model for different variables of rice were developed.

RESULTS AND DISCUSSION

Performance of cultivated extent, harvested extent, rice production and productivity

In Sri Lanka, rice is grown under a wide range of physical environments such as different elevations, soils and hydrological regimes. There is a wide range of climatic and soil conditions in the country.
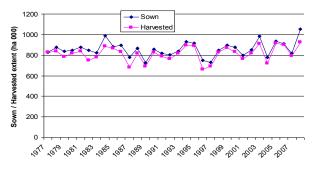
Based on the rainfall and elevation, seven major agro-ecological zones (AEZ) have been identified (LCDZ, LCIZ, LCWZ, MCIZ, MCWZ, UCIZ and UCWZ). These AEZ were further subdivided into 24 agro-ecological regions, considering the rainfall distribution, soil type and the landform. Rice is grown in all the agro-ecological regions except in WU_1, WU_2, WU_3 and IU_2. If water conditions are right, almost all kinds of soils could be used for rice cultivation. In Sri Lanka, the hydromorphic associates of almost all its great soil groups are used for rice cultivation (Panabokke 1996). Therefore, compared to many other rice growing countries, Sri Lanka grows rice under a wide range of environmental conditions. Further, rice lands in Sri Lanka are categorized either as irrigated (major and minor irrigation systems) or as rain-fed and are cultivated in two distinct cultivation seasons. The major cultivation season (*Maha*) which is from late September to early March is fed with inter-monsoon rains and with the Northeast monsoon, which is well distributed in the Island. The minor cultivation season (*Yala*), which is from early April to early September, brings rain mostly to the Southwest region of Sri Lanka. Therefore, the extent under paddy cultivation in *Yala* is lower than that of *Maha* season. Water availability is the major factor that determines the cultivation land extent in the country.

In year 2008, the gross extent sown and production were 1.05 million ha and 3.86 million tons respectively (Central Bank 2009). However, sown extent and harvested extent have not increased significantly with the time. It has shown high variation year by year. Further, average sown extent and harvested extent were recorded 8.58 and 8.13 million ha, respectively. In 1984, 1995 and 2007/08 cultivated extent reached the maximum (Central Bank 1985; 1996 and 2009). Fig. 1 illustrates that the highest number of land extent have been cultivated in 2008. It means that Sri Lanka has maximally used the suitable land for rice cultivation. If water is available at the correct time in the season, all rice farmers cultivate their land. In addition, market
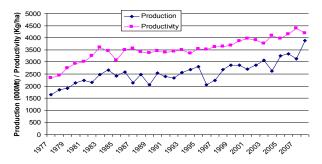

Figure 1: Sown extent and harvested extent of rice from 1977 to 2008

Figure 2: Total production and productivity of rice from 1977 to 2008

price of paddy, Government incentive and subsidies also affect the cultivation.

Fig. 2 clearly illustrates that tha total production and productivity have a strong relationship with time. Though the sown extent and harvested extent did not increase significantly from 1977 to 2008 the total production and productivity have increased significantly. Total production and productivity have increased by 235.7, and 178.9 % respectively. Therefore, the responsible factor to increase the total rice production was increase in productivity. The rice productivity is now more than 4,000 kg/ha.

On this background, future demand of rice should be met through increasing the productivity of the land. The total production and productivity can be further increased through better field practices because potential yield of different rice varieties are still higher than the actual yield (Table 1).

The coefficient of determination values (R^2) for the different forecasting model in terms of cultivated land extent and harvested land extent of rice have shown non significant results. Therefore, there was no any appropriate model to predict the future trend in terms of cultivated land extent of rice. The values of coefficient of determination of the different forecasting model have shown by the table 2. The highest R^2 value has recorded to the cubic model. For that reason, most suitable predicting model for the total production and productivity of rice was cubic model. Cubic model is the most appropriate model for forecasting the future rice production and productivity. The developed model for total production was $Y = 1557.82 + 173.52t - 11.17t^2 + 0.24t^3 (r^2 = 89.51)$ while developed model for productivity was $Y = 2227.67 + 210.13 t - 11.19t^2 + 0.22t^3 (r^2 = 95.20)$.

Table 1: Potential yield of different rice varieties at respective breeding stations

Variety	Duration (Months)	Potential yield (t/ha)
BG 300	3.0	6.5
BG 94-1	3.5	7.0
BG 352	3.5	7.0
BG 350	3.5	7.0
BG 379-2	4.0	7.5
BG 403	4.0	7.5
BG 400-1	4.0	7.5
BG 304	3.0	6.0
BW 351	3.5	7.0
BG 450	4.5	7.0
LD 355	3.5	5.0

Source: Dhanapala 2000

Potential strategies for narrowing the yield gap

A comprehensive programme from land preparation to consumption of rice is required to increase the productivity by reducing the yield gap. Attention should be made to the increase production and productivity rather than increasing the cultivate land extent.

I. Increasing paddy production
Production extent in the country cannot be increased any further, but the cropping intensity could be increased (Dhanapala, 2000) revealed that the cropping intensity can be easily increased from 119 % to about 130 %, so that the total annual cultivated extent would be 4.5 million ha. More of the neglected rain-fed rice lands in the Low Country Wet Zone as well as those with supplementary irrigation facilities (minor irrigation systems) in the Dry and Intermediate Zones have to be given due priority in the rehabilitation process to improve cropping intensity as envisaged.

II. Bridging the yield gap
Comprehensive programmes are needed to improve the productivity. A technical component, addressing issues pertaining to genotype and environment interaction are discussed below.

III. Appropriate cultivars
Emphasis is given to location specific cultivars to maximize the use of natural resources. Grain yield of rice could be increased by growing medium duration (4-4.5 month) cultivars rather than short duration cultivars. It is intended to increase the present extent under medium duration cultivars wherever possible. However, when water is limiting, increasing the cultivated extent using short duration cultivars (3-3.5 month) with intensive management is recommended.

IV. Use of quality seed rice
Use of quality seed rice to maximize yield and to maintain quality of the harvest is encouraged. However, supply of seed rice to farmers at an affordable

Table 2: Coefficient of determination values (R2) of different forecasting models for production and productivity of rice(%)

Criteria	Linear regression model	Quadratic model	Cubic model
Production	67.5	69.7	80.1
Productivity	81.0	81.7	90.7

price at the correct time is increasingly difficult. Therefore self-seed rice production is encouraged while the farmer is supplied with mini-kits of seed with new cultivars for multiplication. Private sector participation in the seed industry is also encouraged by the government.

V. Collective and timely (seasonal) cultivation
Timely cultivation with the onset of monsoon rains is essential to economize the use of inputs and to maximize the use of natural resources. Delayed planting especially in the *Maha* (October-March) season affects the growth and the age of the rice crop. Farmers are encouraged to follow a uniform cultivation calendar without any overlapping of different growth stages in a given tract. This would help to integrate crop management practices on a tract basis thus reducing time spent on maintaining individual crops. Further, it would make the job of extension and related supporting services easy as well as organizing marketing and other activities properly.

VI. Matching the season with the climatic change
Matching the season accordantly to the climatic changes is required. Many farmers have complained that the monsoons period have shifted due to changes of climate. Sandika and Withana (2009) found that majority of farmers' perception on the north-east monsoon is more altered than south-west monsoon. According to their findings the season need to be adjusted according to the climate change.

VII. Soil fertility improvement and sustenance
Improvement of the soil's physical, chemical and biological status for its sustainability is the key feature of this whole package of practices. At present, due to the increased cropping intensity and high temperature, the organic matter content in rice fields in the Dry and Intermediate Zones of Sri Lanka has been reduced to less than 1 %. The use of improper implements for ploughing has led to the formation of a shallow plough layer or hardpan resulting in poor plant growth and grain yield. The top soil is often coarse textured and therefore the addition of organic matter, especially rice straw and/or animal waste and ploughing occasionally to a depth of about 20-25 cm is considered advantageous in the majority of the rice lands. Macro and micronutrients, based on soil test values should be added at the correct time.

VIII. Stand establishment
Predominantly, stand establishment in rice in Sri Lanka is carried out by direct sowing. Transplanting of rice seedlings is negligible in Sri Lanka as it is labour intensive and labour cost is high. It is always recommended to transplant, medium duration rice varieties while direct seeding is suitable for short duration varieties. This is also important to maximize the grain yield as well as to minimize the nutrient removal from the soil. Maintaining optimum plant density as recommended for different duration of rice varieties would further increase grain yield while saving the soil nutrients.

IX. Weed management
Weed management is a major problem in rice as water is limiting in most instances. It is recommended to practice integrated weed management by proper land preparation and by using manual, mechanical and chemical weed management practices. Use of correct herbicides at the appropriate stage of crop growth and application of the correct dosage are important to improve the effectiveness of weed control by the chemical method.

X. Insects, pests and diseases management
Rice pests include pathogens, insects, rodents, and birds. A variety of factors can contribute to pest outbreaks, including the overuse of pesticides and high rates of nitrogen fertilizer application (Jahn *et al*. 2005). Weather conditions also contribute to pest outbreaks (Cohen *at el*. 1994). For example, rice gall midge and army worm outbreaks tend to follow high rainfall early in the wet season, while trips outbreaks are associated with drought (Douangboupha *et al*. 2006). Sandika and Withana (2009) found that a positive relationship of pest and diseases out brake with climatic change. Misuse of insecticides can actually lead to pest outbreaks (Cohen *et al*. 1994) by reducing the populations of natural enemies of rice pests (Jahn 1992), More emphasis is given to use safer insecticides at correct amounts to minimize pest damage. By implementing the Integrated Pest Management strategies it is intended to reduce the cost while reducing environmental pollution.

XI. Nutrient management
Management of the major nutrients such as Nitrogen, Prosperous and Potassium with micronutrients where needed is another area with high priority in this package of practices. Nitrogen management of the growing rice crop is very important as return to all the other practices depends on proper N management of rice. Location specific target yield based fertilizer guidelines are available for all the age classes of rice for ready reference.

XII. Post harvest management
Post harvest losses in rice in Sri Lanka are as high as 15 % of the grain yield. It is intended to reduce this loss by proper time of harvesting, correct pro-

cessing and storage. Value addition to rice is considered important in order to increase the income from rice farming in Sri Lanka.

XIII. Rice-based integrated farming

To maximize the profit and to sustain a conducive soil environment, integration of crops and livestock is encouraged wherever possible. Diversification of paddy lands to upland crops have marginally resolved the poor income but affected the paddy production. A study in the Philippines, demonstrated that although a shift from rice monoculture to rice-fish farming requires a 17% increase in labour investment and an initial 22% increase in investment capital, the additional fish production increases overall farm income by 67%. A project with 256 farmers in Bangladesh revealed that net benefits of the integration of fish farming were more than 20% to rice cultivation alone as farmers stocking fish used less fertilizer and pesticides. Overall net benefits in integrated systems were 64% higher in the dry season and 98% higher in the wet season (Dela Cruz, 1992). Paddy yields could be increased by recycling paddy straw and paddy husk ash in the rice-ornamental fish system. Rice-fish integration is a solution to increase paddy production, improve productivity of irrigation water and secure satisfactory income to the farmer with minimum environmental problems.

CONCLUSIONS

In the year 2008 the gross extent sown and production were 1.053 million ho and 3.875milliont. However, sown extent and harvested extent have not increased significantly with time. These parameters shown high variation year by year. Further, average sown extent and harvested extent were 8.58 and 8.13 million ha, respectively. Sri Lanka has maximally used the suitable land for rice cultivation. Total production and productivity have shown strong relationship with time. Though the sown extent and harvested extent did not increase significantly from 1977 to 2008, total production and productivity have increased significantly during these period. Total production and productivity have increased by 235.7, and 178.9 % respectively. Therefore, the responsible factor for increasing the total rice production was increment of the productivity. Therefore, future demand for rice should be met through increasing the productivity of the land. Total production and productivity can be further increased through better field practices because potential yield of different rice verities are still higher than the actual yield.

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